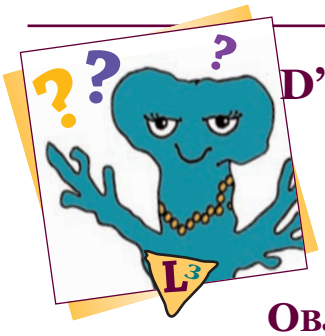


D'Scerner: Critical Appraisal of a Review Article on the Role of Dopamine in Addiction

Teacher Section for Parts 1, 2, and 3

Objectives:

Using instructional materials in the activity, students will be able to:

Module 1 Thinking About the Study

- Find sources of potential bias in the study and describe how they might affect the results in Part 1, 2, and/or 3
- Identify the type of study design in Part 1
- Indentify independent, dependent, and controlled variables in the study in Part 1 and/or 2

Module 2 The Results

- Create graphs (Part 1) and scatter plots (Part 2) from data presented in data tables
- Create a line of best fit on a scatter plot (Part 2)
- Determine trends in a scatter plot (Part 2)
- Use the best type of graph to represent data
- Use data presented in Venn Diagrams
- Explain the importance of "surprise" findings (Part 1 and/or 2)

Module 3 Analyzing the Results

- Use a written guide to systematically analyze the study results to determine their meaning (Part 1, 2 and/or 3)
- Explain why it was important to disclose a limitation in the study (Part 3)
- Explain how technology has helped reveal the biology of addiction (Part 2)

Module 4 Comparing and Contrasting

- Compare and contrast the journal report to the media report to determine accuracy of the media report in Part 1, 2 and/or 3
- Complete a Venn Diagram that compares the journal and media reports in Part 1, 2, and/or 3

Activity Description:

How often do we hear *"Research Says"* …? To develop science literacy skills, students need to ask *"Does it Really…"*. Using a peer-reviewed journal article that has been transformed for age appropriateness, students will analyze a peer-reviewed review article about drug addiction research. They will compare the results reported in the journal article to a media article that reported the results of the same study groups. Student analysis is carefully directed in a systematic way through the use of four student

modules. The modules created for each critical appraisal lesson are very similar in structure to help students develop scientific "habits of mind" as they work through the lessons. This lesson is based on many studies done to analyze the importance of dopamine in the biology of addiction. The study is divided into three parts to help students process the information. Students will learn about the importance of review articles in fast-paced areas of science. Each of the three parts can be done as a stand-alone lesson or they can be done together. The review was funded by the National Institute on Drug Abuse.

Materials:

- 1 class set of the Journal Article *The Role of Dopamine in Addiction Part 1, 2, and/or 3*
- 1 class set of the Media Article *Dopamine and Addiction*
- 1 copy of the *Student Modules* (Parts 1, 2, and/or 3) per student

(***Note:*** If copy numbers are limited, you can make a class set of the modules and have students record their answers in a journal or on their own paper)

Management Suggestions:

The lesson can be divided into separate modules; each can be done at different times of the year to align with the scope and sequence.

Suggested Modifications:

Allow students to work in pairs and provide modules with some information prefilled for students in need of such assistance.

Suggested Extensions:

Students can research other important functions of dopamine.

References Used:

Hill, AB. (1965). The environment and disease: Association or causation? *Proceedings of the Royal Society of Medicine*, 58, 295-300.

Last, JM. (2000). A Dictionary of Epidemiology. USA: Oxford University Press.

Volkow, N., et al. (2002). Role of Dopamine, the Frontal Cortex and Memory Circuits in Drug Addiction:Insight from Imaging Studies. *Neurobiology of Learning and Memory* 78, 610-624.

Wingert, P. (2006). Dopamine and Addiction. *Newsweek*, accessed online at http://www.newsweek.com/id/44295/output/print on Dec. 2, 2009.

Activity "Administrivia"

Intended Grade Level: 6–8

Key Concepts:

Critical appraisal skills, compare/contrast, analyzing results of a study, study design, variables, controlled variables, neurotransmitters, PET Scans, drug abuse, dopamine, brain reward system, addiction

Process Skills Utilized in Lesson:

Communication, inference, prediction, analysis of data, graphing

Previous Learning Assumed:

Basic scientific process skills, graphing skills, sources of bias

Relevant TEKS

6, 7, and 8 Grade Science

6, 7, 8.2 Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:

(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns;

(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

6, 7, 8.3 Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

6, 7, and 8 Grade Health

6.4 Health information. The student comprehends ways of researching, accessing, and analyzing health information. The student is expected to:

(A) list ways to evaluate health products, practices, and services such as sunblocks, dietary aides, and over-the-counter medications; and

(B) use critical thinking to research and evaluate health information.

