THE SCIENTIFIC METHOD

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Harvard Billerica Addiction Science Education (BASE) Project

ADDICTION SCIENCE CURRICULUM

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"If they don't depend on true evidence, scientists are no better than gossips."
-Penelope Fitzgerald[1]

"It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast. It keeps him young."
-Konrad Lorenz[2]

"It is a capital mistake to theorize before one has data."
-Sir Arthur Conan Doyle[3]

Introduction to the Scientific Method

Objective

This module introduces the scientific method to students. Students will review the process of scientific inquiry and have the opportunity to understand the types of thinking and activities involved in scientific investigations. The Harvard BASE Project will develop students' critical thinking skills by using the scientific method to investigate the consequences of drug use and other addictive behaviors on the mind and body. This curriculum will encourage middle school students to experience three general approaches to scientific investigation: (1) ordered or informed observations from case studies; (2) surveys; and (3) directed experimentation. This module will provide students with the information necessary to understand the essential steps of the scientific method. Consequently, the activities included in this module permit students to complete a scientific investigation using the scientific method.

Education Standards

This module satisfies the curriculum requirements of both the National Science Education Standards (1994) and Massachusetts State Science Frameworks (1995) for the systematic approach to scientific investigation known as the scientific method. These standards indicate that upon completion of middle school, students should be able to:

- Note relevant details, patterns and relationships when making observations.
- Recognize the difference between questions that can be answered through direct investigation and those that cannot.
- Use personal experience and knowledge to make predictions.
- Use multiple lines of inquiry to address and analyze a question, (e.g., experimentation, survey, interview, and secondary sources).
- Design an investigation specifying variables to be changed, controlled and measured.

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[1]Fitzgerald, P. (1990). *The Gate of Angels*, ch. 3. From The Columbia Dictionary of Quotations. In Microsoft Bookshelf [CD-ROM]. Redwood Hills: Microsoft Corporation.

[2]Lorenz, K. (1963). *On Aggression*, ch. 2. From The Columbia Dictionary of Quotations. In Microsoft Bookshelf [CD-ROM]. Redwood Hills: Microsoft Corporation.

[3]Doyle, Sir A.C. (1892). *Scandal in Bohemia*. From The Columbia Dictionary of Quotations. In Microsoft Bookshelf [CD-ROM]. Redwood Hills: Microsoft Corporation.

- Use more complex tools to make observations, and gather and represent quantitative data (e.g., microscopes, graduated cylinders, computer probes). Think critically and logically about the relationships between evidence and explanations.
- Recognize trends in data (even when patterns are not exact).
- Recognize and analyze alternative explanations and procedures.
- Represent data and findings using tables, models and graphs.
- Communicate ideas and questions generated, and suggest improvements or alternatives to the experimental techniques used.

This module instructs students about the use of scientific methods when conducting a scientific investigation. Basically, the scientific method is an organized approach to problem solving. There is no single, "one true light," scientific method; however, thorough scientific inquiry requires a systematic approach to gathering information about an area of investigation. Scientists apply various process skills (e.g., formulating a hypothesis, conducting an observation, designing an experiment, etc.) to investigate problems of interest. The phenomena under investigation determines the scientific methods that scientists choose to employ. Throughout this module, we suggest that an effective method for teaching science is the inquiry method: students apply integrated process skills to make discoveries and develop concepts.

Combining the Scientific Method with Addiction Science

The ability to think scientifically requires tools and training along with curiosity, creativity and imagination -- just like every other art or intellectual pursuit. Too often, the goals of teaching scientific or **critical thinking** skills and the scientific process get lost in the myriad topics and discoveries of science. Students may hear a brief description of **hypothesis** testing when they are introduced to working with a microscope at the beginning of the school year, or when asked to define a law or a **theory.** However, middle school students rarely go through the process of actually constructing a theory or testing hypotheses. Furthermore, students require sufficient background information about the topic under investigation before they can pose appropriate and relevant questions to be investigated. Many middle school science classes do not discuss the scientific method in depth until students reach the eighth grade; yet the curricula for sixth and seventh grades can include science as investigation and inquiry by exposing children to "hands-on" experiments. Unfortunately, when experiments are disconnected from theory, "hands-on" science often becomes irrelevant to applications outside the classroom.

Using the Scientific Method Outside the Classroom to Explore Other Phenomena is a Premise of the Addiction Science Curriculum

Aside from increasing student enthusiasm and interest for science, one of the goals of the Harvard BASE Project is to increase students' critical thinking skills and decision-making abilities beyond the classroom -- particularly when students are confronted with drug or alcohol using opportunities in their home or by their peers. Reasoning and coming to a conclusion about a specific endeavor -- especially a potentially dangerous endeavor -- with the use of **facts, laws, observations, information, data**, logic and other elements of the scientific method, allows students to make informed decisions about a possible outcome without directly having the

experience under investigation. Critical thinking skills allow students to weigh the risks and benefits associated with specific experiences.

General Student Preparation

Students entering middle school science class should be familiar with the idea that scientific investigations can take many forms. They also should understand that science can be used as a tool to investigate many different topics or areas of interest. For example, the methods of science can help determine whether smoking causes lung cancer or the composition of gases surrounding the planet Venus. Because science is an active process, there is no "one" formula to follow when engaging in the activity. For instance, there is no "one and only scientific method" posted at each scientist's lab bench or inscribed in each scientific lab manual. However, most scientists do have a systematic approach that guides inquiry and **experiment** about the world. This approach or method includes a variety of steps. These steps of the scientific method can be more or less detailed depending upon how many details are described.

By using a relatively standard map, scientists can replicate research. In addition, they can learn and share the methods of science. Throughout the activities in this curriculum we highlight "Featured Steps of the Scientific Method." While there are many different ways to depict the scientific method, this curriculum adopts the "steps" described below as a map to help guide the activities of young investigators. The steps of the scientific method will serve as the focus for each of the accompanying exercises or experiments. Exercises in this and the other modules that comprise the Addiction Science Curriculum include all or some of the following steps, depending on whether an activity is a survey, investigation, observation, or experiment.

Featured steps of the scientific method: ◙

- Identify the area of interest
- Review the available information
- Determine the question or problem of interest
- Construct an explanation, prediction or hypothesis
- Determine the source of data (e.g., subjects, evidence) to be examined
- Determine the **variables** to be used
- Determine the way to measure the variables
- Prepare a data collection system
- Enter the data for analysis
- Analyze and chart the data
- Interpret findings from the results
- Present findings
- Review the existing information in light of new findings. Is it consistent? Does it vary?
- Use the findings to make new observations or ask new questions

In this curriculum, students will have the opportunity to organize, analyze, represent, and interpret data. Some of this evidence derives from clinical studies (i.e., founded on observation and treatment of human beings) that investigate phenomena related to the addictions. Clinical studies require rigorous control. For instance, when scientists want to be able to interpret the influence of specific variables (i.e., independent variables), they have to control the impact of

other factors so these do not confound their research. For example, some research requires that subjects be matched on relevant criteria (e.g., gender, age, academic achievement, socioeconomic status, physical and mental health factors, etc.).

To determine the impact of treatments, experiments require "comparison" groups. In some instances, a comparison group is similar to the "experimental" group; however, this group gets a different type of treatment than the experimental group so the groups can be compared. Sometimes comparison groups are just another experimental group (i.e., they receive a different treatment) and sometimes research requires a "control" group (i.e., they receive a placebo or no treatment). Some experiments are "blind" in which no subject knows whether they are in an experimental or a control group. In a double-blind experiment, neither subjects nor data collectors know who has been assigned to an experimental group or a control group until all of the evidence has been collected. Blind studies protect the research from experimenter bias. Bias can result from the expectancies of the data collectors.

In the exercises that follow, students will represent data that is "statistically significant." Students should understand that a result is statistically significant when the association between the factors has been found to be greater than might occur by chance. Researchers discover whether or not differences in results are "significant" using mathematical tests called inferential statistics.

The American Association for the Advancement of Science (AAAS) Benchmarks for scientific literacy (1993) state that 5th grade students should realize scientific investigations cover physical, biological, and sociological realms. Students entering middle school likely will have had much practice collecting, examining and classifying items found in nature. Therefore, as students begin the addiction science curriculum, they should have learned that classifying occurs regularly in science. However, students entering middle school usually will not have had much experience with controlled experimentation. Similarly, they usually will not understand why different students performing the same experiments can get different results. Therefore, introducing the precision and care associated with the steps of the scientific method will provide students with a steady plan of action that can be built upon through experience.

LESSON PLANS

Lesson: Defining Researchable Problems

Objective

To help students frame questions or scientific problems that are: (1) clearly and properly defined; and (2) researchable in their own classroom.

Featured Steps of the Scientific Method

- **Identify the Area of Interest:** Any question worth studying should be interesting inherently to the investigator; if not interesting, the research will not be sufficiently engaging to hold the investigator's attention.
- **Review the Available Information:** Once an area of interest has been established, a researcher will want to know "what's going on the field" so that they can formulate questions of inquiry that are both novel and relevant. Researchers study previously completed investigations for information, direction, or knowledge gaps. A question that can be answered with a resource book is more of a "fact-based" question than a question of inquiry. Inquiry questions cannot be answered with a trip to the library because answers to these questions change with time, different populations and different contextual conditions. Formulating useful hypotheses about any inquiry based question usually requires familiarity with background materials, statistics or trends, and other relevant information.
- **Determine the Question or Problem of Interest:** This exercise is designed to help students explore the elements of a researchable question. The researchable questions of interest represented in this exercise are those that are inquiry based, rather than those queries based only on facts or concepts. Questions that are inquiry based allow investigators to formulate their own hypotheses, "do" the science necessary to make decisions about the accuracy of their hypotheses, and then draw their own conclusions about the meaningfulness of the question under investigation.

Student Preparation

There is no required student preparation for this exercise. This activity is a first step toward helping students to think critically about what types of questions are researchable, as well as what types of problems they could investigate in their classroom, school or community.

Teacher Preparation

Keys (1996) notes that middle school students tend to think of three distinct types of science questions:

- **Fact-based** questions can be answered using text or library reference books (e.g., "What are the parts of the circulatory system" or "Where does nicotine come from?").
- **Conceptual** questions involve the "why" of something; these questions are philosophical in nature and yield little opportunity for careful scientific investigation. However, these questions usually cannot be answered with a classroom investigation (e.g., "why does the brain remember specific things", "why do drugs affect the brain?" or "why do people become addicted to gambling?"). Why questions help students identify concepts that interest them, but rarely surface in a form that helps to guide scientific investigations.
- **Inquiry** ◙ questions can be used as a basis for student designed scientific (e.g., "which group has a higher heart rate after exercise: boys or girls?," "which group finds marijuana smoking more dangerous, boys or girls?") or descriptive (e.g., "how many cigarette butts are found on the school grounds" or "what is the average caffeine intake per day, per person in the classroom?") investigations. Keys (1996) further explains that the "best inquiry questions are: (1) ***feasible*** within the limits of classroom time, space, and resources; (2) ***genuine*** in the sense that students do not know the outcome prior to conducting the investigation; (3) ***authentic*** in the sense that they draw on the students' real-world knowledge (e.g., what species of plants are on our school grounds?); and (4) ***have potential*** to develop important science concepts (e.g., how will plants grown with fertilizer be different from plants grown without fertilizer?)" (p. 19; emphasis added).

Key Concepts

- **Researchable Problems:** ◙ Science cannot, nor should it be expected to, answer all types of questions. McComas (1996) states that "...scientists as individuals have personal opinions about many issues, but as a group, they must remain silent if those issues are outside the realm of scientific inquiry. Science simply cannot address moral, ethical, aesthetic, social and metaphysical questions" (p. 13). This is because scientific research is meant to be based on evidence derived from observation and experience rather than opinion, taste, or emotion. Carr (1992) explains that a researchable problem must be: (1) ***clearly formulated*** in words; (2) ***testable*** in such a way that evidence regarding the problem can be generated by either experience, observation or experimentation; (3) ***quantifiable*** -- useful empirical data must be identifiable and collectible; and wherever possible, that data should be numerical in nature; and (4) "the events on which data are collected must be accessible and ***observable***, either directly or indirectly, through whatever means are appropriate for the case at hand" (p. 87; emphasis added).
- **Characteristics of a Good Research Question:** ◙ Cummings, Browner & Hulley (1988) note that the criteria for a good research question includes the following (p. 14):

- The Question must be ***Feasible***
  - Adequate number of subjects
  - Adequate technical expertise

    - Affordable in time and money
    - Manageable in scope
- The Question must be ***Interesting*** to the investigator
- The Question must be ***Novel***
    - Confirms or refutes previous findings
    - Extends previous findings
    - Provides new findings
- The Question must be ***Ethical***
    - The question can be investigated ethically.
- The Question must be ***Relevant***
    - to scientific Knowledge
    - to clinical and health policy
    - to future research directions

Materials Needed

- Blackboard
- Chalk

Action Steps

1. Ask students to think about some questions to which they would like to know the answer regarding their class, school or community.
2. Record as many of questions as time permits by writing these on the blackboard.
3. Review the Key Concepts on Researchable Problems and the Characteristics of a Good Research Question. Once you have written down the student questions, discuss with the students into which category these question fall. Draw a line through those questions that fall into the realm of ethics, morality, aesthetics (i.e., questions dealing with beauty or taste in the arts), and metaphysics.
4. Ask students if they think the questions that fall into the categories listed in action step 3 above could be tested in their classroom using objectivity, experience, observation or experimentation.
5. Once you have completed a discussion of the questions that are not likely testable within the classroom, draw a line through those questions that can be answered easily with a show of student hands (e.g., how many boys have birthdays in October, how many people live on Main street, etc.) Explain the difference between a fact-based question and an inquiry question.
6. Ask students if any of the remaining questions can be answered easily by a trip to the school library or with the use of texts or reference books.
7. See what questions remain. If there are none remaining, ask the students to develop more questions that they think could be tested in their classroom. See if these new questions fit the requirements of a "Good Research Question."
8. If some of the questions do fit the "Good Research Question" criteria, discuss the characteristics of these items.

9. Have the class determine if there is one question that they would like to investigate. This project can become a long term portfolio investigation or, if feasible, a homework or special assignment.
10. If there are no questions that fit the criteria of "testable in the classroom" ask students what they would like to know about their class, school, or community. A fun question to start with is "what activities does the class find pleasurable?"
11. See how students respond to this question by writing down different activities on the blackboard (e.g., playing Nintendo, watching scary movies, playing with a puppy, playing baseball, eating ice cream, shopping, sleeping, etc.). Write on the blackboard as many of these activities as time permits.
12. Tell the students to copy the list of activities from the blackboard.
13. Ask students how they would compare these activities in terms of pleasure. That is, which activities gives the most or gives the least pleasure.
14. Permit students, working as individuals, small groups, or the entire class, only one day to complete their data (information) collection.
15. Ask the students to determine, in advance, how they will collect evidence to help them address the pleasure question? Do students generate various scientific methods for data collection or do they rely on disorganized opinion? Have the class discuss and consider the options available to them (e.g., observing, surveying, rating/comparing answers etc.).
16. On the next day, have students share their findings and discuss what the evidence suggests about pleasurable activities and how people spend their time.

Questions for Follow-Up

1. Were students able to compile the information on pleasurable activities in an organized fashion?
2. If they were able to organize their information, how did they analyze it? Did they compare or rate their information in any meaningful way?
3. If students were unable to compare their information, introduce the concept of a Likert scale, and have students rate the pleasurable activities on this scale as a homework activity.

Lesson: Music In The Mood4

Objective

This lesson provides students practice constructing hypotheses, collecting data, and analyzing data using everyday experiences.

Featured Steps of the Scientific Method

- **Identify the Area of Interest:** The general area of interest in this exercise is hypothesis construction.
- **Review the Available Information:** Students will have the opportunity to research a good working definition of an hypothesis. Furthermore, students will have the opportunity to construct hypotheses that are testable.
- **Determine the Question or Problem of Interest:** Students will investigate how the feelings of their family change or shift in response to a particular activity (i.e., listening to different types of music). The question of interest in this exercise is whether or not specific activities such as listening to different types of music have the ability to change or shift feelings or mood states.
- **Construct an Explanation, Prediction or Hypothesis:** In the previous exercise, students rated pleasurable activities; therefore, they already will have an understanding of how specific activities associate with pleasure and enjoyment. In this exercise, students will have the opportunity to hypothesize whether or not certain activities in which their family members are engaged (i.e., listening to different types of music) can change the feeling or mood of that particular family member. Student hypotheses concerning their family members potential mood shift in reaction to different types of music can derive from their past experience or evidence. In other words, students should think of hypotheses not merely as "guesses," but as guides based upon existing evidence or previous experience. When students formulate a hypothesis, they should consider using an "if ...then" statement (e.g., ***if*** this happens, ***then*** you might expect that to occur). Thus, if shifts in feelings are related to activities such as listening to particular types of music, then students might expect to see a positive feeling shift when a family member hears a favorite or pleasing musical tune, and a negative shift in feeling when a family member hears what they consider an unpleasant tune.
- **Determine the Source of Data to be Examined:** Once students formulate hypotheses, and provide examples of these hypotheses, teachers should ask what data students would examine to provide evidence for their hypotheses. Are student family members the best subject source this demonstration? Are mood changes the target variable for this demonstration? Are everyday activities the primary object of this demonstration? Are all of these factors the target of this demonstration? Once the family members are chosen, how will they be evaluated? Will groups of

[4]The idea for this exercise comes from Avram Goldstein's (1980) work: "Thrills in Response to Music and Other Stimuli" Physiological Psychology, 8, (1), 126-129.

family members be compared or will the same group be examined under different conditions?

- **Determine a Way in Which to Measure the Variables:** Since the dependent variable in this exercise is mood, students will have to quantify this variable. Students will have to assign a numerical value to mood and its changes. Positive mood shifts can be indicated by positive values, negative mood shifts can be indicated by negative values. No mood shift can be indicated by a "0" or no change in mood.
- **Prepare a Data Collection System:** Students need to prepare a data collection sheet for each subject. This data collection system should document the time, day, activity, initial mood state (including a numerically quantified baseline mood state), and a scale for the subject to note any mood shifts with as a new musical selection is introduced. In other words, there are two issues under consideration throughout this demonstration: the mood of the family member and the mood changes of the family member in response to the musical activity. This information must collected in some form on a data collection sheet.
- **Enter and Analyze the Data:** Once students have completed their demonstration with their family members, and reviewed the data from the data collection sheets, they must analyze the data to see if mood shifts did occur as a result in changes of musical selection. Students will have to keep a list or key for themselves noting each family member's favorite selection so that they can see if each family member responded with a positive shift in mood when their favorite piece of music was played. Once students have reviewed the data collection sheets, they should see whether or not family members experienced a positive music shift when their favorite music was played. Positive shifts can be scored by giving each shift degree one point. Students can average the scores for family members throughout the class to see if there was a mean positive shift score.

Key Concepts

- **Hypotheses:** ◙ Hypotheses are scientific hunches. Scientists use hypotheses to formulate a logical explanation for a single event, pattern of events or a phenomena. Scientists who formulate hypotheses state formally what they predict will be the outcome(s) of a given experiment before beginning the research (Barhydt & Morgan, 1993). Scientists state hypotheses so they can test the "hunch" against reliable observations (i.e., data). Support for a hypothesis occurs when research findings advance the predicted outcomes. In other words, hypotheses are neither right nor wrong; rather, they are supported by evidence or unsupported by evidence. Hypotheses are attempts to state simultaneously all reasonable or logical explanations in some cases -- or one reasonable explanation that will account for most of the data in other cases -- for a reliable set of observations. Hypotheses can be tested by experiments; based upon the results of this research, hypotheses are sustained or denied -- supported or not.
- **Data:** ◙ **Data** takes many forms. Data can be values derived from scientific experiments, most often expressed in numerical form, or data may be considered factual information - especially information organized for analysis or used to reason or make decisions. The word data originated as the plural of the Latin word

datum, meaning "something given." Scientists use data to test what has been observed in nature.

Student Preparation

Teachers can prepare students for this exercise by completing the previous exercise on researchable questions. Students will to understand the key concepts of this exercise.

Materials Needed

- Blackboard
- Chalk
- Paper
- Pencil
- Data Collection Sheet
- (for home) watch with second hand, or stop watch
- (for home) any stereo or recording equipment including portable stereos (i.e., "boom box") or a radio. Sound equipment must be sufficiently loud for student family members to hear the same music at the same time.

Action Steps

1. The day before beginning this exercise, ask students if they can define the word "hypothesis." What do they think is an hypothesis? Accept answers that discuss hypotheses as "scientific hunches" or guesses based on some evidence and past experience. If students offer the phrase "an hypothesis is an educated guess" ask them what they mean by "educated guess." Accept all ideas that relate to the use of evidence and knowledge as the building blocks of hypotheses.
2. For homework that evening, assign students to develop a complete, working definition of an hypothesis, with some examples.
3. The next day, collect the student definitions.
4. Read a few definitions and select one that comes closest to a complete, understandable, working definition of an hypothesis. If student definitions are unsatisfactory, use phrases from the key concept section on hypothesis to complete this action step.
5. Once the class has agreed upon a working definition of an hypothesis, ask students to think about their day (if this is an afternoon class), or their yesterday (if this a morning class).
6. Ask students if their feelings or mood shifted or changed during the day (e.g., did they experience a shift in feelings from the time they awoke to when they dressed for school, from leaving the house to coming to school, entering a class, eating lunch, talking to a best friend, etc.). If students don't need prompting, don't give them examples.
7. When students give examples of feelings or mood shifts, ask them to hypothesize what caused the shift in feeling or mood.

8. Write at least 10 different hypotheses from students on the board. If time permits, get an hypothesis from each student.
9. Examine the "causal factors" for mood shifts. See if students can classify these: are some factors time based (e.g., my mood shifted 8:10 when I realized I was late for the bus)? Are some factors activity based (e.g., my mood shifted when I came home and was able to play a game, read a novel, etc.)? Are some factors environment based (e.g., my mood shifted the minute I walked into the room of my least favorite/most favorite class)? Or are some factors based on the actions of other people (e.g., my mood shifted the minute my mother yelled at me/the minute she hugged me)?
10. Once the class classifies some of these causal factors into groups, ask them to consider which of the groups of factors they can exert control over -- for instance if they had to construct an experiment on mood shifts.
11. Help students understand that they can expose people to various activities with little difficulty if people are willing participants. This is much easier to investigate than most of the other factors that you will classify.
12. Write a 7-point rating scale upon the blackboard (i.e.,-3, -2, -1, 0, +1, +2, +3), where negative numbers indicate negative moods (-2 is more negative than -1), 0 equals a neutral state, and positive numbers indicate positive moods (+2 is more positive than +1).
13. Tell students to think of a specific family member.
14. Ask students to hypothesize how that family member would likely respond on the 7-point scale if he or she had to listen to another family member's favorite piece of music, that is, a sibling having to listen to his grandmother's favorite piece of music, or a parent having to listen to the student's favorite piece of music.
15. Now ask the students to hypothesize how the family member would likely respond on the scale if they had to listen to their own favorite piece of music (e.g., a sibling listening to his/her own favorite piece of music).
16. Explain to students that they going to conduct a demonstration designed to test their family members for "mood shifts" or shifts in feelings as a function of a specific activity. In this case, the activity will involve family members listening to different types of music.
17. To complete this experiment, each student must first survey each family member (or those people they are living with) independently about the favorite piece of music that they own. Each student must then make a tape recording of the various pieces, or borrow the various pieces of music from the family members to play at home. When making a tape of these pieces, students should randomize the selections (using their key to recall which family member was linked to a favorite selection). If families have no sound equipment with which to do this, students can survey family members on their favorite radio station using a radio to complete the experiment. In the case of radio station choices, students should randomize the order of the stations presented.

18. If students can make a tape of the music samples, they should select 30 representative seconds from each family member's favorite piece so that the piece can be recognized (i.e., from the refrain of melody, or if the piece is a classical piece, students should ask the family member which passage is his or her favorite 30 seconds segment). They will need the stopwatch or second-hand watch to complete this task.
19. If students choose the radio to provide music, they must make sure they know the favorite radio station for each family member (i.e., where to find it quickly with good reception). They will then turn to that radio station and keep it at that channel for thirty seconds before moving to the next station (they will need the stopwatch or second-hand watch to complete this task).
20. Students can design their own data collection instrument based on the number of family members they will survey, collect music from, and later, play music for. The instrument should include a rating scale for each piece of music, or radio station to be played (a sample instrument is provided at the end of this lesson). Students must be able to match each family member's favorite musical selection (or radio station) to the family member's response sheet (e.g., by creating a key for the selections).
21. Students must select a particular night during which participating family members can congregate.
22. Students should hand out the data collection instrument to all family members, explain that they are conducting an experiment, and that family members should be as honest as possible when completing the data sheet.
23. Students should tell all family members to sit quietly for 30 seconds. After 30 seconds each family member should answer the first question on the sheet which is a baseline measure of that person's mood at that particular time (moods are quantified as either positive or negative with varying degrees of each).
24. After family members mark their data sheets, the student will play the first 30 second interval of their tape (or radio station) and at the end of the 30 seconds, the family member must rate his or her feeling using the numbered scale on the sheet.
25. Students should repeat action step 24 until all pieces of music or stations have been heard.
26. Students should collect data sheets.
27. Students should be able to see if there was any shift feeling or mood among their family members throughout the various pieces, or if the family members all felt the same way when listening to the different pieces as they did when they first sat down.
28. The class can pool their results (i.e., music selection experimenters in one pool and radio experimenters in a different pool) to see if subjects experienced any feeling shifts during the experiment.
29. Does the evidence support the hypothesis that listening to music can affect one's mood or shift one's feeling state?

