The University of Texas at Austin Undergraduate Research Journal is a student edited and published multidisciplinary journal of undergraduate research.
The editors of this journal wish to thank Dr. Juan M. Sanchez, Vice President for Research, Dr. James W. Vick, Vice President for Student Affairs, Dr. Lucia Gilbert, Vice Provost, Dr. Linda Ferreira-Buckly, Associate Dean of Liberal Arts, and Ms. Sarah Simmons, Natural Sciences Undergraduate Research Program Coordinator for their generous support and guidance.

They also thank the University Co-op for their generous support.

They offer their appreciation as well to Ms. Christine Henke, Ms. Annie Elderbroom, Ms. Becky Carreon, and the Senate of College Councils for helping to make the UT–Austin Undergraduate Research Journal possible.
FROM THE EDITORS

On behalf of the 2003-2004 staff, we would like to present to you the third edition of The University of Texas at Austin Undergraduate Research Journal. We are very proud of this issue and all of the hard work that it took to create this compilation of undergraduate research. Though we are still a relatively new publication, and one that will be in constant development over the years, we are confident that we are embarking upon a journey that holds great opportunity for the future.

We would like to extend our gratitude to Linda Ferreira-Buckley and Sarah Simmons, our co-faculty advisors as of Fall 2003. Through countless meetings, they offered continual support and expert guidance. We are extremely grateful to have had the opportunity to work with such talented and generous women.

Compared to the previous two years of publication, 2003-2004 was by far the most competitive. It was very difficult to narrow the submission field down to the eight entries that were selected for this year’s journal. We are certain, however, that the chosen articles are representative of a diverse range of disciplines and will be accessible to the entire university community.

All of the research found within these pages is the result of diligent efforts by dedicated undergraduate students at The University of Texas at Austin. We hope that by reading the URJ, you will obtain a greater appreciation and understanding of the work being performed on this campus.

If you are interested in contributing to a future edition of the URJ, please visit our website at www.utexas.edu/research/student/urj for more information. We also welcome applications for membership to our staff.

Sincerely,

Erin Budd, Abdul Farukhi, Co-Editor Co-Editor

FROM THE PROVOST AND THE VICE PRESIDENT FOR STUDENT AFFAIRS

Dear Colleagues: We are delighted to introduce the first student publication of undergraduate research at The University of Texas at Austin. This volume represents the broad range of scholarly work being done by our students and the excellent results being produced on our campus and in fieldwork throughout the world. The Senate of College Councils has provided a valuable service to our academic community by selecting some of the finest student efforts and publishing the work so that others may benefit from it.

In 1995 the Carnegie Foundation for the Advancement of Teaching created the National Commission on Educating Undergraduates in the Research University, often called the Boyer Commission after its initial presiding member, the late Ernest L. Boyer. Their landmark report proposes ten ways to change undergraduate education. Their first recommendation calls for strengthening student involvement in research, beginning at the earliest levels in the college experience. This publication is a clear indication that our University has already made major strides toward accomplishing the goals of the Commission.

On behalf of our faculty and administration, we congratulate the students who conducted the research reported here and the members of the Senate of College Councils whose hard work and dedication have brought this publication from an idea to a finished product. We look forward to expanding opportunities for undergraduate research and continued recognition of the students and their results.

Sincerely,

James W. Vick, Sheldon Ekland-Olson, Vice President Executive Vice President for Student Affairs and Provost
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Small-Scale Renewable Energy in Panama—Current Status, Lessons Learned, and Barriers Faced

Abstract

Small-scale renewable energy technologies are desirable because they provide electricity to rural residents while protecting the environment. However, a variety of barriers have hindered the growth of renewable energy. This study identifies the problems that have been overcome and those that still remain for the small-scale renewable energy industry in Panama, as seen from the perspective of equipment vendors.

Introduction

There are many types of renewable energy: hydroelectric, solar (thermal and photovoltaic), wind, geothermal, ocean, and biomass. Renewable energy has incredible potential as a sustainable energy form, as by definition it does not deplete its source. Small-scale
technologies, which can be owned and operated by one
or a few individuals, include solar thermal, wind, solar
photovoltaic, mini-hydroelectric, and a few types of bio-
mass processors.

Small-scale renewable energy technologies were first
introduced in the 1970s, and their use has expanded in-
credibly since then, with a 10% average annual growth rate
since 1990. Current worldwide use of all types of renewables
is 13.5% of total energy use, with solar, wind, and tide en-
ergy constituting 0.1% of world energy use.6 Renewable
energy makes up 21.3% of Panama’s energy usage. Of that,
31.7% is hydroelectric, 68.3% is biomass, and a negligible
amount is geothermal, solar, wind, and tide.6

One of the most common uses of small-scale renew-
able energy is providing electricity for a household, in or-
der to run light bulbs, televisions, radios, etc.1 Solar ther-
mal energy is also used in the home for heating water, a
luxury that can be afforded by some.11 Electricity can also
be provided for community use, lighting, charging batter-
ies, or powering training centers, schools, and health cen-
ters.9 Water pumping (for community or agricultural use)
is another common use of renewable energy.1 Finally, solar
energy is used in remote applications for commercial pur-
poses, like telecommunications and marine signaling.9

Two and a half billion people do not have access
to reliable modern energy sources, and most of these
people are located in rural areas, making it particu-
larly costly to extend the electricity grid (which can
cost upwards of $10,000 per kilometer).1 Most rural
residents use biofuels, like wood and dung burning, to
meet their energy needs. These fuels are often
burned indoors and can cause health problems due
to the emission of hazardous chemicals, especially
when ventilation is poor. Biofuels are inefficient and
time consuming to collect. They also can be envi-
ronmentally damaging and contribute to deforesta-
tion.11 Between 19% and 35% of Panama’s population
of 2.84 million does not have electricity.14 Small-scale
renewable energy technologies can operate off-grid,
making them particularly appropriate for rural areas
in developing countries.

Methodology

This research focuses on the views vendors (those
who sell and install energy systems for individual cus-
tomers) of small-scale renewable energy equipment and
was conducted through face-to-face and phone inter-
views. Interview questions fell into four general areas:
basic information about their business, problems faced
and lessons learned, barriers faced by their business, and
their thoughts on the future of the industry.

There are seven small-scale renewable energy
vendors in Panama (see Table 1). They range in size
from small divisions of multinational corporations to
business partnerships run out of owners’ homes. Most
vendors focus on solar photovoltaic (PV) projects,
but many also do projects in wind and solar thermal
energy, with a very small number doing
mini-hydroelectric projects.

Part 2
Problems Faced and Lessons Learned

Vendors have encountered a variety of problems and
adapted to face them. Some of the lessons they have
learned are cataloged below; they fall under five general
categories: adaptation to local conditions, education,
reducing costs and increasing profits, proper installation, and sustainability of installed systems.

**Adaptation to Local Conditions**

There are a variety of local conditions characteristic to Panama that must be adapted to, including weather and climate, illiterate or uneducated users, and different usage conditions.

**Solar Insolation**

*Problem:* The amount of light energy available in a day (known as solar insolation) varies, as the climate in Panama varies significantly from region to region. This variability in the amount of sun makes designing solar systems in Panama particularly difficult.¹

*Solution:* Vendors have had to learn the amount of solar insolation available in each area through experience. In the mountains of Chiriquí or Darién, there are approximately 2 hours per day of usable solar energy. In San Blas or the Azuero Peninsula, the sun provides up to 5 hours per day of usable energy.¹

**Angle for Solar Panels**

*Problem:* Solar panel installation guidelines are tailored for countries in temperate zones and generally suggest an installation angle of about 45°. The angle of the sun is different in Panama, since it is in the tropics, so the installation calculations made according to manufacturers’ guidelines can be incorrect.¹

*Solution:* In Panama, panels should be installed more horizontally, with a small degree of angle to ensure rain does not pool on the panel.¹

**Equipment Damage by Insects**

*Problem:* Insects often seek refuge inside renewable energy equipment, as they are attracted to the heat. This can cause equipment damage.¹

*Solution:* Customers should put a mosquito net around the equipment, ensuring it is able to exchange air and cool itself down, while keeping insects out.¹

**Equipment Deterioration due to Climate**

*Problem:* Panama’s climate has high humidity and high precipitation, and many locations are exposed to corroding ocean breezes. This leads to rapid equipment degradation.¹

*Solution:* Vendors should choose corrosion-resistant equipment. For example, casings should be made out of plastic, not metal, and solar panels should be well-sealed to keep water out.¹

**Digital Controller Readouts**

*Problem:* Digital controller readouts are helpful in providing details on battery status. However, illiterate customers cannot use such a complicated display, resulting in system damage when the controller is used improperly.¹

*Solution:* The vendor can provide two types of controllers—one with the digital display, for advanced customers, and one with a basic indicator of battery level using red, yellow, and green lights. The latter controller is much more appropriate for illiterate users.¹

**Education**

All vendors I spoke with participated in initiatives to educate the public about renewable energy and cited ignorance as one of the major problems facing the industry.

**Educating the Populace About Renewable Energy**

*Problem:* Most Panamanians are not knowledgeable about the benefits and uses of renewable energy.⁷

*Solution:* This is addressed through a variety of publicity initiatives, including advertising campaigns, television and radio shows, participating in fairs around the country, and taking part in university classes, seminars, and lectures.¹ Some vendors also lend equipment for use in the universities.¹ All vendors produce literature about renewable energy and their business. Finally, many people learn about renewable energy by visiting a vendor’s store.¹
Changing Public Opinion About Renewable Energy

**Problem:** Most Panamanians think renewable energy does not work. This is from the failure of previously installed projects, due to bad design, bad installation, faulty equipment, or failure to account for local climatic conditions.8

**Solution:** A lot of work remains to be done in combating this stereotype. One solution is instituting standards for renewable energy to ensure that fewer projects fail after being installed.11 As more and more quality systems are installed, people will start to believe in the technology when they see the experiences of their neighbors and friends.3 Another approach is via publicity, by showing videos and pictures of successful projects within Panama.10

Reducing Costs and Increasing Profits

Vendors use various techniques to reduce cost and increase profit, including producing materials locally, running publicity campaigns, and reducing overhead costs.

Competition Among Vendors

**Problem:** Competition has increased over the last five years, as the number of vendors has increased threefold. As a result, the margins on renewable energy have been steadily decreasing, making covering basic costs like renting office space and paying engineers more difficult.10

**Solution:** A publicity strategy helps differentiate businesses from each other and attract customers.10 Another approach is to lower fixed costs, by running one’s business out of the home, or geographic, technological, or funding-source specialization.11 Some vendors focus on David, Santiago, or Panama City, while Swisscontrol focuses on solar thermal technologies and Pass has developed expertise at working with the government.8,11 Many vendors also supplement their income from renewables with other types of work.1

Reducing Costs by Producing Locally

**Problem:** Importing equipment from Europe and the U.S. is expensive, due to shipping costs, import taxes, and higher wages and material costs abroad.1

**Solution:** Vendors have purchased renewable energy technologies from abroad and learned how to construct them so they can be produced locally. This is not feasible for complicated technologies, like solar panels or wind turbines, but is an excellent approach for stands, casings, etc.1

Proper Installation

Proper installation is essential to ensure the renewable energy system does not fail later because the equipment is connected incorrectly. Improper installation can be costly for the vendor and the customer if the vendor has to return to fix an improperly installed system.1 Many vendors only guarantee their equipment if they install it themselves. Problems faced include arriving at the installation location, facing emergencies, and working with electricians.

Preparation for Installation

**Problem:** The installation team has to ensure they have the right tools for the installation, for most installation locations are very remote.1

**Solution:** The team should bring a variety of tools and extra supplies, including an electric drill for use on metal roofs, a first aid kit, extra lengths of cable, and extra light bulbs.1

Transportation to and from the Installation Location

**Problem:** Most renewable energy buyers live in very remote areas, making getting there difficult. Sometimes the roads are in poor shape or nonexistent, so other forms of transportation (such as traveling on horseback and on foot) must be used. Frequently, rivers must be crossed; when these rise, the installation location cannot be reached.9 The installation team may also be stuck at the installation site if weather conditions change, or the installation may take longer than expected.1

**Solution:** Some vendors may teach the customer how to install the equipment so they or their employees do not have to travel to the installation site in person. Easy-to-use equipment exists that makes it easier for customers to install the system themselves.11 If the vendor is going to install the system, which is the most common approach (in order to ensure it is done correctly), the vendor has no choice but to be patient in the fact of
obstacles and delays. The installation team is often housed by the customer, in order to save money, but the team should also bring extra food, tents, and bedding in case there are delays or problems.¹

*Interactions with Electricians*

**Problem:** Many electricians are not knowledgeable about the design and installation of renewable energy systems. This can result in a poorly designed or inadequate system, or the system may not function due to improper installation.¹

**Solution:** Most vendors only provide equipment guarantees if they install the equipment. Additionally, vendors can help train electricians on the proper installation of renewable energy equipment, but this has the danger of creating competition.¹

*Sustainability of Installed Systems*

The technology behind renewable energy is sustainable; it does not deplete the source of energy. However, vendors must be sure the systems themselves are as sustainable as the technology is. The long-term sustainability of a system depends on the ease of and need for maintenance and damage prevention.

*System Maintenance*

**Problem:** Certain types of equipment, especially batteries, require maintenance at intervals of 6 months to a year.¹ However, many rural users do not have the expertise or motivation to perform this maintenance, resulting in system failure. Also, many rural users are not particularly careful with the equipment and can damage it relatively easily.⁹

**Solution:** Vendors switched to using equipment that did not require much (if any) maintenance and was more rugged.⁹ Vendors can also train customers how to repair their own equipment, as has been done with the Kuna Indians.¹¹

*Theft*

**Problem:** Theft of solar panels is a problem, particularly with public systems (like those installed on telephones, water pumps, health centers, and schools). Solar panels are also stolen from signaling buoys in the ocean and the Panama Canal.⁹

**Solution:** The equipment must be installed very securely and out of reach of thieves. For example, solar lighting was put up in the town center of many Kuna villages; all of the equipment was put on top of tall poles so it would not get stolen.¹

**Part 3**

**Barriers to Be Overcome**

Almost all vendors cited high cost, lack of government incentives, government bureaucracy and corruption, and lack of knowledge about renewables as the four major barriers they face. Other barriers include the lack of standards and competition from foreign companies.

*High Equipment Cost*

Renewable energy technologies are expensive. The cost has decreased over the last 10 years but is still high, especially when compared with the income of an average Panamanian.¹⁰ This has a variety of impacts. First, it reduces demand. Many customers that come to a vendor’s store out of curiosity are deterred by the high prices.¹⁰ Also, the high cost makes purchasing equipment a big investment. As a result, vendors cannot maintain a stock of equipment, as they cannot afford the investment without a sure payoff; there is no guarantee that their stock will sell.¹ Because vendors cannot maintain a stock, they must import equipment as it is request by customers. Equipment bought piecemeal is more costly than equipment bought in bulk, due to manufacturing economies of scale and transportation and importation costs, which increases the prices even further.⁹ Without financing to import equipment in bulk, small vendors cannot grow, as they are forced to always purchase equipment on an as-needed basis, paying higher prices.¹⁰

*Lack of Government Incentives*

The high cost of renewable energy equipment is compounded by the lack of government incentives to purchase the equipment; this problem was highlighted by all vendors. Many other countries have reduced import taxes
for renewables in order to promote the growth of the industry, but Panama has not. Import taxes on solar panels are 15%, while those on gas generators are 3%. This is a particular problem because no renewable energy equipment is made locally; it all must be imported.