6.5 Health behaviors. The student engages in behaviors that reduce health risks throughout the life span. The student is expected to:

(C) describe chemical dependency and addiction to tobacco, alcohol, and other drugs and substances;

6.10 Personal/interpersonal skills. The student describes healthy ways to communicate consideration and respect for self, family, friends, and others. The student is expected to:

(G) identify stressors and their impact on the health of the individual and family.

7-8.4 Health information. The student knows how to research, access, analyze, and use health information. The student is expected to:

(A) use critical thinking to analyze and use health information such as interpreting media messages;

(B) develop evaluation criteria for health information;

7-8.5 Health behaviors. The student engages in behaviors that reduce health risks throughout the life span. The student is expected to:

(H) explain the impact of chemical dependency and addiction to tobacco, alcohol, drugs and other substances;

(I) relate medicine and other drug use to communicable disease, prenatal health, health problems in later life, and other adverse consequences;

Key Words for Web Page: Critical appraisal skills, compare/contrast, analyzing results of a study, study design, variables, controlled variables, graphing, neurotransmitters, PET Scans, drug abuse, dopamine, brain reward system, addiction

Role of Dopamine, the Frontal Cortex and Memory Circuits in Drug Addiction: Insight from Imaging Studies-Part 1

Abstract: Dopamine is a chemical messenger in the brain. It is important in the brain reward system. Dopamine also plays a role in drug addiction. Drug addiction is a disease characterized by drug-induced "highs", withdrawal, and craving.

Many researchers use PET (positron emission tomography) images of the brain to study drug addiction. PET helps us to learn more about the role of dopamine and the brain pathways it controls.

PET scans show that increases in dopamine occur during drug use. Dopamine causes drug-induced highs. During withdrawal, PET scans show a decline in dopamine. Low dopamine reduces the good feelings from taking drugs. This will cause drug-seeking as a means to experience the high again. It may also cause the uncomfortable moods or cravings of withdrawal.

Using PET scans, we claim that changes in Dopamine levels help cause addiction. Dopamine disrupts parts of the brain that control motivation, drive and self-control.

Background: Dopamine, a chemical messenger in the brain, has many functions. It is important in behavior, thought, movement, motivation, reward, mood, sleep, attention, and learning. Dopamine activates some neurons. Dopamine sometimes attaches to proteins called dopamine receptors and dopamine transporters (DAT). This lowers levels of dopamine in the brain. *When dopamine can't attach to the proteins, dopamine levels in the brain rise.*

Images of the human brain in action allow expanded drug addiction research. These images are created by PET scans. PET scans allow researchers to see areas of brain activity during specific events. This has helped understand brain pathways and addiction. PET scans allow scientists to see how dopamine affects brain circuits.

Addiction pathways in the brain are formed during drug-induced highs. These highs feel good and the brain remembers what caused the good feelings. Drug users want to repeat experiences that feel good. Soon, more and more of the drug is needed to get the same good feeling. Withdrawal results when the drug is no longer taken. This is followed by a powerful desire for the drug (craving). Craving leads to repeated use of drugs of abuse. In turn, repeated drug use strengthens addiction pathways in the brain.

All learned behaviors make specific pathways in the brain. These pathways create long-term memories. Brain pathways can change in strength. Strengthening brain pathways helps us to learn and remember things. In this way, addiction becomes a life-long disease.

This article was transformed for age level from the original article, which appeared in *Neurobiology of Learning and Memory*, Volume 78, pages 610-624 (2002).
This article is for K–12 educational use only.
This transformation follows peer-reviewed format.

AUTHORS:
Nora D. Volkow,*
Joanna S. Fowler,†
Gene-Jack Wang,* and
Rita Z Goldstein*
*Medical Department and Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973

Methods: This article is a review of over 77 studies. Review articles are useful in pulling together the results of many studies and providing a "current state" of research. This type of effort is especially helpful in rapidly expanding areas of research. The authors of this paper divided the review into five specific areas of drug addiction research; one is included below.