Questions for Follow-Up

1. Did students note any factors that may contaminate the results from this demonstration? For instance, could the order in which the musical selections were presented effect the outcome of the results (i.e., each person's feeling state?), how about the effect of having al family members in one room listening to the music? **Teacher Guide: The order in which musical selections are presented could absolutely effect the outcome of the demonstration. Similarly, the context in which the music is presented to the family members all in one room could effect the outcome of the demonstration. For instance, if family members are not getting along, or have just had an argument before the demonstration, their subsequent moods could be effected dramatically merely by being in the same room with the other family members. The room itself might be distracting, compared to an experimental room which would be free of distractions. The order of musical selections will effect each member differently depending on their musical tastes. For instance, a family member who prefers calm music and does not hear his favorite selection till the end of the demonstration, could be affected greatly compared with a different family member who hears his favorite music immediately. Ask students how they might control for these problems in a true experimental design if they had the time and facilities to conduct a true experiment on this issue (e.g., by having members listen to music alone, in a neutral room or laboratory with no distractions, through a walkman; by making sure the order of songs for each family member is tailored to have their favorite song in the same selection position; by making sure family members are tested individually, but at the same time of day, etc.).**
2. Ask students to hypothesize what other activities might shift mood or feeling state from a negative mood to a positive one.
3. Ask students to think about certain activities in which they have become involved when they are in a sad or bad mood that are pretty reliable in helping them get out of that mood (e.g., talking to friends on the phone, eating ice cream, cuddling animals, punching things, playing music, writing in a diary, taking a walk, etc.).
4. Ask students what they would do if none of these activities worked to change their mood from bad to a little better.
5. Some people who use drugs and alcohol use these substances because they feel nothing else will make them feel better as quickly or as easily when they are feeling low. Ask students if they can construct hypotheses regarding other reasons why people might use drugs and alcohol.
6. Write these ideas on the board. Select one hypothesis and ask students to brainstorm how they could test that hypothesis in an experiment.
7. Ask each student to think of 5 different ways they could make themselves feel better, without taking or drinking any substance, if they were in a miserable mood. Tell them to write these down on a piece of paper.
8. Are any of these ways destructive or negative (e.g., shopping for things you can't afford, stealing, hurting someone, yourself, other people or animals, destroying property; etc.)? If so, tell students to cross these off the list and hypothesize, based on

evidence and experience, the most positive things they could do for themselves if they were in a foul or miserable mood.

MUSIC DATA COLLECTION INSTRUMENT

Name_____ **Date**_____

Using the number scale below, please rate how positive or negative your overall mood is at this exact moment (please circle one of the numbers below):

very positive	somewhat positive	slightly positive	neutral	slightly positive	somewhat positive	very positive
-3	-2	-1	0	1	2	3

After first music selection: How do you feel now?

very positive	somewhat positive	slightly positive	neutral	slightly positive	somewhat positive	very positive
-3	-2	-1	0	1	2	3

After second music selection: How do you feel now?

very positive	somewhat positive	slightly positive	neutral	slightly positive	somewhat positive	very positive
-3	-2	-1	0	1	2	3

After third music selection: How do you feel now?

very positive	somewhat positive	slightly positive	neutral	slightly positive	somewhat positive	very positive
-3	-2	-1	0	1	2	3

After fourth music selection: How do you feel now?

very positive	somewhat positive	slightly positive	neutral	slightly positive	somewhat positive	very positive
-3	-2	-1	0	1	2	3

During the music that you consider your favorite piece, did you ever experience any thrills (for example, tingles, or a prickly feeling at the back of your neck or along your spine)?

no yes

THANK YOU FOR YOUR TIME

Lesson: The Message in a Bottle

Specific Objectives

This lesson will show students that preconceptions often interfere with the ability to conduct objective scientific investigations -- even at the earliest stages of hypothesis construction.

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** In this brief lesson, teachers are asked to introduce students to the early steps involved in the scientific method (i.e., determining the problem and constructing an appropriate hypothesis). Teachers should focus on how to objectively build a hypothesis. During this discussion on problem definition and hypothesis construction, teachers will be holding a sealed, clear, relatively small plastic bottle filled with mercury and shift it from hand to hand during the discussion as if the bottle were filled with feathers. After teachers discuss the topics of problem definition, hypothesis construction, and the need for objectivity throughout scientific method, *all the while shifting the mercury-filled bottle back and forth*, they can ask students to think of fairly simple, testable, questions. After such questions are elicited, teachers can ask "how about a question immediately before us, such as "what is in this bottle?"
- **Construct a Prediction, Explanation or Hypothesis:** Students should be asked to construct some general, preliminary ideas about the bottled contents based on observable phenomena (e.g., what can be held in a plastic container; a dark liquid). Because the observation 'data points' in this case are so few in number, teachers should check to see how specific students are getting with their hypotheses of the bottle's contents. Teachers can ask students if anyone in the room thinks they have a good idea of what is in the bottle based on observation alone. If any student comes forward with an idea, the teacher can hand that student the bottle. When transferred gingerly, the student likely will be very surprised by the weight of the bottle. Ask the student why he or she is surprised -- did they think the bottle would be lighter? Why did they think the bottle would be lighter -- based on what evidence? How did the student's conception of the teacher's behavior with the bottle add to, or distort the available evidence? Students should then revise their hypotheses of what is in the bottle given their new knowledge of its "weighty" property.
- **Testing the Hypothesis:** When students are finished revising their hypotheses regarding the bottle's contents, teachers can discuss how one would begin to test the hypothesis, beginning with a discussion on laboratory safety, and handling of scientific specimens. Alternatively, teachers can tell the students exactly what is in the bottle, and explain how the properties of the element mercury make it useful for thermometers and barometers used in scientific work.

Key Concepts

- **Inadequate Evidence:** Adequate supporting evidence is at the heart of hypothesis construction. Without adequate evidence against or in support of a proposition, observers are unable to make a fair or prudent decision regarding that proposition. Hypothesis construction becomes difficult under these conditions, and is often led by assumptions rather than facts. Leading with assumptions in absence of information can often backfire -- especially if the circumstances surrounding the event have the potential to be dangerous. Unfortunately, scientists at the frontiers of new knowledge or technology run into the problem of inadequate evidence for new hypotheses or new theories regularly. "Either the proper evidence has not yet been uncovered, or our present methods are not yet capable of finding the required evidence" (Carr, 1992, p. 282). Thus, these scientists generally proceed with caution and subject their methods to the most rigorous mental scrutiny before conducting a physical test. In most cases, the problem of inadequate evidence has much to do with the nonexistence of opposing evidence, "no news is good news" thinking, and the inability to regard all angles of a problem (Carr, 1992). For the present problem of "what is in the bottle," students should learn to recognize that the evidence supporting any hypotheses other than the most basic and general (i.e., a liquid), is woefully inadequate. Consequently, to determine more useful hypotheses, the bottle contents must be subjected to more extensive investigation (e.g., explored, measured, compared, etc.). In addition, lack of evidence must be paired with caution as any investigation of new areas proceeds.
- **Preconceptions:** Science education researchers recently have given much attention to student preconceptions regarding phenomena. A preconception can be understood as an existing knowledge set or expectations; this McCormack identified this condition as an "initial state idea" that a student or learner holds concerning a specific event or phenomenon (McCormack, 1992). "When preconceptions are inaccurate, they can be considered misconceptions or naive conceptions" (McCormack, 1992, p. 28). Dealing with preconceptions is an important problem for scientists: it is very helpful to stimulate misconceptions or inaccurate prior knowledge about any scientific phenomena into awareness. Engaging students in the incongruities of their own misconceptions of scientific facts not only stimulates interest, it also helps students change the 'misconception' to knowledge based on verifiable, supporting evidence.
- **Prejudice/bias:** ◙ Teachers can remind their students that all observers carry with them biases and prejudice about the events they observe. Bias is defined as a particular tendency or inclination, especially one that prevents impartial consideration of a question. Prejudice for purposes of scientific inquiry, is a roadblock to clear, objective thinking. Prejudices typically are negative opinions or feelings formed before in investigation without evidence, knowledge, thought, or reason. "Bias is responsible for much incorrect work. The universal occurrence of prejudice and the necessity for safeguards against its influence is certainly not sufficiently appreciated" (Wilson, 1972, p. 66). Good science requires both students and scientists to be as objective as possible so that their observations, hypotheses, and interpretations of data will not be distorted.

Student Preparation

The primary student preparation needed for this module is a brief introduction to the steps required in conducting a scientific investigation. Teachers should be prepared to fully discuss the problems that a lack of evidence, bias and prejudice create for hypotheses construction.

Materials Needed

- Chalkboard and chalk or newsprint and markers
- 1/2 pint, tightly sealed clear plastic bottle, containing mercury

Action Steps

1. Holding the bottle of mercury in your hand, ask students to define the scientific method. One student should write the class responses on the chalkboard or newsprint. During this discussion casually shift the bottle of mercury from hand to hand several times with a lightness of touch. Depending on the nature of the students' responses, validate correct responses, and offer alternative responses to the incorrect responses -- focus this discussion primarily on the need to define a question that can be tested, and on the importance of forming a hypothesis with as much knowledge and objectivity as possible.
2. After this discussion on testable questions and objective hypothesis construction, present the question of "what is in the bottle?" to the students.
3. Ask students to construct some general, preliminary ideas of the bottled contents based on observable phenomena (i.e., the "what" is contained in a small plastic vessel -- it is liquid, it is dark). Because the observable "data points" in this case are so few, teachers should check to see how specific students are progressing with the construction of their hypotheses of the bottle's contents. Provide only about 5-10 minutes for this activity step.
4. Based only on their observations, ask the class if anyone in the room thinks they have a good idea of what is in the bottle. If any student comes forward with an idea, hand this student the bottle with a lightness of touch.
5. It is very likely that the student will be surprised by the weight of the bottle. Ask the student why he or she is surprised -- did they think the bottle would be lighter? Why did they think the bottle would be lighter -- based on what evidence? How did the student's conception of the teacher's behavior with the bottle add to, or distort, the available evidence. Ask the students how they would revise their hypotheses of what is in the bottle given their new knowledge of this "weight" property.
6. Ask students how this experiment pertains to scientific method?
7. Ask students how their preconceptions may have interfered with their hypotheses concerning the contents of the bottle.
8. Continue the discussion of preconceptions by asking students how they perceive scientists. Ask students what they think scientists look like. These responses can be recorded on the chalkboard or newsprint. If you

receive stereotypical answers (e.g., "nerds in laboratory coats surrounded by beakers of offensive chemicals"), offer alternative responses, including: yourself as a science educator, their family physicians, any computer scientists they may know, marine biologists, zoologists, geologists, pharmacists, etc.

9. Ask students how their preconceptions regarding scientists prevented them from coming-up with some of these descriptions.
10. Using addiction science analogies to further classroom discussion on bias and preconceptions, have students complete the following homework assignment. Ask students to write brief responses to the following questions:
    - What is alcoholism?
    - How does someone with addiction act?
    - What do people with alcoholism or addiction look like?
    - What is the evidence for your conclusions?

The next day, review student answers to these questions. Offer students who answer the questions with stereotypical portraits of persons suffering from drug dependence with alternatives to their hypotheses. One can do this by reviewing some notable personalities who have admitted to drug and alcohol dependence; for example:

- Elizabeth Taylor (award winning actress, movie star) has admitted to and was diagnosed with dependence on prescription drugs and alcohol.
- Mickey Mantle (baseball star) had admitted to, and was diagnosed with alcohol dependence. Mr. Mantle passed away in 1995 due to complications from a liver transplant. Mr. Mantle required the transplant due to cirrhosis and cancer of the liver.
- Dwight Gooden (Cy Young award winning baseball star) has admitted to polydrug dependence.
- James Taylor (award winning musician, popular music star) has admitted to and was diagnosed with narcotics dependence.
- Sigmund Freud (physician, scientist, father of psychoanalysis) admitted to tobacco and cocaine dependence.
- Betty Ford (former First Lady, Founder of the Betty Ford Center) has admitted to, and was diagnosed with alcohol and prescription drug dependence.

Each of these personalities, and countless others in sports, the arts, medicine, and in public service, has been considered a high achiever in his or her respective field. None fit the stereotype of a "drug addict" or "alcoholic." Of course, one discovers that the question "what does a person labeled an addict or an alcoholic look like?" has no single, precise answer which has as much to do with the complexity of addiction as it does with the innovation of addiction science.

Questions for Follow-Up

1. How do preconceptions and biases limit scientists in their search for knowledge?
   Teacher Guide: Accept answers that demonstrate student understanding of preconception and bias.

2. What happens when we draw conclusions based on only one source of information?
   Teacher Guide: Accept answers that indicate students' understanding of the need to check a variety of sources before coming to a conclusion -- or the problems with coming to conclusions based on little evidence.

Lesson: The Nine Dot Problem

Specific Objective

This lesson is a quick critical thinking puzzle that will teach students the necessity of investigating all sides or angles of a problem. In other words, students will discover how to observe their evidence in a way that goes beyond artificial, self-limiting boundaries.

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** Students will be given the 9 dot puzzle that asks the question: "How does one connect all nine dots using straight lines without removing their pen or pencil from the paper?"
- **Construct an Explanation, Prediction or Hypothesis:** Teachers should make sure that there is not a student "expert" available who has done the problem before. If there is, use that student or students as helpers and have them connect the dots using the possibilities that other students offer. By attempting to solve this problem repeatedly, each attempt provides a distinct example of testing a specific and newly formulated hypothesis.
- **Testing the Hypothesis:** Unless students think to go beyond the outer frame of the nine dots, they will not be able to complete this exercise. Provide as many attempts as your time allows to get the point across -- after discussing the limitations of preconception and bias, either teacher or student experts can help the class solve the problem on the board for all to see. Please use the diagrams at the end of this lesson if you have never completed this exercise.

Key Concepts

- **Preconceptions:** Science education researchers recently have given much attention to student preconceptions regarding phenomena. A preconception represents a set of knowledge and expectations, otherwise known as an 'initial state idea' that a student or learner holds concerning a specific event or phenomena (McCormack, 1992). McCormack (1992) notes "When preconceptions are inaccurate, they can be considered misconceptions or naive conceptions" (p. 28). It is helpful for student misconceptions or inaccurate student prior knowledge about any scientific phenomena to be brought to the student's conscious awareness. Engaging students in the incongruities of their own misconceptions of scientific facts not only stimulates interest, it also helps students positively change their views.
- **Prejudice/bias:** ◙ Teachers should remind their students that all observers carry with them biases and prejudice about the events they observe. Bias is defined as a particular tendency or inclination, especially one that prevents impartial consideration of a question. Prejudice for purposes of scientific inquiry, is a roadblock to clear, objective thinking. Prejudices typically are negative opinions or feelings formed before in investigation without evidence, knowledge, thought, or

reason. "Bias is responsible for much incorrect work. The universal occurrence of prejudice and the necessity for safeguards against its influence is certainly not sufficiently appreciated" (Wilson, 1972, p. 66). Good science requires both students and scientists to be as objective as possible so that their observations will not be distorted and their problem solving responses limited.

Student Preparation

Teachers should prepare students for this exercise by providing a brief overview of the steps involved when conducting a scientific investigation. This exercise is concerned mainly with the limits prejudice and bias place on inquiry -- therefore discussion on the need for objective hypothesis construction is relevant, as is the idea of considering many perspectives when constructing a carefully crafted and logical answer to a question. This exercise is not grade specific and requires little in the way of background for the point(s) that it illustrates.

Materials Needed

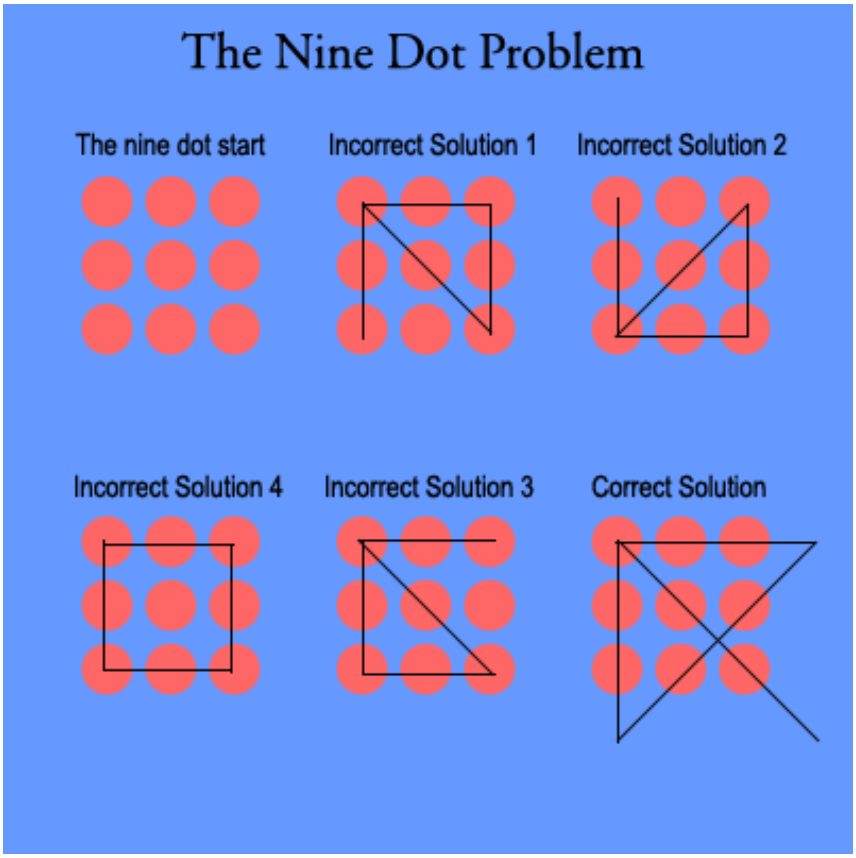
- Chalkboard and chalk
- Paper and pencils

Action Steps

1. Tell the children that they are going to experience bias and a shift in the way they see the world during the next several minutes.
2. Draw three rows of three dots each on the chalkboard (as in the illustrations below).
3. Ask each student on their paper to connect these 9 dots with 4 straight lines, never taking their pens or pencils off the paper.
4. Remind the students that each dot only can have one line through it and that they are not allowed to lift their writing instrument off the paper.
5. As the students begin, ask them if they are making any assumptions about this puzzle.
6. Give them enough time to try to solve the puzzle.
7. While they are struggling with the problem, once again, ask them about their assumptions: are any assumptions keeping them from solving this puzzle?
8. Show them one of the incorrect solutions (as below). Incorrect solutions 1-3 are the most common mistakes that appear. Incorrect solution 4 is quite uncommon! Once again, ask students if they are making any assumptions that keep them from solving the puzzle.
9. Show them another incorrect solution.
10. Ask if anyone has solved the problem. If they have and the others are sufficiently frustrated, let the student draw their solution on the chalkboard for all to see. Then discuss how they overcame the assumptions that students typically make as described below.

11. If no one has solved the problem, begin a discussion with the students about their assumptions and how these might have interfered with their ability to solve the problem.
12. Have they assumed the problem is solvable? Have they assumed that you told them the truth? Have they assumed they cannot go outside the perimeter of the nine dots? Remind them that the instructions never said that they could not go beyond the boundary established by the 9 dots. This was an assumption they made about the problem.
13. How did these assumptions interfere with their ability to solve the problem? Remind the students that if 9 dots in space can interfere with their ability to problem solve, what can they expect to happen with real world problems that they might investigate?
14. Be sure to present the solution to this problem before the children leave the classroom. Often, students will get frustrated without learning the correct response within the activity's allotted time. The correct solution below indicates that solving problems accurately requires that we get beyond our assumptions.

THE NINE DOT PROBLEM



Questions for Follow-Up

1. What assumptions do students make about the dangers associated with tobacco, alcohol, marijuana, or other drugs?
2. How do our assumptions influence our attitudes towards people who use tobacco, alcohol or other drugs?
3. What assumptions do we often make about the people who get in trouble with tobacco, drugs or alcohol?
4. When friends use drugs, does that influence an individual's decision to use drugs? How?

Lesson: Sample Survey

Objective

This lesson shows students how to collect, analyze, and interpret data based on results of a sample survey.

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** Sixth grade students (n=361) in Merrimack Valley Massachusetts school systems (approximately 90% of all enrolled sixth grade students) were surveyed for their responses to a series of questions about the perceived danger of smoking cigarettes.
- **Construct an Explanation, Prediction or Hypothesis:** Teachers give students the following statement: *How dangerous is smoking cigarettes to my health?* Massachusetts sixth grade students (n=361) were given a survey and asked to respond to a statement about the perceived danger of smoking cigarettes. Do students think their responses to the perceived danger of smoking cigarettes will be higher or lower than the Massachusetts 6th grade student sample? What factors influence this decision?
- **Determine the Source of Data to be Collected:** The source of data in this exercise will be student responses to the question: *How dangerous is smoking cigarettes to my health*? Students also will be given the relevant data from the sixth grade Merrimack Valley student sample survey to compare and contrast with their own responses.
- **Prepare a Data Collection System, Enter Data for Analysis:** Students will prepare a table of classroom responses and record those responses in the table.
- **Chart the Data, Interpret and Present Findings:** Students will make a bar graph showing their results. Students will interpret their results and present these to the class. Students will have the opportunity to compare their answers to the survey question with the answers from the sixth grade Merrimack Valley student sample on perceived danger of smoking cigarettes.
- **Review Information in Light of New Findings:** After students chart, interpret and present their findings, they will be able to draw some conclusions about their original hypothesis. Did they find support for their ideas from the available data?

Key Concepts

- **Data Collection:** "The purpose of collecting scientific data is to gain insight on some class of events or things in nature" (Carr, 1992, p. 181). For example, these things could be the occurrence of a certain characteristic among 6th grade females, the occurrence of a characteristic among a species of bird in Massachusetts, the occurrence of bad reactions to a prescription drug in the marketplace, or the amount of betting that occurs among junior high school students during the 1996 Super Bowl. When collecting data, the entire class of possible observations, including all

possible members, is called the population. When all members of a population are examined, the data collection is called a census. When only a randomly selected set of members is examined, the data represents a sample (Carr, 1992).

- **Sampling:** In most situations, attempting to obtain a census of a population is unwieldy, takes a huge amount of time, and is not practical. Thus, scientists developed a technique for inferring information about a large population by examining only a portion of that population. This technique is known as sampling. Sampling allows scientists to infer characteristics about a larger population using the randomly selected sample as representative of that larger population. Sampling works only when: (1) the samples are selected by a truly random process in which, (2) all members of the population have an equal chance of being selected; and (3) the chances of any one individual being selected does not depend on prior selections.
- **Surveys:** Surveys are designed to investigate the beliefs, knowledge, attitudes, actions or states of human groups as they are, with minimal interference. Surveys usually consist of extensive studies of a group or population and are designed to yield specific results.
- **Arithmetic Mean:** The mean is one way to determine the middle of a distribution. It can also be thought of as the balance point of a distribution. Calculating the mean: The mean is found by adding all the terms and then dividing the sum by the number of terms. For example, 1 + 2 + 7 + 10 + 10 = 30 (number of responses) divided by 5 (number of terms), equals 6 which is the mean.

Student Preparation

Students should have a basic understanding of how surveys work to gather data that would otherwise be unobtainable. Teachers can discuss telephone surveys or surveys that have been mailed to households as an introduction to how surveys often are administered. Teachers can review a sampling strategy briefly by asking students how they would select a sample of students from their specific class following the rules for a correct sampling procedure. A very simple random sampling procedure would involve selecting names out of a hat. Each student's name should be written on a slip of paper, folded over and placed into a hat. A blind-folded selector will then pick ten names from the hat. An alternative random sampling strategy uses calculators or computers to generate random numbers. By matching randomly generated numbers against a list of names a random sample can be drawn. For example, if there are 30 students in a class, a list of randomly ordered numbers from 1 to 30 can be generated; students with numbers 1-15 represent a random sample since all students had equal opportunity of being assigned numbers 1-15. Random number tables that can be used for this purpose also are available in many statistics texts readily available in the library. Once students understand surveys and the importance of random sampling, teachers can present the background information on data from the 1993 National Survey of Drug and Alcohol Use for eighth graders, as well as the 1995 data from the Harvard BASE survey of the Billerica and Lowell school systems.

Materials Needed

- Notebook paper

- Pencil
- Graph paper to create charts

Background Information: In 1995, the Harvard Billerica Addiction Science Education Project (Harvard BASE project) conducted a needs assessment of science education issues relevant to middle school students (Shaffer, Walsh, Howard, Hall, Wellington & Vander Bilt, 1995). The goal of this assessment was to generate knowledge to be incorporated into the development of science education curricula for middle school students. The curricula will help teach students about the addictions within the context of the scientific method. Part of this needs assessment involved surveying a sample (n=361) of sixth grade students in the Merrimack Valley school system to determine their patterns of gambling and substance use prevalence. Students were surveyed for their responses to the perceived danger of smoking cigarettes. The data reported that 73 (28.9%) respondents believed smoking cigarettes was *not at all* dangerous to their health; 22 (18.5%) respondents believed smoking cigarettes was *slightly* dangerous to their health; 29 (16.8%) respondents believed smoking cigarettes was *somewhat* dangerous to their health; 60 (19.5%) respondents believed smoking cigarettes was *very* dangerous to their health; and 177 (26.5%) respondents believed smoking cigarettes was *extremely* dangerous to their health (see Figure 1 below).

Action Steps

1. Write the following statement on the blackboard: ***How dangerous is smoking cigarettes to my health?***
2. Ask students to rate their answers on a scale of 0-4, where 0 = not at all dangerous; 1 = slightly dangerous; 2 = somewhat dangerous; 3 = very dangerous; 4 = extremely dangerous.
3. Ask every student to write down their responses privately and anonymously on a piece of paper. ***TELL STUDENTS NOT TO WRITE THEIR NAMES ON THE PAPER***.
4. Ask the students to pass in their responses to the teacher.
5. Teachers record student responses (anonymously) on a grid that looks like the example below.
6. When the answers are on the board, ask students to chart the responses in their notebooks. This chart should look something like figure 1 below.
7. Class responses can be compared to the chart available in table 2. This data represents findings from a sample (n=361) of sixth grade Merrimack Valley school children. Individual classrooms may find it interesting to see how representative a sample they are when compared with a larger sample.
8. Teachers write the mean from the sixth grade Merrimack Valley sample on the blackboard.
9. Teachers ask the class to figure out the mean for their responses.
10. If teachers desire, they can ask the students to chart their responses and the responses from the larger Massachusetts Merrimack Valley sixth grade student sample.
11. Students can compare their responses to the Merrimack Valley sixth grade student responses.