A law has been put forward in the Panamanian Assembly to lower import taxes on renewable energy equipment, but it has failed to pass after being introduced three times. This may be due to opposition by large utilities, who would lose money due to competition from the renewable energy industry. While some vendors are confident the law will pass, others do not expect any action until after the May 2004 elections, and still others think that the import taxes will be increased to prevent small-scale renewable energy from competing with existing energy businesses (Confidential Source).

**Government Bureaucracy and Corruption**

All government-sponsored projects go through a bidding process, with the winner determined by price. Variables like the experience of the company, the quality of the equipment, and the financial security of the company do not have a significant impact. Ignoring equipment quality is especially problematic, as this can result in failed projects. This is compounded by the government buying systems but rarely paying for system maintenance, so the systems fail and are not repaired, as the installation company has no monetary incentive to repair problems with its project. However, there has been a recent trend for the government to include maintenance and training in its project plan, though the success of this largely depends on how it is implemented (Confidential Source).

The solicitation process is also affected by corruption and under-the-table payments, which discourages vendors from participating. This corruption continues in the design process; manufacturers can exclude competitors’ products by requesting certain design specifications. The company awarded the project then has to follow these specifications (Confidential Source).

Additionally, when a renewable energy business installs systems paid for by the government, there is usually a significant delay between the end of the project and the remittance of payment. This can cause difficulties for the business, which may have outstanding debts from the installation.

**Lack of Awareness of and Misconceptions about Renewable Energy**

As previously mentioned, lack of awareness of renewable energy and its benefits and misconceptions about the technology are significant barriers to the expansion of the renewable energy market in Panama. Customers must know the advantages of renewable energy before they will buy it. This is especially important for affluent Panamanians and foreigners, as they have the capital to spend on renewable energy systems. Educating government officials is also important because they decide whether to purchase traditional or renewable energy for rural electrification.

Though knowledge is much greater than a decade ago, much work remains to be done, especially in combating the misconceptions about renewable energy. At fairs, some renewable energy vendors have been laughed at because people think the technology does not work.

**Lack of Standards**

Panama does not have a body regulating the installation of renewable energy or the standards of the equipment. This lack of standards contributes to the failure of systems, which reduces support for the technology. Equipment in Panama should resist humidity, rain, and corrosion. However, this makes the equipment more expensive.

**Competition with Non-Panamanian Companies**

Many development projects are funded by outside agencies, like non-governmental organizations, banks, or countries’ foreign aid bureaus. Frequently, such external funding requires that materials, technology, and expertise be purchased from the country that donates the money, in order to provide economic benefits to that country. This is problematic because these outside companies may not be aware of local conditions that affect how the system should be designed. As indicated previously, Panamanian companies have learned lessons...
regarding climatic conditions, equipment deterioration, and amount of solar insolation. Foreign companies are likely to make these mistakes, as they have not gained a sufficient amount of local experience. Also, it is difficult to get these companies to repair damaged or faulty equipment, as international transportation is very costly. Most importantly, the use of outside vendors and engineers hinders the development of the renewable energy industry in Panama by withholding investment. Occasionally, these projects also work with local businesses or installers, but they frequently do not. One advantage, however, to importing technology and expertise is that it will likely be more advanced than that available locally.8

Part 4
Future Prospects

NGO Formation

One initiative with strong potential to help the renewable energy industry is the formation of a non-governmental organization for renewable energy in Panama. This organization is forming with the objective of developing the renewable energy industry and its technology; it should be launched officially in about a year. Members will work together on projects and share information.10 The organization will also help protect the reputation of member renewable energy vendors by providing a guarantee of quality. This will help overcome bad designs and installations and low public trust in renewable energy. It may also put pressure on the government to reduce the import tax on renewables or pass other types of incentives.7

Conclusion

Overall, renewable energy in Panama faces a bright future. Knowledge of the technology is increasing, and as knowledge increases, demand will increase. Many of the people now purchasing renewable energy are foreigners, as they typically have more money and have trust in the technology. This work will open the door for the expansion of the industry; people will see successful examples and be motivated to install their own systems.9 Government incentives would be a great boon, but the industry will still grow, albeit more slowly, without them.

One vendor sees full acceptance of the technology in the future, based on what he has seen in the last seven years.7 All vendors are optimistic and expect the industry to grow, especially with new technologies (like flexible solar panels and fuel cells) and with the continuing decrease in price of the technology.9

References

Changes in Presidential Public Approval Ratings at the Start of U.S. Military Conflicts Abroad, 1950–1999

Connor McGee, College of Liberal Arts

Abstract

It is commonly said among pollsters that wars are always popular in the beginning. However, is this to suggest that the American public responds positively to all military conflicts or only to wars? This research design was meant to investigate to what extent the beginnings of U.S. conflicts abroad altered public opinion. The methodology began with a government-created list of instances U.S. troops were used in foreign nations, which was filtered to create a definition of foreign conflict. By cross referencing those cases with a comprehensive list of presidential public approval ratings, adjusted for both approval and disapproval, a correlation could be derived to infer which foreign conflicts were the most popular and unpopular. As expected, wars generated the rally-around-the-flag
effect, but, unexpectedly, other comparatively small skirmishes seemed to generate a proportional response. It is suspected that this is the result of a “post-crisis” event (building on Brody’s theory) that reflects a positive change in the face of a small military victory. The results also support the notion that in overseas conflicts, themes are important for shaping American public opinion.

Article II of the U.S. Constitution grants the president very limited and narrow powers, including the ability to act as commander in chief of the armed forces. In the modern presidency, this power may possibly be used as a foreign policy tool to strengthen domestic approval ratings. Given the growing importance and publicity of the executive branch since World War II, it is necessary to examine if military conflicts abroad consistently shape public opinion. Although Vietnam showed that military conflicts can eventually contribute to a decline in favorability ratings, it must be seen whether or not the declaration of battle directly affects the president’s approval rating. The underlying assumption is that wars and battles are directly tied to the public’s mood. However, this may not always be true. Presidents have the ability to organize a potentially limitless number of battles, especially when the conflicts are smaller and shorter in length. This research design will examine the prevailing literature to understand which foreign policy factors have had the most influence on the public according to political scientists. Then it will attempt to find any trends that incur immediately when a president orders any type of military action related to a conflict abroad.

Predictions and Expectations

It is likely that the public, regardless of how low its sophistication or attentiveness at any given moment, will still react to the cues of peers, elites, partisan lines, and unknown miscellaneous references. It is not completely certain whether the direction of cause and effect of public opinion is from the masses toward the policy makers or vise versa, but there should be some correlates between the two, which will be used to measure how the public reacts to foreign policy decisions. Even when people aren’t well-informed, they will form lay opinions about the president, as Witkoff and Shapiro found. They argue that for whatever reason public opinion shifts on foreign policy, it is still rational to the informational and circumstantial changes that develop (Witkoff 1986, Shapiro 1988).

Although Toth, Kohut, and Jentleson argue that certain themes of foreign conflict will resonate with the public (Kohut and Toth 1994, Jentleson 1992), this is probably untrue at least in terms of an immediate reaction. Instead, the prevalent argument will be taken from Brody that foreign conflict carries a momentum that lasts from beginning to end, stemming largely from the pre-crisis buildup of a long-term event such as a war. Any changes that occur will be small and gradual (Brody 1994). This seems like the most plausible prediction considering that the public is generally large and uninformed. If a small group of people repeatedly changed their opinions, they could make quick shifts with little resistance. But for a group as massive as the American population to make quick and repeated shifts takes time. For millions of people to change their minds all at once, or even in subgroups, there has to be some kind of delay so that information can disseminate and they can respond to the cues of others. It seems logical to think that they have to respond to cues if they are generally uninformed. Therefore, as Brody has stated, changes during the course of a foreign conflict will be small and gradual (Brody 1994).

However, this is not to say that lack of sophistication and attentiveness will never give rise to a measurement error regarding foreign conflicts that gain little media attention. The public cannot be expected to look for these incidents when the media will pay little attention to them. Scenarios that didn’t incur major shifts should be the ones where public attentiveness was lower, the president’s cues were not as solidly established despite being the commander in chief of the armed forces, the life-span of campaigns will have been much smaller, and when there were missions where the UN or NATO had larger roles in planning, which will have diluted American patriotism towards the rallying effect. As this applies from Truman to the Clinton presidencies, it is
suspected that the “rally-around-the-flag” effect (Mueller, 1973) will be seen in the conflicts with the longest lifespan and the highest media coverage. Namely, they’ll have rallied behind the Korean War, the Vietnam War, and first war against Iraq. Also, it will be proposed that American presidential approval was not influenced in any other situations of overseas conflict. In a small number of cases, quite simply, missions will have been just too easy to accomplish. That is, there will have been no need for presidential cues, significant military buildup, and the mission’s lifespan will have been extremely short. All of these effects will also contribute to the lower media coverage that would have otherwise primed the public for a shift due to international conflict. If major news organizations couldn’t have spent more than a day covering a conflict, and they only had enough time to report the results, the public won’t have paid a remarkable amount of attention to it.

Given these predictions, any change in public approval in instances other than Korea, Vietnam, and the Iraqi war should be coincidental and have incomparable magnitude to the other major scenarios. If there were any other large shifts, they will probably be the result of other factors such as the state of the American economy. Certainly, though, there should not be any other shifts of comparable size to the three major wars that will be included with the other cases of foreign conflict. If this expectation is inaccurate and there are such anomalies, though, they should be carefully examined for a pattern.

Methodology and Data Collection

In this research design, there is a strong need to find a set of instances in which foreign conflict abroad occurred and there also must be corresponding data to infer what the presidential approval was at or around that time. It is assumed that there is no existing list of foreign conflicts abroad that already matches the herein ideal definition of “military conflict abroad.” Therefore, before any resources are collected, the definitional parameters should be set so that any non-qualifying, potential instances of conflict abroad are filtered out. This will maintain consistency and eliminate any bias that might stem from interpreting a dramatic change in presidential approval rating for an instance that only partially qualifies or doesn’t qualify at all. Then, the method of calculating shifts in presidential approval rating should be clearly spelled out and applied against the available resources to determine the most effective, unbiased, and consistent way to show changes in values.

Broadly speaking, “military conflict abroad” shall be assumed to be any instance not on American soil where US troops, naval craft, or aircraft set out to deliberately and intentionally engage or attack foreign persons or facilities. The most comprehensive list of these instances, before they have been filtered by the definition herein, comes from Richard Grimmett. He is the author of Congressional Research Services report number RL30172, titled “Instances of Use of United States Forces Abroad, 1798-1999” (Grimmett 1999). This research will cover only instances after WWII, which will be set to start on September 3rd, 1945, the day after Japan formally surrendered to the United States. All of the instances before this date will be excluded.

Since the potential cases that will be used for this design have already been laid out, the qualifiers of this section shall act as filtering mechanisms to remove events that do not fall under the necessary definition. Only instances that have been made available to the public will be used. There will be no distinction for undeclared wars, UN or NATO missions, battles, and any other operations, regardless if Congressional approval was available or not. Despite the outcome of a mission, battle, or war, the U.S. must have engaged or attacked foreign persons or facilities. Failure on this criterion will not qualify as foreign conflict, even if the underlying circumstances are coincidental. For example, the case in which President Carter attempted a rescue mission for hostages in Iran in 1980 will not be included in this analysis because the helicopters that were used suffered mechanical failures before reaching their objective and thus the mission was cancelled. Failure of this criterion also applies to instances in which U.S. troops or craft were attacked, but the U.S. declined to immediately respond with military force. All missions that were intended solely for evacuation, security, surveillance, seizing property, or preventive reasons shall be excluded if it did not
escalate into fighting. Any instance in which foreign troops were sent solely for the purpose of build-up before an attack will also be excluded. Neither operational size nor significance of a mission will be weighted. As the author of the available list of foreign conflict cases has already filtered out some instances of his own that do not contradict the laid-out definition, covert actions, disaster relief, and routine alliance stationing and training exercises are not included. Any operations in which troops were sent as “forces” will be assumed to have fought and therefore contributed to the overall definition of conflict that is sought.

Functionally speaking, each instance of foreign conflict will be associated with a change in presidential public approval based on the date in which it either occurred or was reported. Presidential approval ratings shall be taken from available Gallup polls of The Roper Center’s online database known as iPoll (“Presidential…” 2003). This being the most comprehensive source available, public approval ratings will be dependent upon the dates in which that information was recorded, though it is not expected that Gallup attained this information on a day-by-day basis to maintain the highest accuracy of this project. Because of this limitation, comparisons will be made using polls before and after a given international conflict. The poll that occurred either before or on the date in which an incident began or was announced will be compared with the following available poll. However, if in the rare circumstance an approval poll was taken on the same day of a military conflict, it will be used as the preliminary Gallup poll to be compared with the following one. It shall be assumed that the public needs a “reaction period” to assess how it feels about each event. Fortunately, in most of these limited cases, the following poll was merely taken within a week of the event.

After the two polling dates have been compared, the following formula will then be used to extract an average percentage point change:

\[ \frac{[(A_1 - A_2) - (D_1 - D_2)]}{2} \]

where A₁ and D₁ stand for the approval and disapproval ratings (respectively) on the date in which an incident began or was reported, and A₂ and D₂ stand for the approval and disapproval ratings for the following available poll. Within the mathematical calculations, negative values will never be inverted to reflect positive values. The reason that both approval and disapproval ratings are being used is because there are instances in which the population that previously had no opinion of the president could switch their opinion in the following survey to either approve or disapprove. Hence, a president could have an increase in both approval and disapproval ratings. In those cases, to say that a president had an increase in approval rating would be misleading. Therefore, the above-stated formula adjusts the approval rating to reflect the overall change. If the formula results in a positive number, this will indicate increased adjusted approval, and inversely for negative values, it will indicate increased adjusted disapproval. This will be interpreted as an overall immediate shift either in the public’s approval or disapproval of a foreign conflict (see Appendix A or Appendix B for results).

It is important to note that only mobilization and demobilization of “approve” and “disapprove” responses will be examined. Any cases in which respondents answered “I don’t know” will not be compared with the other responses because it cannot to any degree measure presidential approval or disapproval. Even if there are instances in which there is a significantly higher mobilization of “I don’t know” responses, this will not be taken into account. This methodology is only interested in measuring the bipolarity of the two given responses.

Results & Conclusion

Overall, the general expectations seemed well-founded. Certainly, the starts of the Korean, Vietnamese, and Iraqi wars had their rallying effects. However, there appears to be instances of rallying effects that were not accounted for ahead of time for missions that were easier and quicker to carry out than an average war. This would imply that the lifespan of a conflict does not affect public opinion, but rather that the context is the key variable as offered in the literature (Kohut and
Toth 1994). For President Reagan, there were two massive boosts in approval ratings that occurred at the same time as the unaccounted conflicts, both of them having to do with Libya. In 1981, he received an adjusted eight-point increase around the same time that two Libyan planes were shot down. In 1986, he received an adjusted six-point increase around the same time he had authorized the bombings of terrorist facilities and military installations in Libya. George H.W. Bush received a nine-point increase after he sent military troops to Panama to arrest General Noriega. President Clinton received two sizeable boosts from attacking Iraq: once when the incident occurred the day after he had been inaugurated and a second time about six months later. The former is more likely attributable to a successful election and inauguration considering that the attack was relatively minor and occurred against Iraqi planes. However, the latter situation was a retaliatory response to a learned assassination attempt of former President Bush. The significance of this attack might have had a patriotic rallying effect for Americans. Lastly, Clinton had received one more increase late in his career after he had bombed Iraqi industrial facilities shortly after UN weapons inspectors had been deported from the country.