RESULTS AND SUMMARIES OF RESEARCH:

Dopamine Involvement in Drug-Induced Highs

In one study, a group of cocaine abusers received cocaine. Another group of healthy control subjects received another drug called MP. MP acts like cocaine, but is not addictive. Both cocaine and MP raise levels of dopamine in the brain (Ritz et al., 1987). They raise dopamine by attaching to dopamine transporters (DAT). DATs are proteins that normally bind to dopamine, clearing it from neurons. If drugs like cocaine and MP bind to the DATs instead, dopamine floats freely, *causing levels of dopamine to rise higher than normal* (Ritz et al., 1987).

Cocaine and MP occupied more than 60% of DATs. This caused more dopamine in the brains of test subjects (Volkow et al., 1994). Test subjects generally reported feeling high as dopamine levels in their brains increased (Figure 1).

There was, however, an unexpected finding in this study! Some test subjects did not feel high even when 50% of DAT were occupied by the cocaine and MP (see ***Figure 1***). This unexpected result was an *opportunity* to extend the research. We formed a new hypothesis to explain why the drug did not cause a high in some test subjects. Maybe there is another protein to which the drug can bind.

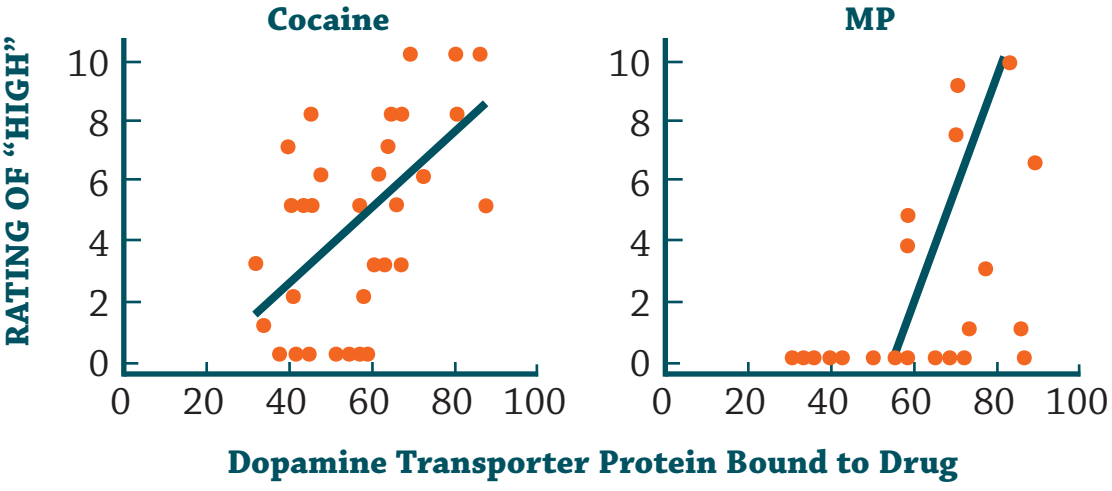


Figure 1 Rating of Drug-Induced High vs Percentage of Dopamine Transporter Binding

Note: When dopamine can't attach to the dopamine transporter protein because the drug attached to it, dopamine levels rise.

We designed a new study to test the new hypothesis. Healthy test subjects were given the drug MP. We did brain PET scans. This time, however, the drug attached to a dopamine *receptor* protein (instead of a transporter protein). *This is another way in which dopamine levels rise in the brain.* Dopamine levels increased in more test subjects this time. They reported feeling high as dopamine increased in their brains. When dopamine did not increase, test subjects did not feel high (***Figure 2***). Researchers found a second way for dopamine levels to rise. Increases in dopamine were again linked to feeling high.

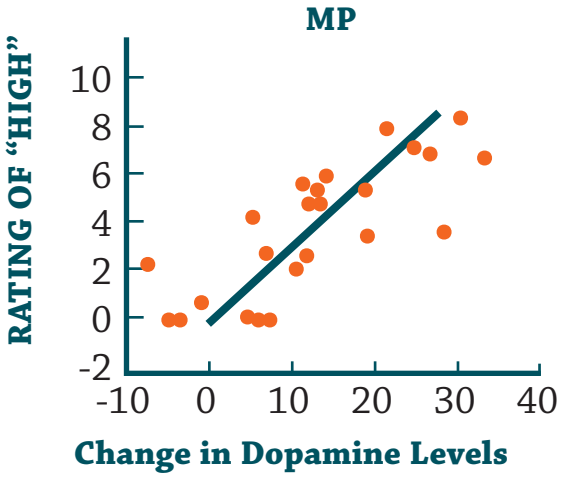


Figure 2 Rating of Drug-Induced High vs Change in Dopamine Levels When MP Drug is Taken

Fischman and Foltin (1991) reported the same results. Therefore, two independent studies had the same findings.