TABLE 1

6TH GRADE CLASSROOM RESPONSES

Dangerousness of Smoking

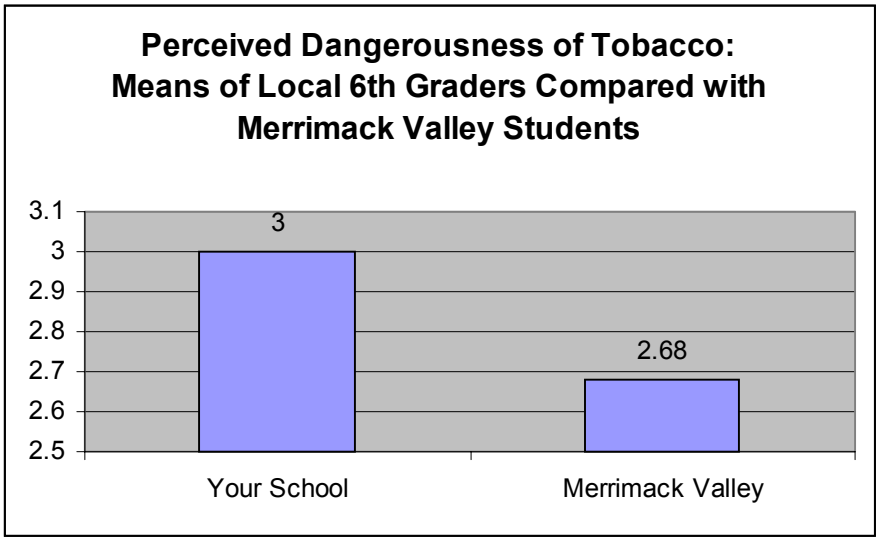
Classroom responses	not at all	slightly	somewhat	very	extremely
Student 1		x			
Student 2				x	
Student 3					x
Student N		x			
Totals	0.00	2.00	0.00	1.00	1.00

TABLE 2

6TH GRADE MERRIMACK VALLEY STUDENTS

Dangerousness of Tobacco

6th Grade Responses	not at all	slightly	somewhat	very	extremely	Total
Number of responses	73.00	22.00	29.00	60.00	177.00	361.00
% of 6th grade	20.2%	6.1%	8.0%	16.6%	49.0%	100%
% of danger of cigarettes	28.9%	18.5%	16.8%	19.5%	26.5%	23.8%
% of Total	4.8%	1.4%	1.9%	3.9%	11.6%	23.8%



Questions for Follow-Up

1. How did the classroom answers compare with the larger sample?
2. What conclusions can be drawn based upon the comparison between the local classroom answers and the larger Massachusetts sample?
3. Were student's surprised by the results of their classroom survey compared to the larger sample responses? What was surprising?

Lesson: Student Drug Use -- Comparisons Between Local Schools and National Schools

Specific Objective

To give students a basic understanding of the scientific method involved in survey research. Students will be shown a subset of a survey designed for their peer group, as well as the resulting data generated by that survey. Students will use this data to construct their own graphs, make group comparisons, and construct interpretations. In addition, this activity will help students learn some basic rules regarding the use of surveys as a scientific technique for investigating human thoughts, attitudes, beliefs, behaviors, knowledge, and states with minimal involvement from the investigator. Students will be given data to compare (national vs. local statistics) and correlate important relationships (e.g., how perceived dangerous relates to levels of drug use).

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** Teachers should discuss the recent rise in teen drug use; or discuss teen drug use in general, and ask students what they believe the prevalence of drug use is among a typical middle school population (in this case, the population is from the Billerica/Lowell areas of Massachusetts).
- **Construct an Explanation, Prediction or Hypothesis:** Using the statistics from the national Monitoring the Future survey (e.g., Johnston, O'Malley, Bachman, 1994) on eighth grade drug use, as well as what students believe they know about their peers, students will have the opportunity to estimate what they think the prevalence of drug use is among the Billerica/Lowell students in comparison to the national averages. Do they think that alcohol use, cigarette use, inhalant use, and marijuana use would be higher or lower than the National averages?
- **Charting and Interpreting Data:** Students will be given the relevant data from the Harvard Billerica Addiction Science Education (BASE) project survey to compare and contrast with the national survey data. Students will have an opportunity to graph the comparative data and draw conclusions. Were their original estimates supported by the data?

Key Concepts

- **Data Collection:** "The purpose of collecting scientific data is to gain insight on some class of events or things in nature" (Carr, 1992, p. 181). For example, these things could be the occurrence of a certain characteristic among 7th grade females, the occurrence of a characteristic among a species of bird in Massachusetts, the occurrence of bad reactions to a prescription drug in the marketplace, or the amount of betting that occurs among junior high school students during the 1996 Super Bowl. When collecting data, the entire class of possible observations, including all possible members, is called the population. When all members of a population are

examined, the data collection is called a census. When only a randomly selected set of members is examined, the data represents a sample (Carr, 1992).

- **Sampling:** In most situations, attempting to obtain a census of a population is unwieldy, takes a huge amount of time, and is not practical. Thus, scientists developed a technique for inferring information about a large population by examining only a portion of that population. This technique is known as sampling. Sampling allows scientists to infer characteristics about a larger population using the randomly selected sample as representative of that larger population. Sampling works only when: (1) the samples are selected by a truly random process in which, (2) all members of the population have an equal chance of being selected; and (3) the chances of any one individual being selected does not depend on prior selections.
- **Surveys:** Surveys are designed to investigate the beliefs, knowledge, attitudes, actions or states of human groups as they are, with minimal interference. Surveys usually consist of extensive studies of a group or population and are designed to yield specific results.

Student Preparation

Students should have a basic understanding of how surveys work to gather data that would otherwise be unobtainable. Teachers can discuss telephone surveys or surveys that have been mailed to households as an introduction to how surveys often are administered. Teachers can review a sampling strategy briefly by asking students how they would select a sample of students from their specific class following the rules for a correct sampling procedure. A very simple random sampling procedure would involve selecting names out of a hat. Each student's name should be written on a slip of paper, folded over and placed into a hat. A blind-folded selector will then pick ten names from the hat. An alternative random sampling strategy uses calculators or computers to generate random numbers. By matching randomly generated numbers against a list of names a random sample can be drawn. For example, if there are 30 students in a class, a list of randomly ordered numbers from 1 to 30 can be generated; students with numbers 1-15 represent a random sample since all students had equal opportunity of being assigned numbers 1-15. Random number tables that can be used for this purpose also are available in many statistics texts that can be found in the library (e.g., Myers, 1969). Once students understand surveys and the importance of random sampling, teachers can present the background information on data from the 1993 National Survey of Drug and Alcohol Use for eighth graders, as well as the 1995 data from the Harvard BASE survey of the Billerica and Lowell school systems.

Materials Needed

- Survey instrument subset from Harvard BASE Survey (included at end of lesson)
- Statistics from background information provided below
- Graph paper and pencil to graph statistical comparisons

Background Information: In 1993, the National Institute on Drug Abuse (NIDA) completed a study comparing surveys on the self-reported drug use patterns of 8th, 10th and 12th graders. This research, known as the Monitoring the Future Study, is a long term (i.e., longitudinal) survey project which examines adolescent drug using patterns. Data is available

from 1973 to the present. Recently, adolescent drug use prevalence rates have shown increases for certain drugs used by 8th, 10th, and 12th graders. For example, in 1992, the eighth grade sample exhibited a significant increase in use of marijuana, cocaine, LSD and other hallucinogens compared with previous samples. By 1993, the eighth graders were joined by the tenth and twelfth grade samples who also demonstrated an increased level of marijuana, stimulants and hallucinogens use (Johnson et al., 1994). This data was derived by surveying approximately 18,300 students. In 1993, the 8th grade sample revealed:

- 12.6% had used marijuana in their lifetime and of those, 5.1% had used in the past 30 days
- 19.4 % had tried various inhalants in their lifetime, and of those, 5.4% had used in the past 30 days
- 45.3% had smoked cigarettes in their lifetime, and of those, 16.7 had smoked in the past 30 days
- 67.1% had used alcohol in their lifetime, and of those, 26.2 had used an alcoholic beverage in the past 30 days -- 26.4% of eighth graders reported getting drunk at least once in their life.

In 1995, The Harvard BASE Project conducted a survey with a random sample of middle school students drawn from both the Billerica and Lowell middle school districts. In this survey, local 8th graders stated that:

- 26.1% had used marijuana in their lifetime and of those, 11.2% had used it in the past 30 days
- 16.4% had used inhalants in their lifetime and of those, 8.6% had used these in the past 30 days
- 41.1% had used tobacco in their lifetime and of those, 21.9% had used it in the past 30 days
- 54.2% had used alcohol in their lifetime, and of those, 25.1% had drunk an alcoholic beverage in the past 30 days.

In addition to comparing local with national rates, teachers also can ask students to compare and contrast 7th grade substance use levels with 8th grade rates. In the 1995 Harvard BASE Study, 7th graders from the Billerica and Lowell middle school systems reported the following:

- 12.6% had used marijuana in their lifetime, and of those, 7% had used it in the past 30 days
- 19.9% had used inhalants in their lifetime, and of those, 9.1% had used these in the past 30 days
- 25.3% had used tobacco in their lifetime, and of those, 12.3% had used it in the past 30 days
- 31.4% had used alcohol in their lifetime, and of those, 12.8% had drunk an alcoholic beverage in the past 30 days.

Action Steps

1. Ask students to hypothesize, based on knowledge of their own behavior and the behavior of the peers, what percentage students in their grade (1) have ever tried

marijuana; (2) have ever used an inhalant (e.g., glue, gasoline or vapor sniffing); (3) have ever tried tobacco; and (4) have ever tried alcohol.

2. Write the hypotheses that the majority of the class can agree upon for the questions in step one on the board.
3. Present students with the national statistics on eighth graders provided below. Ask students if they wish to revise their hypotheses based on these statistics.
4. If students are not eighth graders, ask them to hypothesize what the eighth grade use in your area is likely to be based on the national survey statistics and what the students know of their peers.
5. Discuss the definition of a survey. Explain the differences between surveys and observations in nature. For instance, surveys are performed exclusively with humans. Observations can be done with anything in nature. In surveys, there is often some interaction between the investigator and the humans under study; in observations, the investigator tries to minimize the amount of interaction with the subjects under study as much as possible. Discuss surveys as a special scientific method that is used to gather information that cannot be collected via observation or designed experimentation.
6. Introduce the parts of a survey; describe how surveys are given including discussion on full populations versus random selection of subjects in a sample.
7. Give students a copy of the questions used in the Harvard BASE survey (found at the end of this lesson). These questions were asked of a sample of Massachusetts middle school students so that scientists could get an idea of drug and alcohol use by that age group in that area. Discussion on anonymity and confidentiality can be presented so that students can understand why students would admit to illegal behaviors such as underage alcohol, tobacco, and illicit drug use.
8. Give students the data from the Billerica survey and the national survey; ask them to compare these data sets. They can use line or bar graphs to illustrate the data.
9. Students can the choose data they deem important; however, their presentation should be logical and easily understood by other students. Have them justify why they chose to present each of the data sets in the manner selected.
10. Are students comparing similar data? For instance, what would be the problems with a comparison between Harvard BASE Project 7th grade data with national survey 8th grade data? What would students do with different types of data that are not comparable? For instance, the National Survey reports rates of eighth graders admitting to intoxication, whereas the Harvard BASE survey does not report these rates.
11. Compare the completed graphs included in this activity (Figures 1-3, found at the end of this lesson) with the student graphs.
12. Did students notice that inhalant use by Harvard BASE 7th graders was greater than inhalant use by both the Harvard BASE eighth grade and national survey eighth grade groups? How do students explain this? Teachers should note that national survey results reflect that inhalant use tends to peak at about the 8th grade. Harvard BASE data from 1995 indicate that 7th grade is the time in middle school during which highest level of inhalant use occurs. Sixth grade students reported inhalant use was at

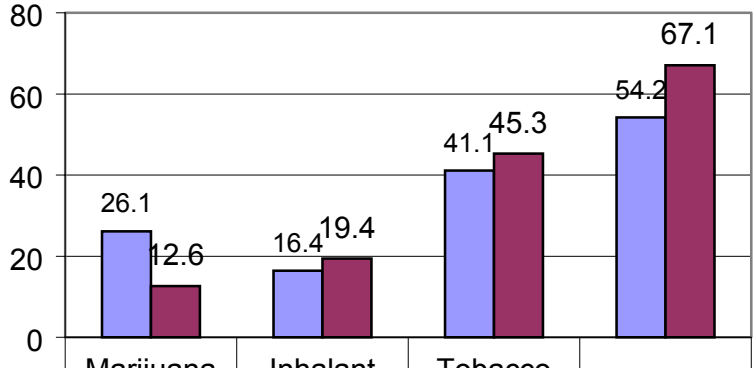
17.6% for lifetime use and 7.7% of 6th grade students reported using inhalants during the month prior to the survey.

13. Ask students why they think inhalants are so popular among middle school students compared with high school students. How does the price and accessibility of these drugs influence their popularity?
14. Ask students what they noticed about local marijuana use compared with the national survey data on marijuana use. Why do students think marijuana is popular? Do the students know that the chemicals produced by the combustion of smoking marijuana cigarettes are more toxic than those produced by smoking cigarettes, or do they think marijuana is safer than cigarette smoking?

Questions for Follow-Up

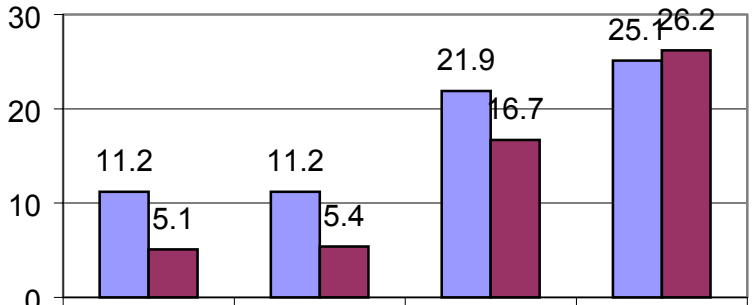
1. Ask students if they would like to conduct their own survey about the behaviors, attitudes, or ideas of their class. They must go through the process of defining the question that they wish to be answered, and drawing up a small survey to answer that question.
2. Ask students why they think inhalants, alcohol and cigarettes are the most popular substances among their peers. What makes these substances potentially dangerous for users?

Figure 1: Local vs. National comparisons of 8th grade student lifetime alcohol & drug use



	Marijuana Use	Inhalant Use	Tobacco Use	Alcohol Use
Billerica/Lowell	26.1	16.4	41.1	54.2
National	12.6	19.4	45.3	67.1

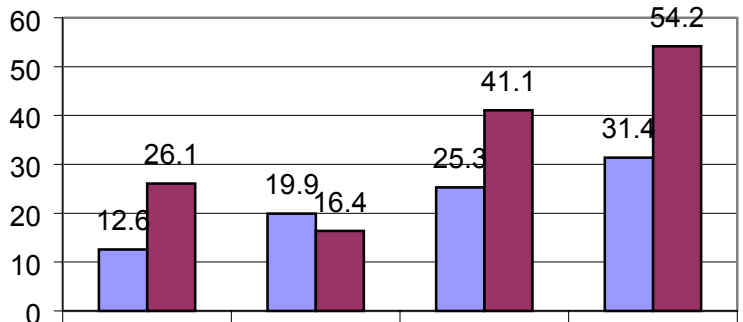
Figure 2: Local vs. National comparisons of 8th grade student alcohol & drug use for the past 30 days



	Marijuana Use	Inhalant Use	Tobacco Use	Alcohol Use
Billerica/Lowell	11.2	11.2	21.9	25.1
National	5.1	5.4	16.7	26.2

Billerica/Lowell National

Figure 3: Local student lifetime alcohol & drug use: Comparison between 7th and 8th graders



	Marijuana Use	Inhalant Use	Tobacco Use	Alcohol Use
7th Graders	12.6	19.9	25.3	31.4
8th Graders	26.1	16.4	41.1	54.2

7th Graders 8th Graders

STUDENT WORKSHEET:

QUESTIONS FROM THE HARVARD BASE MIDDLE SCHOOL SURVEY

Using the following scale, when was the most recent time that you participated in the following activities?

0 = Never; 1 = In the past 30 days; 2 = 2 to 12 months ago; 3 = More than a year ago; D = Don't know

Gambling by buying lottery tickets.....	0	1	2	3	D
Smoking or chewing tobacco	0	1	2	3	D
Drinking alcohol	0	1	2	3	D
Using marijuana.....	0	1	2	3	D
Sniffing inhalants (for example, glue, white-out)	0	1	2	3	D
Taking stimulants (for example, cocaine, crack, speed)	0	1	2	3	D
Taking narcotics (for example, heroin, codeine).....	0	1	2	3	D
Gambling on sports, card games, sports cards or other activities ..	0	1	2	3	D

Using the following scale, during this school year, about how many of your close friends:

0 = None; 1 = A few; 2 = Some; 3= Most; 4 = All

Smoke or chew tobacco.....	0	1	2	3	4
Drink alcohol.....	0	1	2	3	4
Use marijuana.....	0	1	2	3	4
Gamble by buying lottery tickets.....	0	1	2	3	4
Sniff inhalants (glue, white-out).....	0	1	2	3	4
Take stimulants (cocaine, crack, speed).....	0	1	2	3	4
Take narcotics.....	0	1	2	3	4
Gamble on sports, card games, sports cards or other activities.....	0	1	2	3	4

Lesson: They Melt in Your Mouth, Not in Your Hand

Objective

This lesson will show students how appearances can be deceiving, even with something as innocuous as M&M candies. This is a "case study" lesson which can be used in tandem with the next case study (i.e., "Things are not always what they seem") to show how poor decisions are made when facts are unclear and students act impulsively. Alternatively, these case studies can be presented as separate and independent activities. An allergic reaction to food is presented in this case study and a typical reaction to a drug overdose is presented in the next lesson. This lesson introduces the concepts of addiction, dependence, and allergies.

Featured steps of the Scientific Method

- **Determine the Question or Problem of Interest:** The questions of interest in this lesson are derived directly from the incident provided in the case study. Once students have heard the narrative case study they should ask themselves the following questions: (1) What happened to Joe at the party? (2) What is Joe's relationship with M&Ms and (3) Is Joe's relationship with M&Ms problematic?
- **Construct an Explanation, Prediction or Hypothesis:** Using information from the case study, students will hypothesize what happened to Joe. Once students understand the concept of dependence upon a substance, they may hypothesize whether or not Joe has an M&M dependency.
- **Determine the Source of Data (e.g., Subjects, Evidence) to be Examined:** Students must test their hypotheses regarding Joe and his behavior using the information and details from the case study. Teachers can guide students through their testing process by asking the questions provided in the action steps. In addition, selected students will get to try the M&M's for themselves to see if they can stop eating M&M's after having just one.
- **Preparing a Data Collection System and Enter the Data:** As the teacher reads the narrative case study to the students, students should be jotting down important facts and details concerning the case. Once teachers have read the narrative, they can make a list -- elicited from the students -- concerning the salient facts about Jumpin' Joe. Teachers should help students discern between relevant and irrelevant data.
- **Interpreting Data, Presenting Findings and Drawing Conclusions About the Hypothesis from the Data:** Were the students' hypotheses supported by the evidence? Are terms like addiction and dependence often overused and misused so that their meaning gets fuzzy? Shaffer (1995) cautions "[t]he average citizen will find that, without a clear definition of addiction, the distinctions among an array of human characteristics (e.g., interest, dedication, attention to detail, obsession, compulsion and addiction) will remain blurred.

Key Concepts

- **Addiction:** ◙ The term addiction is applied broadly according to the Merriam-Webster Medical Dictionary as "persistent compulsive use of a substance known by the user to be physically, psychologically, or socially harmful." To this definition we should add: "an addictive behavior is the persistent and compulsive need for a specific behavior known by the user to be physically, psychologically or socially harmful (e.g., gambling). Fleming, Potter & Kettyle (1996) define addiction as "the compulsive use and impaired control of intake of a drug despite its adverse consequences. Characteristics of [drug] addiction include preoccupation with the acquisition of the drug, compulsive use of the drug, propensity to relapse, loss of control, and denial. Specific areas of the brain account for each of these features of addiction. The definition of addiction incorporates tolerance, dependence, and two other important elements -- compulsive drug use and loss of control" (p. 9). One guide to thinking about addiction is to think of the "**3 C**'s." Substance abuse and addictive behaviors tend to involve the following patterns: (1) **C**ompulsion to use the drug or engage in the activity; (2) a feeling of being out of **C**ontrol regarding the drug use or activity; and (3) **C**ontinued use in the face of adverse physical or emotional reactions.
- **Allergy:** ◙ An allergy is a condition in which the body produces an abnormal (i.e., meaning not typical of the general population) immune response to certain antigens (i.e., foreign substances) which include dust, pollen, specific foods or drugs, and fur or dander of specific animals. These irritating substances are also known as allergens. Allergies are exaggerated reactions to things that normally are destroyed by antibodies in non-allergic people. People with allergies release an over abundance of histamine to counteract the antigen. This histamine release may result in itching, skin rashes, sneezing, respiratory problems, and other problematic physical states.
- **Drugs, Drug Products, & Drug Substances:** ◙ A general definition of a drug is: "any chemical agent (natural or synthetic) that affects living processes" (Shaffer & Kaufman, 1985, p. 38). The Federal Food and Drug Administration defines medical drugs as (a) articles recognized in the official United States Pharmacopoeia, official Homeopathic Pharmacopoeia of the United States, or official National Formulary, or any supplement to any of them; and (b) articles intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in man or other animals; and (c) articles (other than food) intended to affect the structure or any function of the body of man or other animals. A *drug product* is the finished dosage form (e.g., tablet, capsule, etc.) that contains a drug substance generally, but not necessarily in association with other active or inactive ingredients. The *drug substance* of a specific drug is the actual active ingredient intended to diagnose, treat, cure, or prevent disease or affect the structure or function of the body.
- **Drug Dependence:** ◙ Dependence has been defined as the "persistent drug intake to prevent or diminish the physical or **psychological** disturbances of withdrawal" (Fleming, Potter and Kettyle, 1996, p. 7). Addiction and dependence are terms that tend to be used interchangeably -- a problem that keeps lay people and clinicians alike mired in what Shaffer (1995) calls "conceptual chaos." Teachers may wish to

view addiction as a continuum of behaviors with dependence representing a particular point or set of behaviors on that continuum, related to the use of specific substances or activities. In other words, addiction refers to a variety of *compulsive* and *excessive* behavior patterns, such as compulsive gambling, whereas dependence refers specifically to the problems associated with *physical adaptation* (i.e., neuroadaptation). Neuroadaptation is a physiological phenomenon associated with development of tolerance and withdrawal. The term addiction is not present in the DSM-IV (i.e., Diagnostic and Statistical Manual of Mental Disorders) chapter on "Substance-Related Disorders." However, the term dependence is present in the diagnostic manual and is associated with a variety of substances and substance using patterns. The DSM-IV states that "[t]he essential feature of Substance Dependence is a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance-related problems. There is a pattern of repeated self-administration that usually results in tolerance, withdrawal, and compulsive drug-taking behavior" (1994, p. 176).

Student Preparation

For this lesson, students will need to have the background material provided as well as the definitions listed above. It also may be helpful for teachers to elicit preconceptions regarding allergies.

Materials Needed

- Four bags of M&M's, 1 bag each of each type: plain, peanut butter, peanut, and almond
- One bowl in which to put the mixed M&M's
- Background information and case study provided below

Background information. Jumpin' Joe loves rock-n-roll and likes to play basketball. He is very popular with the other kids in middle school. He dresses well and is a very good athlete. He loves to eat peanut M&M's. He doesn't eat them everyday or even every week -- especially when he's in training -- however, when he does eat M&M's, he eats a lot of them. In fact, Joe says he can never eat just one, or even just one dozen, even though no-one has tested him in this area. When Joe's friends see him in the school corridor or at school dances they give him peanut M&M's. Joe is very attractive. The girls in the school think it is fun to feed him M&M's when they see him. Since Joe loves the attention he receives from the girls, he tries to impress them by eating more than a dozen M&M's at any given time.

Angel is a new girl in the middle school who moved from New York City. Jumpin' Joe thinks Angel is very smart and quite pretty. Joe would like to impress Angel so that she will go to the Halloween dance with him. Rumor has it that Angel thinks Joe is cool.

Teacher Guide: At this point in the narrative, ask the students:

1. Do they think the amount of M&M's Joe consumes is a problem for Joe?
2. Do they think the amount of M&M's Joe consumes is a problem for others?
3. Why do the students think Joe likes peanut M&M's so much?

Joe suffers from some allergies. He is allergic to gluten and any products that contain wheat-barley-rye-oats and malt. He also suffers from an allergy to almonds and cashews. He can eat peanuts and walnuts without any problem.

>>At this point teachers should discuss what an allergy is, and why some people have them when others do not. Then, teachers can return to the narrative:

Angel decides to have a "welcome me to the school" party and invites Jumpin' Joe and his crowd. When Joe comes to the party, he is really excited -- the music is excellent, the lights are low -- everyone is having a great time drinking Dr. Pepper, eating pizza, and having fun. Joe spots at least four giant bowls of mixed M&M's. Angel knew he loved M&M's so she bought all four types for him. Joe thinks that he is in M&M heaven.

Teacher Guide: At this point in the lesson you should:

1. Mix the four different types of M&M's in one bowl.
2. Ask the students if anyone has an allergy to specific nuts, chocolate, gluten or if anyone has had any other problems eating any type of M&M's.
3. Show the bowl of M&M's to the class and offer one to a non-allergic student -- make sure it is only one.

When Joe sees the M&M's he quickly begins to eat many from the bowl, washing them down with Dr. Pepper. He continues to dance, sing and eat more M&M's for a few minutes. Suddenly, however, Jumpin' Joe looks very pale and becomes short of breath. He looks as though he is about to become quite sick. He then passes out!

Teacher Guide: At this point in the lesson you should:

1. Have the students view the M&M's with the room darkened and have them attempt to figure out which type is which. The peanut and almond M&M's look quite similar; the plain and peanut butter M&M's can be labeled correctly when seen.
2. Have a student pick out one M&M and tell the class which type it is.
3. Have different students taste the M&M's to see if they can tell the difference between these.
4. Remind the students that they can have only one M&M each time. If they want more, do not allow them to have more.

Action Steps

1. Most of the action steps for this exercise are embedded within the narrative. Before presenting the narrative, ask students what they think addiction is, then ask them what they think dependence is. Write relevant answers on the board.
2. Present students with definitions for addiction, allergies and dependence highlighting the differences.
3. After presenting the information on addiction, allergies, and dependence, read the students the case study regarding Jumpin' Joe and follow the instructions in the narrative as you go.