To account for these oversights, it seems that Brody had a very logical point in that there is a pre-crisis event that sets the tone throughout the conflict (Brody 1994). However, when the conflicts’ life spans are extremely short, this theory should be expanded to say there is also an immediate post-crisis event that takes place shortly after media outlets report an American military win. The tone immediately after this win will typically shape a presidential approval change that will reflect a positive change among the public.

The evidence at hand suggests a stronger indication that themes are important in regard to overseas conflict. Despite the fact that they can occur in short, one-day stories that media outlets will barely have time to cover, there seems to be enough sentiment behind them to induce a rallying effect.

Acknowledgement
Special thanks to Dr. Daron Shaw of the Department of Government.

End Notes
1. The existence of “miscellaneous references” is an assumption. I presume that there are other factors that drive public opinion in regard to foreign policy, even though it is not definitively known. “Miscellaneous references” refers to criteria that categorically are either uncommon or individually specific.
### Appendix A

The following is a chart of each date of conflict correlated with the adjusted presidential approval change. There were two instances in which data was unavailable because there was no secondary Gallup poll to use for a measurement due to the fact that the respective presidents in each of these cases were finishing their terms. The date marked “April 1986” should be pointed out because it has no specific date associated with it and therefore has the same adjusted point change as the previous date of conflict.

<table>
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<tr>
<th>President in Power</th>
<th>Date of Conflict</th>
<th>Adjusted Presidential Approval Change</th>
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<tr>
<td>Truman [D]</td>
<td>June 30, 1950</td>
<td>8</td>
</tr>
<tr>
<td>Kennedy [D]</td>
<td>April 1962</td>
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<tr>
<td>Johnson [D]</td>
<td>August 8, 1964</td>
<td>4</td>
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<tr>
<td></td>
<td>April 28, 1965</td>
<td>5</td>
</tr>
<tr>
<td>Nixon [R]</td>
<td>April 30, 1970</td>
<td>2.5</td>
</tr>
<tr>
<td>Reagan [R]</td>
<td>August 19, 1981</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>August 21, 1982</td>
<td>2</td>
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<tr>
<td></td>
<td>September 29, 1982</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>October 25, 1983</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>March 26, 1986</td>
<td>-2</td>
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<td></td>
<td>April 16, 1986</td>
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<td></td>
<td>April 1986</td>
<td>6*</td>
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<td></td>
<td>September 23, 1986</td>
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<td></td>
<td>January 4, 1989</td>
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<td>August 9, 1990</td>
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<td>9</td>
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Appendix B

Adjusted Percentage-Point Approval Change

The following are the referenced instances in which the United States used military troops abroad for the purpose of conflict, as determined by the definition used by the author. For further details regarding definitions and criteria, see the “Data and Methodology” section of this paper. The original source for this list is from Richard L. Grimmett, author of Congressional Research Services report number RL30172, titled “Instances of Use of United States Forces Abroad, 1798-1999.” Richard Grimmett is a specialist in national defense in the Foreign Affairs, Defense, and Trade Division. For the sake of brevity, this list has been filtered to include only instances in which there was at least an adjusted 5% change.

a) June 30, 1950—Korean War.

The United States responded to the North Korean invasion of South Korea by going to South Korea’s assistance, pursuant to United Nations Security Council resolutions. U.S. forces deployed in Korea exceeded 300,000 during the last year of the conflict. Over 36,600 U.S. military were killed in action.

b) June 30, 1950—Korean War.

d) April 28, 1965—Dominican Republic.

The United States intervened to protect lives and property during a Dominican revolt and sent more troops as fears grew that the revolutionary forces were coming increasingly under Communist control.

f) August 19, 1981—Libya.

On August 19, 1981, U.S. planes based on the carrier U.S.S. Nimitz shot down two Libyan jets over the Gulf of Sidra after one of the Libyan jets had fired a heat-seeking missile. The United States periodically held freedom of navigation exercises in the Gulf of Sidra, claimed by Libya as territorial waters but considered international waters by the United States.

k) April 16, 1986—Libya.

On April 16, 1986, President Reagan reported that U.S. air and naval forces had conducted bombing strikes on terrorist facilities and military installations in Libya.
p) December 21, 1989—Panama.
On December 21, 1989, President Bush reported that he had ordered U.S. military forces to Panama to protect the lives of American citizens and bring General Noriega to justice. By February 13, 1990, all the invasion forces had been withdrawn.

On January 18, 1991, President Bush reported that he had directed U.S. armed forces to commence combat operations on January 16 against Iraqi forces and military targets in Iraq and Kuwait, in conjunction with a coalition of allies and U.N. Security Council resolutions. On January 12, Congress had passed the Authorization for Use of Military Force against Iraq Resolution (P.L. 102-1). Combat operations were suspended on February 28, 1991.

u) January 21, 1993—Iraq.
On January 21, 1993, shortly after his inauguration, President Clinton said the United States would continue the Bush policy on Iraq, and U.S. aircraft fired at targets in Iraq after pilots sensed Iraqi radar or anti-aircraft fire directed at them.

w) June 10, 1993—Somalia.
On June 10, 1993, President Clinton reported that in response to attacks against U.N. forces in Somalia by a factional leader, the U.S. Quick Reaction Force in the area had participated in military action to quell the violence. On July 1, President Clinton reported further air and ground military operations on June 12 and June 17 aimed at neutralizing military capabilities that had impeded U.N. efforts to deliver humanitarian relief and promote national reconstruction, and additional instances occurred in the following months.

x) June 28, 1993—Iraq.
On June 28, 1993, President Clinton reported that on June 26 U.S. naval forces had launched missiles against the Iraqi Intelligence Service’s headquarters in Baghdad in response to an unsuccessful attempt to assassinate former President Bush in Kuwait in April 1993.

During the period from December 16-23, 1998, the United States, together with the United Kingdom, conducted a bombing campaign, termed Operation Desert Fox, against Iraqi industrial facilities deemed capable of producing weapons of mass destruction, and against other Iraqi military and security targets.

Works Cited

From Wrinkles to Bioterrorism: The Big Role of Little Synaptobrevin in Neurotransmission

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Abstract

This report examines the role of the protein synaptobrevin in synaptic transmission by using electrophysiological techniques in the fruit fly, Drosophila melanogaster. We show that the strength of synaptic signals in a mutant with reduced synaptobrevin is weak, as previously shown. Additionally, we report two novel results showing that short-term depression and prolonged depletion, where normally weakened electric signals are present, are not evident in the mutant. These results indicate that vesicle fusion is tightly controlled by the amount of synaptobrevin in the mutant fly. Hence, our studies strengthen the notion that synaptobrevin is a critical component of vesicle fusion.
Introduction

There are approximately 110 cases of botulism reported in the United States each year. Symptoms include double and blurred vision, slurred speech, difficulty swallowing, dry mouth, and muscle weakness (Center for Disease Control). These symptoms are caused by a bacteri-produced substance that paralyzes muscles. Botulinum toxin, popularly known as Botox, is currently used cosmetically to paralyze facial muscles, eliminating wrinkles. This toxin is also on a list of potential weapons for bioterrorism as high concentrations of the airborne toxin will paralyze respiratory muscles resulting in death. In 1992, Schaivo et al. found that botulinum toxins block neurotransmitter release by cleaving the SNARE complex, which consists of the three proteins synaptobrevin, syntaxin, and SNAP-25, and thus prevents it from functioning. In order to understand how this lack of neurotransmitter release results in paralysis of muscles, one must first appreciate how nerves and muscles communicate (Figure 1). The brain “talks” to muscles via a flow of electrical signals. When the electric charge reaches the end of the neuron right above the muscle, it triggers the release of signaling molecules, called neurotransmitters. Sacks of membrane or vesicles inside the neuron that contain neurotransmitters fuse with the membrane of the neuron with the help of the SNARE protein complex, and the neurotransmitters are released into the space between the neuron and the muscle known as the synapse. Neurotransmitters travel a short distance to the muscle and bind to receptors on the muscle’s surface. This binding, in turn, generates electrical signals in the muscle as positively charged ions cross the muscle’s membrane surface, leading to muscle contraction.

Therefore, when the botulinum toxin cleaves synaptobrevin and impairs the functioning of the SNARE complex, the vesicles cannot fuse with the neuron’s membrane. Neurotransmitters cannot be released, and so muscles cannot contract; paralysis results.

Our research group decided to further investigate the role of synaptobrevin in vesicle fusion. We chose a common laboratory fruit fly, Drosophila melanogaster, to study the use of synaptobrevin in neurotransmission. In addition, we studied a mutant fly in which less functional synaptobrevin protein is incorporated into its vesicle membranes than in a normal, or wild type, fly. Thus, these mutant flies, as one would expect, have a difficult time surviving into adulthood, in part because the ability of their muscles to contract is very poor. In this report, we examined how reduced levels of

Figure 1  Diagram Illustrating Communication Between Neuron and Muscle

Electrical signals, in the form of positive charge or action potential, travel to the end of the neuron right above the muscle. Vesicles inside the neuron fuse with the neuron’s membrane and release neurotransmitters into the space between the neuron and the muscle. Neurotransmitters bind to receptors on the muscle’s surface, and electrical signals are generated in the muscle.

Elizabeth Mercer et al.
synaptobrevin in the mutant fly affect synaptic signaling, synaptic plasticity, and synaptic vesicle dynamics upon prolonged neuronal activity.

**Methods**

All recordings were taken from fly 3rd instar larvae (3 recordings from 2 wild type and 2 mutant type flies, 6 total recordings) that had been sliced along the anterior posterior, or head-tail, axis and pinned open in a 2.5 mM Calcium solution (Stewart et al, 1994). A glass micro-electrode (with resistance between 20 and 35 Mega Ohms and an internal conductive electrode solution of 3 Molar Potassium Chloride) was used to penetrate the larval muscles and record the amount of electric potential that entered the muscle after stimulating its innervating nerve.

The nerve fiber that innervates the muscle was stimulated by pulling the end of the axon bundle into a suction electrode and by passing a 0.85 V through the suction electrode. Setup also included a high-powered microscope with viewing monitor, an analog to digital converter, an IGOR / DataPro program, an Axoclamp 2B amplifier, foil to exclude as much ambient noise as possible, and an air table to minimize vibrations.

**Results/Discussion**

**Part 1**

*Comparison of Ability to Generate Synaptic Signals*

A complete removal of synaptobrevin leads to no release of neurotransmitter in flies (Deitcher et al, 1998). Thus, we hypothesized that with less functional synaptobrevin, the mutant fly forms fewer SNARE complexes, and thus less neurotransmitter is released. Toward this goal, we examined the amplitude of synaptic signals when we stimulated a nerve that innervated muscle with a single low frequency stimulus in both the wild type and mutant flies.

In the graph below (Figure 2), the strength of synaptic signals in both the synaptobrevin mutant and wild type is illustrated. The y-axis represents the internal resting potential of the muscle cell. At rest, this number typically varies from approximately -65 to -85 millivolts, but when the neuron signals the muscle cell via neurotransmitters, as indicated in the graph by the slight downward line in both traces, positive charge enters the cell proportionate to the amount of neurotransmitters released by the neuron. As seen in the graph, less positive charge enters into the synaptobrevin mutant cell, indicating that less neurotransmitter is released by the neuron for the same strength of simulation. This result, consistent with Stewart and his colleagues’ findings (Stewart et al, 2000), indicates that the reduction in transmitter release results from less functional synaptobrevin present in the mutant. Together with the observation that complete loss of synaptobrevin leads to no release at all (Deitcher et al, 1998), our data support the notion that synaptobrevin is critical to neurotransmitter release as a component of the SNARE complex.

It should be noted here that the difference between the initial resting potentials of the two traces in Figure 2 is not ideal, but are also not unexpected, as the exact resting potentials of different cells may vary. However, synaptic potential is larger in a more negative resting potential. Thus, the mutant’s synaptic potential would be smaller if its muscle’s resting potential was also at ~70 mV, as in the wild type.

**Part 2**

*Short Term Synaptic Plasticity*

The relationship between nerves and muscles is not static. Like most other bodily systems, the ability of a neuron to signal a muscle will change given different conditions. This is known as synaptic plasticity, which is thought to be important for learning and memory. For example, if a nerve is continually rapidly stimulated, it will use up the stores of neurotransmitters in its vesicles. As a result, the muscle will receive less signal even though the neuron is being stimulated at the same rate. We sought to test whether the synaptobrevin mutant had a normal synaptic depression in response to repetitive stimulations.

We delivered two consecutive (twin) electrical pulses to the nerve in quick succession and then observed how the synaptic potential changed during the stimula-
The mutant was found to have chaotic responses to twin-pulse signaling. In the wild type fly, the amplitude, or height from the base to the top of the trace, of the second peak (-50 to -30 mV, 20 mV amplitude) resulting from the second stimulation of the nerve is much lower than the first (-70 to -30 mV, 40 mV amplitude). This is called synaptic depression. With a normal amount of synaptobrevin, SNARE complexes form and almost all of the vesicles that are ready to fuse do so with the first stimulation, releasing a large amount of neurotransmitter. On the second pulse, a smaller amount of neurotransmitter is released because many vesicles have not had time to “reload,” getting into the proper position and allowing membrane proteins to form the SNARE complexes necessary for fusion. The amount of depression seen in the wild type fly is directly related to the time in between pulses. The longer the inter-stimulus interval, the less depression of the second peak, as more time between stimuli allows more vesicles to get into ready position (data not shown).

Upon examination of amplitudes in the case of the synaptobrevin mutant, however, there is no consistent pattern of depression. As seen in Figure 3A, in addition to having smaller amplitudes overall, in some traces depression is evident (bottom trace at 60 ms), but in others (top trace at 60 ms) the amplitudes of the two peaks are approximately the same (approximation of amplitude calculation illustrated with dotted lines). The mechanics of this phenomenon are still unknown. Theoretically, one could imagine that the formation of SNARE complexes is difficult in the first place, so even though there is a normal amount of vesicles and fusion sites, only a small fraction of the vesicles will be able to fuse with the membrane. On the first pulse, again, all vesicles that can fuse do so, but on the second pulse, the release of neurotransmitter depends on how many of the vesicles waiting happen to be able to form SNARE complexes. If we assume the ratio of vesicles to available fusion regions in the mutant is higher, it makes sense that depression is less likely to occur in the mutant. Examples of facilitation, where the amplitude of the second peak is higher than that of the first, were also observed in the mutant, possibly simply because in those cases the available vesicles managed to line up correctly.
in a short amount of time. Though the mechanisms above are purely speculative, it can be conclusively stated that the mutant’s behavior to twin-pulse stimulation is more variable than that of the wild type.