Conclusion: Imaging studies show drug-addicted brains have major problems with dopamine function. Researchers have found two ways in which dopamine levels in the brain are controlled. If drugs of abuse bind to either transporter receptor proteins, dopamine levels in the brain rise. The result is feeling high. Dopamine is important in the addiction process.

References:

Fischman, M. W., & Foltin, R. W. (1991). Utility of subjective-effects measurements in assessing abuse liability of drugs in humans. *British Journal of Addiction*, **86**, 1563–1570.

National Institute of Drug Abuse accessed at http://www.nida.nih.gov/ on July 12, 2009.

Ritz, M. C., Lamb, R. J., Goldberg, S. R., & Kuhar, M. J. (1987). Cocaine receptors on dopamine transporters are related to self-administration of cocaine. *Science*, **237**, 1219–1223.

Volkow, N. D.,Wang, G. J., Fowler, J. S., Logan, J. Schlyer, D., Hitzemann R., et al. (1994). Imaging endogenous dopamine competition with [11C]raclopride in the human brain. *Synapse*, **16**, 255–262.

Study Disclosure:
Funding Support for the study: US Department of Energy, the National Institute of Drug Abuse, the National Institute on Alcohol Abuse and Alcoholism, and the Office of National Drug Control Policy.

Institution: Brookhaven National Laboratory, Upton, New York

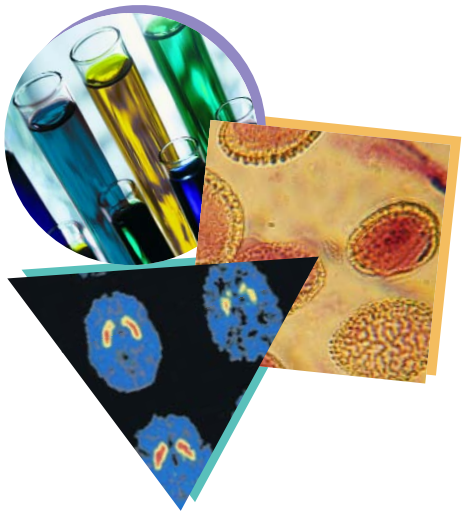
This study was funded by the National Institute on Drug Abuse. None of the authors disclosed a conflict of interest.

Flesch-Kincaid Grade Level 6.7
Flesch Readability 62.1

TEI News Reviews
A Plain Language Anthology
Teacher Enrichment Initiatives

STUDY FINDS:

Dopamine and Addiction



Only the weak become addicted. If that's what you think, Dr. Nora Volkow is determined to change your mind. Dr. Volkow is the director of the National Institute of Drug Abuse (NIDA). She is also one of the country's leading addiction researchers. Volkow says brain science is proving that we all can become addicted to something. People can become addicted to drugs, alcohol, tobacco, gambling, and even food. Becoming addicted is more a matter of chance than we ever realized. With the right mix of genetics and life experience, anyone can find themselves addicted to something.

Many people might find that idea unsettling. Volkow finds it fascinating *and* encouraging. Everything we learn about one type of addiction might teach us something about other types. "Just imagine," she says, "if all the private money being spent to understand and treat obesity could help us understand and treat alcoholics and drug addicts."

Volkow is steering NIDA to use breakthroughs in one area of addiction research to advance research in others. In the next year, she predicts, we'll see progress in new treatments, such as drugs that disrupt and weaken a person's memory of how good an addictive substance feels. "If we could interfere with that response, we might be able to weaken the addiction," she said.

Much addiction research centers on dopamine. Dopamine is a brain chemical associated with pleasure (and other functions). Dopamine receptors are proteins that act as docking stations for dopamine in the brain. New research by Volkow and others shows that high levels of dopamine receptors protect against addiction. In turn, low levels increase the chances of becoming addicted.

Non-addicts balance desire for pleasure with positive goals such as protecting family and friend relationships and career success. Low levels of dopamine receptors throw off that balance. Many illegal drugs actually change the brain over time by strengthening memories of pleasure from taking the drug. Taking drugs becomes the most important need in an addict's life. "Drugs are a more powerful reinforcer than anything else," says Volkow. "That's why people will even steal to get the money they need for drugs. Addiction "makes us lose our judgment, our values."