4. Once the narrative case study is completed, ask the students whether or not they think Joe is addicted to M&M's. Then ask the students if they think Joe is dependent on M&M's. Finally, ask students if they know why Jumpin' Joe got sick.
5. Do the students think that Jumpin' Joe knew about the almond M&M's (remember, these are a relatively new type of M&M and not all children know the difference between these and other M&M's).
6. Ask the students if they think that it is easy to eat just one M&M at a time. If they state that it is not easy, ask them why they think it is difficult to stop at just one. Discuss what M&M's are made of (i.e., sugar, chocolate -- which contains small amounts of caffeine, and larger amounts of theobromine, a close chemical relative to caffeine). Weil (1993) states "one of the most famous sources of caffeine is chocolate, also made from the seeds of a tropical [i.e., the cacao] tree. Chocolate, which contains a lot of fat and is very bitter, must be mixed with sugar to make it palatable. It, too, contains a stimulating drug [i.e., theobromine]...." (p. 43).
7. List the salient details of the case on the blackboard. Salient details are all facts pertaining to Joe's use of M&M's, his allergies, and his behavior.
8. Once these details are listed, ask students the following questions: Is it fair to say that Jumpin' Joe is addicted to M&M's? **Teacher Guide: The answer is no. Joe likes the attention he gets from girls when they feed him M&M's and he likes M&M's a lot; however, he has not stolen or committed socially egregious acts in pursuit of M&M's. His school activities are not failing due to a preoccupation associated with procuring and eating M&M's. His social activities have more to do with his outgoing personality and talents than his interest in M&M's. Use of M&M's has not regularly gotten Joe into trouble -- his last episode with almond M&M's was an accident, however. Of course, had Joe been less impulsive about grabbing as many M&M's as he could, he might have checked to see if almond M&M's were present. However, almond M&M's are relatively new on the market, and it was fair for Joe to assume that he could eat what was in the bowls without getting ill. Now, if Joe continued to be careless about his M&M intake after this episode, or if he continued to eat almond M&M's in spite of this adverse reaction, addiction might be emerging. Similarly, if Joe started to experience problems in his life -- losses at school or home due to his obsession with M&M intake -- one could say that Joe's M&M use was problematic. If these behaviors continued in spite of repeated problems and losses it would be fair to say that Joe was addicted to using M&Ms.**
9. Ask the class if Jumpin' Joe was dependent on M&M's? **Teacher Guide: Once again the answer is no. It is unlikely that Joe could not get through the day normally without an M&M -- he does not eat them every day, or even every week. He does not eat them during basketball training and he manages to be a great basketball player. He has no evidence of an M&M withdrawal when he does not eat M&M's. He does not exhibit either physical or psychological dependence on M&M's. No one has ever tested Joe to see if he could stop eating M&M's after having just one, or two; however, his patterns of being able to quit M&M use when he wants to, without any side effects or withdrawal symptoms, indicates that he is not dependent.**

10. Ask the class if Jumpin Joe's reaction to the M&M's was the result of an allergic reaction to a specific type of M&M or an overdose of M&M's in general? How do they know? **Teacher Guide: Jumpin Joe has been eating so many regular and peanut M&M's for so long that it is unlikely that he could overdose from the amount of peanut and regular M&M's he ate at the party. Joe's reaction to the M&M's he ate, however, was very rapid and extreme. We have evidence that he is allergic to almonds. As Joe ate whatever he could grab from the mixed M&M bowls, he stood a good chance of grabbing and eating a few almond M&M's. Thus, it is much more likely that Joe's reaction was an allergic one to a specific type of M&M rather than an overdose of M&M's in general.**

Questions for Follow-Up

1. Can students name other ways in which the words "addiction" or "overdose" have been misused? For instance, is it possible for someone to be a "addicted" to books, or to "overdose" on studying, or talking to one's friend on the telephone? What do the terms "love-addicted" or "workaholic" mean?

Lesson: Things Are Not Always What They Seem

Objective

This lesson will teach students that the consequences of poor logic can be tragic. In addition, they will learn about the effects of a drug overdose. Students will apply the scientific method to investigate a case study. Specifically, the case study will illustrate the problems that can happen when someone inhales a white powder without knowing its content.

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** The question of interest in this exercise should be discussed once students receive a brief background on drug overdose, the differences between effects from stimulant overdose compared to narcotic overdose, and have heard Bill's case study. After students have heard Bill's case study, they should ask themselves the following questions: What happened to Bill? What likely was the content of the powder that he inhaled? What was Bill's justification for using the powder?
- **Construct an Explanation, Prediction or Hypothesis:** Using the information on stimulant and narcotic overdose, as well as the details from the case study, students should be able to hypothesize what Bill ingested and what happened to him. They also should recognize that a number of factors biased his thought process so that he could justify his behavior. His assumptions about what he was ingesting, his predictions about what would happen when he ingested it, and his reasons for ingesting the powder were based on poor evidence and an absence of logic.
- **Prepare a Data Collection System:** As a teacher presents information about stimulants, narcotics, and Bill's experience, students should jot down facts and details. Teachers also should help students discern between relevant and irrelevant data.
- **Interpret and Present Findings; Review Information in Light of New Findings:** Based upon the available evidence, did the data support the students' hypotheses regarding Bill's experience? Use follow-up questions to reinforce the lessons associated with this activity.

Key Concepts

- **Critical Thinking:** "Critical thinking is an approach to problem solving and decision making. Good science cannot be done without it. The basic processes of critical thinking include planning, information gathering, defining a frame of reference or context, monitoring, accounting for biases and evaluating. Critical thinking involves recognizing and accounting for the assumptions, background logic, biases, intentional deception, and other factors that tend to distort the outcome of scientific thought processes" (Carr, 1992, p. 20).
- **Hypotheses:** Hypotheses are scientific hunches. Hypotheses are attempts to formulate reasonable or logical explanations of a single event, pattern of events or phenomena. In some cases, a hypothesis represents one reasonable explanation that

will account for most of the data. Hypotheses are neither right nor wrong. Hypotheses simply receive support or fail to receive support from the available evidence. Hypotheses are stated so that each formulation of explanation can be tested against reliable observations; based upon the results of these tests, hypotheses are supported or rejected.

- **Predicting: Predicting** is the act of stating precisely what one thinks will happen in a future situation/event/occurrence based upon current information. As the available information becomes more sophisticated, so do predictions. Like hypotheses, predictions should be discussed as "being supported by the data" or "not supported by the data" rather than as right or wrong (Barhydt & Morgan, 1993).
- **Overdose:** An overdose of something is exactly what it sounds like: too much of a substance, or using more than the recommended dosage. In the context of drug use, an overdose of a drug can cause people to be: (1) unconscious of their activities for a brief period of time (e.g., as in a blackout); (2) completely unconscious and inactive (e.g., as in passing out); or (3) leading to coma or death in an extreme case of an overdose. Signs and symptoms of an overdose depend upon which drug or medication has been ingested. For instance, a narcotic overdose (e.g., heroin) not only depresses the nervous system, causing people to lose consciousness, it also depresses the respiratory system, causing shallow breathing or, in extreme cases, respiratory arrest. By contrast, stimulant overdose (e.g., cocaine or amphetamine) accelerates heart rate and blood pressure while causing blood vessels to constrict. This situation can lead to heart attacks, strokes, or, in extreme cases, seizures.

Student Preparation

To complete this activity, students will need the definitions presented above as well as the brief background information provided below. It is helpful to elicit preconceptions about depressant and stimulant drug use; depending upon how much students already know about these drugs, teachers can provide more or less background information. However, since there is considerable variability around the knowledge associated with these drugs, we recommend a careful review of stimulating and depressing drugs.

Materials Needed

- Paper and pen or pencil
- Background information on stimulants and narcotics provided in the following section.

Background on cocaine and amphetamines. Cocaine and amphetamines are the stimulants that commonly come to mind when people discuss chronic stimulant abuse and the array of physical, psychological and social problems that stimulant abusers often face. Cocaine and amphetamines can be inhaled (i.e., snorted), smoked or injected. Originally, cocaine was used a topical anesthetic. Cocaine and amphetamines are available in a white powder form for snorting. Physically, cocaine and amphetamine use cause a rush of adrenaline that increases heart rate and constricts blood vessels (i.e., capillaries, veins and arteries) causing an increase blood pressure. For users, cocaine or amphetamine use has the capacity to cause heart pain,

irregular heart beat, or a ruptured heart valve. People with heart conditions are at greatest risk for these complications of use. People who have suffered from a previous head injury or who are at risk for having seizures increase their chance of having a stroke or a seizure from cocaine or amphetamine use. Even young and healthy first time users of cocaine or amphetamine put themselves at risk for heart attack, stroke, or seizure depending on the amount and purity of the stimulant ingested. Len Bias, the young basketball player attending the University of Maryland in the late 1980's, died from a heart attack after ingesting cocaine. People who abuse cocaine and amphetamines also can suffer important psychological consequences. Indeed, chronic stimulant users may experience "...irritation, outbursts of anger, violent or assaultive behavior, paranoia, delusional thinking, visual and auditory hallucinations, or any combination of these symptoms (Kauffman et al., 1985, p. 8). In addition, even after users stop ingesting stimulants, this group remains at higher than normal risk for anxiety disorders.

Background on heroin. Heroin is an illegal drug scientists classify as an analgesic (i.e., a pain reliever). Heroin's chemical structure is similar to morphine, which is a natural analgesic. "Just before the turn of the century, morphine was altered chemically to produce heroin in an attempt to find a more effective pain killer which did not have addictive properties. Unfortunately, the opposite proved to be true. Since heroin crosses the blood-brain barrier much more rapidly than morphine, the rush was more instantaneous and intense, thus creating a subculture of heroin abusers in the 20th century" (Inaba & Cohen, 1993, p. 100). Heroin can be injected under the skin, into a muscle or vein, snorted, or smoked. Heroin is available in powder form; it can be beige, white, or light brown in color. Taken by injection, heroin usually provides users with an intense "rush" or good feeling (i.e., euphoria) that lasts a few minutes, followed by a feeling of calm, peacefulness, or drowsiness. Smoking heroin provides a somewhat less intense response; eating heroin stimulates an even more mild response. Sometimes, first time heroin users experience nausea and vomiting.

Users of heroin often report that it makes everyday problems fade away; it provides users with a sense of peace that they never felt possible. Of course, once users of heroin have had their high diminish, it becomes quite apparent that their real world problems remain -- including the new problem of how to pay for more heroin. "The power of the heroin rush to make people uninterested in other experiences and totally committed to heroin is so overwhelming as to be an argument against ever trying the drug at all " (Weil & Rosen, 1993, p. 87).

Problems with heroin use. Like cocaine and amphetamines, heroin is illegal in the United States. Heroin is sold in black markets or on the street; therefore, there are no controls on the drug's purity or content. This problem becomes apparent when a user, who is used to purchasing a heroin compound that is 7% pure, ends up with a product that is closer to 70% pure. When this circumstance affords users the opportunity to take their regular dose, the more pure heroin is 7 times the strength to which they have adapted (i.e., become tolerant). These users are leading candidates to overdose from heroin use. Furthermore, drug dealers often mix their products with other impure materials. For instance, heroin is often mixed with infant laxative, Tylenol, or vitamins to make the actual volume of the product increase, thereby increasing their profits. These impurities, when injected into the bloodstream, under the skin, or into a muscle can cause dangerous infections.

Heroin overdose. Whereas cocaine and amphetamine overdose can result in heart attack, stoke or seizure, heroin overdose can lead to a complete depression of the nervous and

respiratory systems. When people overdose on heroin (i.e., taken too much), they likely will suffer with some or all of the following problems: (1) depressed respiratory system to the point where breathing is very slow and shallow; (2) clammy skin; (3) tiny pupils; (4) very depressed levels of consciousness -- sometimes to the point of unconsciousness; (5) lowered blood pressure sometimes combined with rapid or even inconsistent heartbeat; (6) convulsions; (7) coma; (8) hypersensitivity to impurities in the heroin compound that can result in life-threatening anaphylactic shock; or (9) death from any of the above mentioned problems (e.g., coma, convulsions, anaphylactic shock, depressed respiratory system, etc.). Unfortunately, when users of heroin overdose, they are often in the company of other drug users who are either unwilling to call for help in an emergency since they are afraid of being caught using illegal drugs or are unable to get help because they are intoxicated. Intoxication places most drug users in a mental condition that makes responsible behavior difficult; it should suffice to say that they are ill prepared to handle a crisis.

Narrative Case Study: "Things Aren't Always What They Seem"[5]

Bill is a 17 year-old boy who is entering his senior year of high school. He maintains a solid "B" average and is interested in attending the local University upon graduation. He has a variety of friends at school: some are in the student government, some are on his football team, others are on the school newspaper. Some of Bill's friends are less academically involved. In fact, some are the type of friends that he knows his mother can't stand. Bill's classmates often refer to this last group of friends as "stoners." Bill enjoys this group of friends. He calls them his "let loose" crowd because he feels totally relaxed with them. They don't seem to be very judgmental; they listen to great music and talk about very interesting things. Bill doesn't smoke cigarettes, although he tried them on a few occasions. He has asthma and cigarettes just make his breathing worse. Bill thinks marijuana is a pretty boring drug and its smoke also aggravates his lungs. However, Bill has tried marijuana with his football friends as well as with his "let loose" friends. On the 4-5 occasions he has had marijuana, Bill never had more than half a marijuana cigarette (joint). Each time he tried marijuana, Bill just wanted to eat Doritos and watch TV.

Over the summer, Bill began partying more and more with the "let loose" crowd. At one party, a friend brought some white powder cocaine and everyone, including Bill, tried one "line" (approximately 1/16th of one gram) of the cocaine by snorting it. Bill inhaled the powder through a small (3") straw or a rolled up dollar bill. Bill thought it was fun, but couldn't see the huge attraction associated with cocaine; it just made him feel like dancing the whole night -- even though he wasn't really sure who to dance with -- or be really "hyper" when he was standing around. When he tried cocaine, he couldn't sleep at all that night. Eventually, one of the girls from his "let loose" group introduced her sister, Amber, to Bill at a party. Amber was visiting from California and she thought the group was okay, but pretty straight.

One evening, when the group was at Bill's house and his parents were gone for the weekend, everyone had a few beers and one of the group members brought out some cocaine for everyone to split. Amber started laughing and asked some of the people how they thought they were ever going to get high on such a small amount of cocaine split so many ways among them.

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[5] *This case study portrays a young man who overdoses on heroin because he thought that he was ingesting cocaine.*

Amber then turned to Bill and said, "I've got something much more interesting for you to try. It's called China White, and it's the best." Bill smiled and said "China White? I thought most cocaine came from Bolivia or Columbia." Amber laughed even harder and said, "Well sweetie, this is better than any Bolivian you've ever snorted." Bill looked at Amber: to him she looked gorgeous and wise. He looked at the white powder that she had cut into four lines for them to snort. He also thought that the cocaine he had tried before was no big deal. He thought, why not try more -- say double the amount -- and see what would happen. He also wanted to show Amber that he wasn't some dork. A little more cocaine wasn't going to give him a heart attack or anything, so he combined three of the powdered "China White" lines into one large line and snorted all of it.

Bill then passed his demi-straw to Amber, who looked at him like he was insane, and then he just sat for a few minutes. Suddenly, he felt as though he was going to vomit everything he had eaten for that week. Oddly enough, this thought didn't bother him at all. He attempted to stumble toward the bathroom, feeling mildly amused by the situation. He didn't get very far; he just decided to fall into a corner and get sick. Bill never thought getting sick was any fun; but this time it was painless, and even funny. He thought it was mildly disgusting. The fact was, he couldn't care less that he was getting sick in front of a girl who he was trying to impress just moments earlier. He didn't care about all the other people at the party. He just wanted to get it over with and sleep. Bill finished retching and tried to say something to Amber. He realized that his voice was one large wheezing sound. He thought maybe he was having an asthma attack, but he wasn't sure. He just knew that breathing was getting more and more difficult. Once again, he wasn't anxious at all about not being able to breathe. Gradually, he fell unconscious to the floor.

Action Steps

1. Tell students that they are going to discuss critical thinking and how it is applied both inside and outside the classroom. Discuss the problems with (1) assumptions and (2) predictions based on little evidence. Compare and contrast assumptions and predictions with hypothesis construction. Tell students you are going to tell them a story about the problems a high school student encountered when he made an assumption about a white powder and what he could do with it.
2. After the preceding discussion, explain to students that you are going to discuss the differences between two powerful white powders -- other than sugar -- that can produce "...striking changes in the body and mind in tiny doses" (Weil & Rosen, 1993, p. 9). These two drugs are cocaine and heroin. Give the students the information in the background section on cocaine, amphetamines and heroin.
3. When it appears that students have a grasp on the key concepts and background information, read the case study. Upon finishing the case study, teachers should ask students what they think happened to Bill. Students can write down their observations to formulate a general hypothesis regarding Bill's situation. Students then can test their hypotheses using the following steps based on the evidence that they were able to collect from the case study.
4. Have students do some data collection: students should make a list of the various substances Bill had tried with his different groups of friends, the amounts that he has used, and how often he has used them.

5. Beside each substance noted from their first list, students can describe the feelings Bill associated with each of the substances he had taken. Also, students may describe the activities in which Bill was engaged or thinking about doing after he had taken each substance.
6. Ask students: "Given what has been taught about some illicit substances, what drugs do you think Bill used with Amber? Do you think Bill was simply "high" or intoxicated from the substance Amber gave him? Do you think Bill suffered an overdose from it?" Ask students to explain each of their answers.
7. In the case study, Bill took an illegal substance thinking it would have a specific effect on him. He anticipated this effect based on previous experience with another illegal substance that looked almost exactly like the one Amber gave him. Ask students about his poor logic in this instance. Ask about the other influences on his thought process as well.

Questions for Follow-Up

After going through the steps involved in the scientific method of inquiry regarding Bill's loss of consciousness, it should be clear to the students that Bill suffered an overdose from ingesting the three lines of heroin or "China White" that Amber gave him. Bill displayed the typical signs of heroin overdose by someone new to heroin ingestion. Students should also consider the following questions:

1. Did Bill have any clues that he might be taking an "unknown" substance before he took it?
2. Do you think he would have taken the substance even if he had known what it was?
3. Was there any point in this case, before Bill lost consciousness, where you thought Bill should have thought twice about what he was taking?
4. Think about the circumstances surrounding Bill's loss of consciousness (e.g., the other people, what everyone was doing and taking, how Bill got the substance, why Bill snorted how much he snorted, etc.). Was Bill even interested or capable of using logic in his situation?
5. Think about people who take illicit or "street" drugs in general. Can they ever be completely sure of what they are getting when they buy or take a drug from someone else? Can you think of reasons why they wouldn't or would care?
6. Bill is unconscious from his overdose by the end of the story. What might happen to him if he doesn't get medical help or intervention? Explain your answer.
7. How likely do you think it is that Bill's friends will get him some medical help? If Bill were somewhere else; for instance, in a park with Amber and her California friends, do you think it would be more or less likely that someone would get help for him?

Lesson: Emotions and Craving6

Objective

This lesson gives students the opportunity exercise more skills in data collection, measurement, and hypothesis testing. In addition, it informs students about the possible relationship between emotional states and behavior.

Featured Steps of the Scientific Method

- **Determine the Question or Problem of Interest:** In this exercise, the following question is of interest: "is the desire or craving to engage in a pleasurable behavior linked to particular emotional states?" For instance, if a student's favorite or most pleasurable activity is eating ice cream, is the student more or less likely to crave ice cream when he or she feels a certain way (e.g., tense, relaxed, sad, happy, restless, calm, frustrated, satisfied, anxious, carefree)?
- **Construct an Explanation, Prediction or Hypothesis:** Gossop (1990) notes that addiction scientists were interested in the relationship between mood and the craving of particular substances (in this case, cigarettes and opiates). What scientists discovered was that strong craving or desire to use these substances was associated more closely with the following emotional states: being tense, unhappy, restless, anxious, or frustrated. For this exercise, students will be asked to hypothesize which feelings are likely to be linked more strongly with the desire to participate in their favorite activity.
- **Determine the Source of Data (e.g., Subjects, Evidence) to be Examined:** In this exercise, the subjects are the students themselves. Data will be collected on how students rate their level of craving to perform their favorite activity when they feel a certain way.
- **Prepare a Data Collection System:** Students may use the table at the end of this exercise to complete the activity, or they may elect to modify it in some way (e.g., by adding other emotional states). If the table is modified, it is critical that all students receive the same data table with the same emotional states and the same rating scale.
- **Enter and Chart the Data for Analysis:** The class will total the craving score across all of the students for each of the emotions. The total scores will demonstrate which emotional state stimulates the most craving for pleasurable activities. In addition, students may be able to cluster groups of like activities to see if some emotional states tend to trigger specific types of activities.
- **Interpret and Present Findings:** Gossop (1990) noted that cigarette and opiate addicts craved their substances of choice most intensely during particular emotional states (i.e., when tense, unhappy, restless, frustrated, or anxious). The subjects also were asked to rate their craving for substances when feeling either excited or

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[6]The idea for this exercise came from the article: Gossop, M. (1990). Compulsion, craving and conflict. In D.M. Warburton (Ed.), Addiction Controversies. Chur: Switzerland: Harwood Academic Publishers, (236-249).

curious. Neither excitement nor curiosity stimulated craving for their specific substances. In this study, students may find that some emotional states more regularly stimulated craving for the pleasurable activity than other emotional states. Students should compile class findings to see if some conclusions can be drawn. They may find that particular emotional states trigger particular types of activities (e.g., tension may trigger the urge for a more physical activity, frustration may trigger the urge for an activity that involves eating, etc.).

Key Concepts

- **Craving:** Craving has been described as a an overpowering yearning, a strong desire, a "motivational state associated with a strong desire for an expected positive outcome" (Marlatt & Gordon in Gossop, p. 241), and a desire to experience the effects or consequences of a given act that is assumed to culminate in immediate pleasure or enjoyment (Marlatt & Gordon in Gossop, p. 241). The experience of craving for people dependent on alcohol or other drugs includes feelings that a drug is necessary for normal or optimal levels of functioning. This feeling can range from an a mild desire to an intense drug hunger. When this craving remains unsatisfied, adverse reactions are often experienced by the sufferer and sometimes evident to observers. These reactions may be perceived as unusual agitation, anxiety, depression and/or acting out.
- **Craving and Addiction:** What patients, physicians and researchers mean by "craving" varies greatly across studies looking at craving and addiction. The phrase "drug craving" is the most commonly reported response to drug signals (Childress et al., 1992). Historically the word has been equated with "withdrawal"; however, people who abuse cocaine often use the word "craving" to label a "a state of intense anticipation for the rewarding effects of the drug" (Childress et al., 1992, p. 66). Using PET scans, scientists are currently trying to visualize the brain chemistry of craving states that have been triggered by exposure to drug-related cues in cocaine-abusing patients. With the future development of radiotracers for many different brain chemical systems, it could be possible to create a picture of what a "craving" state for a certain drug looks like in the brain. Such a "picture" would aid the development of medications that could modify the response to drug triggers (Childress et al., 1992).

Student Preparation

The first lesson in this module (i.e., the lesson on "what's a researchable question") should be completed before attempting this exercise. Many of the action steps in this exercise depend upon student output from the "researchable question" lesson.

Materials Needed

- Paper
- Survey (copy provided at end of lesson)
- Pencil

Background information. The 3-C's. Substance dependence has also been defined by the 3-C's: **C**ontinued use in the face of adverse physical or psychic reactions; **C**ompulsion to use

the drug; and, a feeling of being out of **C**ontrol regarding the drug use. In other words, the 3-C's suggest that drug addiction is the continued use of a drug or drugs in an uncontrolled and compulsive manner in spite of the adverse consequences associated with such use (Gold, Washton, & Dackis, 1985; Smith, 1986). Gossop (1990) notes that the following criteria are elements of what is meant by an addiction:

1. A strong desire or sense of compulsion to engage in the particular behaviors (particularly when the opportunity to engage in such behavior is not available).
2. Impaired capacity to control the behavior (notably in terms of controlling its onset, staying off or controlling the level at which the behavior occurs).
3. Discomfort or distress when the behavior is prevented or stops.
4. Persisting with the behavior despite clear evidence that it is leading to problems (Gossop, 1990, p.239).

Action Steps

1. Ask students to think about the highly pleasurable activities they introduced and rated in the previous exercise (i.e., "what's a researchable question?"). If they still have their information from that exercise, they can use those sheets.
2. On the blackboard, write the list of most highly rated activities in terms of pleasure.
3. Ask students if they understand the word "craving." If they don't, define it for them using the key concept. Ask students to use it in a few phrases to make sure they understand it.
4. Ask students to think of the activities listed on the board and to write down their favorite activity -- the activity has to be one that they do on some regular basis.
5. Ask students when they have a very strong desire or craving to do that activity, and whether the craving to perform that activity is regular and ongoing.
6. Tell students that you are going to provide a list of 10 different feelings or emotions. Next to each emotion, there is a 5 point response scale, where 0 = never, 1 = rarely 2 = sometimes, 3 = often and 4 = always. This list is provided at the end of this lesson in the table on "Understanding the Relationship Between Craving and Emotion."
7. When students get their list, they need to rate the intensity of their craving to do only their favorite activity under each of the emotional conditions listed: for instance, if their favorite activity is playing baseball, do they ever have a craving or desire to play baseball when they are tense? If they never do, they should place a 0 in the correct column next to the word tense. If they sometimes do, they should place a 2 in the correct column next to the word tense. Similarly, if they always crave playing baseball when they are tense, they should circle 4 in the corresponding column.
8. Ask the class to total the score across all of the students for each of the emotions.
9. Which emotional state stimulates the most craving?
10. Based on class results, are there particular emotions that seem to stimulate craving for particular types of activities?

Questions for Follow-Up

1. Ask students to hypothesize why certain emotional states stimulate more craving for pleasurable activities than others. Would this explanation hold for unpleasant activities?
2. What specific factors might be responsible for this relationship?
3. If students have not considered brain chemistry as factor in causing or responding to emotional states, this discussion can be introduced as a conceptual problem which can exercise critical thinking skills.
4. Can the relationship between craving and emotional state change? If so, how? If not, why not?
5. Can students devise an investigation to learn more about the relationship between emotional states and craving.

STUDENT DATA COLLECTION SHEET

Please list your favorite, regular, most pleasurable activity:_____

Look at the emotions in the far left column. Does feeling any of these emotions cause you to crave participating in your favorite activity? If not, check never. If so, please check the box that lists the degree to which you crave indulging in that activity. For instance, if playing baseball is your favorite, regular, most pleasurable activity, does feeling "tense" trigger the craving to play baseball rarely, sometimes, often, or always? If it never does, then you would check the "never" box.

Understanding the Relationship Between Craving and Emotion					
	0 = Never	1 = Rarely	2 = Sometimes	3 = Often	4 = Always
Tense					
Relaxed					
Sad					
Happy					
Restless					
Calm					
Frustrated					
Satisfied					
Anxious					
Carefree					

Lesson: Representation of Cigarettes and Smoking in Magazines

Objective

The objective of this comprehensive exercise is to have students complete a study which examines the representation of cigarettes in magazine advertising media. During this lesson, students will need to go to a public library to collect data from TIME and Newsweek magazines.