Three example traces cannot give an overall picture of what is happening, however. In the graphs below (Figure 3B), 9 wild type and 14 mutant traces were averaged over 6 trials. The first graph illustrates the amount of variability in a number known as the facilitation index. This number is simply a way of quantifying how much the amplitude of the second peak was increased or decreased with respect to the first (calculated by \((EJP_2 - EJP_1)/EJP_1 \times 100\)). This gives the percent by which the second peak is facilitated (if the percent is positive) or depressed (if the percent is negative). In the case of the wild type fly, depression is fairly consistent, and all averages are approximately the same. Note that the error bars are small, indicating that responses are consistent in amplitude. In the mutant, 3 animals showed very different responses: one actually showed facilitation, the second one showed slight depression, and the third one showed depression to the same extent as wild type. However, the error bars in the mutant are large, suggesting there were large variations in synaptic responses. These data, combined with the average facilitation index of approximately 0, shown in the second graph, indicates that overall, the second peak is not depressed or facilitated in the mutant, but rather the outcome of each trial is fairly random. This contrasts highly with the wild type data that show consistent depression.

**Part 3**

**Synaptic Vesicle Dynamics with Long Bursts of Signaling**

Given that short-term synaptic depression was not evident in the twin-pulse stimulation of the mutant, our research group wondered whether it would be at all possible to deplete synaptic vesicles in the mutant’s nerve terminal if we stimulated the nerve for a longer period. We generated a protocol that gave 3 minutes of 10 hertz stimulation, followed by 1 minute of 1 hertz stimulation.
Just like the above cases, the change in the muscle’s membrane voltage was indicative of the number of neurotransmitters released, and thus the number of vesicles that fused with the neuronal membrane. In the wild type fly, the stored vesicles inside the neuron are slowly depleted (indicated by the arrow). Then, a baseline point is reached where vesicles are fusing with the membrane as fast as they are being recycled or re-made. When the protocol is switched to the 1 hertz simulation, the neuron is able to recover its stored population of vesicles while firing, as seen by the slowly rising peaks in Figure 4A (arrow).

In the mutant, however, again the pattern is lost. Throughout the protocol, the mutant’s response is variable but fairly consistent. Recall that the amplitude of the voltage change is the important facet; the rise at the beginning of the baseline of the mutant’s data trace is most likely indicative of a muscle contraction (see double arrows), having no effect on the amplitude of the peaks or the amount of neurotransmitter that is being released.

These data were highly unexpected, and the mechanism by which the mutant behaves remains elusive. It is possible that for the mutant, the rate-limiting step is not the availability of “readily releasable” vesicles, but rather the number of SNARE complexes that are able to form and fuse, given a certain amount of time between stimulation pulses. Thus, the probability for release and depression is low in the mutant. As a simple example, suppose 10 vesicles are waiting inside the mutant and wild type fly’s neuron. Among these 10 vesicles, only 5 are ready in position to release transmitter. However, the mutant vesicles form less functional SNARE
In the wild type, clear depletion of the pool of vesicles to a stable point where release rate is approximately the same as recycling rate is evident under the 10 Hz stimulation. When the protocol switches to the 1 Hz stimulation, the pool of vesicles slowly gets larger or is recovered, as evidenced by the trend of increasing membrane voltage change in the muscle (see arrows). In the mutant, however, no clear depletion or recovery is evident.
complexes with the neuronal membrane, and thus, the mutant will have fewer vesicles undergo fusion (Figure 5). On the first stimulation, all 5 “readily releasable” vesicles in the wild type and only 2 of the 5 “readily releasable” vesicles in the mutant will fuse. Ad interim, the wild type fly may only be able to move 3 vesicles into the “readily releasable” position given the short amount of time between pulses. In the mutant, however, there are still 3 “readily releasable” vesicles remaining in position, and in the same short amount of time, perhaps 1 more vesicle may be moved. At the second stimulation, all 3 of the wild type vesicles fuse, and 2 of the 4 fuse in the mutant. When comparing the ratios of the wild type (5:3) and the mutant (2:2) released vesicles in this case, one can visualize how depression is less likely to occur over time in the mutant.

Alternatively, SNARE formation, as opposed to SNARE function, may be hampering the mutant. In this case, the mutant is only able to form SNARE complexes for 2 vesicles. At the first stimulation, the 5 vesicles in the wild type and the 2 in the mutant will fuse, releasing relative amounts of neurotransmitter. At the second stimulation, eight vesicles remain unattached in the mutant’s neuron, so even though the probability that an individual SNARE complex will form is still less than in the wild type, depression is less likely to occur over

This graph is needed for completion’s sake only. Though no new data are shown, this shows that the examples in Graph 4 are not coincidental, isolated cases. The average trends shown in this graph are consistent with the examples shown in Figure 4A.
In this hypothetical example, depletion is evident in the wild type. In the first proposed mechanism of the mutant, depletion is not evident because once formed, SNARE complexes are less functional. Less vesicles fuse with the membrane, and consequently, more vesicles remain in “ready position” than in the wild type fly. Thus, depletion in the mutant is less likely to occur. In the second proposed scenario, less SNARE complexes form in the mutant, but all that form will fuse. In this case, the number of vesicles that remain in the neuron “balance” the fact that an individual complex is less likely to form.

time, because more vesicles remain in the neuron. Theoretically, if less functional synaptobrevin is incorporated into each vesicle of the mutant, it may be a matter of getting the vesicle proteins to line up correctly with the membrane proteins so that they can intercalate, causing fusion. If this is based on the orientation of the vesicle, the variability seen could be explained by the way the vesicle comes into contact with the membrane. Think of this like a ball with a spot on it being thrown at a wall with a set of spots. The spots may contact one another on the first or the fiftieth try; the connection would be fairly random. Both models appear to fit the theoretical prediction that synaptobrevin controls the release probability. However, these examples are for illustration only; the exact mechanisms involved are still unknown.
Conclusion / Future Research

Our studies have expanded the understanding of how synaptobrevin is used in SNARE complex formation and vesicle fusion, and, significantly, our results reveal 2 novel findings about the synaptobrevin mutant. It is hoped that comprehension of synaptobrevin's facets will contribute to a clear picture of toxin action, with the ultimate goal of more effective botulism treatment.

It was expected, and has been shown previously, that the synaptobrevin mutant would exhibit a smaller signal response (EJP) than the wild type (Stewart et al., 2000). However, the fact that depression and depletion are absent from the mutant, given our protocols, was highly unexpected. Rather, previous hypotheses would have suggested that depression and depletion would be evident, though their extent would be smaller than in the wild type fly. Though at this time we can only speculate as to the rationale behind these findings, clearly our present understanding of the function of synaptobrevin in mutant awaits further investigation.

A longer, faster depletory protocol should be used to make sure that the mutant vesicles cannot be reduced to a base line synthesis level. A biochemical test that quantifies the number of SNARE complexes could also be performed to try to rule out one of the above-proposed mechanisms, as that is the main difference between them. Also, it would be interesting to conduct the same experiments on a syntaxin mutant. Recall that this protein is a different member of the SNARE complex that is bound to the neuronal membrane. If the above data were approximately replicated, it would indicate that we were observing results of a less functional SNARE complex in general, as opposed to something specific about the synaptobrevin protein’s function. Also, the relative importance of syntaxin and synaptobrevin in forming the SNARE complex could be determined.

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References

Inequity and Violence in Brazil

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Abstract

Although much has been written about the relationship between inequality and violence, it is difficult to find strong correlations between the two—in fact, there is no conclusive evidence that inequality causes violent crime. This paper analyzes the relationship between two types of violent crime, homicide and rape, and various social indicators in Brazil for the year 2000. Specifically, I am interested in how the incidence of violent crime corresponds with literacy, state economic productivity, economic inactivity, urbanization, and racial geographic distribution. The kind of inequality studied here is that existing between (and not within) Brazilian states and regions. That is, inequality in terms of differences in literacy and racial geographic distribution, for example.
Literature Review

Racial Inequality

Racial inequality in Brazil is well documented. Differences between whites and nonwhites are usually explained in terms of race and history. Lower literacy rates and higher mortality rates among blacks are thought to be the result of blacks’ experience with slavery. Slaves were forced into a stratified society and had little choice after abolition but to remain in Brazil, where racism prevailed (Rose, 1998). Racial inequality is usually explained by the “momentum” of oppression from colonial times, which is why nonwhites are disadvantaged. One author argues that the legacy of “whitening” has created an environment where “the surest means for a Brazilian of African heritage to gain upward mobility is to possess a whiter skin than his parents” (Skidmore, 1974). Slavery entrenched inequality and discrimination, the effects of which carried into the post-abolition era to create a legacy of inequality that preserved the racial social order (Marx, 1998). If we adhere to the traditional convention that poor and disadvantaged individuals are likely to commit crime to alleviate their situation, then we might conclude that many nonwhites are at a higher “risk” of committing crime than whites.

Geographic racial distribution is also important because of the strong correlation between socioeconomic status and race. Within cities, an area’s socioeconomic status and housing market are strong predictors of segregation. Whites’ segregation is ensured by the concentration of nonwhites in low socioeconomic classes in distinct neighborhoods. Moreover, segregation levels increase as income levels rise in metropolitan areas (Telles, 1992). Some authors argue that regardless of individual differences, macro-social patterns of residential inequality give rise to social isolation and the ecological concentration of the disadvantaged, thereby undermining social organization and control of crime (Hagan and Peterson, 1999). We might conclude that in densely populated, segregated Brazilian cities it is difficult to exercise social control and manage crime prevention. Also, if social isolation and concentration of the disadvantaged undermines crime control, we may expect nonwhite geographic units (tracts, blocks, etc.) to exhibit higher violent crime rates than white geographic units, where presumably social control is successfully exercised. Using aggregate data available, it is not possible to differentiate between crime occurring in rich or poor neighborhoods or to argue that poor or nonwhite persons commit crime only in their communities. However, we can observe the relative importance of urbanization and racial distribution with respect to crime, since these variables vary considerably from state to state.

Regional Inequality

Economic development is unequally distributed throughout Brazil. In developing nations, job scarcity and poor conditions have led to massive rural-urban migration, resulting in hazardous conditions and large urban centers (Clinard and Abbott, 1973). The growth and diversification of the Brazilian economy did not eliminate regional inequalities that have characterized Brazil since colonial times (Wood and Carvalho, 1988). Historically, the northeast has been underdeveloped, while the southeast has fared better in income, educational achievement, and percentage of households with running water, sewage and electricity (Wood and Carvalho, 1988). Researchers hypothesize that “present-time oriented” persons (Lewis, 1968), such as the poor, are at a relatively higher risk of committing crime or engaging in deviant behavior. Theories emphasizing environmental factors argue that crime is more likely to occur in areas with great income inequality. Being poor, they suggest, is the most important factor influencing individuals to become involved in crime (Currie, 1986).

Violence in Cities

A crime study in the U.S. postulated that higher pecuniary benefits of crime coupled with the decreased likelihood of punishment in large, anonymous urban space explain about 27% of the effect for overall crime, except crime that is non-pecuniary in nature such as rape. The remaining 45-60% of the urban crime effect can be related to “observable characteristics” of individuals and cities, especially those that reflect tastes, social influences and family structure. At least in the U.S., the connection between city size and crime is explained by
the fact that families are much less intact in cities, the higher benefit levels of crime in cities and the lower probability of arrest. Although they acknowledge larger cities have higher homicide rates than smaller cities, and that urbanization appears to be correlated with higher incidences of crime, they also point out that in Japan or Switzerland, high urban densities are not correlated with high crime. The reason is because under different social conditions, density can lead to social control and limited crime. One variable highly correlated with crime is that of female-headed households, which is one way families were described as “less intact” in cities (Glaeser, 1996). Similarly, at least one author has questioned the role of family size and marriage status in producing crime, suggesting single persons and children of single parent households may be more inclined towards crime (Englander, 2003). If high urban population densities explain higher crime rates, then we can expect regions with high urbanization rates to exhibit higher crime rates than relatively less urban regions. In fact, one recent study using 1991 state-level aggregate data in Brazil found that controlling for inequality, urbanization persists as the variable with the most influence in predicting homicide (coefficient = .374, p-value = .051) (Cano, 2001). Interestingly, another researcher found no significant correlation between unemployment, poverty, and violent crime in Minas Gerais, though modernization/industrialization indicators such as city size were strongly correlated with the incidence of crime (Beato, 1999).

Other researchers hypothesize that family disruption, urbanization, and anonymity accompanying rapid population change weaken the capacity of a community to exercise social control informally (Hagan and Peterson, 1995). This argument recognizes a community’s ability to prevent crime through neighborhood watches, for example, and not entirely through law enforcement bodies. Nevertheless, the implications are similar to the previous argument’s: high population turnover may result in high crime rates, though it does not necessarily cause crime. This argument subtly implies that the community’s resistance to crime is lowered, resulting in higher incidences of crime.

### Inequality and Crime

One explanation of the inequality-violent crime relationship is that inequality leads to violent crime by denying individuals resources necessary for healthy life and environment. Several studies have consistently found a positive correlation between low socio-economic status and crime (Braithwaite, 1979). Another argument is that less privileged people manifest discontent with their situation through violence (frustration-aggression explanation). Examples include engaging in street crime or directing one’s anger at more vulnerable members of society (Chasin, 1997). Some argue that areas exhibiting low levels of labor force activity are likely to be poor areas, where people are likely to engage in violent crime. However, it is usually acknowledged that poor rural areas usually have less crime than do urban areas. Again, this difference has been explained by differences in urbanization rates (Chasin, 1997). In addition, low labor force participation levels are associated with higher levels of psychiatric symptoms including depression and anxiety. Studies have shown suicide rates are directly related to unemployment and unhealthy behaviors such as smoking and drinking. The implication is that when people are unemployed, they are put under stress and are at a higher risk than the employed population for committing crime or engaging in deviant behavior (Chasin, 1997).

### Social Disorganization and Social Distance

Social disorganization theory purports that poor communities exhibit social disorganization because they do not have resources to manage problems. It is speculated that high mobility in an area causes anonymity, producing a lack of community unity. This is especially the case in Brazilian cities, in which there exists a great deal of heterogeneity. Social disorganization theory suggests that the absence of social control through the absence of common social values allows for delinquent behavior to develop, which can be transmitted to subsequent generations (Jones, 1998; Shaw and McKay, 1972). Nonconformity, i.e. crime, can be expected when social controls are less than effective. Related to this is the study of the community, especially as it applies to “social distance.” The segmentation of people in com-
munities, especially those that refused to get close to one another, suggests the disintegration of society at the family and individual level (Hinkle and Hinkle, 1954). This theme emphasizes the anonymity of urban life, where people may not know or care about one another. Where these conditions are met in urban environments, the argument goes, crime is likely to occur. Rape, for example, may be more likely to occur in these circumstances—in rural environments, which are less populous and where people may know each other more intimately, the “risk” of rape is decreased, since the “cost” of raping someone is increased. Homicide may also be more likely under urban conditions where impunity prevails.

Teresa Caldeira has researched the growing social distance between the rich and poor in Brazil. One of the more ominous traces of social distance is the prevalence of “fortified enclaves,” or guarded residences where wealthy Brazilians detach themselves from the immediate environment. Caldeira describes the closed condominiums and elite private institutions of the rich as a way of life, where walls separate social classes and, incidentally, racial groups (Caldeira, 2000). Furthermore, security industries, including those in car armory and video surveillance, have boomed because of the public interest in safety (Caldeira 2000; Romero, 1999). The kind of separation between people in Brazil creates highly segregated and unequal spaces within cities, where social control may be exercised in certain, small communities, and less so in surrounding communities.