Future research will center on how to increase dopamine receptors in people with low levels. It appears that levels are affected by both genetics and experience. Animal research shows that receptors decrease under high levels of stress, and go up when the stress is relieved. Whether that is true in humans is unknown.

But Volkow says that may explain why some can drink or use a drug for years and not get addicted. "Then something tragic happens, and their environment and genetics collide" in a harmful way.

Volkow hopes that as we learn more about addiction, curing it will become a higher priority."I've never met anyone who thought they would become addicted," she says. "…this disease robs you of free will. The challenge is to find a cure."

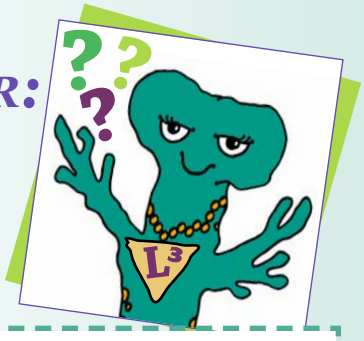
This transformation is made from the original article:Wingert, P. (2006). Nora Volkow: A passionate advocate for addicts of all kinds, she's determined to find a cure. Newsweek, accessed online at http://www.newsweek.com/id/44295/output/print on December 7, 2009. Note: This transformed article has a Flesh Kincaid Grade Level 8.1, Flesch-Kincaid Reading Ease 60 (Transformed from Grade Level 10.4 and Readability 54.3).

MODULE 1–THINKING ABOUT THE STUDY

ROLE OF DOPAMINE IN DRUG ADDICTION

D'Scerner and her L'ete group must deal with this preliminary information to help clearly discern the facts of this case.

D'SCERNER, THE LIFE-LONG LEARNER: STUDENT GRAPHIC ORGANIZER



General Information:

Name of Study **Role of Dopamine in Drug Addiction**

First Author _____

Funders _____

Institution(s) _____

Disclaimers/Disclosures _____

Health Science Content _____

Describe the test subjects of the studies reviewed in this article _____

Purpose of review article _____

Design of Article

- ❑ Newspaper
- ❑ Magazine
- ❑ Peer-Reviewed Journal
- ❑ Web Article/Blog
- ❑ Interview

Words to Define _____

MODULE 1–THINKING ABOUT THE STUDY

ROLE OF DOPAMINE IN DRUG ADDICTION

ETHICAL TREATMENT OF TEST SUBJECTS

Why was it important for researchers to use a substitute drug for cocaine in the healthy test subjects?_____

_____

Each study reviewed in this article was approved by scientific review boards. Why is this important? _____

_____

STUDY DESIGN

After reading Part 1 of the article, determine if the study was an ***observational*** or ***experimental*** study. Then decide which study design was used and check the appropriate box. Explain your choice in the space provided.

OBSERVATIONAL CHECK LIST

- ❒ Case Report
- ❒ Case Series
- ❒ Cross Sectional
- ❒ Case-Control Study
- ❒ Cohort Study

❒ ***Observational***-Explain Your Choice

_____

_____

_____

Why is this important to know?

_____

_____

_____

EXPERIMENTAL CHECK LIST

- ❒ Intervention Study
- ❒ Randomized Controlled Trial

❒ ***Experimental***-Explain Your Choice

_____

_____

_____

Why is this important to know?

_____

_____

_____

D'Ziner is a master at identifying the basic design in any study. He hones in on clues and puts them together to reveal the true design of any study.

MODULE 1–THINKING ABOUT THE STUDY

ROLE OF DOPAMINE IN DRUG ADDICTION

D'Riddler takes the lead in identifying the study variables, bringing the group one step closer to the heart of this study.

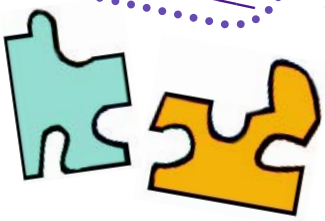
STUDY DESIGN

Identify Variables in the Study Described in Part 1

Identify Independent Variable of study

Identify Dependent Variable of study

Identify Controlled Variables of study



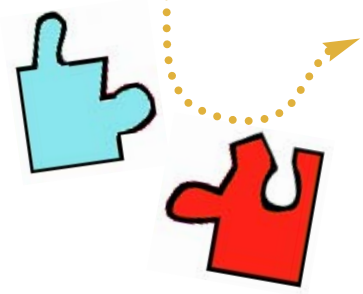
D'Isabler uses her well-honed super sleuthing skills to detect and disable any sources of bias that might affect the results of this study.