Featured Steps of the Scientific Method

- **Identify the Area of Interest:** The area of interest in the exercise concerns the representation of cigarettes and smoking in the media.
- **Research the Available Information:** Students will have the opportunity to review relevant background information provided in the lesson.
- **Determine a Question or Problem of Interest:** The question of interest in this exercise concerns how smoking is represented in print media - specifically news magazines. A second question of interest is whether or not the representation of smoking in print media has changed over the past half century as more information about the dangers of smoking become available to the public.
- **Construct a Prediction or Hypothesis:** In 1964, the Surgeon General released a report indicating that smoking cigarettes is hazardous to human health. Before this report, cigarette advertising in magazines had a certain style, and the volume of advertisements per magazine had a somewhat consistent rate. When the Surgeon General reported the dangers of cigarette smoking, what do students think cigarette advertisers did? Would cigarette advertisers slow down on advertising, and back out of tobacco products contracts since these products were deemed hazardous to health? Or conversely, would advertisers respond by being more aggressive in their advertising and try to make cigarette smoking more glamorous in spite of the Surgeon General's report? Based on their own knowledge, and after reviewing the information presented in the background material, students will have the opportunity to construct hypotheses for the following questions regarding the representation of smoking in the media: (1) did advertising themes in smoking change over time? if so, how?; (2) did advertising volume change over time or in response to information regarding the dangers of smoking? if so how? and (3) did the characters or types of models used in the advertising change over time, if so how?
- **Determine the Source of Data to be Examined:** Students will have the opportunity to examine two news magazines, TIME Magazine and Newsweek over a period of 50 years, to note the changes in cigarette advertising in terms of volume and themes.
- **Determine the Variables to be Used:** The independent variable in this exercise is the time frame in which the first Surgeon General's Report on the dangers of cigarette smoking was made available to the public (i.e., in 1964).
- **Determine the Way to Measure the Variables:** The dependent variable in this exercise is the number of advertisements for cigarettes in various news magazines before and after the Surgeon General's report of 1964, and whether or not that

number changed over time. Other dependent variables to measure include: (1) a change in advertising themes over time (e.g., from a picture of a cigarette box that has advertising copy directed at the inherent pleasure of smoking to a picture of couples smoking and engaging in sports that has advertising copy directed at the pleasures of smoking in association with other pleasures); and (2) a change in advertising characters (e.g., a businessman smoking to "Joe Camel").

- **Prepare a Data Collection System:** Students will have the opportunity to create a data collection system that contains separate tables for different magazines. The collection system should be a retrospective system that goes both forward and backward in time from the year 1964 in such a way that enough data can be collected to see patterns in (1) advertising volume; (2) advertising themes; and (3) advertising characters.
- **Enter Data for Analysis:** Once students have reviewed their data, they will be able to look for trends in advertising volume, themes, and characters. What was cigarette advertising volume like in the twenty years before 1964? How about the 20 years after? The surgeon general's 1964 report targeted the dangers of smoking. Did advertising in the years after 1964 reflect the dangers of smoking while commenting on the pleasures of smoking? Did advertising characters or models seem to appeal to any group of people or did they seem targeted for particular customers? Did similar trends in advertising appear in both TIME and Newsweek magazines?
- **Chart the Data, Interpret Findings:** Once students have reviewed, charted, and analyzed their data, they should be able to see some trends in cigarette advertising. Were advertising campaigns more or less aggressive in response to the 1964 Surgeon General's report? Did advertising change in terms of volume, theme, and characters? If so, how?
- **Present Findings:** Students will have the opportunity to graph and chart their findings for class presentation.
- **Review the Information in Light of New Findings:** Students will have to review their original hypotheses regarding cigarette advertising after the Surgeon General issued the report.
- **Use the New Findings to Make New Observations or Ask New Questions:** Some advertising campaigns (e.g., Joe Camel campaigns, Marlboro products campaigns) appear to be targeted at particular groups of people. How do students find themselves reacting to these campaigns? Joe Camel offers concert tickets to popular bands and Marlboro offers clothing with so many "proof of purchase" cigarette coupons. Have students ever responded to these advertisements by buying the cigarettes to get the coupons? How could students discover whether members of their age group were affected by these and similar cigarette campaigns?

Key Concepts

- **Experiment:** An experiment is a test under controlled conditions that is made to demonstrate a known truth, examine the validity of a hypothesis, or determine the efficacy of something previously untried. The word experiment is derived from the Latin expression "experiri" which means "to try." Experiments must be replicable

and repeatable to maintain credibility within science and with other scientists. Once scientists have defined their problem in writing, they should describe the design of their investigation or experiment in writing. For instance, what materials will they need to perform their investigation? Is the investigation a simple comparison? What are the independent and dependent variables? What is the data collection system? Upon analyzing the resulting data, was the initial hypothesis supported or unsupported by the evidence?

- **Experiments as Comparisons:** Experiments are often comparisons. "Two events may be compared with each other, or an event may be compared with the probability of obtaining the same result through the operation of chance alone. For example, you might compare the action of two different drugs in treating similar patients, or compare the effectiveness of a new clinical laboratory test procedure against the probability of correctly guessing the result (by chance)" (Carr, 1992, pp. 92-93). In a comparison known as "simple matching paired comparison," two samples are compared with each other after being randomly selected from the same pool of the larger population (Carr, 1992). "For example, from a large pool of patients suffering headaches, you could randomly select some for the control group and others for the test group. When a pain reliever is administered, the results of the two groups are compared with each other" (Carr, 1992, p. 94). For an exercise in magazine advertisement measurement before and after a specific event has occurred, the scientist would want to randomly select an equal number of magazines to review before and after the event in question. The scientist would want to go back in time and forward in time an equal amount of years from the event to have a matched comparison.
- **Tobacco, Cigarettes, and Smoking in the United States:** Although physicians and scientists were concerned about health hazards associated with tobacco as early as the end of the 17th century, it was not until 1964 Surgeon General's report on the ill effects of smoking, that the general public became educated on the health threats of smoking cigarettes. Three years after the surgeon general's report was published, the Fairness Doctrine of 1967 legislated that broadcast media (radio and television) must balance cigarette advertisements with reports on the health risks associated with cigarettes. The Fairness Doctrine was followed by an all out ban of cigarette advertising in the broadcast media with the Public Health Cigarette Smoking Act of 1969. However, it was not until 1971 that this act was enforced, and the electronic media ceased advertising cigarettes.

Student Preparation

This activity reviews all of the scientific method steps that have been presented to students throughout this module. Students need to have an introduction to the steps of the scientific method before completing this activity. This activity is not recommended for students who have not been introduced to the scientific method.

Materials Needed

- Figure 1 illustrating Cigarette Consumption per U.S. Adult
- Slips of paper numbered 1-52 in a sac

Action Steps

1. On the chalkboard, do a quick brainstorm exercise on places where we get information about cigarettes and smoking (e.g., friends, family, media, etc.). If students do not suggest the representation of cigarettes and smoking in *magazines*, make sure to do so.
2. Ask students if they knew cigarette smoking was not always considered to be hazardous to health.
3. Ask students to hypothesize the approximate date when the hazards of cigarette smoking first became public knowledge.
4. Pass out the handout which illustrates Cigarette Consumption per U.S. Adults.
5. Briefly describe the construction of the graph: Along the x-axis are years 1925 to 1990, broken down into five year periods. Along the y-axis is the number of cigarettes consumed per year, per U.S. adult. Important events are highlighted along the time line to give an historical framework to the changes in cigarette consumption from 1925-1990. The line represents the pattern of U.S. adult cigarettes consumption during this time period.
6. Ask students to interpret the trend of cigarette consumption as depicted by the graph.
7. Select a student, or students, to read aloud the historical events highlighted on the graph.
8. Using the attached background outlining the historical events, define and discuss these events with students. During the discussion, list on the chalk board each historical event with its corresponding date and key facts.
9. How close is the date of the Surgeon general's report of 1964 to student's hypotheses about when the hazards of cigarette smoking first became public knowledge?
10. Now ask students to think about how the changes in laws and public knowledge about the health risks associated with cigarette smoking might influence how cigarettes and smoking are represented in the *magazine media*. Discuss all types of advertising representation (e.g., content or theme of the advertisement, characters in the ad, and frequency of articles compared to ads in a magazine.
11. Remind students that although cigarette advertising was banned on TV and radio, no such restrictions ever have been placed on the print media.
12. Discuss the following sample hypotheses*:* Might magazines have fewer or greater cigarette adds after the broadcast advertising ban was put into effect in 1971? Will the Surgeon General's report of 1964 precede an increase or decrease in the number of magazine articles about the hazards of cigarette smoking? Will magazines be more or less likely to advertise cigarettes as a result of the nonsmokers' rights movement? How might number of articles be influenced by the nonsmokers' rights movement? How might an increase in excise tax on cigarettes effect cigarette advertising?

13. Next, on the chalk board, draw 2 blank graphs. Both graphs should have years on the x-axis broken down in half decades like in the handout. One graph should have # of cigarette advertisements (0-5) on the y-axis and the other graph should have # of articles (0-5) related to the hazards of cigarette smoking on the y-axis (examples at end of action steps -- figures 1 & 2).
14. Ask students, as a group, to graph how they would predict (i.e., hypothesize) the trends of both frequency of cigarette advertisements per magazine and articles on smoking hazards, based on what they have learned from the handout and class discussion.
15. Have students select an historical event for each variable that might be a transition point for changes in trends on their predicted graphs (e.g., a ban on broadcast media for advertisements -- surgeon general report for articles). Highlight this event and date on the graphs.
16. Have students recreate this graph on their handout.
17. Now ask students to restate their graphic hypotheses in words. For example: Cigarette advertising would go up around 1964-65 as a response to the Surgeon General's 1964 report; articles on the health hazards of smoking cigarettes would also go up around this time period.
18. Now tell students that they are going to conduct a study that will give them information on whether or not their hypotheses were correct based on information gathered from two particular sources, TIME and Newsweek magazines.
19. Ask students to think about where they would look to get this information. If the students do not come up with this information on their own, tell them that in order to find the information, they would will need to go to the library and collect this data directly from the magazines.
20. Tell students that their task is to gather data on frequency of advertisements for cigarettes and articles on health hazards associated with cigarette smoking from the 50 most recent *full* years. Tell them that each year will be researched, and every one will be responsible for collecting data on a portion of these years.
21. Tell the students that these magazines are issued weekly, therefore making 52 magazines per year. Tell them that a common thing that researchers do when collecting data, is to collect data on a *random sample* of an entire population.
22. Ask students why they think that researches usually study samples versus entire populations (e.g., efficiency, practicality, time, resources, etc.)? Why is it important to select randomly (e.g., unbiased sample, influence of other variables, etc.)?
23. Assign two years to each student making sure all 50 years are covered. The following instructions are based on a class size of 25 people. (Adjustments should be made accordingly depending on the number of kids per class if necessary, some could collect data on more years, or number of years could be altered). Suggestion: it's better if students collect data from one recent

and one later year (e.g., Student A: 1940 & 1980, Student B 1941 & 1981, Student C: 1952 & 1972, etc.). This way the students will have a chance to see the different ways cigarette smoking is represented in magazines.

24. Randomly select three weeks from each year: To do this, pass around previously prepared bag of slips of paper numbered 1-52. Have each student select three slips of paper, record their selected numbers, and then return the slips of paper to the bag. Repeat this exercise for each student.
25. Discuss with students how this all-familiar exercise of "picking a number from a hat" represents same components of random number generation an essential tool for scientific research. Describe that computer random number generation is used by scientists instead of simply picking numbers out of hat because the table can be recreated in a report to demonstrate proof of random selection (if you have a classroom computer that can do this, show students this way of selected random numbers as well as the hat method).
26. The numbers students have selected represent the weeks of the year from which they need to collect their data. Each student will sample three magazines from TIME and three from Newsweek for their two assigned years (therefore, six issues per each magazine for a total of 12 magazines sampled).
27. Tell students they will be responsible for designing a data collection sheet to note the cigarette advertisements per week, per year, per magazine. You may also want them to collect data on themes and characters within advertisements to see if they notice any change in these. Describe a typical data sheet to students (depending on their skill level, you may wish to create the data sheet with them in class). Describe to students that they'll need to go to a public library to complete this assignment. Discuss bound periodicals and microfilm/fiche here. Make sure students know where to look for this information.
28. After data is collected. Have students chart the data for their own magazine sample. Then students can aggregate the data from their class study to make a chart of the entire sample.
29. How did volume of cigarette advertisements change in response to the Surgeon General's report? Were there more or less advertisements? If students did collect thematic or character data on the advertisements, did they notice any changes in these areas over time?

Figure 1: Example of cigarette advertisement chart for hypotheses construction.

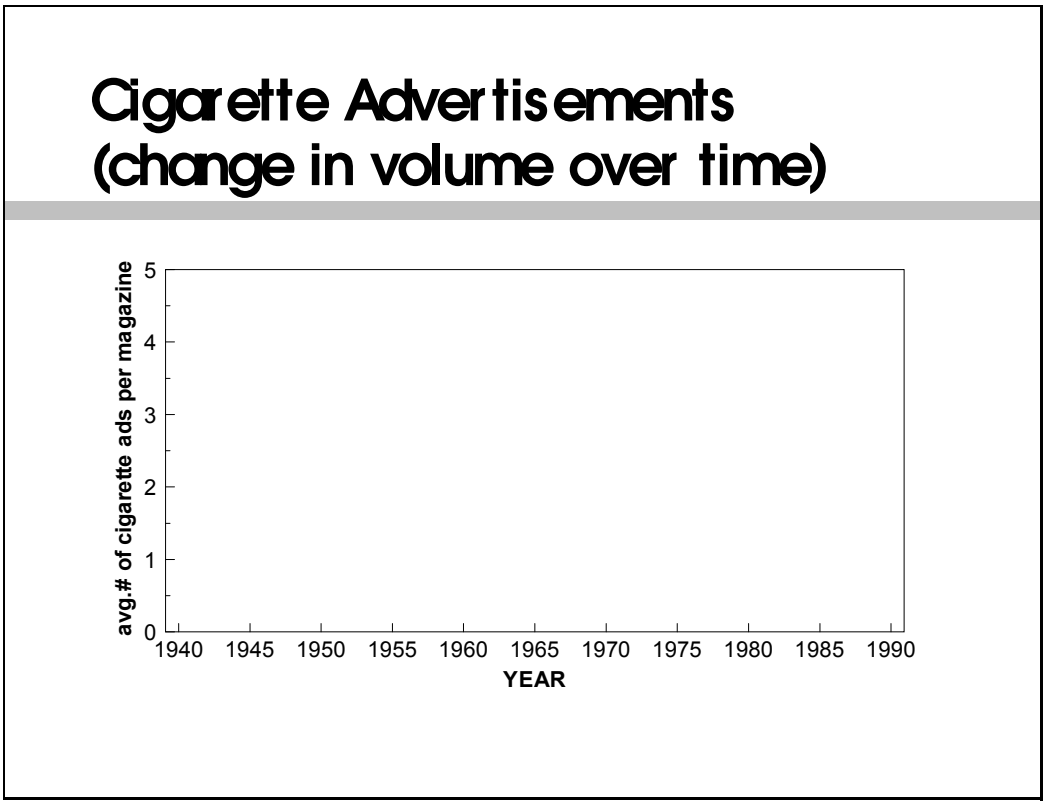
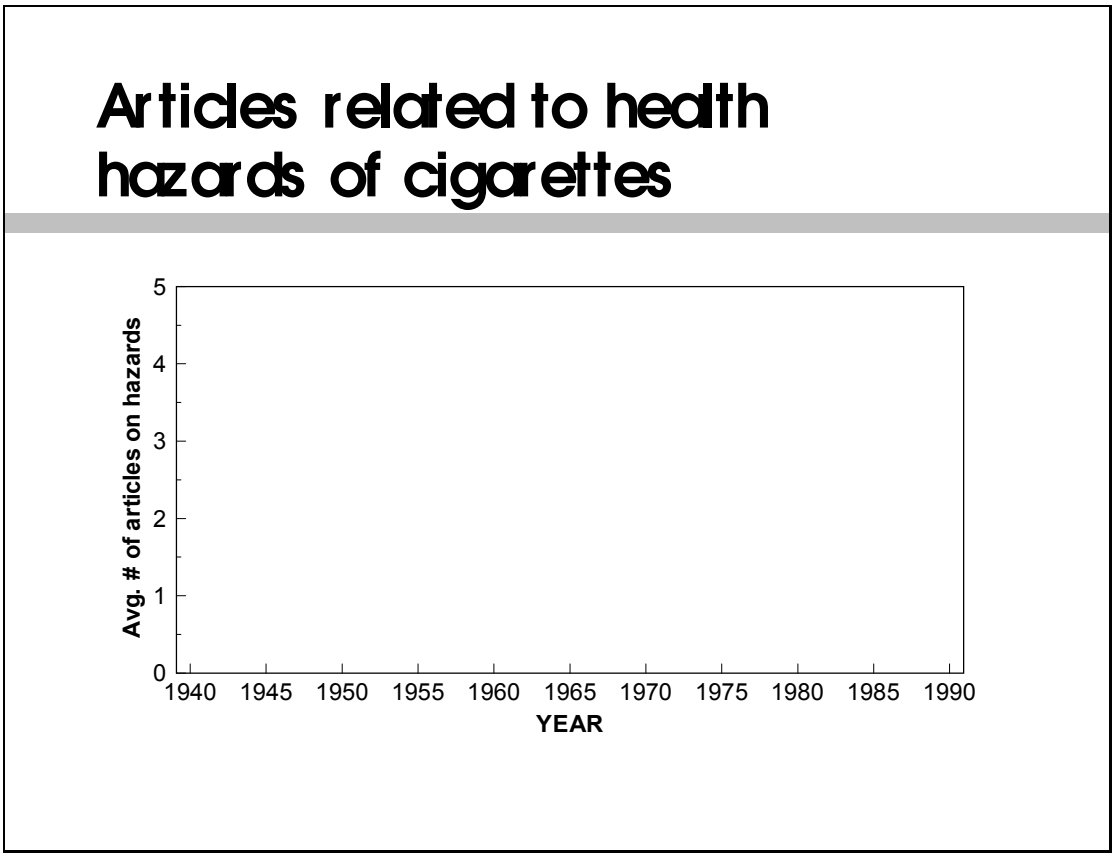


Figure 2: Example of chart on magazine articles related to the health hazards of cigarette smoking for hypotheses construction.

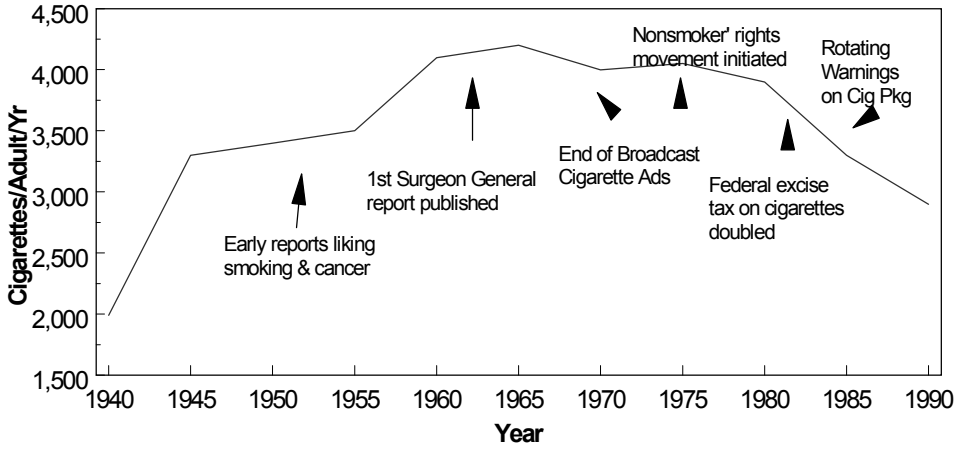


Questions for Follow-Up

1. Tell students that another study they could do is to focus on cigarette representation in magazines.
2. In order to do this they have determined two variables to measure cigarette representation in magazines -- frequency of cigarette advertisements and frequency of articles on the health hazards related with cigarette smoking.
3. Ask students how they would complete this study.
4. Give students a list of the steps involved in the scientific method (either from the front of this lesson, or from the text visuals. Ask students to fill in each step with their activities when conducting this experiment.

STUDENT HANDOUT

Adult Cigarette Consumption in the US from 1925-1990 in Relation to Historical Events



Source: Dept of Health and Human Services

TEACHER RESOURCE GUIDE

Defining Science and the Scientific Method

Defining the scientific method and delineating the skills necessary to conduct research scientifically requires some definition of the concept and nature of "science." The National Science Education Standards (1994) and the Massachusetts State Science and Technology Frameworks for Science Education (1995) define science as systematized knowledge derived from observation, study and experience. The word science derives from the Latin word scientia, which means "to know." Science is verified knowledge; that is, knowledge that can be validated by evidence and communicated to other people in a reliable manner.

Defining Science

Scientists have a variety of interesting ways to describe their domain. All of these descriptions serve to illustrate a style of thinking: "Science is storytelling, albeit of a special kind. Science is the invention of explanations about what things are, how they work, and how they came to be. There are rules, to be sure: for a statement to be scientific, we must be able to go to nature and assess how well it actually fits our observations of the universe. Science is theory, mental constructs about the natural world" (Eldredge, 1982, p.1). "One way to view science is as an intellectual approach, a style of thinking and a set of methods all designed with one goal -- to exclude or at least minimize the chance of being mislead by an observation. This is really what the scientific method is all about. It is a set of rules for not getting fooled" (Rensberger, 1986, p. 14). Science is not just a pursuit of any knowledge, however. Scientists crave new knowledge to get relief from their condition of craving knowledge (Braben, 1994). It is this constant state of science, one of metabolism and growth, that makes science so exciting. "Mere knowledge, though it be systematized, may be a dead memory; while by science we all habitually mean a living and growing body of truth" (Pierce, 1957, p. 192).

Approaches to science: how we investigate. Approaches to science generally take three fundamental forms of investigation: (1) ordered or informed observations; (2) surveys; and (3) directed experimentation. Ordered or informed observations, which are discussed at length in the following section on observations, are primarily the province of the field biologist, geologist, or zoologist. The informed observer follows a plan of what to collect, where to collect it, how to methodically document or record the observed event and how the observations should be interpreted (Carr, 1992).

Surveys are similar to informed observations; scientists use surveys to investigate the beliefs, knowledge, attitudes, actions, or states of human groups as they are, with minimal interference. Unfortunately, the mere act of surveying involves interaction between subject and surveyor and that interference can influence results. Nevertheless, surveys remain an important form of inquiry: these provide a means of obtaining information that would otherwise be unavailable. Surveys can be divided into three types: (1) retrospective surveys that attempt to find out how things with the population surveyed were in the past; (2) current surveys that attempt to look at things the way they are now; and (3) prospective surveys that follow a specific population for a period of time into the future to see how they change.

Directed experiments are planned events in which the effects of calculated acts are observed. In directed experiments, except for the variable (i.e., set of conditions) under investigation, the scientist controls all of the variables if possible. In other words, the scientist "sets up a situation in which a phenomenon can be observed to change so that confounding factors are either well controlled or eliminated altogether" (Carr, 1992, p. 6). Experiments must be replicable to be considered worthwhile.

Students learning the scientific method must acquire a skill set that allows them to probe methodically nature's mysteries. Students come to science class already equipped with some of these basic skills, but they need time and practice to acquire the integrated skill set needed for directed experimentation. The next section will address the specific process skills students require to perform investigations and directed experiments.

The Difference Between Basic Science Process Skills and Integrated Science Process Skills

The education standards listed at the beginning of this module provide a beginning outline of the process skills involved in the scientific method. These process skills can be divided into two groups: basic and integrated process skills. Students must acquire the basic process skills to perform the most fundamental scientific observation and classification investigations. Integrated process skills build upon the basic process skills so that students can design and conduct an "real" experiment, complete with a hypothesis, controlled and experimental variables. Integrated process skills further enable students to analyze, interpret and reach conclusions about the data obtained from directed experimentation. Barhydt and Morgan (1993) group these process skills as follows:

- The Question must be ***Feasible***
    - Adequate number of subjects
    - Adequate technical expertise
    - Affordable in time and money
    - Manageable in scope
- The Question must be **Interesting** to the investigator
- The Question must be ***Novel***
    - Confirms or refutes previous findings
    - Extends previous findings
    - Provides new findings
    - The Question must be Ethical
- The question can be investigated **ethically**.
- The Question must be ***Relevant***
    - to scientific Knowledge
    - to clinical and health policy
    - to future research directions

Students can conduct an investigation without engaging in a formal experiment. Indeed, investigation (i.e., careful gathering of information) is distinct from experimentation because it lacks control variables and a hypothesis (Barhydt & Morgan, 1993). If teachers are interested in training students completely in the scientific method, they need to help students access the

requisite integrated process skills that permit experimentation in all of its stages -- from creating hypotheses, to nullifying or verifying each hypothesis through the various stages of experimentation. Most students need experience with basic science process skills before tackling an integrated task like experimental design. Therefore, we will review the component parts of the scientific method as follows: (1) Basic science process skills; (2) Integrated process skills; and (3) the types of thinking essential to both basic and integrated process skills.

Basic Science Process Skills: Observation, Recording Data, Classification, and Data Analysis

Observation. Observation, also known as "informed observation," implies selection and leads to description. In other words, an informed observation is a principle method used to investigate nature's secrets, but it requires observers to be specific in their choice of what is to be observed. "An unwise choice [in observation] yields items so remotely connected that no amount of study would ever determine their interrelations" (Wilson, 1972, p. 52). Once students have selected the specific event to observe, they should go to wherever the informative event is likely to occur, equipped with the appropriate tools to observe the expected event. Students should take whatever precautions necessary to increase the probability that the informative event will occur (e.g., when studying animal interactions in nature be careful to remain still, quiet, etc.).

Recording data. The major point to reinforce when teaching about informed observation is the necessity for immediate, careful recording of the observed data in a journal or notebook. Good records are important for a variety of reasons, including: (1) human memory is fallible and without proper records an observation is useless once its entertainment value has been exhausted; (2) good records allow students to recognize patterns that may exist in their data -- one of the major goals of science is to discover patterns in nature; (3) good records allow students to make inferences from their observations -- for instance, in field observations of animals, patterns in data may lead students to draw specific inferences about animal behavior; (4) good records allow students to compare their work with other students so that they can notice informative details and extend each other's work; (5) good records allow students to compare their own new observations with earlier observations and note relationships that may exist; and (6) good records of conditions, assumptions, variables and results of an observation allow students to quantify their work by using numerical measures that permit a precise description of observations.

Students may want to know what type of data to record. Generally, the answer is to record data that provides information about the event observed. Depending upon the situation, scientists conducting field observations should record the date, time of day, the temperature, the weather conditions, and the location of the observation including physical characteristics of the environment. If the observation involves animals, the animals' behavior patterns and presentation should be recorded within the context of the physical environment (e.g., time of day, etc.). Record keeping within the context of directed experiments will be discussed in that section.