**Data and Methods**

Data on rape and crime were taken from the Secretarias Estaduais de Segurança Pública. Social indicator data on percent urban, economic activity, GDP production by state, percent population nonwhite and literacy were taken from the Instituto Brasileiro de Geografia e Estatística. One of the drawbacks to these data is that detailed statistics are not available for urban areas, which would tell us more about crime occurring in unequal urban spaces. The data also does not discriminate between victims and aggressors. However, the prospect of this analysis is not to analyze inequality at the city or city block level, but rather at the federative unit level. Related to the nature of aggregate level analysis is the ecological fallacy. Since I use state level aggregate data, I do not distinguish between criminals and noncriminals, nor do I identify a cause of crime. However, the macrosocial level of explanation allows us to observe what kinds of community characteristics co-vary with differential rates of crime. The object of this approach is not to explain individual level involvement in crime, but to identify qualities of states that co-vary with high rates of violent crime. In doing so, the ecological fallacy is avoided since the unit of analysis is the state.

Another problem with the data, especially rape data, may be that of underreporting: women, or men, may never report rape to authorities. We might expect reported rape rates to more accurately represent actual rape rates in urbanized states if it is true reporting mechanisms are more efficient/reliable in cities. Although rape may be prone to subjectivity, homicide is relatively free of this constraint. Nevertheless, both measures ought not to be regarded as totally accurate—reporting bias and subjectivity plague the validity of these data.

Departing from the notion attributing the occurrence of crime solely to economic factors, I have included data on urbanization into my analysis. Because research in the U.S. suggests urbanization correlates positively with crime, and because Brazil’s urban populations vary drastically from state to state, this variable was included as an important social indicator.

Using the STATA 7 program, five social indicator and two violent crime variables were correlated with each other; then, the crime variables were regressed against the social indicator variables. In both analyses, the variables were weighted with a sixth social indicator variable, population distribution by state. The distribution variable allows us to account for the rather unequal distribution of persons throughout the country. The distribution variable is also useful because it adds importance to the percent urban variable. Keeping in mind how populations are distributed geographically gives the crime-inequality analysis greater depth.

When analyzing the results, the objects of concern were primarily the relative magnitude of coefficients, the positive or negative sign of said coefficients and

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the relative size of the p-values. Since no specific hypothesis was tested, and since there were so few observations, I am concerned only with describing the relationship between variables.16

Results and Discussion

Correlations

Homicide is more strongly correlated with percent population urban (.544) than it is to other social indicators, with state GDP production being the second strongest correlation (.476). That homicide is strongly correlated with percent population urban supports the trend in the literature suggesting that higher homicide rates occur in more urbanized areas. Nevertheless, Brazilian states may be too large to properly assess the relationship between urbanization and homicide; more detailed information (possibly at the district level) is needed. The state GDP production-homicide relationship is not usually discussed in research and the relationship here is not straightforward. When a Brazilian state produces a large portion of the national GDP, such as the states of Sao Paulo (35%) and Rio de Janeiro (11%), it is clear industry and commerce are very well developed in those states.17 In contrast, Piaui in the northeast produces less than one half of one percent of Brazil’s GDP. Intuitively, we might expect states with well-developed industry and commerce to have lower homicide rates than states contributing little to the national GDP.18 This is the case because states contributing little to the national GDP are expected to be (and are) negatively correlated with economic inactivity (-.48). Following the argument that populations residing in economically distressed states resort to crime more readily than populations in economically prosperous states may not be the best approach in this instance. That relationship, if it exists elsewhere, may be overshadowed by the strong correlation between percent population urban and state GDP production (.72). It is probably not the case that states with high GDP production are more likely to have higher homicide rates, but that because states with high GDP production are also heavily urban, they are strongly correlated with homicide.19 In countries with lower levels of inequality with respect to the geographic distribution of industry and commerce, we might not see such a strong relationship between homicide and GDP production. Urbanization, or rather, the unequal distribution of industry may inflate the GDP value.

As for the social indicator variables and rape, economic inactivity and literacy are the most strongly correlated, with values of -.56 and .56 respectively. According to the data, rape rates are low when levels of economic inactivity are high. Conversely, rape rates are high when literacy is high. Economic inactivity itself correlates strongly with urbanization (.70), while literacy correlates strongly with economic inactivity (.80), and urbanization (.84). At first look, the data suggest counterintuitive relationships between rape and two social indicator variables mentioned, economic inactivity and literacy. Higher levels of reporting in urbanized spaces where reporting mechanisms, awareness and law enforcement are more readily accessible and reliable may explain the relationship of rape with literacy. It is not usually expected that in highly literate spaces there will be more rape than in less literate spaces. Since highly urbanized states have higher literacy levels than their rural counterparts, we might conjecture that they report the incidence of rape more than rural folk do. Since economic inactivity and literacy are strongly linked with urbanization, it may be the case that these two variables are suggestive of the influence urbanization. In other words, urbanization appears to be the more influential variable, with economic inactivity and literacy being variables reflecting urbanization’s influence. If this is the case, according to this model, where urbanization is high we may expect high literacy, low economic inactivity and high rape rates. Where urbanization is low, high economic inactivity, low literacy and low rape rates may be expected. However, the urbanization-rape relationship is not as strong as the economic inactivity-rape or literacy-rape relationships. It appears economic inactivity and literacy are intimately related to urbanization, though urbanization’s influence is not fully brought to light in the correlation. It is possible urbanization’s influence is obscured somehow by the distribution of literacy and economic inactivity, or that urbanization’s influence is accounted for in literacy and economic inactivity.
Regressions

Urbanization stands out as the most influential predictor of homicide in the regression. The importance of state GDP production decreases in the regression, though the influence of literacy on predicting homicide becomes the second most important variable. In the correlations, the relationship between homicide and literacy was positive; holding other variables constant, literacy, relative to other indicators, stands as the second most influential indicator in the regression. The regression relationship now “makes sense,” as the overwhelming effect of urbanization is lessened and the “rural effect” is allowed to come through. Nevertheless, GDP retains its unintuitive relationship with homicide—the urbanization effect may have been lessened, though the fact remains that industry (GDP) is highly unequally distributed notwithstanding urbanization; therefore, it should come as no surprise that a relatively weaker relationship persists.

In the case of rape, the economic inactivity and literacy coefficients are the most prominent, thus the variables maintain their relative importance in this model. It may be the case that economic inactivity and literacy retain their importance for two reasons: 1) higher reporting in urban areas and 2) highly unequal distributions of industry and educated persons in Brazil. The p-values for the mentioned variables are .172 and .084 respectively; the lowest p-value belonging to percent nonwhite (.082). Although economic inactivity and literacy retain their relative importance in the model, the relationship between urbanization and rape and percent nonwhite and rape changes—the coefficients’ sign, or direction, switches. One way to interpret the urbanization-rape regression relationship is that when the importance of urbanization is lessened in the regression model, it allows for some of the “rural effect” to come through. That is, the urbanization effect is, in a sense, neutralized, and allows for some of the rural crime, which is apparently less prevalent than urban crime, to be represented in the model. This interpretation is consistent with the sign change on the nonwhite variable, since nonwhite populations tend to inhabit less urbanized states (correlation value = -.67 for urbanization); the “rural effect” may be more prominent once relationships are held independent of one another. On a final note, it appears, however, that the urbanization effect is not “obscured” as stated earlier, and that economic inactivity and literacy are relevant independent of urbanization. Still, there is room to conjecture that urbanization’s influence is somehow accounted for through the variables of economic inactivity and literacy, or that the nature of the unequal distribution of said variables is enough to inflate their relative influence.

Conclusion

The data are telling of the inequality existing in Brazil. Distributions of people, resources and industry have a significant effect on how variables will relate. Variation in the social indicators allows us to evaluate their association with homicide and rape. In economically depressed states and those with high illiteracy and economic inactivity, higher homicide and rape rates were not found conclusively to follow. When rape was regressed and other variables held constant it appears urban-state crime became less prominent, allowing for the influence of rural crime to become manifest. Nevertheless, this interpretation is tentative; a more accurate analysis must include disaggregated data.

Since homicide and rape are very different kinds of crime, future studies ought to include variables in the model that capture family structure aspects of Brazilian society. Especially in the case of rape, where three causal theories of rape dominate, it might be useful to include a “single parent family” or “single mother family” indicator. A model studying homicide specifically may to consider including a variable distinguishing whether or not households have access to goods such as refrigerators, televisions, etc., or may utilize the aforementioned “single parent family” indicator. Another factor worth considering in future models is that of an inequality index, such as the Gini or the Theil index. More importantly, the need for accurate and complete data at the county, census tract, or city block level for Brazil is necessary if solid conclusions are to be
reached. Crime data must also be collected consistently by government agencies over time and must use the same criteria for identifying crime.

The notion of social disorganization in Brazil\textsuperscript{25} is an important consideration when evaluating high crime rates in urban spaces. As Brazil manages cities and regions where industrialization is concentrated, society is being changed by population and market fluctuations. Social disorganization, extreme inequality and underreporting may explain why crime apparently occurs more often in urbanized, highly literate, and economically active spaces. Taken together, the variables suggest counterintuitive results requiring careful interpretation in order to be reconciled with classical notions of the origins of crime. Taking the results at face value produces results that do not fit neatly into categories some research suggests. For example, from this analysis we cannot conclude that poor states produce higher rates of crime, or that nonwhite persons\textsuperscript{26} resort to crime more often than the white persons. For those types of conclusions, we would need more specific crime data on offenders, victims and location of crime. It is possible that “intuitive” results were not yielded because of the nature of the aggregate level analysis.\textsuperscript{27} Had more specific, disaggregated data been available for analysis here, we may indeed have found that poor urban spaces within cities exhibit higher rates of crime than non-poor urban spaces. We may also have found that nonwhite city quarters, because they are poor, produce higher rates of crime than white quarters.\textsuperscript{28} What we can conclude from this analysis is that urbanization appears to have a very considerable impact on homicide, though the urbanization-rape relationship is ultimately not straightforward. While other variables appear to be overshadowed by the influence of urbanization, especially since many variables “go together” with urbanization, the result of the rape analysis is inconclusive pending further investigation.

**Appendix A**

*Description of the Variables:*

- **Population urban:** This is the measure of urbanization and was acquired by dividing the number of persons in a state living in urban spaces by the total state population (rural and urban folk) and multiplying by 100. It is a notable indicator, since it illustrates which states are populous and industrialized.
- **Four Year Average GDP Participation (1996-1999):** This measure indicates the participation of major regions and states in the gross domestic product of Brazil at current market price. Each measure was acquired by adding the GDP contribution values of each state for the four years indicated and dividing by four, yielding an index of GDP participation. This measure is of particular interest because it shows which states are more economically developed.
- **Economic inactivity:** This measure indicates the percentage of persons (men and women) 10 years or older not economically active in the week of reference in the year 2000. The measure was acquired by dividing the number of persons not economically active by the total population and multiplying by 100; in both instances, persons were age 10 years or older.
- **Nonwhite Population:** This measure indicates the percentage of the population that is nonwhite (or which is black, brown, “yellow,” and indigenous) in any one state. It is an important measure because it gives us an idea of how extreme regional racial distribution is in Brazil. This measure was acquired by dividing the nonwhite population in each state by the total population of each state and multiplying by 100.
- **Population Distribution:** This is a measure of what percentage of the population lives in any one state and is important because it is used as a weight in the correlation and regressions. Not using population distribution as a weight gives bias to small states.
- **Literacy Rate:** This is a measure of the literate population in any one state and was acquired by dividing the number of literate persons 10 years and older by the state’s total population 10 years and older and multiplying by 100. This is used as a
proxy for education and is a valid measure in Brazil, given that there are large portions of the population that are illiterate and that illiteracy varies considerably from one state to another.

End Notes
1. The author is indebted to the guidance, mentorship, and support of Dr. Omer Galle, Dr. Bryan Roberts, Mr. George Lara, Dr. Andres Villareal, Dr. Thomas Pullum, the Population Research Center at the University of Texas at Austin, and the Mellon Foundation.

2. However, it may be that single parent households are positively correlated with crime because they are more vulnerable to crime (if, for example, men have anything to do with preventing crime occurring near or inside their homes). Nevertheless, in the argument proposed in the text, the emphasis is on crime as a consequence of inherent features of certain types of families, and not on outside forces. Under any circumstance, these proposals and arguments ought to be considered.

3. As quantified by Theil index.

4. Dr. Claudio Beato of the Universidade Federal de Minas Gerais.

5. Interestingly, dissimilar results have been found for Mexico, where “contrary to the assumptions of social disorganization theorists, who argue that urbanization and high population density lead to greater anonymity and a loss of social control, a larger number of residents per square kilometer is consistently found to be associated with lower rates of homicidal violence.” (Villareal, 2002).

6. Crime theory buttresses these ideas in developing countries. Rising crime rates in developing states are commonly thought of as products of rapid social change linked with globalization, industrialization, and urbanization. In developing nations, urbanization has occurred at a faster pace than it did in developed nations. Economic development has failed to keep up with urbanization and population growth, resulting in urban unemployment, poor housing, and inadequate social services (Clinard and Abbott, 1973). These factors have significantly affected the growth of crime in urban areas (United Nations, 1971).

7. See Graph.

8. See Table One.


10. Homicide and rape data were difficult to gather, since Brazilian statistics of this nature are not widely published nor are they easily available for the same level of analysis over time. For some years, only regional statistics are available, while for other years state level data are abundant. Further, rates of crime may be released by one agency for each state, while another agency does the same, yielding different rates. Agency reporting, standardization, and lack of communication between federal entities hamper stable and reliable reporting of crime rates.

11. For example, crime occurring in areas with high levels of inequality or in very poor areas.

12. For example, a wife may not acknowledge her husband has raped her.

13. Though a recent study found that northeastern Brazilian states do, in fact, underreport deaths (Cano, 2001), this is not to say the data are useless; analysis must recognize data deficiencies while acknowledging that those measures represent some approximation of the actual rape and homicide rates.

14. Population distribution by state is termed “variable” but the term is not used in the same way as it is applied to other social indicators. Population distribution by state is employed as a weight in the regressions and correlations, but was not included as a variable in the regressions or correlations.

15. For example, while two states might have similar percent urban values, one state may have many more millions of people than another.

16. Please refer to Table Two, Table Three and Table Four.

17. In other words, the total economic output may be considered a proxy for the degree of industrialization.

18. Please refer to the “Regional Inequality” section.
19. A similar argument may be made explaining the Literate Population/Homicide relationship. That is, homicide and percent population literate are positively correlated because of the unequal distribution of literate persons in cities. If these arguments are correct, it follows that literacy is more equally distributed than industry.

20. Economic inactivity is low when urbanization is high.

21. Literacy is high when economic inactivity is low.

22. Literacy is high when urbanization is high.

23. One would expect a 1.12 percent increase in the homicide rate for every one percent increase in urbanization.

24. Theories explaining the origin of rape include the 1) feminist theory which holds that rape is “the result of long and deep-rooted social traditions in which males have dominated nearly all important political and economic activities;” 2) Social learning theory, which sees rape as aggressive behavior toward women which is shaped by life experience and is learned; 3) Evolutionary theory: “theorists consider aggressive copulatory tactics as an extreme response to natural selection pressure for males generally to be more assertive than females in their attempts to copulate.” (Ellis, 1989).

25. Social disorganization in this context refers to disruption caused by impunity, corruption and drug wars.

26. Who happen to be poorer and are highly correlated with economic inactivity, .83.

27. This phenomenon is discussed in Cano, 2001. Apparently, the level of analysis (international, federative or micro-community) heavily influences the types of results that will be yielded.