STUDY DESIGN

Sources of Bias

Sponsors, Funders, Target Audience, Predetermined study goals – How might each of these affect the results of the study?

How did the research team handle any possible impact on the study from factors such as conflict of interest?



MODULE 2–THE RESULTS

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

The data collected in this study were organized into a visual representation called a scatter plot or scatter graph. This type of graph gives a good visual picture of the relationship between two variables. Each point on the scatter plot represents data from one test subject. Once all the points are plotted, the data can be examined for trends and patterns.

1. What are the variables in this study?

2. How many test subjects were there in this study?

3. Why was a scatter plot a good type of graph to use in reporting the data from this study?

D'Cypher is the real master when it comes to the data. There's no one better to have on the team when it comes to sorting out the numbers.

Nature of Data Collection

- ❒ Self Reported
- ❒ Clinical or Lab Setting
- ❒ Interview in Person
- ❒ Phone Interview
- ❒ Questionnaires

Check all that apply and explain how each might affect the results?

Scatter Plots

The page that follows contains data tables and graph paper so you can make a scatter plot that shows the relationship between study variables. Learning to recognize patterns in scatter plots is an easy way to analyze your results. You will also draw a line of best fit on each scatter plot.

See page 3 for instructions.

4. **Positive Relationship between variables:** A positive relationship between variables is represented by an upward slope on the scatter plot. A negative is represented by a downward slope. Use the graph paper at the bottom of this page to create a scatter plot of the data in **Table 1**. Be sure to include a complete title, axes labels, and units of measurement. Draw a line of best fit on your scatter plot (see page 3).

Table 1 The Relationship Between High Feeling and Amount of Cocaine Bound to Dopamine Transporter Protein

Rating of High Feeling	0	0	1	1	2	2	3	4	4	4	6	6	8	8	9	10	10
% of DATS Bound to Cocaine	0	0	35	40	40	60	60	25	60	70	40	80	60	40	80	90	85