Biases and predictions. Teachers should remind their students repeatedly that all observers carry with them biases and opinions about the events they observe. Good science requires both student scientists and experienced scientists to be as objective about their observations as possible so that observer bias will not distort the data and the data collection

process. In an informed observation, personal experience and knowledge will help students to make predictions about the event. Indeed, students should state what they think will happen during an observation before the event takes place. They should base this prediction or hypothesis on the information that they have already. As their information about an observable event becomes more sophisticated, so will their predictions. Students should be aware, however, that prior experience and knowledge, unharnessed by excruciating objectivity, may influence events. One way for students to gain some objectivity in scientific investigation is to regard their predictions less personally: the data either support or fail to support the stated predictions. Scientists are not right or wrong -- particularly during the early phases of research -- because science often can advance more by data that fails to support a hypothesis than when data appears to confirm a specific experimental hypothesis. For example, for many decades researchers thought there was an "addictive personality" that caused excessive behavior patterns. However, when Canadian researchers Gendreau and Gendreau (1981) identified the so-called addictive personalities among prison inmates and then asked about their drug using patterns, the relationship disappeared. If researchers had continued to first identify drug abusers and only then study their personalities, it would still appear as if personality causes drug abuse. The clever research of the Gendreaus reveals that *the personality changes associated with addiction actually may be the result of drug abuse rather than the cause*.

Classification. If observation implies that selection leads to description, then classification implies selection taken to an ordered extreme. Classifiers (e.g., botanists, zoologists, anthropologists, etc.) take scientific description to its limit by using language that is both precise and concise. The vast numbers of living and nonliving forms in existence must be named and ordered so that scientists worldwide can discuss a specific entity under examination with some precision. Without the use of common contexts, reference points, descriptors and hierarchical levels, scientists could not accurately communicate with each other about any organism, biosystem, molecule or category of elements. Research in a disordered world would be stymied.

For students, acquiring the process skills of classification and ordered description leads to understanding about the relationships among the items classified. This is particularly true in the field of biology where categories of organisms form hierarchies that illustrate different degrees of evolutionary relationship among the organisms. As a process, classifying involves grouping or sorting items by having a rationale for these groups based on the observable properties of the items within the groups. The process of classifying helps students order their information; it allows them to detect similarities and differences between various types of information. For instance, when studying addiction science, classification provides order to the overwhelming amounts of information students receive about the normal and drug impaired functions of the human body. By applying systems of classification to the human nervous system, students can tackle large amounts of information within a manageable format.[7]

Data analysis and interpretation. **Data analysis** and interpretation require meticulous organization regardless of whether the information was gathered from an informed observation or an experiment. Once data has been organized, students should examine the data for patterns and relationships. Data analysis permits scientists to draw conclusions from the observation or

[7]Teachers can find more detailed information on classification as well as hands-on activities in the Addiction Science modules: Life Sciences: Classification of Organisms and Physical Sciences: Chemistry.

experiment. Teachers should encourage students to infer whatever significance is warranted by the evidence, and nothing more. "If the problem [or question to investigate] was properly stated, the experiment was properly designed and carried out, and the data is not corrupted by some external factor, then the analysis of the data should be relatively easy" (Carr, 1992, p. 90). The interpretation of data is what scientists described earlier as a special kind of storytelling and explaining. For student and experienced scientists alike, interpreting evidence by creating (theoretical) explanations can be one of the most exciting and rewarding parts of the scientific process.

Integrated Science Process Skills: Formulating Hypotheses and Conducting Directed Experimentation

Theories, Models, Hypotheses and Laws. The words "theory," "**model**," "hypothesis" and "law" are often misunderstood and misused, especially by students trying to get a grasp on the concept of scientific method and experimentation. Theories are probably the most misunderstood item from this group of concepts. Some students may discount others' theories, mentally throwing them upon the heap of uninformed opinion, whereas other students will exalt pet scientific theories to the supreme court of nature's "laws." Indeed, many lay people hold abstract, disorganized theories as unarticulated ideas about how the world works, or how their brains conduct electricity. However, when scientists or lay people formulate explicit ideas that get completely articulated, theories emerge. Carr (1992) defines a theory as "...an intellectual construct derived from human ingenuity in the mind of the scientist;" while noting that, "Any statement of a theory must include as complete a statement as possible for the underlying assumptions (which could prove critical later on), the consequences, and predictions of observations that could be logically assumed to follow from the theory" (p. 34). Carnap (1954) offers the following characteristics of a theory: (1) it must be a fully articulated idea; (2) it must have an empirical base (i.e., data) to review in support of the idea; (3) it must include a syntax for discussion of rules and relationships between the data base and the articulated idea; (4) using the syntax, a model (i.e., usually a visual representation) of it should be developed; (5) it must provide an opportunity for the data to feed back and relate to the original idea; and (6) it must have a mechanism so that ideas may be revised based on incoming data. Often theories are not articulated completely before scientists construct a model of how the theory works or what it means. Thus, models help scientists to better picture and describe the theory which is under construction.

Models. Models are representations created to help describe a theory, to represent reality, or to explain some aspect of reality. Models can either be scale (i.e., a miniaturized version of a larger object), analogue, or mathematical. When most people think of models they are thinking of a scale model. For instance, a scale model of a car looks like a real car scaled down by a factor of about 100 (Gardner & Kemer, 1993). Scale models provide engineers and scientists a practical way of designing and manufacturing new technologies. Testing ideas with scale models can be completed with less expense and more speed than tests on the full size object of interest.

Analogue models represent a similarity in the behavior of the actual structure under design (i.e., strength, flexibility, motion, etc.). In science, analogue models often bear no resemblance to their real-life counterpart. For example, "In the decay of a sample of a radioactive element a specific fraction of the element's atoms will decay in a fixed period of

time, but it is impossible to predict which atoms will change. This process can be modeled by throwing a large number of dice. After each throw a certain fraction of the dice (about one sixth) will land with "6" facing up. In the model, these dice can represent decayed atoms, which are then removed with each throw" (Gardner & Kemer, 1993, p. 8). Obviously, in this example, dice bear little resemblance to a decaying radioactive element. Scientists use mathematical models to express abstract ideas in the form of symbolic equations. These are among the most useful of all models. Consequently, scientists use mathematical modeling in almost every area of science.

As we described before, scientists also use models to describe scientific theories, or systems that help explain some aspect of the natural world. Used in this manner, the model becomes part of the process of science we call the scientific method: "You may start by making some observations, either in conjunction with a formal experimental research protocol, or by serendipity. These observations are then analyzed, and a model of how they work (or what they mean) is created. A tentative theory is then developed from the model. From the theory predictions and hypotheses are derived, and these form the basis for an ordered observation, or directed experiment that makes additional observations" (Carr, 1992, p. 35).

Hypotheses and Laws. An hypothesis provides the basis for any scientific experiment or observation. In many cases, a hypothesis is so simple that it is possible to test it directly through experimentation. However, more complex hypotheses may posit connections between events or detailed cause and effect relationships that are difficult to test in a single experiment. "Analogy is a very powerful tool in the construction of hypotheses, but imagination is of utmost importance" (Wilson, 1972, p. 58). A hypothesis is an assumption, based on scientific knowledge of facts and laws, that is created to test the logical or empirical consequences of a situation regarding some population under study (Carr, 1992). This definition clearly separates hypotheses from laws which are simply, observed regularities in nature. In other words, scientific laws describe the state, relationship among, or order of phenomena that "...so far as is known is invariable under the given conditions" (Carr, 1992, p. 31).

Directed experimentation. The hallmark of the scientific method is critical thinking applied to inquiry or experimentation. Roger Bacon, the great English scientist of the 13th century stated that "there are two modes of acquiring knowledge, namely by reasoning and experience. Reasoning draws a conclusion, but does not make the conclusion certain, nor does it remove doubt so that the mind may rest on the intuition of truth, unless the mind discovers it by the path of experience" (Seldes, 1986, p. 30).

During directed experimentation, students plan situations -- most likely in a lab or a classroom -- to create some informative events that will occur and can be observed (Carr, 1992). Students should keep in mind that experiments test a hypothesis through empirical observation. Questions that cannot be answered through directed experiments often involve direct observation. In addition, some questions regarding the origin of the universe, earth and man can be probed by theorizing, or through intellectual constructs. Models represent these intellectual constructs and are based on known facts and laws. We encourage teachers to emphasize that skepticism, receptivity, objectivity, honesty and curiosity are qualities central to learning and using the scientific method.

A scientific experiment is "...a stratagem, perhaps with an element of ingenuity, to create a deliberate act through which some effect or result can be observed" (Carr, 1992, p. 83). The

following steps should be observed when conducting an experiment (adapted from Carr, 1992, p. 84-90):

1. Make sure that the problem to be solved, or the question to be answered with the experiment is researchable.
2. Once it has been decided that the problem is indeed researchable, clearly define the problem in words. This is also known as forming the hypothesis of the problem.
3. Design the method(s) for examining the problem so that useful empirical data can be identified and collected; wherever possible that data should be numerical in nature.
4. Review the design with others, seeking criticism for design flaws.
5. Make sure that the events on which data are collected are accessible and observable, either directly or indirectly, through whatever means are appropriate for the case.
6. Describe the design of the experiment in writing.
7. Describe the method of data collection in writing.
8. Perform the experiment that will support or fail to support the hypothesis.
9. While performing the experiment, systematically collect the data.
10. Analyze and interpret the resulting data.
11. Present the results in a form that can be understood by others.
12. Submit the data and the experimental design to others for criticism.
13. Remember: "experiments never fail, experimenters do. Nature does what nature must" (Sumner cited in Carr, 1992, p. 90).

There are some important elements to consider when presenting experimental results. A good experiment should be replicable. Replicability of an experiment is dependent upon the clear instructions or "method" by which the experiment was performed. Therefore, the presentation of experimental results should include at leas the following information (adapted from Carr, 1992, pp. 106-107):

- Clearly state the problem being investigated.
- Conduct a literature search on past investigations of this problem. Record results of that search.
- Precisely describe the method used to carry out the experiment, including apparatus or instruments used.
- Precisely describe the actual performance of the experiment -- any unusual occurrences that were experienced should be noted. Also, "when something looks funny, record amount of funny" (Carr, 1992, p. 107).
- Tabulate data and calculate relevant statistics. Where possible, give all raw data.
- Discuss any and all negative results.
- Present further questions arising from the course of study.
- Include any factor that could be helpful to other researchers in replicating the experiment.

Reason, logic, and critical thinking. Famed science writer Isaac Asimov offered an historical view of science that has current relevance: "[The Greeks] felt that the natural laws, when found, would be comprehensible ...With confidence in the fair play of nature, human

beings needed to work out an orderly system for learning how to determine the underlying laws from the observed data" (1972, p.7). In other words, the Greeks were extremely bright, but they did not insist on testing hypotheses to confirm or disprove their ideas. Asimov continues: "To progress from one point to another by established rules of argument is to use 'reason.' A reasoner may use 'intuition' to guide the search for answers, but must rely on sound logic to test particular theories. To take a simple example: if brandy and water, whiskey and water, vodka and water, and rum and water are all intoxicating beverages, one may jump to the conclusion that the intoxicating factor must be the ingredient these drinks have in common -- namely, water. There is something wrong with this reasoning, but the fault in the logic is not immediately obvious" (Asimov, 1972, p.7).

Asimov's example illustrates faulty logic which can occur for many reasons. In this particular case, a rapid conclusion about water and alcohol was drawn based on little evidence, and even less theorizing. Indeed, faulty logic occurs whenever thinking becomes fuzzy, rushed, emotional, rigid, uninformed, oversimplified, or filled with irrelevant data. Critical thinking gets obscured when conclusions and interpretations become subject to outside forces (e.g., popular opinion, pity, economics or politics). Critical thinking also can be muddied whenever one attempts to apply general rules to particular cases; this circumstance can render the rule invalid in a particular instance. Conversely, when one attempts to apply knowledge gained from a specific sample to the general population without the benefit of a reasonable sampling technique faulty conclusions abound.

According to Carr (1992, p.18), the basic processes of critical thinking include 6 primary activities:

- planning
- information gathering
- defining a frame of reference or context
- monitoring
- accounting for biases
- evaluating

Students should be aware that all of these processes need to be exercised from the very beginning to the end of a scientific investigation. These processes require discipline, an ability to picture the experiment or investigation from start to finish, and an attention to accuracy and detail that may be considered obsessive by observers. Furthermore, for thinking to be truly critical, it must be as objective as humanly possible. Students need to realize how their own world view often distorts their ability to think critically, or how their desire for a specific event to occur (e.g., getting the "best" grade, "best" date, or "best" outcome in an experiment) may cause them to abandon critical thought. As mentioned previously, biases, intentional deception, magical thinking, and assumptions hamper the ability to think objectively and critically.

In sum, science validates knowledge using facts, laws, observations, data, information, logic, critical thinking, hypothesizing and hypothesis testing, modeling, theorizing, experiments, and other techniques. Scientists use precise language to enhance communication, express concepts that may be very abstract, and ensure that others can replicate their work. Students need to become comfortable with the vocabulary of the scientific method, to be accurate with its use, and to understand the relationships among concepts as teachers introduce them. Integrated

science process skills will be developed further with successive addiction science modules and an array of hands-on and minds-on activities.

The following section provides an overview of addiction science theories. The field of addiction science is a relatively new area of investigation and discovery. These theories provide teacher and student with information that can help to guide their investigations and discussions. This material identifies groups of theories with ideas that are both tested and untested -- a ripe area of science inviting the participation of new and creative investigators.

The History, Science and Theories of Addiction[8]

In this section, we will review a sampling of the major theoretical models that have been offered to explain substance abuse and addictive behavior patterns. To understand these models fully, they will be presented in their cultural and historical context. An essential requirement for any type of investigation in the addictions is the recognition of the extent and types of biases present in the field. These biases, in part, are due to the "immaturity" of the addictions' field as a scientific discipline. This immaturity is complicated by the high level of emotion associated with the topic, as well as the lack of conceptual clarity among workers and theorists in the field.

The Emotional Context of Understanding

Many researchers have described the intense emotions that usually surround any discussion of drug use and abuse. Grinspoon noted that these exchanges are less academic and more like "political debates" (Grinspoon & Bakalar, 1985). Stanton Peele recognized that: "Drug and alcohol use are emotional topics, particularly in the United States today. Those who study and treat substance abuse must navigate extremely tricky waters" (1986, p.149). Andrew Weil acknowledged that "Unconscious bias is as common among proponents of drugs as among opponents" (1972, p. 6). Weil cautions further that "unconscious biases act like filters between our perceptions and our intellects. They enable us to screen out observations that do not fit in with our preconceived notions and to see causal relationships where none exist. Worst of all, they blind us to their own presence so that we are quick to defend our erroneous hypotheses with shouts of `I saw it with my own eyes!'" (p. 9).

Some of the contemporary "unconscious or conscious biases" which permeate the field of addictions are particularly relevant to the present discussion. For example, some authors in the field of substance abuse take a moral position with regard to drug use. On the one hand, drugs, especially cocaine, are at fault, and are described in value laden terms, for example, as a "seductress" or "vamp from Hell." On the other hand, drug abusers are often blamed and described in pejorative language. Consider, for example, professional terminology like "impulse-ridden sociopath" or "addictive personality." Street jargon also has a pejorative cast, as in "coke freak," "dope fiend," or "junkie."

Youthful Fields and Conceptual Confusion

The field of the addictions is very young, and marked by controversy, zealous emotion and confusion. It is precisely this chaotic state of affairs which Shaffer (1986; cf. also Burglass

[8]This section was derived and adapted from Shaffer and Jones (1989).

& Shaffer, 1983; Shaffer & Gambino, 1979, 1983) observed when he argued that the field of addictions is in a preparadigmatic period and in the midst of a conceptual crises. The developmental immaturity of the addiction field is evident by the presence of intensely conflicting and polarized explanations of its identity and purpose, anomalous research findings, and few facts (Shaffer, 1986).

A paradigm, according to Thomas Kuhn (1962), is essentially the framework, or perspective, that defines the rules and standards of practice for a particular scientific community of workers (e.g., physicists, psychiatrists, psychologists). Individuals working in the field of addictions do not share a unitary set of rules or standards for the treatment of dependence disorders; in fact, there is controversy as to whether or not these disorders are multi or unidimensional. For example, as some clinicians who treat addictive disorders debate the efficacy and morality of drug (e.g., methadone) versus drug-free treatment, and whether or not psychotherapy can proceed or be useful while a patient is using a particular substance, other clinicians and researchers argue the utility of abstinence or controlled use as treatment outcomes.

Similarly, there is little agreement as to the etiology of addictive disorders. For example, pharmacologists understand the addictions as a set of pharmacological problems involving such categories as drugs, tolerance or binding sites. Psychologists and psychiatrists typically are willing to read into the phenomenon of addiction those problems of learning, compulsion, or ego function. Physiologists posit problems of withdrawal, metabolism, or target organ effects. Sociologists see processes of social regulation, peer pressure, and/or environmental forces. Politicians, lawyers, and law enforcement agents view addiction problems as involving controlled substances, criminals, and/or deterrence. At present, no single theory dominates thinking in the field of addictive behaviors or informs clinical interventions comprehensively. "Nonetheless, current theory and practice, despite the extreme diversity and often strident discord in the field, reflect a growing consensus on the importance of using scientific methods in both research and practice, and on modeling the older, established scientific disciplines" (Burglass & Shaffer, 1981, p. xxi).

Complicating the lack of agreement among addiction workers is the underdeveloped scientific state of knowledge in the addictions. This circumstance is characterized by an inability on the part of addiction treatment specialists to tolerate or even evaluate alternative theories with the prevailing wisdom of our time. Presently, for example, it is pedestrian to consider addiction the consequence of biological, medical or disease processes. Alcoholism is viewed as a disease: a primary condition, biologically based, that is irreversible, incurable, and progressive if not arrested. Such a condition will, according to its followers, lead to premature death. Not only do champions of this model believe that the disease leads to inevitable premature death among addicts, but some believe that the disease is present among family members as well. These advocates have suggested that the "disease" can lead to premature death among those significant others who are not drinking and drugging themselves. Consider, for example, the position taken recently by Young (1987). She proposed, "co-alcoholism [the addiction to have control over people, places and things], like alcoholism, is a primary addiction requiring a primary diagnosis..." that "...produces a chronic physical, mental, emotional and spiritual deterioration, which if left untreated can lead to premature death... and recovery from co-alcoholism requires a system shift at a characterological level" (Young, 1987, p. 257).

Throughout history, research and theory anomalous to the prevailing wisdom tend to be suppressed, oppressed and even censured. Peele (1987), an impassioned opponent of the disease model of addiction, recalled his own and other prominent investigators' experiences generated by their research and publication of alternative (in this case, unpopular) theoretical perspectives. Peele described some of the mechanisms of social suppression designed to restrict his alternative position; these included the use of smear tactics, publication and grant restrictions, allegations of fraudulent research data and social ostracism.

In science, when anomalous data are ignored, denied or suppressed, current ways of knowing are maintained and a crisis averted. When findings that differ from the conventional view cannot be ignored or explained, however, a crisis has occurred. Consider the impact of Galilean, Darwinian or Freudian ideas on the conventional thinking of their time; their positions precipitated numerable debates which were argued against the landscape of emotional orthodoxy in an attempt to suppress and deny these new ways of understanding. In the addictions, we are presently in the midst of a similar conceptual crisis. There are several examples to illustrate this dilemma: the research of Davies (1962) and Sobell & Sobell (1973, 1976) have challenged the dominant notion that the only treatment outcome possible for alcoholics is total abstinence; Peele (1986) has questioned both the research and logic that has accepted a genetic component or predisposition to alcoholism and other addictions; Shaffer (1985) has suggested that the disease model of addiction is simply a metaphor for a commonly observed process and that this metaphor should not be casually substituted for a primary biological process. Taken together or separately, these positions, representative of numerous other anomalous findings, both reflect and fuel the conceptual crisis in the addictions. As a result of the shifting conceptual tides, even devotees of the disease model (e.g., Pace, 1984) have altered their positions so that more adaptive approaches have become acceptable.

It is important to recognize that suppressive forces are not evil and malevolent by nature - though they can be expressed and experienced as such. Rather, these processes are part of the machinery that ever so slowly advances scientific thinking (interested readers should see Shaffer, 1986, for a detailed account of this process in the addictions).

The Twentieth Century and Models in the Addictions

With its roots firmly placed in witchcraft, medicine, psychology, sociology, biology, chemistry, physiology, political science and law, there has been a rich historical progression of theories and explanations offered to explain addictive behavior during this century. In the early 1900s, the dominant theory of the times emphasized "personal responsibility." Drug dependence was viewed as spiritual weakness and evidence of moral turpitude. By the 1920s, drug disturbances, for the first time, were regarded as an indication of psychological defects. In the aftermath of the Depression and Second World War, an appreciation of societal influences on individuals began to appear and by the 1940s and 1950s, the popular theories of addiction emphasized social and environmental factors. The "science" of behaviorism was applied to the study of addiction and by the 1960s behavioral theories represented the prominent explanations of addictive behavior. The 1970s and 80s have demonstrated a theoretical preference for physiological explanations of addiction (e.g., the disease model of addiction, including genetic and/or chemical predisposition's to addiction) (Shaffer & Burglass, 1981; Shaffer, 1986).

Recently, the historical and theoretical trends in understanding addictive behaviors have moved away from interpretations based solely upon personal responsibility and toward explanations based upon involuntary determinants which victimize individuals. It is interesting to note, however, that in spite of this theoretical trend, physicians, psychiatrists, and lay people alike have demonstrated a consistent tendency to hold a combination of medical and moralistic beliefs that underlie their behaviors toward drug using individuals (Caetano, 1987; Orcutt, 1976; Rohman et al. 1987; Shaffer, 1987).

Definitions and Concepts in the Field of the Addictions

Because the scientific study of addictive behaviors is in a "preparadigmatic" stage of development, there is a state of confusion and crisis that surrounds the field's explanatory concepts and definitions. In order to reduce this confusion and provide some internal consistency for this text, the following discussion will review the definitions of "drug," "addiction," "dependence," and "drug abuse."

What is a drug? A drug is any chemical agent (natural or synthetic) that affects living processes (Shaffer & Kauffman, 1985, p. 38). For drugs of abuse, there are six basic categories: (1) narcotics and related analgesics; (2) sedative-hypnotics (including barbiturates, non-barbiturate sedatives, minor tranquilizers and alcohol); (3) stimulants (including amphetamines, cocaine and others); (4) hallucinogens and others like (5) phencyclidine; (6) cannabis and inhalants, which do not readily fit the other categories (Kauffman, Shaffer, & Burglass, 1985). Under most circumstances, it is simpler, though less precise, to organize commonly used drugs by considering them to reside within one of three categories: depressants, stimulants and hallucinogens.

What is Addiction? The concept of addiction has undergone many revisions. Because of the absence of unity in the field, many of the archaic definitions still are held widely among professionals and the public. For the most part, the word addiction is too elastic and, therefore, devoid of meaning, e.g., "work addiction" and "love addiction." Sometimes the concept of addiction is mis-used when it is applied strictly in the medical sense and substituted for the concept of physical dependence. Physical dependence, as evidenced by tolerance and physical withdrawal symptoms, refers to a physiological condition that is often correlated with, but not identical to, addiction.

Physiological and psychological addiction. For the past two decades, a distinction has been maintained between physiological and psychological addiction (Burglass & Shaffer, 1983). Psychological dependence has referred to a state where a drug using person believes he or she requires the effect of a drug in order to function "normally." Physiological dependence is an altered physical state produced by the repeated administration of a drug which necessitates the continued administration of the drug to prevent the appearance of a stereotyped syndrome of unpleasant effects characteristic of the particular drug, that is, the withdrawal or abstinence syndrome. The development of physical dependence is facilitated by the phenomenon of tolerance. A tolerant state has developed when, after repeated administration, a given dose of a particular drug produces a decreased effect. Conversely, tolerance exists when increasingly larger or more frequent doses of the drug must be administered in order to obtain the effects observed with the original dose (Shaffer & Kauffman, 1985). People with heroin addiction, for example, avoid physical withdrawal by increasing their drug intake gradually as their level of

tolerance develops. If withdrawal does occur, the symptoms include a flu-like illness with physical complaints such as nausea and chills. Although physical withdrawal from heroin (or narcotics in general) is not life threatening in the absence of complicating medical conditions, heroin addicts will go to great lengths to avoid the experience of withdrawal; such addicts regularly report a belief that narcotic withdrawal would kill them.

Cocaine, unlike heroin, was considered a drug which did not produce physical tolerance or withdrawal symptoms. Cocaine withdrawal symptoms are not necessarily obvious to an observer -- and, in some cases, the user (e.g., sleep disturbances, changes in rapid eye movement (REM) sleep, fatigue and depression). Consequently, scientists and clinicians originally assigned cocaine dependence only to the category of psychological dependence. Now, with advances in neurobiology, there is evidence that cocaine use is associated with important shifts in brain chemistry. Altered brain chemistry clarifies some of the behavioral patterns observed during cocaine withdrawal. Since high technology neurobiological brain research was absent until the past decade, cocaine had been presented as a "safe" drug. In spite of new evidence, some abusers of cocaine still believe it to be non-addicting.

Revising the concept of addiction. The addictions' field, led by the World Health Organization (WHO), has started to revise the concept of addiction. Currently, for example, addiction is considered to represent a quantitative pattern of behavior. That is, addictive behaviors are characterized by a high frequency of occurrences; they are recognized as having a much higher value than other behaviors previously thought to be more important. In other words, addictive behaviors are identified by their frequency, not simply by the presence of physical dependence. The notion of addiction is now thought to reside along a continuum. This gauge has been referred to as the "dependency syndrome." This syndrome does not require all of its elements to be present at the same time or with the same intensity for it to be identified. Furthermore, the concept of neuroadaptation has been offered to serve as the generic shelter for physical dependence, tolerance, cross-tolerance, and withdrawal. The notion of dependence will be discussed in more detail in the section that follows.

The Dependence Syndrome Concept

The dependence syndrome is a new concept and will likely replace the term addiction. It incorporates the quantitatively defined patterns of behavior, neuroadaptation (as evidenced by tolerance or withdrawal syndrome), and the phenomenon of psychological drug craving or "dependence." In 1969, the World Health Organization considered dependence as a state, psychic and sometimes also physical, that results from the interaction between a living organism and a drug. This state is characterized by behavioral and other responses that always include a compulsion to take the drug on a continuous or periodic basis in order to experience its psychic effects, and sometimes to avoid the discomfort of its absence. Tolerance may or may not be present. A person may be dependent on more than one drug.

In 1981, the World Health Organization redefined dependence as, "... a syndrome manifested by a behavioral pattern in which the use of a given psychoactive drug, or class of drugs, is given a much higher priority than other behaviors that once had higher value. The term syndrome is taken to mean no more than a clustering of phenomena so that not all the components need always be present with the same intensity" (Burglass & Shaffer, 1983, p. 28). The newer World Health Organization definition recognized the complex nature of drug dependence and redefined addiction as a combination of behavioral and contextual symptoms,

existing on a continuum rather than falling into discrete categories. The World Health Organization produced yet another definition of addiction in its 1981 Memorandum. This more recent definition reduced the term to an even lower common denominator found in all psychoactive drugs by introducing "neuroadaptation" as part of the dependence syndrome. Neuroadaptation refers to drug induced changes in the chemistry of the brain, specifically at the single cell or neuronal level. The emphasis by the WHO on a syndrome of dependence recognizes the inefficiency and futility associated with trying to determine the distinction between psychological and physiological dependence.