28. Had this been the case, we could not assume that criminals commit crime only in their own neighborhoods.

References


In Search of an Accident of Hope—The Live or Die Life of Anne Sexton

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Abstract

This article presents my independent research on the poet Anne Sexton. This research was made possible by access to the Humanities Research Center’s excellent Sexton archive. As a piece of literary biography, the essay provides a balanced introduction to Sexton as a poet and a person, an introduction I hope will prove of interest to readers in diverse fields. I address Sexton’s unusual development as a poet, her mental illness, her ambitions and the strategies she employed to further her career, her correspondence with students and admirers, and her teaching efforts at a number of schools and universities. I incorporate analyses of several of Sexton’s poems at key junctures in the discussion of her life, all the while working to maintain the separation between Sexton herself...
and the persona of the poems, a distinction that was frequently blurred by the classification (which she loathed) of her work as “confessional poetry.”

The writing in Sexton’s few journals reveals the eternal nay-saying of the internal critic. “I am too dramatic,” Sexton lamented, wishing instead to take “words in hand and speak out in unprecedented honesty.” If Sexton was going to venture into contemplative journal writing, she wanted to strike deep and draw blood. No messing around, she insisted. In the first entry in her notebooks (May 25, 1960), Sexton stated “Rule one” for writing in the journal: “I must not imitate.” And: “For once, Anne, do not lie. Dare to be yourself.” A year later, in her next entry, Sexton laid down the same kind of law again, “That must be my first rule, to dare to be trite with myself.” Sexton saw herself as always trying too hard to be profound in these notebooks, to be like Stendhal, Rilke, and other writers and thinkers whom she respected. She wanted to be Anne the poet, but she found it difficult to tolerate the floundering and weakness that were part of the process of becoming that Anne.

That Sexton suffered from insecurity and doubt is no wonder: she was twenty-seven and recovering from a mental breakdown when she began to write poetry. She had no education beyond finishing school and, aside from a short modeling stint, had never worked. Even as she progressed in her literary career, Sexton continued to rely heavily on tranquilizers, alcohol, and frequent love affairs to temper the pain of life as she experienced it. Sexton desperately wanted to be loved by the people in her life. She was in constant search of closeness and security in her relationships, yet she harbored terrible fears of public interactions: “Somebody sees me, and I see myself through them. Then it’s all gone, the whole world falls apart.”

Still, the powerful voice of her poems led many readers to envision a flamboyant, self-possessed (if suffering) woman. In some situations—readings, parties, and writing workshops, for example—Sexton played this role beautifully. Peter Davison, an editor at the Atlantic Monthly and a poet himself, described Sexton as he saw her at a party. She had “a combination of awkwardness and grace, long legs and long arms, and smoke, smoke, smoke, smoke, smoke, smoke—always smoking. Intense blue eyes with big pupils; blue-black hair; slightly crooked nose.” Like many others meeting Sexton for the first time, he also noted that she carried herself like a model. Throughout her life, articles and interviews described Sexton as a slender beauty, but by 1967 Sexton was carrying an extra thirty pounds on her once lean frame. Although she laughingly claimed, “I have just plain grown,” the weight gain was the vexing consequence of a serious hip injury, Sexton’s lifelong aversion to exercise, and the side-effects of the tranquilizer Thorazine which she took for many years.

Many of Sexton’s students were shocked when they first met the Pulitzer Prize winner. To them, she seemed more like a fragile and overmedicated creature than the powerful poet they had expected. At Wayland High School, Massachusetts, where Sexton co-taught her first formal class in 1967, several students writing about their impressions of the class described Sexton as “the little lady that writes poems,” and a student at Colgate College wrote of Sexton in 1972: “I thought MY GOD! this person, this poor girl, she’s as scared as I would be.” The descriptions of Sexton as that “little lady” and “poor girl” had nothing to do with her height; after all, Sexton was 5’8”. Her fear of interacting with her students showed, but she persevered and in time found ways to manage this anxiety. Once she did, she became an excellent, if unconventional, teacher. Teaching, like writing, was a kind of magic to Sexton, and she believed that there was no magic without courage.

Sexton often cited her alignment with Franz Kafka’s description of literature as “the axe for the frozen sea within us.” Poetry had certainly shattered the ice in Sexton. She began her adult life as a suicidal mother who believed that her only abilities were sexual and insisted to her psychiatrist that prostitution was the only career in which she might excel. When she discovered poetry and the power of unexpected images and metaphors, Sexton also discovered her own worth as an artist. The persona of these poems is not “Mrs. Sexton,” housewife and mother, but rather the painfully perceptive Anne, the Anne who stirred the pot of remembered hurts and
guilt along with the occasional dazzling joy. The voice of these poems belongs to the woman who, after much pain, had given herself the license to question the most personal conditions of her own life: madness, family, the female body, spiritual hunger, and attraction to death.

Throughout her entire poetic career Sexton struggled with a mental illness that defied exact diagnosis. Martin Orne, her first psychiatrist, noted that Sexton “didn’t fit textbook criteria” and was “hysteric in the classic sense: like a chameleon, she could adopt any symptom.” Sexton suffered from chronic anxiety, “lesions of memory,” and “profound dissociation.”11 Some of Sexton’s readers were convinced that she was schizophrenic; Sexton even received one letter from a doctoral student wanting her response to a dissertation on the relationship between schizophrenia and self-expression.12 Sexton replied that she could be of little help: “I have never been diagnosed as schizophrenic, although I may write like one.”13 Dr. Orne confirmed Sexton’s ironic refutation of this diagnosis: “I never saw evidence in her of loose associations of formal thought disorders, or other major symptoms of schizophrenia.”14

While her writing may not have been evidence of schizophrenia, it often did hinge on farming her unconscious for associations, images, and metaphors. She believed that poetry “milks the unconscious. The unconscious is there to feed it little images, little symbols, the answers, the insights I know not of.”15 Expressed this way, the theory sounds mysterious, but Sexton’s imagistic expression of life experienced vividly, painfully, and personally is often what makes her work terrifying and enduring. In a description of The Death Notebooks, the last collection published before her suicide, Sexton defines several of the key features of her own poetry: “the poems will be very Sexton . . . intense, personal, perhaps religious in places.”16

Indeed, some of Sexton’s poems were full of religious themes and imagery. Among these were “In the Deep Museum,” “Jesus Suckles,” and “The Rowing Endeth.” Some readers and critics found Sexton’s use of religious imagery almost blasphemous, while others saw it as a unique form of devotion. According to Sexton, one Catholic priest told her, “Your typewriter is your altar,” and, “your poems are your prayers.”17 At any rate, Sexton was not concerned with blasphemy. She liked imagining how her “funny God” might be—if she/he/it even existed.18 Reared as a Protestant, she insisted on her lack of interest in joining any organized religion, although she corresponded with a Catholic priest and received religious instruction from an Episcopal seminarian.19 Religion—Christianity in particular—was useful because it provided metaphors for guilt and suffering. In one lecture Sexton remarked, “I am told that my poetry is the work of a victim, of the passive sufferer, of the crucified man. And I put that thought in my mouth and taste it and find it surprising but true.”20

Yet Sexton was careful to make a distinction between personal and autobiographical writing: “I can be deeply personal, but often I’m not being personal about myself.”21 Still, this personal poet was the poet Sexton could be and, her fans would argue, the poet she should be. Her poetry was almost never academic, and Sexton appealed to an audience that included not only the usual intellectuals and aspiring poets but also working people, housewives, and those seeking attention for mental illnesses. As one student wrote of Sexton’s writing, “she knitted together the stuff of our lives. Pictures at the bottom of drawers. Toys from childhood. The broken ends of things.”22

The impetus for Sexton’s early poetic work and many of her later poems came from the private sanctuary of the analyst’s office. Only a month after her first suicide attempt in November of 1956, Sexton began writing poems at the urging of Dr. Orne, her psychiatrist. She had experimented with poetry in high school but had ceased abruptly when her mother accused her of plagiarizing poems by Sara Teasdale. Dr. Orne encouraged Sexton to write because he believed that crafting language might tap into her creative potential and give her a sense of purpose.23 According to Sexton, Dr. Orne had told her, “You can’t kill yourself, you have something to give. Why, if people read your poems . . . they would think, ‘There’s somebody else like me!’ They wouldn’t feel alone.”24 In later interviews Sexton minimized the value of her early efforts, which she had always shown to Dr. Orne: “I kept writing and writing
and giving them all to him” simply “because he was approving.” Sexton categorized this early work as being “just from transference;” however, early efforts as part of therapy rapidly grew into literary creations in their own right. In fact, Sexton was bent on making this jump. When her closest friend and fellow poet Maxine Kumin described a poem as “therapeutic,” Sexton exclaimed, “for god’s sake, forget that. I want to make it a real poem.” Such a piece would be stripped down and reworked until Sexton did make it into a “real poem,” or, if the transformation wasn’t happening for her, it might quickly find its way into the wastebasket.

As a new poet, Sexton had almost no exposure to the great works of modern American poetry that yielded such an influence on the work of her contemporaries. The poetic voices of William Carlos Williams, T.S. Eliot, Edgar Lee Masters, H.D., and many others were entirely absent from Sexton’s writing world. “I’m not an intellectual of any sort that I know of,” she commented in one interview. “I don’t know the multiplication table, can’t spell, can’t punctuate. And until I started at twenty-seven, hadn’t done much reading.” Described by some as a “primitive,” Sexton wrote instinctively, letting associations flow and thumping the typewriter keys to push the words out onto paper. She had remarkable discipline when it came to rewriting; she revised incessantly and sometimes went through hundreds of drafts to make the poem emerge from the sea of images in which it began.

Sexton’s attempts to break into the literary world were met with repeated discouragement from those who mattered most to her, the “real,” established poets and editors to whom she showed her poetry. Despite Sexton’s obvious talent, her gravitation toward unusually personal subjects—her own relationships and experiences with mental illness, for example—provoked discomfort and quite a few negative responses from these early readers. Objections to Sexton’s style and choice of subject were felt especially keenly by John Holmes, her poetry teacher first at the Boston Center for Adult Education in 1957 and later in other workshops. After several years of working together, it became evident that Holmes and Sexton disagreed not only on matters of style but also on matters of behavior. Where Holmes was the reserved gentleman interested in preserving order and propriety, Sexton always wanted to stir things up in the workshop. In a letter to another member of the writing group, Holmes vented his frustrations with what he perceived as a conflation of personal extravagance and artistic irresponsibility. “Not that she has two subjects, mental illness and sex, but that she writes so absolutely selfishly, of herself, to bare and shock and confess. Her motives are wrong, artistically.”

In 1959, after completing her manuscript for To Bedlam and Part Way Back, Sexton encouraged the other workshop members to give her feedback. Holmes responded to the manuscript in a careful, sensitive letter articulating an opinion that Sexton would have difficulty accepting. “Don’t publish it” was his basic counsel. “You’ll certainly outgrow it and become another person, then this record will haunt and hurt you.” This advice was partly rooted in the darker chapters of Holmes’ own life. Holmes’ early adulthood was marred by his struggle with alcoholism and the nightmarish end to his first marriage when his wife slit her wrists and bled to death over his papers. As he strived to escape the shadow of these terrible events, it troubled Holmes that the traumas in Sexton’s life seemed to function so frequently as the inspiration for her work. In “For John, Who Begs Me Not to Enquire Further” (see Appendix), a poem Sexton sent privately to Holmes, she responded to his objections to her style and choice of subject. “For John” is conciliatory in tone rather than confrontational, and it demonstrates a maturity that likely took Holmes by surprise. It also reveals a great deal about Sexton’s own understanding of her work as a poet. Holmes had written to Sexton: “It’s all a release for you, but what is it for anyone else except a spectacle of someone experiencing release?” Sexton answered, saying “not that it was beautiful,” but that there was “something worth learning / in that narrow diary of my mind, / in the commonplace of the asylum.” Indeed, Sexton believed that her personal and emotional experience of the world offered something that might be valuable, not only to her, but also to others. In fact, “tapping” her “own head” was necessary to Sexton’s work given her conviction that “some
thing outside of [her]self” could not speak the truths she valued most. For without the inclusion of the self, unbeautiful as it might be, “you would not know / that the worst of anyone / can be, finally, / an accident of hope.”

The idea that even “the worst of anyone”—even what was revealed in “the common places of the asylum”—could become “an accident of hope” through poetry was a miracle that Sexton did not take lightly. Poetry had the power to transform, and Sexton spoke of her conversion to the work of poetry as though it were a religious experience: it was a “rebirth,” and the process of writing a poem was a daily “miracle.” “If I can write a poem,” Sexton explained in one interview, “I come into order again, and the world is again a little more sensible, and real.”

Still, Sexton understood Holmes’ fear of the exposure of private demons, a fear she described in the poem as “an invisible veil between us all.” As real as this veil might be, in the final lines of “For John” Sexton captured the incredible intimacy that might be possible if the veil could drop:

And sometimes in private,  
my kitchen, your kitchen,  
my face, your face.

Between “my kitchen” and “your kitchen,” “my face” and “your face,” there was only a single breath, the hair’s width of a comma. In other words, Sexton saw her poetry not as mere release, but as efforts towards connection. The eloquence and earnestness of her defense demonstrated to Holmes that she had a mission for her poetry; she was after much more than a messy and imagistic purge of emotion.

The writing of “For John, Who Begs Me Not to Enquire Further” was a kind of assertion of independence, but Sexton was not turning her back on the growth she had experienced in Holmes’ workshop. Her interactions with other poets had helped her to develop her talent and make up for her late start as a writer. She had also established herself in a network of mentors and other writers that included Maxine Kumin, W.D. Snodgrass, Robert Lowell, and Sylvia Plath. And to top it all off, she had discovered and maintained her own voice and approach to poetry in the process. In later interviews she often described how, despite her early attempts to write more conventional verse in the style of other workshop members, “I always ended up sounding like myself.”

Sexton’s commentaries on her development, delivered with pride, underline the importance she placed on establishing her own unique identity as a poet.

But Sexton’s feelings about how critics characterized her writing were another matter altogether. Her place among emerging confessional poets like W.D. Snodgrass, Robert Lowell, and Sylvia Plath resulted in both praise and biting criticism. At best, her critics described her poems as “transformations of experience” and “edifying, heroic acts.” At worst, as one reviewer of Sexton’s work wrote, they entailed “sentimentality, self-dramatization, and the assumption that universal feelings are the private property of the poet.” James Dickey, ever unhappy with the tedious “orthodoxy” of the poetry he lumped into the confessional heap, insisted in his review of All My Pretty Ones that “it would be hard to find a writer who dwells more insistently on the pathetic and disgusting aspects of bodily experience.”

The negative shadings that some critics brought to the label “confessional” contributed to Sexton’s keen dislike for it, but she continued to affirm her vision of poetry. She encouraged students and other aspiring poets to make use of the vast poetic material available to them: their own experiences. “I say a poem should be personal—in the sense of someone having really lived something they are writing about.” Sexton ruefully added, “I’m afraid you may think I’m hawking my own brand of poetry but I’m not. Elizabeth Bishop, May Swenson, sometimes Adreine [sic] Rich have this quality and they are not ‘confessional’ (how I hate the term).”