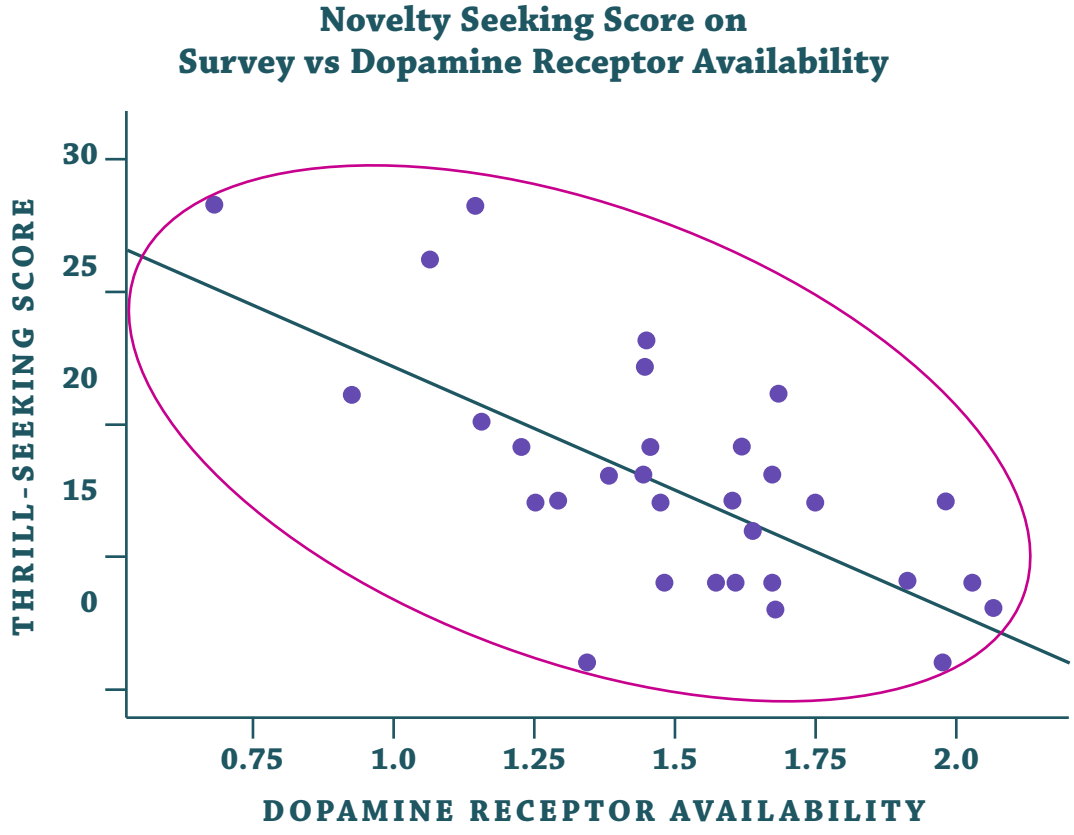
Title

(Axis label)

(Axis label)

How to Estimate a Line of Best Fit

1. Plot the data on a grid.
2. As in other types of graphs, the independent variable should be placed on the X Axis and the dependent variable on the Y axis.
3. Be sure to include axis labels, a complete title, and units of measurement on your graph.
4. Draw a circle around the points so you can see the general trend among the data. See example below.
5. Observe to determine if there is a positive relationship, a negative relationship, or no apparent relationship between variables.
6. Use a ruler and move it around in the circle until approximately one-half of the points are above the line and approximately one-half are below the line.
7. Draw the line on the scatter plot.
8. This is called a ***line of best fit***.
9. The closer points are to the line of best fit, the stronger the relationship between variables. If the points are far away from the line, the relationship between variables is weaker.



MODULE 3–ANALYZING RESULTS

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

D'Finer takes the lead when it's time to analyze the results and define the cause of the results and the degree of certainty about the cause.

What Caused the Results? Describe the results of the study in terms of each item listed below. Write your answers in the space provided. *Modified from Bradford-Hill considerations on causality

Answers Here:

1. Strength of Relationship:

Study bias or factors negatively affecting the experiment make the results less reliable. List factors that affected the study results.

2. Consistency:

Were the results similar in repeated trials or in different studies? Explain. If so, the results are more reliable.

3. Compare Test Group to Control:

How did the test and control groups compare? This helps establish the cause of any observed change.

4. Strength of Effect:

An increase in the treatment that results in an increase in observed change helps verify that the independent variable caused the results. Was this true in this study? Explain.

5. Plausibility:

Is there a reasonable way to explain how the treatment might cause the observed changes? Explain.

6. Study Design:

What kind of study design was used?

7. Analogy:

How could you find out if the results of this study are similar to those of other studies?

MODULE 3–ANALYZING RESULTS

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

Think about your answers so far. What <u>probably</u> caused the results found in this study?

What trend appears in the scatterplots of both graphs? (See Figure 1 in the peer-reviewed article.)

What does this trend among the data mean?

How did researchers react when they got surprising results in their experiment?

Why were these surprising results helpful?

MODULE 4–COMPARING AND CONTRASTING

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

PLANNING PAGE

	Peer-Reviewed Research Report	Media Article
Style		
Title written to catch readers' attention		
Results reported with little information about methods		
Length of article		
Length of paragraphs		
Number of details about the study		
Tables, Charts and Graphs included		
Describe use of pictures and color		
Describe writing style and use of references		

MODULE 4–COMPARING AND CONTRASTING

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

	Peer-Reviewed Research Report	Media Article
Study Description		
Researchers, Organizations and Universities described		
Details about funders and researchers included		
Conflict of interest statement included		
Sources of possible bias reported		
Type of study design reported		
Study sample described		
Detailed description of procedures used in the study		
Unexpected findings reported		

What issue(s) is/are included in the media report but not the research article?

MODULE 4–COMPARING AND CONTRASTING

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

	Peer-Reviewed Research Report	Media Article
Data		
Analysis of data described		
Use of statistics described		
Information about cost of research		
Formulae included		
Overall Comparison		
Conclusions of the researchers described		
Describe which is more reliable and why		
Describe which is more interesting and why		
Overall Accuracy		

MODULE 4–COMPARING AND CONTRASTING

ROLE OF DOPAMINE IN DRUG ADDICTION-PART 1

D'Vennder takes the lead in putting it all together and comparing and contrasting the articles.

Compare and contrast the peer-reviewed article and the media literature article. Consider factors from your completed planning page.

VENN DIAGRAM

RESEARCH REPORT

MEDIA ARTICLE