According to Edwards, Arif, & Hodgson (1982), the dependence syndrome can be identified by the presence of seven factors. These are as follows:

- a subjective awareness of compulsion to use a drug or drugs, usually during attempts to stop or moderate drug use;
- a desire to stop drug use in the face of continued use;
- a relatively stereotyped pattern of drug-taking behavior;
- evidence of neuroadaptation (i.e., tolerance and withdrawal symptoms);
- use of the drug to relieve or avoid withdrawal symptoms;
- the salience of drug-seeking behavior relative to other important priorities;
- rapid reinstatement of the syndrome after a period of abstinence.

The 3-C's. Dependence has also been defined by the 3-C's: Continued use in the face of adverse physical or psychic reactions; Compulsion to use the drug; and, a feeling of being out of Control regarding the drug use. In other words, the 3-C's suggest that drug addiction is the continued use of a drug or drugs in an uncontrolled and compulsive manner in spite of the adverse consequences associated with such use (Gold, Washton, & Dackis, 1985; Smith, 1986).

The experience of craving includes feelings that a drug is necessary for normal or optimal levels of functioning. This feeling can range from an a mild desire to an intense drug hunger. When this craving remains unsatisfied, adverse reactions are often experienced by the sufferer and sometimes evident to observers. These reactions may be perceived as unusual agitation, anxiety, depression and/or acting out.

The Concept of Drug Abuse

Drug abuse is defined as, "... the use, usually by self-administration, of any drug in a manner that deviates from the approved medical or social patterns within a given culture. The term conveys the notion of social disapproval, and it is not necessarily descriptive of any particular pattern of drug use or its potential adverse consequences" (Jaffe, 1985, p. 532).

In the American culture, any use of cocaine is considered abuse because cocaine is illicit. Throughout this curriculum, however, the term "drug abuse" or "cocaine abuse" will be used to recognize and identify a pattern of drug use which impacts negatively on the physical or mental health and/or safety of the drug user. In short, drug abuse will be used synonymously with one end of the drug abuse spectrum, i.e., compulsive drug use.

Like addiction, the term "abuse" is applied inconsistently and can mean anything from one-time experimental use of an illicit drug to drug dependency (Jaffe, 1985). With any type of

psychoactive substance, there exists various patterns of usage. This range includes experimental, occasional, social, recreational, and compulsive drug use (Siegel, 1985).

Models for Understanding Addictive Behaviors[9]

The major theoretical models of addiction can be readily organized into the following models of addiction: (1) psychological (i.e., psychodynamic and behavioral); (2) sociological; and (3) biological.[10] Each of these conceptual approaches will be examined below.

Psychological Models of Addiction

Psychodynamic theories. Contemporary psychodynamic literature suggests that among the various theoretical perspectives there is considerable support of the notion that drug use is a vehicle to correct or compensate for defective personality characteristics (Treece, 1984; Treece & Khantzian, 1986). In other words, instead of viewing drug use as a completely self-destructive act, this perspective considers drug use as an adaptive solution to an internal problem. In spite of its short term utility, however, drug use readily can become self-destructive. These insufficient "ego functions" which drug use medicates, consist of defense mechanisms, low self-esteem, poor regulation and management of overwhelming affect, impaired capacity for self-care and relationships with others. These ego related factors can be reduced to three major conceptual categories: (1) non-specific craving; (2) affect deficits; and (3) self and object deficits. Each of these theoretical positions will be described briefly below.

Non-specific Craving. During the 1980s, psychodynamic theories of drug abuse have moved away from almost exclusive focus on sexual drives and oral dependency as explanations for drug hunger. The trend has been to view excessive appetites as representative of major deficits in ego development (Frosh, 1985). The early literature on addictive behaviors stated that non-specific drug cravings and drug use represented a direct drive (libidinal) or instinctual gratification for the acquisition of pleasurable feeling states, (e.g., "pharmacogenic elation," Rado, 1933). This thinking has changed dramatically. Drug use is not commonly viewed as a pleasure seeking activity but rather as a means of reducing emotional pain. People choose specific drugs for their specific pharmacological properties and the capacity to reduce psychological distress (e.g., Khantzian, 1975).

Affect Deficits. Drug use and the management of painful emotional states may be interconnected. Psychoactive drug use can regulate emotional states by altering or modifying feelings. According to this model, the regulation obtained from the use of psychoactive drugs is not unlike how the well-functioning personality provides protection from emotional intensity, pain, and suffering. If the ego is deficient in providing emotional regulation, then an individual must look elsewhere (outward) for support. The concept of addiction as adaptive implies that drug use is ego supportive and represents a defense mechanism in relation to an internal problem or conflict. Consider, for example, one user's explanation of drug abuse as an adaptation. "Cocaine was a way of numbing out feelings... Being stoned is like having a layer between me

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[9]Portions of this section were derived from Shaffer & Jones, 1989.

[10]Readers should note that this organizational schema corresponds with Zinberg's tripartite model for understanding drug effects (i.e., set, or psychology of the user, setting or sociocultural context of the user, and substance or biochemistry of the drug used).

and reality, like doing things with gloves on. I dealt with emotions by avoiding them. Cocaine, I think, allowed me to avoid dealing with the root of the problem."

According to this psychoanalytic model, what was employed initially as an adaptive coping mechanism can turn readily into a maladaptive, destructive activity. Shaffer called addiction "a two-edged sword; it serves as it destroys" (Milkman & Sunderwirth, 1983, p. 38). In other words, addictive behaviors may have adaptive purposes which service the personality well; however, these adaptations concurrently extract penalties.

According to the "adaptive" psychoanalytic model of drug abuse, individual drug users will "self-select" a drug or combination of drugs for their particular pharmacological properties in order to medicate or relieve the discomfort associated with specific internal states or external events.[11] The process of self-medicating with a specific drug or drugs was named the "drug-of-choice" phenomenon by Wieder & Kaplan (1969). Throughout a drug using career, individuals may be exposed to a significant portion of the psychoactive drug smorgasbord, and eventually, through experience and elimination, select those drugs and drug effects which most efficiently help to reduce personal distress. There are particular emotional states which certain people find very difficult to tolerate; drugs with specific pharmacological properties tend to reduce the discomfort associated with these feelings. This model argues that these drugs will be consistently selected, by the abuser, to modify distressful feelings. Thus, current psychoanalytic theory maintains that there is a meaningful relationship between a drug of choice and the user's state of ego functioning.

Milkman & Frosch (1973) examined the relationship between personality and drug of choice. They identified three coping styles, each associated with a particular drug category. Milkman & Sunderwirth (1983) later named these three coping styles as satiation, fantasy and arousal. Opiates, for example, depress the central nervous system, reduce sensitivity to stimulation and slow us down; these drugs facilitate a satiation style of coping. According to this view, the opiate user seeks to cope with "... negative feelings by reducing stimulation from the external or internal world" (Milkman & Sunderwirth, 1983, p. 38). Khantzian (1985) claims that opiate use specifically aids the user in the management of aggressive drives by dampening or reducing impulsive energy. The hallucinogens similarly assist with a "fantasy" mode of coping. This appeals to personality types who "... experience a sense of disconnection from their internal experience or from their relationships with others. Pharmacologically, hallucinogens 'crack the autistic shell' (Wieder & Kaplan, 1969) so that the person is able to discover new worlds both within and outside himself" (Brown & Fromm, 1987, p. 191). Lastly, the stimulants, e.g., cocaine, encourage the "arousal" mode of adaptation. These drugs attract individuals who utilize physical and mental activity as a means of coping with intrapsychic feelings and conflicts. Pharmacologically, stimulants have energizing properties which promote an active stance of acting out overwhelmingly affects (e.g., rage, aggression). In addition, depressed individuals may seek cocaine and other stimulants as a way of providing needed energy to their depleted mood and apathy.

Self and object deficits. Personality deficits can occur when early relationships with others are somehow inadequate. In these models, the people and things to which a young person relates are called "objects." Disruption of early life development is the basic assumption of

[11] Interested readers are encouraged to see the works of Khantzian, 1975, 1985; Khantzian & Mack, 1983, and Khantzian & Treece, 1985 for more comprehensive discussions of this phenomenon.

object relations theory. For example, people struggling with cocaine addiction can be viewed as individuals who suffered major difficulties during the separation or individuation stages of development. These events occur during the first three years of life. The tasks of these developmental stages are to establish separateness from the mother (or major caretaker) and develop intrapsychic images of the mother and other significant people in the infant's world. During "normal" development, the infant initially experiences that the mother exists only when she is present. The infant lacks a sense of permanence with regard to people. By experiencing the mother's repeated comings and goings, the child learns that she exists even when not in sight. To minimize the fear of the mother's loss or disappearance, the child creates an inner world of images which represent the mother and other loved people (i.e., other "objects"). These images or "internalized objects" provide the infant with constancy even when these objects absent. This acts as a sort of self soothing function, thereby diminishing the child's typical fears and insecurities.

In addition, the infant not only internalizes the mother, but also internalizes some of the functions she provides. If the infant can internalize a "good enough" caretaker, this can form the basis for a positive sense of self and provide the foundation for further personality development. Before the infant builds up a store of internalized images, however, s/he frequently makes use of transitional objects, which symbolize the mother or caretaker and provide a soothing function. A teddy bear or special blanket may serve as companions that help the child tolerate periods of emotional discomfort during mother's physical absence.

Khantzian & Mack (1983) suggest that people with addiction fail to internalize certain aspects of self-care from their early environment, in general, and from their caretaker, in particular. "In searching to identify and understand impairments in survival skills and self-care, we have stressed a developmental perspective focused upon how early nurturing attitudes and the caring and protective functions of parents, particularly the mother[12], are internalized and transformed into positive attitudes of self-regard and adequate structures and functions assuring self-care and self-protection" (Khantzian & Mack, 1983, p. 229). Drug users frequently show a deficiency of appropriate apprehension regarding the consequences of drug use. This deficiency is also linked to generalized difficulties in self-care. These individuals fail to care for and protect themselves; this can perpetuate drug involvement. Perhaps in individuals with better self-care functions, drug use would be terminated before problematic use evolved; possibly illicit drug use would not even begin.

According to the object relations perspective, a person with cocaine addiction, has not internalized adequately the "good enough" caretaker during the separation/individuation stage of development and, as a result, does not have the personality functions sufficient to regulate day to day stress and discomfort. Cocaine, then, often becomes the transitional object. The object deficit view posits that the drug user requires external aid to maintain a sense of well-being. Cocaine temporarily provides these functions which were lacking in the user. During the early stages of use, cocaine provides an increase in self esteem and an improved ability to manage and control painful affects and energy.

In summary, Hartmann (1969) abstracted the four basic tenets of psychoanalytic models of drug abuse.

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[12]It is easy to see why some people have criticized psychological theory for being too critical of mothers!

1. "There is a basic depressive character with early wounds to narcissism and defeats in ego development.
2. There is an intolerance for frustration and pain with a constant need to change a `low' into a `high.' This may come from an early lack of satisfying object relations.
3. There is an attempt to overcome the lack of affectionate and meaningful object relations through the pseudo-closeness and fusion with other drug takers during their common experience.
4. The artificial technique of maintaining self-regard and satisfaction with drugs, of avoiding painful affects, and alleviating symptoms results in a change from a reality-oriented to a pharmacothymic-oriented regimen. This leads to severely disturbed ego functions and ultimately to conflict with reality. Eventually, the drug taking becomes a way of life" (cited in Frosh, 1985, p. 31).

The Behavioral Approach

In this section, we will review the major conceptual underpinnings of the behavioral approach to addiction. In particular, we will focus on the early work of Abraham Wikler. Historically, Wikler has had the most influence on behavioral models of addiction. This review is by no means exhaustive; there are a plethora of contemporary materials available which describe behavioral approaches in detail. Our goal is simply to provide some of the basic canons of this approach.

Behavioral psychology means many different things to different people. Behaviorism is not, nor was it ever, a monolithic theoretical concept or treatment approach. Nonetheless, current behavioral theory and practice, despite extreme diversity and often strident discord among adherents, reflect agreement regarding the importance of using scientific methods in both research, assessment, and practice in the field of addictive behaviors.

By the 1950s, psychoanalytic approaches had failed to solve the riddle of addiction. As a result, there was a growing dissatisfaction with this perspective. At about the same time, behavioral theories were boasting the virtues of employing a more empirical and scientific approach to human behavior; these models began to gain popularity, though not without dissent from competing theoretical camps.

Pavlov and Skinner. The behavioral perspectives were spawned from classical (or respondent) and operant (or instrumental) conditioning paradigms developed by Ivan Pavlov and B.F. Skinner, respectively. These models generated the view that psychopathology is a learned set of dysfunctional behaviors rather than the result of deep seated psychological trauma or physical illness. Thus, disordered thinking, feeling, and acting was conceptualized as a set of maladaptive responses to environmental events which, once learned by the individual, is maintained by reinforcing contingencies.

Therapies guided by behavioral models assume that the individual and the environment are an interacting system of events and that the developing person reacts from birth to external conditions in both the physical and social environment. Therefore, individual behavior is influenced, i.e., altered or maintained, in predictable ways. On the basis of experience with the external world, people acquire consistent patterns of reacting to new conditions as they develop through the life cycle. Finally, according to behavioral theory, individual behavior, modified

and/or maintained by experience, should be the major focus and subject matter of scientific and clinical inquiry.

Conditioning Factors in Narcotic Addiction. In 1965, Abraham Wikler published a chapter on conditioning factors in opiate addiction and relapse. As a result, Wikler emerged as a pioneer in behavioral theory. This paper was the first to consider the roles that operant and **classical conditioning** played during the process of addiction. Wikler's thinking predated contemporary cognitive-behavior modification theorists and practitioners by analyzing the relationship between cognitive and behavioral phenomena. Wikler's view, unlike many behavioral models, considered the drug user as an active, self-determining individual who was not simply a victim of circumstance or conditioning. Addicts were human beings with feelings, thoughts, motives, and ideas, all of which were considered to come into play during the acquisition, maintenance, and extinction of addictive behavior.

As a result of (a) Wikler's concept of conditioned dependence and (b) that "typical" substance abusers continue to spend a great deal of time in the environments that had previously been associated with substance use, naltrexone treatment has been utilized to extinguish the bond between conditioned stimuli (e.g., the environment) and conditioned responses (e.g., opiate use). Naltrexone blocks the reinforcing properties of narcotics so that drug taking behavior will be extinguished. Wikler`s two stage approach to substance abuse perhaps best illustrates the application of classical behavior theory to an understanding and treatment of addictive behavior.

The theoretical explanations that most cogently explain the clinical application of naltrexone and Antabuse as pharmacologic treatments for drug abuse are largely based on the two stage conditioning model developed by Wikler. Naltrexone's action, that of a narcotic antagonist, essentially eliminates the unconditioned reinforcing properties of narcotics by blocking their action. Conversely, Antabuse punishes the use of alcohol by inducing a noxious syndrome; this syndrome - according to behavioral theory - should reduce the use of alcohol. It should be readily apparent to supporters and critics of behavioral theory alike that these interventions, like other treatment approaches, are effective on some clinical occasions and not on others.

Wikler's conditioning model of addiction has been supported by data obtained primarily in animal laboratories. However, support for Wikler's ideas also come from clinical and case research. Nevertheless, since generalization of animal data to humans is equivocal, more empirical research is necessary to provide more support for the details of Wikler's behavioral model. By considering addiction as the consequence of learning, Wikler's formulations potentially permit the development and implementation of more precise treatment techniques (e.g., the extinction of specific conditioned responses that maintain a pattern of drug dependence). It is very curious, however, to note that relatively few practitioners have implemented treatment programs based on the sophisticated theoretical perspectives originally furnished by Wikler. We speculate that his theoretical concepts were too complex, perhaps, for the majority of practitioners to utilize within the typically spartan settings reserved for the treatment of opiate dependence. Wikler's theoretical models have yielded numerous progeny, many of which are not readily recognizable because of the changes that characterize contemporary behavior therapy.

Sociological Models of Addiction

While the psychological literature primarily emphasizes the personality and motivational issues associated with drug use (i.e., the "set"), the social models of addiction focus more on the importance of physical and environmental determinants (i.e., the "setting"). Often, sociological theories focus on the interaction between external setting variables with internal set variables to understand the complexity of drug use/abuse. This section will review briefly the salient sociological theories of addiction within three major groupings: (1) social learning, (2) peer group theory, and (3) social predisposition.

Social Learning Theories

The question, "What causes addiction?" is somewhat a chicken and egg problem. It is impossible, for example, to separate precisely environmental from genetic influences. Is there an "addictive personality?" Are there predisposing characteristics which make specific individuals prone to chemical abuse? Alternatively, we can ask whether or not addiction is the consequence of the social conditions that surround various individuals and their lifestyles.

As we described before, based upon their research, Gendreau and Gendreau (1970, 1971) rejected the concept of an "addictive personality." They claim that support for this personality type derived as an artifact of faulty research methods. Zinberg (1975) suggested that the regressed and "deteriorated ego state" of people with addiction is more a consequence of cynical social conditions than a result of predisposing psychopathology. He maintained that the social milieu is crucial if one is to understand drug use and abuse. This view of addictive behavior stresses the influence of culture and its associated implicit value system, mores and folkways.

Peer Group

It is impossible to have an educated discussion of peer groups and their influence without referring to the work of Chein, Gerard, Lee & Rosenfeld (1964). Their work, *The Road to H*, now more than 30 years old and somewhat limited in its demographic perspective, still stands as a classic which provides us with large scale data within a psychologically meaningful framework. With respect to initial drug experimentation, Chein et al. (1964) stressed the easy availability of narcotics within a deviant peer group milieu as the major determinant to drug use (i.e., in this case narcotics) initiation. Subsequent authors examined narcotic use across a broader sociological spectrum. These researchers also acknowledged the importance of exposure and access but attributed a more active role to individual motivational factors during the initiation process. Both Kandel (1978) and Robins (1974), for example, stress the role of peer influence during drug initiation. Kandel (1978) differentiated factors relevant to common licit (tobacco, alcohol) and illicit drugs (marijuana). Poor relationships with parents, psychological distress, and more deviant personal characteristics distinguish between those who move away from socially popular drugs to those that are illicit (Jones, Treece, & Hoke, 1981).

The social influence of peer drug-using groups, as well as other social variables, contribute to cocaine's popularity. The following are four specific social factors associated with contemporary cocaine use patterns:

- ***Exposure***: The media continues to cover and sensationalize cocaine, and perhaps indirectly creates an even larger cocaine market.

- ***Widespread Use and Social Acceptance***: The homogenization of cocaine (i.e., no longer the exclusive domain of the affluent) into all social classes provides equal opportunities for cocaine abuse among the entire spectrum of the population.
- ***Availability and Access***: The street price of cocaine has decreased while the quality has increased. Cocaine has remained affordable, relatively pure, and readily available in spite of the government's efforts to interdict.
- ***Misinformation***: The historical misconception by many that cocaine is without danger and therefore "safe" deceives curious people with a naive sense of confidence; this information can blind users to the warning signs of cocaine abuse.

Social Predisposition

One way of attempting to understand the social predisposition model of cocaine use and abuse is to apply the "drug of choice" model described earlier to the United States as a social system instead of just to a partcular individual. In other words, what is it about cocaine that the nation has found so appealing? In this section, we speculate about how cocaine became American's illicit drug of choice during the 1980s.

During the 1980s, American society favored the stimulants or energizing drugs. During this period, drugs representing other categories experienced diminished popularity. Alcohol still remains the most widely used and abused drug in America. Currently, marijuana and heroin use is increasing. The following discussion will use cocaine to describe how the use of certain drugs or drug classes become popular and widespread.

To illustrate, cocaine may represent a continuation or extension of the widespread use of licit stimulants like cigarettes and caffeine. In the past, the wholesale advertising of coffee (i.e., not linked to a brand name, but simply presented as a generic substance) has appeared repeatedly on television. These advertisements are usually upbeat, fast tempo music videos with cameo appearances of super-stars endorsing coffee. A very similar advertizing format still is used for caffeine containing products like Coca-Cola and other soft drinks. Advertisements have included slogans like "The Coffee Generation" or "The Coffee Achievers." This achievement-oriented context of the 1980s may provide an influential setting for stimulant use and abuse. The American work ethic and Type A pressures of the current generation no longer are driving people to drink but rather to puffing, sipping, snorting and sniffing. "... In its pharmacologic action cocaine, perhaps more than any other of the recognized psychoactive drugs, reinforces and boosts what we recognize as the highest aspirations of America: initiative, energy, frenetic achievement and ebullient optimism" (Newmeyer, 1987).

The stimulating effects of cocaine appeal to, compliment, and are reinforced by, sociocultural values. America treasures productivity. In the face of trying economic times and mounting international economic challenges, American citizens are being asked to increase production. The consequence can lead to a stress response syndrome (e.g., "burn out"). Cocaine abuse often occurs in individuals who maintain high-functioning jobs. The stimulating effects of the drug are utilized as a means of energizing an exhausted autonomic nervous system. Freud often described the effects of cocaine as "... exhilaration and lasting euphoria." He added that "long-lasting, intensive mental or physical work can be performed without fatigue; it is as though

the need for food and sleep ... were completely banished ..." (Gay, Sheppard, Inaba, & Newmeyer, 1973, pp. 1029-1030).

Biological Models of Addiction

The biological component of chemical dependency emphasizes the "substance" aspect of Zinberg's "set," "setting" and "substance" (Zinberg, 1984). This section will examine some selected biological theories of addiction. These discussion will include addictive "disease," "genetic" or hereditary, "biochemical" or neurotransmission, and "systemic imbalance" models. Finally, there will be a very brief section commenting on animal studies and addiction research.

Disease Model

The disease model currently represents the most popular model of addiction in the United States. Interestingly, it is not the most dominant world-wide explanation for understanding addiction. As we stated before, traditional disease theory considers chemical dependency and "addictive disease" as a primary, predisposing disease which is progressive, incurable, and ultimately fatal if not arrested. In Alcoholics Anonymous (AA), for example, the first step in recovery is to admit being "powerless over alcohol." For the alcoholic, "... alcohol is a poison" and the only medicine for its remission is total lifelong sobriety. Traditionally, even with long-term abstinence from alcohol the individual is not considered to be recovered but "recovering" - once an alcoholic always an alcoholic - because alcoholism is a progressive disease. From this perspective, the disease of alcoholism existed before the alcoholic ever took that first drink; an alcoholic is predisposed to become an alcoholic if they drink (AA, 1939/1976). Lifelong abstention is the only way to avoid the disease entirely.

Alcoholics Anonymous has been relatively successful in helping many overcome the devastation of alcohol dependence. "The therapeutic success of AA is difficult to evaluate ... But the available data suggest that although AA may only reach 5 to 10 percent of alcoholics, for those who attend meetings on a regular basis it is the most effective means of maintaining sobriety currently known..." (Mack, 1981).

In theory, the disease model shifts personal accountability from the individual to some external agent, thus reducing individual guilt and remorse. What had been associated previously with purposeful behavior, can now be seen as the result of sickness. Acceptance of the disease model diminishes the harsh moralistic tone associated with both public attitudes toward alcoholics as well as how alcoholics view themselves. In short, the disease model of alcoholism allows blame or responsibility for the condition to reside outside of the afflicted "victim." If embraced, this view permits more individuals to make their once kept private sickness public, and receive treatment without fear of scorn and ridicule. In practice, however, the disease model has not been separated completely from stigma. For example, recent evidence (Caetano, 1987; Rohman et al., 1987; Shaffer, 1987) has revealed that although both the public and the medical profession are willing to call chemical dependency, cocaine abuse and alcoholism diseases, this view continues to rest on a foundation of harsh moralistic judgment. This research demonstrates that although people may be quite willing to comply with the convention of calling addiction a disease, underneath this veneer they do not seem to believe it. They do not consider addiction as a disease in the same way that they do for biologically based sicknesses such as cancer, malaria, measles, scarlet fever or AIDS (Shaffer, 1987). Consequently, people with addiction still feel

stigmatized as do many individuals who contract a wide array of diseases. While people with addiction are not responsible for the development of their disease, they are responsible for directing their recovery. Unfortunately, many observers argue that addiction is the consequence of willful misconduct. Nevertheless, nobody seeks to become addicted to psychoactive drugs. From the disease model perspective, addiction is the result of psychoactive drugs insidiously commandeering the brain.

Genetic Theory

Recently, Collins (1985) reviewed the essential literature concerning genetics and alcoholism. His analysis of how alcoholism is transmitted within families suggests that children of alcoholic parent/s have a two-to-four times greater probability of becoming alcoholics than the general population (i.e., children from non-alcoholic parents). Adoption studies also indicate that adopted children with alcoholic biological parents had four times a greater incidence of alcoholism than adopted children who had non-alcoholic biological parents (e.g., Goodwin, 1979).

It is extremely difficult for scientists to separate hereditary and environmental factors in their research. Those who argue against genetic predisposition for addiction-proneness suggest that the negative results of being reared in a dysfunctional, chemically abusing family may sufficiently impair offspring and produce a vulnerability to alcohol/chemical dependency. This argument does little to offset the importance of the adoption studies mentioned above, however. The "nurture versus nature" dichotomy is ultimately a straw man. Environmental and genetic factors are always confluent in effect; the weight of their interaction represents shifting influences on human behavior. Many adoption studies, for example, neglect to inform the reader of "nurture" influences that may have affected the subjects studied. Consider the importance of an adopted child's exposure to a biological parent who is addicted. Heath (1987) recognized that all models which stress the role of genetics in determining alcoholism also stress the interaction of this factor with individual, social, and other environmental factors.

Vaillant's (1983) longitudinal study of the natural history of alcoholism found that Irish Americans were much more likely to become alcoholics than Southern Europeans. This finding can easily be interpreted as confirmation that alcoholism or other chemical dependencies are genetically based. Peele (1984) noted, however, that American Indians and Chinese Americans - two groups recognized for their shared and exaggerated metabolic reactions to alcohol - manifest very dissimilar rates of alcoholism. Although similar in biological predisposition, these different rates of alcoholism seem to reflect the dissimilar social mechanisms responsible for their respective styles of drinking.

Heath (1987) summarized the problems associated with a strict genetic explanation of addiction: "It has been recognized since ancient times that something like what we call 'alcoholism' tended to 'run in families' - but so does speaking Swahili, eating with chopsticks, attending Oxford University, being a bank president, or a number of other behavior patterns that no one would think of calling genetic" (p. 21). "... the popular misconception of the meaning of 'alcoholism as a genetic disease' harms not only the social sciences (by inappropriately discrediting the relevance of environmental factors), but it also is prejudicial to most approaches toward prevention, and may even undermine treatment for many who need it. Until gene splicing becomes routine, far too many people view genetics as destiny, unalterable so that the

quest for a 'marker' becomes viewed as a hope of labeling incipient alcoholics at an early age, and anyone who ignored that warning would certainly be trapped. Such labeling and such resignation may be harmful to any number of individuals who might otherwise enjoy the benefits of drinking along with other aspects of a more 'normal' life" (p. 30).