The nature of the poetry Sexton wrote, especially the first book, To Bedlam and Back, which explored Sexton’s experiences in a psychiatric ward, had a real impact on the way in which fans, would-be poets, and students wrote to her throughout her career. Many, even those who had never actually met Sexton, addressed her simply as “Anne” and wrote long, confiding letters about...
death, mental illness, the heartbreak moments of parenting, the agony of trying to write, and other personal fears and traumas. Sexton almost always responded to these letters. To amateur writers she gave diplomatic responses with kind but generic advice, often directing them to Rilke’s Letters to a Young Poet, which she held in high regard. She responded gently to her supporters among the mentally ill, quietly affirming their experience and encouraging them to hold on to anything that would help them stay afloat in life. To one woman at McLean Hospital, Sexton wrote, “Poetry led me by the hand out of madness. I am hoping I can show others that route.”

However, any letter she received that seemed colored by pride disproportionate to the talent of the writer would be sure to receive a curt, or incisive, reply. “Stop writing letters to the top poets in America. It is a terrible presumption on your part,” she wrote to one undisciplined poet, then added, “Rework or forget the whole thing. Spots of brilliance, associative imagery (sp?) is not enough [sic].” But to writers in whom she discerned real talent, Sexton wrote with the insight and optimism that had so encouraged her when she was a young poet in search of critical responses from established poets. “You have force, you have imagery, you know what to do with words and what they’ll do for you. Nothing will stop you. You are a poet. Don’t stop. What I am trying to tell you is this can be your life. I hope you will choose it.”

Sexton recognized herself and her own needs in these correspondents. She understood their hunger for approval, for contact. The words of one grateful graduate student—“Yours was the first REAL VOICE I have heard back” from the poetry world—could have been Sexton’s own when she began to write in the late 1950s. Sexton often mentioned that letters of encouragement from an early mentor, W.D. Snodgrass, had helped to give her the “strength to be myself and to hell with the rest of them.” Even Sexton’s rare, harsh replies to the more presumptuous letters read like the reprimands that she issued against herself in her journal entries.

Indeed, Sexton was extremely ambitious, and she envisioned herself in the company of writers like Kafka and Dostoevsky. “I have to be great,” she exclaimed to her therapist. “I want to leave the impact of my personality carved in marble.” The prospect of fame seemed to appeal to Sexton in the same way that being liked by those around her did. In this sense, her ambition was another manifestation of her desperate desire to be loved. As for literary significance, Sexton was convinced that the gift of going “down deep” into the unconscious was what set great writers apart from the rest. Singling out this characteristic was Sexton’s way of establishing her own terms for success, terms she knew she could take on.

One could hardly plumb the depths of the unconscious more faithfully than Sexton, who spent several evenings a week in therapy and took copious notes on tapes of her sessions with Dr. Orne. She was constantly exploring her associations and trying to lay claim to the syntax of the mind. Sexton’s conception of what makes a writer great did not equate creativity with madness; however, it did render the “heightened awareness”47 engendered by frequent psychoanalysis almost a creative necessity. Sexton’s diligent efforts in psychotherapy attested to her real desire to gain mastery over the illness that limited the potential of so many of her days. Still, the illness became valorized in that it provided the main impetus for her explorations of her unconscious in therapy.

Sexton’s ambitions as a writer were complex and contradictory. On the one hand, she wanted to be a “great” in the historical sense, like Kafka and Dostoevsky. On the other, she was keenly interested in popular success. If garnering a large audience meant coming down to earth, Sexton was ready to take advantage of the traditional structure of her family, her home in the suburbs, and her relatively undistinguished New England lineage. “I have a best-seller mind, I’m really rather ordinary. I am popular with the masses: I have the common touch, I write about the middle class!” Sexton made sporadic efforts in fiction which were partly inspired by her interest in reaching the kind of audience J.D. Salinger’s work garnered. “You can move people more with a story than with poems. Catcher in the Rye speaks for its time, to many people,” Sexton noted. Sexton’s aspirations to popular success were not exactly harmonious with her hopes for long-term liter-
ary greatness, but both impulses reflected her desire to tap into an even deeper source of the approval and attention than that provided by her family and friends.

Sexton did not manage the move into fiction that she had hoped would put her work in the hands of middle-class Americans throughout the country. Her comic novel on sex life in the suburbs never reached completion, though the draft reflects her participation in a trend of the 1950s and 60s, a time when one of the only acceptable ways to criticize the institutions of home and family seemed to be through humor. However, Sexton did gain more widespread recognition as she began to give readings at a variety of venues in 1965, and she was increasingly acknowledged in poetry circles as a dramatic reader. From her earliest performances, “Her Kind” (see Appendix) was the poem with which Sexton began her readings to tell the audience “what kind of woman I am and to warn you of what kind of poet I am.” It was part warning and part promise that a reading from Sexton—the “middle-aged witch” as she called herself in the introductory poem of Transformations—would not be like any other. Then, in 1968, Sexton began to perform with Her Kind, a musical group that grew from a student’s project setting her poetry to music. The title of the group was apt; the jazzy accompaniments of Her Kind would bring not only a new dimension to Sexton’s work but also a wider audience, some of whom might be “her kind.”

Sexton went to incredible lengths to bolster the courage and charisma she felt she needed to make it through her readings, which she described as “freak shows” that sold Anne the poet as “the actor, the clown, the oddball.” Because she suffered from terrible stage fright, Sexton scripted and carefully rehearsed both her readings and any comments she would make. She confessed to one admirer writing for a literary journal, “All the things you quote from the reading, my little introductory notes, are, I hate to tell you, not in the least spontaneous with the exception of one or two sentences.” Despite her laborious preparation, the hours before a performance usually found Sexton in a bar or hotel room downing staggering amounts of liquor just to stay calm. The travel necessary for many of her readings was also a source of trauma; Sexton hated flying in airplanes. In one essay, Sexton claimed that a single poetry reading usually stole a month from her writing and life since she needed two weeks before the reading to overcome her stage fright and two weeks after it to recover from the emotional drain of the performance.

Working the poetry circuit became a way of maintaining the high standard of living to which her family had grown accustomed even as Kayo’s success in business affairs fluctuated. Sexton proved an effective self-promoter, and she managed to negotiate ever higher fees for her readings. After winning the Pulitzer Prize in 1967, she began to set her performance fees by monitoring the offers made to James Dickey, the poet whose reviews of her early work had been among the most scathing. By 1974, the year of her death, Sexton was routinely requesting $2,000 dollars for out of town poetry readings, although she was usually willing to settle for $1,500. Sexton had become one of the best paid poets of her generation, and there was no trace of the cowed “little lady” in the shrewd businesswoman negotiating these deals.

While public readings earned her the “real money,” Sexton’s work as a teacher brought together several of the passions and needs of her life. Her teaching credentials boiled down to her talent as a writer, and while this qualification was affirmed by a substantial number of literary prizes and honorary degrees, it was still questioned by some of Sexton’s fellow teachers. Sexton viewed teaching, with the many kinds of interactions it necessitated, as a serious matter. “The class, the life of it, will teach me or destroy me,” she wrote in one of the early entries of her teaching journal. Sexton believed that teaching in spite of her anxieties was necessary if she was to become, as she hoped, “more a saint and less an egocentric writer.”

Sexton’s first major teaching position at Wayland High School in 1967 was part of an experimental English class she had helped design. Sexton was to function as a “poet in residence”—classroom evidence of the inner-workings of literary creation—while Bob Clawson, a young high school teacher, would be responsible for running the class. The course would have neither grades
nor a set curriculum, and the students would play an integral role in directing the focus of the class. Sexton’s idealism was obvious in her description of the objectives of the course some months before her teaching position at Wayland High School, Massachusetts, began. She hoped that the students, once they discovered the potential of language, would themselves begin “to teach, to spread the word.”69 Sexton was later disappointed to discover that many of the students had less lofty interests; they were anxious to graduate and often more concerned about passing College Board exams than about unleashing the power of language.

Still, Sexton’s experiences in the classroom both terrified and amazed her. The idea of being alone with the class was enough to fill her with dread: “If I’m loved, why am I nervous? Because I’m afraid there’ll be nothing to say and there will be that dreadful silence.”60 On teaching her own poems, Sexton complained that “they keep turning to me for meanings that I refuse to give.”61 Sexton remained reluctant to explicate her own poems for the class, and instead she invested herself in original assignments that would hold silence at bay and help the students discover more of the tricks of language for themselves. After reading Sexton’s “In the Deep Museum” (see Appendix), a poem that imagines Christ waking, finding himself buried, not resurrected, and then letting rats devour his flesh to “keep the miracle,” she had the class write first person testimonies of the Crucifixion. Other assignments included graffiti-writing projects, prayers, and writing in the style of Sherwood Anderson’s “The Story of Win Bidlebaum is a Story of Hands.”

Some of the papers generated by the students possessed a startling originality, and Sexton basked in these flashes of young talent. “When they open, it’s better than when I open,” she wrote after describing some of the pieces she and Clawson had received from the students. Despite the uneasiness that remained with Sexton as she negotiated the difficult territory of teaching, the class was for her “a small miracle.” Sexton found the immediacy of the teaching experience refreshing: “I sometimes feel the class is far more important than my writing. They give a quicker response for one thing. When you write you wait three years and then they crucify you. When you teach you wait five days and they give it to you, give it to you, give it to you.”62

Sexton continued to experience the work of her students as the most valuable and personal kind of gift. In 1968 she taught a poetry class at McLean’s Hospital, a private mental institution, and offered a one month long private workshop for six Oberlin students home for the holidays. With the Oberlin students, Sexton was in charge of a small gathering of committed writers, not a crowd, as she had sometimes viewed the Wayland and McLean classes.63 Sexton began to find herself as a teacher and establish her methods for teaching the tricks of poetry to young writers, abilities she would strengthen when she began to teach a poetry course at Boston University in 1969. Although Sexton was uncomfortable with the talk of canonical literature that sometimes worked its way into university discussions, she more than made up for this gap in her knowledge by showing students how to fight for the being of the poem. In a review of one of her Boston University courses, a student named the questions constantly implied in Sexton’s workshop: “Does the poem have guts? Is imagery used as a vital way to intensify the poem, and not as mere decoration? Does the poem get to its content with heart and an acute eye? Does the poem work, in its breathing, its life-span? Does the poem get to life-experience, in all its ambiguity or lyricism or terror or love?64

Sexton viewed the relationship between poets and their poems as sacred, and she did not allow outsiders to visit her workshops. They were intense sessions similar to therapy in their intimacy, but there was room for comic asides as well. “We needed the laughter. It was a great shock absorber,” wrote one student who studied with Sexton in the final workshop of 1974.65 Sexton also made a regular practice of inviting students to her home for private conferences. Her students brought their own work for an individual critique, and after a discussion of the work, Sexton shared a piece of her own poetry and asked for suggestions. To many students, “this little peek” at Sexton’s work in progress was “a great, generous, equalizing gift.”66

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Friendships often evolved from these poolside chats. Sexton’s letters to former students were conspiratorial, peppered with reminders like, “Don’t let the bastards get you down,” and, “Don’t worry about your muse.” These outgoing letters also make it clear that her students were an important part of her life and support system. To one long-term student she wrote, “I miss you, I miss you, I miss you, as a poet as well as a friend.” To another, “you could think of [our workshop] as holding me together. Somehow what I try to give or bring forth helps me in a way that even my own writing cannot.”

In the same way that Sexton seemed to understand her students’ need for respect and generous personal attention, they recognized her vulnerability and need to feel loved. Especially in her final year of teaching, Sexton’s students became a “sort of class-beast that surrounded her, great, loving and focused, attentive.” The letters students sent to Sexton were gentle, playful at times, and always full of appreciation. “Some people seem to have the instinctive gift for being a good teacher, and you are one of them,” wrote one student. Passing on news about other students in a previous workshop, another student told Sexton, “All of us talk about the time spent in the fall with you as a sort of golden age.” Other students spoke of their concern more directly. “I hope you’ve felt well in your body—strong and sleek, powerful in that way, the way you look to others, but don’t always feel in your self.”

In May of 1967, when Sexton learned that her third book of poetry, Live or Die, had been awarded the Pulitzer Prize, she was ecstatic. Sexton had entertained hopes for the prestigious prize after publishing each of her books of poems, and she had even joked that she might “write a book and leave it, so when I die it can be published, and of course it will get the Pulitzer Prize—I want it just as much for when I’m dead as when I’m alive!” The title for Live or Die came from Saul Bellow’s Herzog: “With one long breath, caught and held in his chest, he fought his sadness over his solitary life. ‘Don’t cry you idiot! Live or die, but don’t poison everything.’” But Sexton had not encountered the passage in the published text; it had come straight to her door five years earlier. In 1961 Sexton had written Bellow a fan letter, and in his reply, Bellow had included the passage from what was then only a partial manuscript of Herzog. The words were magic to Sexton. They were still outside the finality of print—they might live on in the published novel, or they might die in a draft stored away somewhere. Sexton pasted the message over her desk.

Live or Die marked a change for Sexton, for the final poem, “Live” (see Appendix), ended the book on a positive, life-affirming note. For some this was too obvious or programmatic an ending; others complained that the finale lacked the polish of the earlier poems in the collection. Yet the fact that its imagery and language still seemed raw in places was appropriate; after all, the speaker of the poem has just discovered life for the first time. “What a bargain!” she cries, seeing the sun, “her yolk moving feverishly.” And,

God! It’s a dream, lovers sprouting in the yard like celery stalks

The speaker has no time to smooth out the wrinkles of the poem’s images and metaphors, for the whole poem is stretching toward the last lines, enacting its mandate:

I say Live, Live because of the sun, The dream, the excitable gift.

As much as Sexton’s family and friends might have liked to construe “Live” as a sign that she had finally chosen life over death once and for all, the cry Live, Live! belongs to the poem’s persona, not to Anne Sexton herself. In an interview in September 1974, less than a month before her suicide, Sexton reminded that “poems stand for the moment they were written and make no promises.”

On October 3, 1974, after giving a successful reading at Goucher College, Sexton returned to find her entire Boston University class waiting for her at the airport. She was delighted. The next day, after lunch with a friend, Sexton prepared for her final departure. This time it would not be a symbolic act, as Sexton viewed her early suicide attempts, nor would she choose to use her
“kill-me pills,” the barbiturates that she usually carried in her pocketbook. She removed her rings, put on her mother’s old fur coat, and poured herself a glass of vodka. She made her way to the garage, closed its doors, and climbed into her red Cougar. She started the car and turned on the radio. The attention of loved ones, literary success, the esteem of her students, and even poetry’s “accident of hope” could not bind Anne Sexton to the excitable gift of life.

APPENDIX

1. Her Kind

I have gone out, a possessed witch, haunting the black air, braver at night; dreaming evil, I have done my hitch over the plain houses, light by light: lonely thing, twelve-fingered, out of mind. A woman like that is not a woman, quite. I have been her kind.

I have found the warm caves in the woods, filled them with skillets, carvings, shelves, closets, silks, innumerable goods; fixed the suppers for the worms and the elves: whining, rearranging the disaligned. A woman like that is misunderstood. I have been her kind.

I have ridden in your cart, driver, waved my nude arms at villages going by, learning the last bright routes, survivor where your flames still bite my thigh and my ribs crack where your wheels wind. A woman like that is not ashamed to die. I have been her kind.