In spite of these criticisms, new research (Benjamin, Lin, Patterson, Greenberg, Murphy, & Hammer, 1996; Ebstein, et al., 1996) reveals that genetic material (i.e., alleles of D4 **dopamine** receptor gene, located on the short arm of chromosome 11) encode one of the five known subtypes of human dopamine receptors. The activity of these receptors is associated with the positive subjective experiences that emerge from novelty-seeking or risk-taking. Although, these experiences are associated with complex personality characteristics. The D4 receptor gene helps to regulate behaviors influenced by the dopamine neurotransmitter pathway. These findings provide the first direct support for the neurobiological basis of potentially addictive experiences.

Chemical Receptor Site Theory

There are important biochemical mechanisms that influence the subjective effects of psychoactive drugs. All drugs alter the brain's chemistry within the central nervous system. First, the drug (e.g., cocaine) enters the blood stream of the user via various routes of administration (e.g., through oral, intra-nasal, intravenous administration or by smoke inhalation and "freebasing"). Orally ingested drugs take the longest to be absorbed by the bloodstream; drugs that are smoked (e.g., "freebased" cocaine and tobacco) or injected intravenously are more rapidly absorbed. Once the drug is in the blood stream, it penetrates the blood-brain barrier. This barrier is where the drug joins with the brain's neurochemistry. Chemical messengers called neurotransmitters are altered by the presence of a drug.

The effects of drugs on biochemical and neurotransmitter processes are very complicated and will be described here only in a most elementary form. Each neurotransmitter, with its chemical message, travels through and along a nerve cell, or neuron, to a location at the end of the nerve known as an end foot or presynaptic terminal. Every neuron ends at a gap which marks the end of one neuron and the beginning of the next; this gap is known as the synapse. An electrical charge that spreads down the neuron causes the neurotransmitters to be released, along with their messages, into the synapse. Three things can happen to a neurotransmitter once it has entered the synapse: (1) it can attach itself to the neuron located on the other side of the synapse (i.e., the postsynaptic membrane); (2) it can be deactivated or neutralized by metabolic process; or, (3) it can be retrieved or taken back to the first neuron in the presynaptic membrane or end foot area. This process of retrieval is referred to as a "reuptake" mechanism.

Chemical receptor theorists speculate that some individuals have a deficiency of certain chemicals in their brain. Rather than becoming addicted due to the depleting effects of chronic drug abuse, researchers hypothesize that these people do not produce sufficient supplies of opiate-like chemicals which are naturally produced by the brain, (i.e., endorphins). Therefore, some clinicians suggest that individuals who are deficient in their brain chemistry seek external substances to compensate for their biological inadequacies (e.g., Khantzian, 1978).

Systemic Imbalance Theory

Systemic imbalance theorists postulate that a predisposing biochemical imbalance exists in the chemically dependent person and that "relief" can be obtained by the application of cocaine or other psychoactive substance(s). Khantzian and Treece (1985) examined 133 opiate addicted subjects and found that 60 percent of them suffered with depression or described a history of depression. Mirin and Weiss (1986) studied the biological correlates of substance abuse and found that a substantial minority of drug users experience psychiatric problems that preceded drug abuse; these disorders include affective disorders, attention deficit disorder, generalized anxiety disorder and panic disorder. Stimulant abusers evidence a higher frequency of affective disorders (particularly bi-polar illness) than any other type of drug users. Among cocaine abusers, there is a higher rate of affective disorder than among non-stimulant users. Cocaine users also have a higher rate of positive family history of affective illness. Systemic imbalance theorists struggle with some of the same questions that plague other biological researchers. Which, for example, came first, the biochemical imbalance or the drug use?

Animal Studies and Addiction

There are a remarkably large number of animal studies present in the addictions field. Some findings are important, if not essential, to an understanding of human addiction; most, however, are not relevant to natural recovery and cocaine quitting. We will review here one ingenious set of experiments called the "Rat Park Chronicle" (Alexander, Hadaway, & Coambs, 1980). This study integrates many of the findings and principles obtained from other animal research and illuminates some of the most basic assumptions about addiction and the interactive role of set, setting and substance.

Alexander et al. (1980) compared opiate intake among two rat colonies. Each colony consisted of a radically different environment. The first rat environment was the typical laboratory set-up of steel cages; each cage contained one rat who was physically isolated from the other rats. The second setting attempted to achieve a natural rat habitat: "Rat Park is open and spacious, with about 200 times the square footage of a standard cage. It is also scenic (with a peaceful, British Columbian forest painted on the plywood walls), comfortable (with empty tin cans and other desiderata strewn about the floor), and friendly (we ran coed groups of 16-20 rats)" (Alexander et al., 1980, p. 55).

The researchers conducted three experiments which were called, the "easy access," the "seduction" and "kicking-the-habit" (p. 55). The "easy access" procedure involved two drinking solutions available to both rat colonies around the clock. These solutions consisted of narcotic morphine with sugar added, and sugar water.

The "seduction" procedure offered two liquids to the rats; one solution was morphine with an ever increasing level of sugar (increases occurred every five days). Apparently, rats have a "sweet tooth" and the researchers sweetened the pot, or, in this case, the morphine. The second solution in the seduction experiment was plain, unsweetened water.

The third condition, "kicking-the-habit," provided the rats with only the morphine solution for a period (57 days) sufficient to produce physical dependence. The dependent rats were then given 2 solutions to choose from: morphine or water. The statistically significant results indicated the following: "No matter how much we induced, seduced, or tempted them, the

Rat Park rats resisted drinking the narcotic solution. The caged rats drank plenty, however, ranging up to 16 times as much as the Rat Park residents in one experimental phase and measuring 10 times as much in some other phases" (Alexander et al., 1980, p. 56).

The researchers concluded that if rats are given a suitable environment in which to live, they will resist drug use. Alexander et al. also state that the typical laboratory setting is extremely stressful for rats (and other animals) who are temperamentally "gregarious, active, curious animals" (1980, p. 56). When put into "solitary confinement" with only a drug, "extreme forms of coping behavior" occur (e.g., drug intoxication). We believe that these findings have important implications for humans and for the conventional belief that there are "addictive" drugs. It appears that drugs alone may have little capacity to produce addiction and some influence producing physical dependence. The unique subjective effects or consequences of drug taking behavior has much more to do with the interactions that occur among a substance, set and setting.

Animal researchers, in their efforts to reduce extraneous variables, often contaminate the results of their own studies. Their research supposedly (1) eliminates "set" as a variable; (2) creates a world for the animal which exaggerates "setting" (and an artificial one at that) where the animal exists in isolation and sensory deprivation, and then (3) draws conclusions based on the particular "substance" studied as if a drug could be observed in isolation.

Stage Change Models for Addiction

There is a new developmental model which can help students to understand how addiction emerges and how people with addiction recover. This model applies to the full range of addictive behaviors. By listening to people with addiction, their personal way of making sense of their addiction and recovery experience, Shaffer (1992, 1994) elaborated a new model of addiction that integrates many of the ideas inherent in other models of addiction. In addition, this stage change approach to understanding addiction suggests fresh ways of utilizing prevention and treatment interventions over time. This approach suggests six stages of developmental change that can describe both the emergence of addiction and the evolution of recovery. Each of these stages will be described below.

The Emergence of Addiction: Initiation. To become addicted to any activity or substance and then to successfully quit, one must first engage in the activity at some point. Everyone who uses a drug, however, does not become a drug abuser or addict. In fact, the vast majority of those who have tried a psychoactive drug or engaged in gambling or other potentially addicting activities do not become addicted (e.g., Shaffer & Jones, 1989). However, for a wide array of interactive biological, psychological and social reasons, some initial episodes of drug use provide a portal into the addictive process.

Substance Use Produces Positive Experiences. If an activity (e.g., drug use, gambling, over eating) is not associated with some positive consequences, it will be discontinued. Positive effects can be a direct result of the pharmacological properties of the drug or the psychological reinforcement (e.g., relief of depression, peer group encouragement and praise, or reduced sexual inhibition) obtained by its use. The consequences also can be positive in a more indirect manner. For example, some drug users experience more social rewards, are held in higher esteem, and have more to do when they are using the substance. Without some positive consequences, any activity or drug use would not be continued to the point that addiction could emerge. The

experience of positive consequences is fundamental to understanding the development of ambivalence that emerges during the often repetitive cycle of addictive behaviors characterized by the next phase. In addition, an understanding of these positive consequences is essential if clinicians expect to manage effectively the feelings of countertransference hate that often emerge during the treatment of addiction.

Adverse Consequences Emerge. For drug use or any other activity to be considered as an addiction, it must, by definition, be associated with adverse consequences. When adverse consequences emerge, most people restrict, regulate or modify their behavior. They moderate their activities or abstain entirely. People with addiction, however, are unable to modify their behavior. For biological, psychological, or social reasons, they remain unable to temper their actions. At the beginning of this process, they do not even contemplate readjusting their behavior (e.g., Prochaska & DiClemente, 1985, Prochaska, DiClemente, & Norcross, 1992; Prochaska, Norcross, & DiClemente, 1994). The essence of this addiction predicament (Shaffer & Gambino, 1989) is that the object of addiction continues to provide some of the previous positive consequences while simultaneously producing adversities that begin to weigh more heavily (Shaffer, 1992, 1994). *Addictive behaviors servewhile they destroy.* The reason that these repetitive behaviors can be so very destructive rests on the notion that people with addiction are not fully aware that the negative effects produced by their excessive substance abuse (or other addictive behaviors) is, in fact, the result of that behavior pattern. This period represents the "throes of addiction."

Shaffer and Robbins (1995) suggest that during this phase, people with addiction believe their behavior has little to do with their suffering. Instead, they perceive others as the source of their problems. The urging of friends and family to reduce or stop the addictive behavior is of little consequence; in fact, their pleading can become the fuel that energizes the addictive behavior so that the pattern intensifies further. At this level, addicts are capable of making sense of their world, with one exception: they cannot make any causal association between their addictive behavior and the life problems that they have had to endure. To minimize the discomfort associated with these problems, persons with addiction persist in engaging in those behaviors that previously had produced positive consequences. The result is the maintenance of repetitive, excessive behavior patterns—addictive behaviors—that repeat without the apparent presence of a regulatory mechanism capable of restoring control by breaking this cycle.

The Evolution of Quitting: The Turning Points. For people who have experienced addiction and then successfully recover, adverse consequences of substance abuse enter into their awareness and life takes a turn. This turning point into awareness, or insight, has often been considered the end of denial. More accurately it is a reclaiming of the blaming and projections that characterize phase three. No longer are one's problems the result of external events; no longer can one continue to claim victimization. The adverse consequences associated with addictive behavior now are experienced as one's own. This is the beginning of an epistemological shift. The person struggling with addiction is confronted by the recognition that their drug using behaviors has influenced or directly caused such problems as poor health, financial difficulty, and/or family disintegration. They now realize that their behaviors are not anomalous and not without adverse effect. Often experienced as a life crisis, the person with addiction recognizes that their lifestyle must now change if they are to regain control. They begin to recognize that they must give up the positive consequences of their behavior that continue while they gain access to the negative outcomes that are connected with the addictive

behavior pattern. The event or events associated with the turning point experience(s) mark the beginning of the evolution of quitting.

A turning point represents the shift between unencumbered substance abuse and the realization that this abuse is directly responsible for the presence of profoundly negative life circumstances. The thought of quitting or controlling drug abuse first appears prior to the actual turning point. This thought represents the ambivalence which is at the core of addiction.

Ambivalence During the Turning Point. Addiction is a well-known destructive behavior. Like all patterns of human behavior, addictive behavior patterns perform some service. Usually, people have difficulty understanding the adaptive or useful value of these patterns. The result is that efforts to change these behaviors often fail. Whether recovery is self or other initiated, it is very important to understand that addictive behaviors serve while they destroy.

This double edged sword we call addiction produces ambivalence for the person with addiction who is thinking about change. Ambivalence is a feeling of conflict. It is a simultaneous sense that we both want and don't want to change. Ambivalence creates a mixed feeling that we both like and don't like what we have, want or experience. In spite of the obvious destructive power of addiction, people in the midst of addiction cling to the part of this experience that they like, the part that was adaptive originally and produced positive consequences (during phase two). As drug abusers become aware of their ambivalence, they begin to express a wish that they want to quit. However, they do not yet want to stop. Increasing levels of self observation develop and the substance abuser now begins to realize that the costs of addictive behavior exceed the benefits. Substance abuse is explicitly identified as the major[13] destructive agent in their life. It is at this point that a quitter often asks friends and significant others to help them stop. Before a turning point, the burden of self-control had been delegated more to others than oneself; the acceptance of personal responsibility represents the actual turning point.

A turning point is not simply a transition. It is actually the end of a complex dynamic process about drugs (or other addictive behavior). We consider it an end point even though abstinence and recovery might be months or years away. Needless to say, the experience of a turning point does not produce instantaneous results. Commonly experienced turning points have been described as periods of dissonance associated with feelings of self-loathing or a deterioration of personal values (Shaffer & Jones, 1989). Other turning point perceptions include the recognition that substance abuse is beginning to exacerbate rather than diminish intra- and inter-personal conflict. An extremely important yet commonly reported turning point centers around the recognition that one's deteriorating physical condition is related to drug abuse. This is experienced as a do or die situation: if drugs are used, the user believes that they may die as a result. Other turning points, less extreme but no less important, involve the recognition that one may lose what is important to them, for example, their job or a special relationship, because of their drug involvement.

Active Quitting. Once a turning point is experienced, the process and task associated with active quitting can begin. Two basic approaches to quitting were identified: "tapered quitting" and "cold turkey quitting." It is possible, that a successful quitter will mix these

[13]They also may be involved addictively with other substances or activities.

approaches in order to find a method that works. The majority of quitters, however, fall predominately or entirely into one style or the other. Few successful quitters mix their stopping strategies.

The notion of active quitting is important. Successful quitters make observable changes during this second phase of the stopping stage of addiction. The methods for quitting drugs include energetic attempts to avoid the drug, gain social support for personal change and engage in some form of self-development that helps to manage stress (e.g., Carey, Kalra, Carey, Halperin, & Richards, 1993). Thus, this phase is characterized neither by thoughtfulness nor ambivalence. It is identified by important and marked behavioral change and lifestyle reorganization. New activities are elevated to a position of prominence; they gain intra- and inter-personal value. Old behaviors become devalued and less meaningful.

Relapse Prevention. Very few individuals who stop their drug use remain totally abstinent from that moment. Marlatt & Gordon (1985) examined how slips, that is, single episodes of drug use, can lead to full blown relapse. Biological, psychological and sociological factors interact to influence the risk of relapse for any individual. The final phase of quitting involves the maintenance of new skills and lifestyle patterns that promote positive, independent patterns of behavior. The integration of these behaviors into regular day to day activities is the essence of relapse prevention (e.g., Brownell, Marlatt, Lichtenstein, & Wilson, 1986).

The experience of natural quitters suggests that having a number of strategies and tactics to draw upon is essential to maintaining abstinence. Successful quitters substitute a variety of behavior patterns for their old drug using lifestyle. For example, they become regularly involved in physical exercise. At times these substitute patterns also can become excessive. This risk is most probable when (a) excessive behavior patterns serve as anodynes to uncomfortable affective states, and/or (b) self-observation skills are weak and poorly developed. Flights into spiritual or religious conversions also help many individuals sustain their abstinence. For some, it took the shape of entry into formal treatment. Others occasionally substitute other drugs that they consider less troublesome than their drug of abuse. The use of pharmacological substitution is extremely risky and often backfires. The results of drug substitution can be as devastating and destructive as the original drug abuse.

In sum, there are six major phases that describe the cycle of addiction. The first three phases comprise the natural history stage of addiction, while the last three are associated with quitting, or the treatment history of the addictive disorder. The first stage serves as groundwork for the second stage and thus must not be lost sight of in the therapeutic process.

Summary

Scientists consider drug abuse and addiction to be the consequence of a complicated blend of biological, psychological and sociological factors. In short, drug abuse and addiction reside neither in the drug nor in the personality of the user. Addictive behaviors are the result of many interactive factors that vary in prominence from individual to individual. It is essential to take a multidimensional view of drug use, abuse and addiction: the psychological determinants of drug use, the developmental phase in which abuse occurs, the social and cultural contexts in which intoxicants are used and abused and the pharmacological properties of the substance. Zinberg offered the tripartite model for understanding drug effects (i.e., set, setting, and drug). In this module, we reviewed a representative sample of models from each of these domains.

GLOSSARY

CLASSICAL CONDITIONING: A learning process by which a subject comes to respond in a desired manner to a previously neutral stimulus that has been repeatedly presented along with an unconditioned stimulus that elicits the desired response (Microsoft, 1995).

CRITICAL THINKING: "Critical thinking is an approach to problem solving and decision making. Good science cannot be done without it. The basic processes of critical thinking include planning, information gathering, defining a frame of reference or context, monitoring, accounting for biases and evaluating. Critical thinking involves recognizing and accounting for the assumptions, background logic, biases, intentional deception, and other factors that tend to distort the outcome of scientific thought processes" (Carr, 1992, p. 20).

DATA: Data can take many forms. Data can be values derived from scientific experiments, most often expressed in numerical form, or data may be considered factual information - especially information organized for analysis or used to reason or make decisions. The word data originated as the plural of the Latin word *datum*, meaning "something given." Scientists use data to test what has been observed in nature. Data can be "raw" or data which has been recently collected and has had no analysis performed upon it to illicit any conclusions from it; or data can be analyzed to inform a theory or guide a hypothesis. Data may be clean (or checked to insure that the method taken in its collection was solid, and that the data itself is valid). Data is used to develop explanations with evidence.

DATA ANALYSIS: Data analysis involves recording, interpreting and presenting findings. Recording data is the act of writing the information collected in an organized manner -- usually on a table or chart rather than in sentences or outlines. Data analysis requires the scientists to review their findings, and use statistics to determine the reliability and significance of their findings. Interpreting data is the process of organizing the information gathered to look for patterns and relationships. Once those patterns are recognized, scientists must report their findings and conclusions. Interpolating from the data means making predictions based on the findings by staying within the actual findings; such as using a graph to look for patterns and predictions that fall "inside" the plotted data. Extrapolating from the data involves making predictions based on the findings by going beyond the actual findings; such as using a graph to look for patterns and predictions that continue beyond (or "exit") the graph (Barhydt & Morgan, 1993).

DOPAMINE: A monoamine neurotransmitter formed in the brain by the decarboxylation of dopa and essential to the normal functioning of the central nervous system. A reduction in its concentration within the brain is associated with Parkinson's disease (Microsoft, 1995b).

EXPERIMENT: An experiment is a test under controlled conditions that is made to demonstrate a known truth, examine the validity of a hypothesis, or determine the efficacy of something previously untried. The word experiment is derived from the Latin expression "experiri" which means "to try." Experiments must be replicable and repeatable to maintain credibility within science and with other scientists.

FACT: Facts are measurements or observations that an be consistently replicated and are most often found in reference handbooks. Facts also include operational definitions of basic quantities like mass, length, or time, or the conversion among such quantities (National Science Teachers Association (NSTA), 1995).

HYPOTHESIS: Hypotheses are attempts to state simultaneously all reasonable or logical explanations in some cases -- or one reasonable explanation that will account for most of the data in other cases -- for a reliable set of observations, stated so that each explanation may be tested and, based upon the results of those tests, denied. Although mathematics can prove by induction, science cannot. In science, one can only prove that something is not true. Accumulated evidence can be used to corroborate hypotheses, but science remains mainly tentative (NSTA, 1995). Scientists who formulate hypotheses state formally what they predict will be the outcome/s in a given experiment before beginning the experiment (Barhydt & Morgan, 1993). Verification of a hypothesis occurs when the findings in an experiment demonstrate the predicted outcomes. Nullification of a hypothesis occurs when the findings in an experiment demonstrate that the predicted outcomes did not occur (Barhydt & Morgan, 1993).

INFORMATION: Information has been called "Data with order and context imposed" (Carr, 1992). Information may also be defined in the following ways: (1) as knowledge derived from study, experience, or instruction; (2) as knowledge of a specific event or situation (intelligence); (3) as a collection of facts or data; or (4) as a numerical measure of the uncertainty of an experimental outcome.

LAWS - *Empirical Laws or Observed relationships:* A law is a generalization of a relationship that has, through observation or measurement, been established among phenomena represented by two or more concepts (with proper controls when there are more than two variables), but which relies on no theory or model for its expression or utilization (e.g., Snell's law of refraction, Boyle's Law). An empirical law is often a precursor to a theory, and such laws in their most primitive form are often regarded as theories (e.g., Newton's "theory of colors" as a precursor to the wave model and to the electromagnetic theory -- or the empirical law of evolution, in contrast to the theory of natural selection (NSTA, 1995). "Many people, when they hear the phrase "scientific law" immediately think of something that is both universal and unchangeable. But in science a law is merely an observed regularity in nature . . . or a statement of order or the relation of phenomena that so far is known is invariable under the given conditions. Thus a scientific law is neither universal nor immutable, but rather it is something that is always observed to happen the same way -- at least the way it was in the past" (Carr, 1992, p. 31).

MODEL: A model is a representation, usually visual, sometimes mathematical, always conceptual used to aid in the description or understanding of a scientific phenomenon, theory, empirical law, physical entity, organism, or part of an organism (e.g., wave model, particle model, greenhouse model of Earth and its atmosphere) (NSTA, 1995).

OBSERVATION: An observation is the act of examining or monitoring the change of an organism or system, closely and intently, through direct sense perception; and noticing and recording aspects not usually apparent on casual scrutiny. When conducting an observation, one must be as objective as possible and not allow one's own expectation of an event influence that event. In most scientific investigations, many independent observations of an event are conducted to minimize what are known as "influence

effects." "Influence effects" often cause problems in experimentation, which is why valid experiments are replicable (Carr, 1992). Independent studies occur at all levels of the scientific process so that each level may be verified. Crucial to the process of observation is the accurate and truthful recording of the observation made and of the data collected from the observation. Inferring is the process of explaining what one thinks about an object or event based on one's observations.

PREDICTING: Predicting is the act of stating what will happen in a future situation based on the available information. As the information becomes more sophisticated, so do the predictions. Predictions should be discussed as "being supported by the data" or "not supported by the data" rather than as right or wrong (Barhydt & Morgan, 1993).

PSYCHOLOGICAL: Of, relating to, or arising from the mind or emotions (Microsoft, 1995).

THEORY: A theory is used to explain facts, observations, phenomena, and empirical laws. A theory is expressed in terms of various concepts that often have been quantified and for which symbols are sometimes used in their representation. Theories are often but not always mathematical. In its simplest form a theory provides hypotheses by which it can be tested. All theories are tentative, and even the most recent version of one of them is merely one stage in a continuous process. Theories are unlike the facts, observations and empirical laws of science all of which can be replicated and are independent of the observer and therefore map one-to-one with physical reality. Different theorists can create quite different theories and these alternative theories can explain the same set of phenomena. To the degree that such theories make the same predictions, they are equally valid. In that sense, the theories are not reflections of reality and may well be considered subjective. Scientists accept as the best theories or models those that make the most comprehensive, testable predictions. The fact that a theory makes a prediction, and that prediction often results in a new empirical law, merely corroborates the theory. The theory is never proved. But the resulting empirical law stands until such time that replication fails to produce the same result or results. (NSTA, 1995).

VARIABLES: Controlling variables is the process of holding all variables in an experiment constant except one whose influence is being investigated in order to establish whether or not there exists a unambiguous cause and effect relationship. Scientists often use the phrases 'providing a control' or 'providing variables' when they discuss experimental design. Providing a control is providing a standard of comparison to check the findings in an experiment. Providing variables are providing the experimental or altered objects and conditions, which are compared to the control in an experiment (Barhydt & Morgan).

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STAGES OF CHANGE

Initiation

Positive Consequences

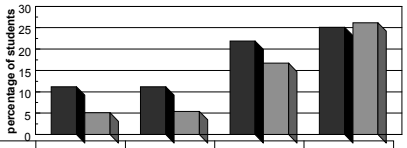
Adverse Consequences Emerge

Turning Point(s)

Active Quitting

Relapse Prevention or Change Maintenance

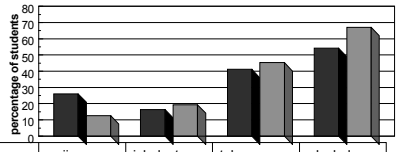
Figure 2: Local vs. national comparisons of 8th grade student alcohol & drug use for the past 30 days



	marijuana use	inhalant use	tobacco use	alcohol use
Billerica/Lowell	11.2	11.2	21.9	25.1
National	5.1	5.4	16.7	26.2

National data taken from Johnson et al., 1994
Billerica/Lowell data taken from Shaffer et al., 1995

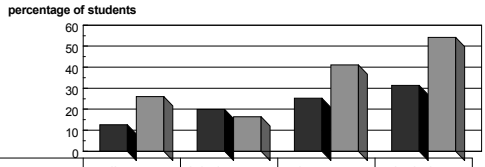
Figure 1: Local vs. national comparisons of 8th grade student lifetime alcohol & drug use



	marijuana use	inhalant use	tobacco use	alcohol use
Billerica/Lowell	26.1	16.4	41.1	54.2
National	12.6	19.4	45.3	67.1

National data taken from Johnson et a., 1994
Billerica/Lowell data taken from Shaffer et al., 1995

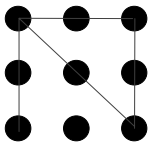
Figure 3: Local student lifetime alcohol & drug use: comparison between 7th and 8th graders.



	marijuana use	inhalant use	tobacco use	alcohol use
7th graders	12.6	19.9	25.3	31.4
8th graders	26.1	16.4	41.1	54.2

Data taken from Shaffer et al., 1995

Incorrect Solution 1



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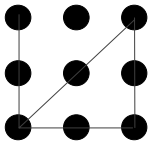

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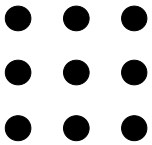

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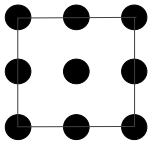

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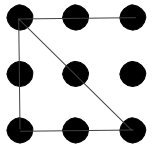
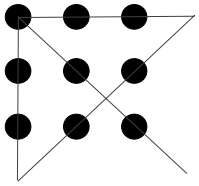


Correct Solution



THE SCIENTIFIC METHOD

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