2. For John, Who Begs Me Not to Enquire Further

Not that it was beautiful, but that, in the end, there was a certain sense of order there; something worth learning in that narrow diary of my mind, in the commonplaces of the asylum where the cracked mirror or my own selfish death outstared me. And if I tried to give you something else, something outside of myself, you would not know that the worst of anyone can be, finally, an accident of hope. I tapped my own head; it was glass, an inverted bowl. It is a small thing to rage in your own bowl. At first it was private. Then it was more than myself; it was you, or your house, or your kitchen. And if you turn away because there is no lesson here I will hold my awkward bowl, with all its cracked stars shining like a complicated lie, and fasten a new skin around it as if I were dressing an orange or a strange sun. Not that it was beautiful, but that I found some order there. There ought to be something special for someone in this kind of hope. This is something I would never find in a lovelier place, my dear, although your fear is anyone’s fear, like an invisible veil between us all . . . and sometimes in private, my kitchen, your kitchen, my face, your face.

*aTo Bedlam and Part Way Back (1960).*

*bTo Bedlam and Part Way Back (1960).*
3. The Fortress

while taking a nap with Linda
Under the pink quilted covers
I hold the pulse that counts your blood.
I think the woods outdoors
are half asleep,
left over from summer
like a stack of books after a flood,
left over like those promises I never keep.
On the right, the scrub pine tree
waits like a fruit store
holding up bunches of tufted broccoli.
We watch the wind from our square bed.
I press down my index finger—
half in jest, half in dread—
on the brown mole
under your left eye, inherited
from my right cheek: a spot of danger
where a bewitched worm ate its way through our soul
in search of beauty. My child, since July
the leaves have been fed
secretly from a pool of beet-red dye.
And sometimes they are battle green
with trunks as wet as hunters' boots,
smacked hard by the wind, clean
as oilskins. No,
the wind's not off the ocean.
Yes, it cried in your room like a wolf
and your pony tail hurt you. That was a long time ago.
The wind rolled the tide like a dying woman. She wouldn't sleep,
she rolled there all night, grunting and sighing.
Darling, life is not in my hands;
life with its terrible changes
will take you, bombs or glands,
your own child at
your breast, your own house on your own land.
Outside the bittersweet turns orange.
Before she died, my mother and I picked those fat branches, finding orange nipples
on the gray wire strands.

We weeded the forest, curing trees like cripples.
Your feet thump-thump against my back
and you whisper to yourself. Child,
what are you wishing? What pact
are you making?
What mouse runs between your eyes? What ark
can I fill for you when the world goes wild?
The woods are underwater, their weeds are shaking
in the tide; birches like zebra fish
flash by in a pack.
Child, I cannot promise that you will get your wish.
I cannot promise very much.
I give you the images I know.
Lie still with me and watch.
A pheasant moves
by like a seal, pulled through the mulch
by his thick white collar. He's on show
like a clown. He drags a beige feather that he removed,
time, from an old lady's hat.
We laugh and we touch.
I promise you love. Time will not take away that.

4. In the Deep Museum

My God, my God, what queer corner am I in?
Didn't I die, blood running down the post,
lungs gagging for air, die there for the sin
of anyone, my sour mouth giving up the ghost?
Surely my body is done? Surely I died?
And yet, I know, I'm here. What place is this?
Cold and queer, I sting with life. I lied.
Yes, I lied. Or else in some damned cowardice
my body would not give me up. I touch
fine cloth with my hand and my cheeks are cold.
If this is hell, then hell could not be much,
neither as special or as ugly as I was told.
What's that I hear, snuffling and pawing its way
ward me? Its tongue knocks a pebble out of place
as it slides in, a sovereign. How can I pray>
It is panting; it is an odor with a face
like the skin of a donkey. It laps my sores.
It is hurt, I think, as a I touch its little head.

—from All My Pretty Ones (1962)
—from All My Pretty Ones (1962)
It bleeds. I have forgiven murderers and whores and now must wait like old Jonah, not dead nor alive, stroking a clumsy animal. A rat. His teeth test me; he waits like a good cook, knowing his own ground. I forgive him that, as I forgave my Judas the money he took. Now I hold his soft red sore to my lips as his brothers crowd in, hairy angels who take my gift. My ankles are a flute. I lose hips and wrists. For three days, for love’s sake, I bless this other death. Oh, not in air—in dirt. Under the rotting veins of its roots, under the markets, under the sheep bed where the hill is food, under the slippery fruits of the vineyard, I go. Unto the bellies and jaws of rats I commit my prophecy and fear. Far below The Cross, I correct its flaws. We have kept the miracle. I will not be here.

5. Live

Live or die, but don’t poison everything. . .
Well, death’s been here for a long time—it has a hell of a lot to do with hell and suspicion of the eye and the religious objects and how I mourned them when they were made obscene by my dwarf-heart’s doodle. The chief ingredient is mutilation. And mud, day after day, mud like a ritual, and the baby on the platter, cooked but still human, cooked also with little maggots, sewn onto it maybe by somebody’s mother, the damn bitch! Even so, I kept right on going on, a sort of human statement, lugging myself as if I were a sawed-off body in the trunk, the steamer trunk. This became a perjury of the soul. It became an outright lie and even though I dressed the body it was still naked, still killed. It was caught in the first place at birth, like a fish. But I play it, dressed it up, dressed it up like somebody’s doll. Is life something you play? And all the time wanting to get rid of it? And further, everyone yelling at you to shut up. And no wonder! People don’t like to be told that you’re sick and then be forced to watch you come down with the hammer. Today life opened inside me like an egg and there inside after considerable digging I found the answer. What a bargain! There was the sun, her yolk moving feverishly, tumbling her prize—and you realize she does this daily! I’d known she was a purifier but I hadn’t thought she was solid, hadn’t known she was an answer. God! It’s a dream, lovers sprouting in the yard like celery stalks and better, a husband straight as a redwood, two daughters, two sea urchings,

*From Live or Die

Ashley Ray
picking roses off my hackles.
If I’m on fire they dance around it
and cook marshmallows.
And if I’m ice
they simply skate on me
in little ballet costumes.
Here,
all along,
thinking I was a killer,
anointing myself daily
with my little poisons.
But no.
I’m an empress.
I wear an apron.
My typewriter writes.
It didn’t break the way it warned.
Even crazy, I’m as nice
as a chocolate bar.
Even with the witches’ gymnastics
they trust my incalculable city,
my corruptible bed.
O dearest three,
I make a soft reply.
The witch comes on
and you paint her pink.
I come with kisses in my hood
and the sun, the smart one,
rolling in my arms.
So I say Live
and turn my shadow three times round
to feed our puppies as they come,
the eight Dalmatians we didn’t drown,
despite the warnings: The abort! The destroy!
Despite the pails of water that waited,
to drown them, to pull them down like stones,
they came, each one headfirst,
blowing bubbles the color of cataract-blue
and fumbling for the tiny tits.
Just last week, eight Dalmatians,
3/4 of a lb., lined up like cord wood
each
like a
birch tree.

I promise to love more if they come,
because in spite of cruelty
and the stuffed railroad cars for the ovens,
I am not what I expected. Not an Eichmann.
The poison just didn’t take.
So I won’t hang around in my hospital shift,
repeating The Black Mass and all of it.
I say Live, Live because of the sun,
the dream, the excitable gift.

End Notes
   HRHRC. 16:2.
   HRHRC. 16:2.
   HRHRC. 16:2.
   Middlebrook. Quoted in AS, p. 140.
7. Student papers. 1967. Bill Mercier and Lester Lugey,
   respectively. Miscellaneous. HRHRC. 40:6.
11. Orne, Martin. September 8, 1989. Interview with
    Sexton, dissertation proposal. HRHRC. 38:2
    son. HRHRC. 37:8.
14. Orne, Martin. September 8, 1989. Interview with
    reprinted in NES, p. 85.
30. See Middlebrook, p. 100.
32. Sexton, Anne. “For John, Who begs Me Not to Enquire Further.”
75. Sexton, Anne. September 10, 1974. Interview with Steven and Rise Axelrod, HRHRC. 16:3
DNA Microarrays and Bayesian Multiple-Hypothesis Testing

James Scott, College of Natural Sciences

Introduction

DNA microarrays are some of the most powerful tools in modern biology. Yet because of that power, they are also some of the most fickle. To put it simply, they give biologists an enormous statistical headache.

What is a DNA microarray? The best way to answer that question is by analogy with a small chessboard, where each square represents a single gene. Except, instead of eight squares by eight like a chessboard, microarrays might have 100 squares by 100, for a total of 10,000 genes—all packed onto a chip of about three square inches.

Scientists use microarrays to monitor the effect of some stimulus upon many of these genes simultaneously. For example, you might want to see how alcohol affects the genetic expression
profile of a rat’s brain—in other words, which genes in a brain cell are differentially expressed because of alcohol exposure. So you take two different measurements of the genetic expression profile of rat brain cells (one for sober rats, one for drunk rats). Then you view the results by hybridizing the relevant strands of RNA to bits of the rat genome, which has been partially encoded on microarrays. A few of the genes will have their expression profiles altered with respect to the baseline expression level. In other words, they will be made more (or less) active because of the alcohol. Identify those genes, and you’re that much closer to understanding alcohol addiction.

These applications sound great in theory. The problem is that microarray data are very hard to analyze. One factor is the sheer number of genes being tested, which means that random error creeps into the experiment with astonishing frequency. Another problem is the complexity of the underlying statistical model, often called a mixture model. And yet a third problem is the issue of economics. How bad is it if I dismiss a truly active gene as nothing but random noise? And how much will it cost me if I keep doing experiments on a false positive thinking it was real? These costs can be quantified, but traditional statistical methods lack a straightforward way for taking them into account.

Over the summer of 2002, I developed a statistical procedure for dealing with these problems as best as can be expected. It’s called Bayesian hierarchical modeling, and I will show you how it performs on a simulated data set. But my goal in this paper isn’t to explain the nuts and bolts of that procedure. Instead, I want to explain in more detail why analyzing data from DNA microarrays is so difficult. These lessons, more than any individual procedure, are what I took away from my research experience.

To do that, I need to explain three concepts: random variation, multiple-hypothesis testing, and mixture models. You should be aware that what follows is something of an idealization of how DNA microarray data are collected in the real world. After all, we have to do that to create a statistical model—and this paper is about statistics, not biology. If you’re interested in the process by which scientists transform the raw numbers from microarray experiments into a form usable by statisticians, you should explore Baldi et al.

Random Variation

Almost all physical systems are subject to random variation.

Think, for example, of an experiment that involves flipping a fair coin 10 times. Since the chance of getting heads on each flip is 50%, you’d probably expect to get 5 heads, and this is certainly true on average. But if you performed the 10-coin-flip experiment many times in a row, you’d only get 5 heads about 25% of the time. The other 75% of the time you’d get something else—plenty of 4’s and 6’s, some 3’s and 7’s, a smattering of 2’s and 8’s, and only rarely a 1 or a 9. And if you had nothing to do all day but flip coins, you might even get a run of 10 heads or 10 tails. This is the essence of random variation: everything turns out how you’d expect in the long run, but each trial might be a bit off from the average.

In their own way, genes are no different than coins.

Let’s forget about microarrays for moment and talk about just a single gene. That gene’s expression profile has a normal numerical range associated with it. In repeated experiments, the gene will stay within this range most of the time, just like a series of 10 coin flips will usually yield between 4 and 6 heads. But every once in awhile, the expression can creep outside that range just by random chance alone—just like you might get 9 out of 10 heads from time to time, even if the coin were fair. This will fool you into thinking that the stimulus you’re studying actually caused a change in the gene’s expression profile, when the real culprit is just random chance.

Let’s say we want to find out whether a single gene is active. If it’s inactive, its average, or mean, expression level will be 0 (units don’t matter here). Although it won’t be exactly 0 each time we observe it, it will usually be pretty close—say, for example, between –2.0 and 2.0 about 95% of the time.

So what happens if we observe an expression level for that gene of 2.1? There are two possible explanations.

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Hypothesis A says, “Don’t get excited. The mean expression level is still 0; the extreme result was just a random occurrence.” Hypothesis B, on the other hand, says, “The mean expression level isn’t 0 after all; the extreme result was due to a real effect on the gene.”

Deciding between these two claims is the whole point of a branch of statistics known appropriately as hypothesis testing. Different schools of thought approach hypothesis testing in different ways, but I’m specifically referring to something called Bayesian hypothesis testing. Its goal is to quantify random variation so that, given the data, we know exactly how reasonable each hypothesis can claim to be.

**Multiple-Hypothesis Testing**

Now that you understand simple hypothesis testing, I should explain multiple-hypothesis testing.

Let’s go back to the coin-flipping example. You know from experience that flipping a coin 10 times and getting 10 heads or 10 tails is very rare. In fact, with a truly fair coin, these each happen about 0.1% of the time, meaning that you’d have to perform 355 trials of the 10-flip experiment to get even a 50% chance at seeing all 10 heads or all 10 tails. Of course, if you did 1,000 trials, your chances of seeing 10 heads or 10 tails shoot to 85%.

These numbers capture an intuition we probably all share. Even very rare events—the lightning strike, the hole-in-one, the royal flush, the 10 heads in a row—will happen eventually if you just wait long enough. It’s like the old proverb: even if you’re one in a million, there are 1,000 people just like you in China.

By now the connection to microarrays should be apparent. A microarray is like stuffing 10,000 single-gene experiments onto a 3-square-inch wafer. We’d fully expect to see some expression levels very far from 0, just by random chance alone, even if—and this is the crucial point—all the genes were inactive.

Let’s plug in some numbers. Imagine we’re doing a microarray test in which each inactive gene has a 5% chance of randomly creeping outside its normal range between –2.0 and 2.0. If our chip has 10,000 genes on it, then we’d expect around 500 such “false positives.” Now imagine the actual experiment turns up 550 genes that we observe to be more than 2 units away from 0. Some of them will be false positives—that is, caused by random chance. And some of them will be real alterations of the baseline expression level.

Distinguishing between these two cases is the dilemma of multiple-hypothesis testing. It is the main reason that analyzing DNA microarray data is so hard.

**Mixture Models**

The problem gets worse. What if a gene is differentially expressed, but only slightly? That gene could be scientifically important, yet you might never pick it out from the sea of random noise.

Again, some numbers will help make the point. An active gene whose mean expression level is, for example, 0.5 looks a lot like an inactive gene, except that its normal numerical range will be offset just a tad. Using the same scale as before, you’d observe it between –1.5 and 2.5 about 95% of the time. Let’s say that on the particular day you ran your microarray experiment, you observed a value for that gene of 0.7. How can you tell whether that number is a small deviation from 0.0, or a slightly smaller deviation from 0.5?

A situation like this is called a mixture model. Most of the genes on a microarray will have mean expression levels of 0, and those that aren’t will have their mean expression levels distributed roughly according to a bell curve that is itself centered around 0. And all of the genes, whether expressed or not, are subject to random variation (which also happens to look like a bell curve). Hence the term “mixture model”: each individual observation can be conceptualized as a mixture of two bell curves.

There’s the population bell curve, which describes the distribution of differentially expressed, non-zero genes. And there’s also the observational bell curve, which describes the distribution of measurements you will get in a series of repeated measurements for a single gene.

The problem of hypothesis testing then becomes the problem of deciding which of these bell curves contributed to each particular data point. Often, however, these bell curves aren’t very different from one another (for the technically inclined, the ratio of their variances isn’t that far from 1). This makes the problem
even harder. Often, the only solution is to run several microarrays, which has the effect of shrinking the observational bell curve so that it becomes sufficiently different from the population bell curve.

The Solution
Bayesian Hierarchical Modeling

Without going into the specifics of Bayesian hierarchical modeling, I want to show you the results this powerful method can give. If you're interested in the gritty details, see Scott and Berger.

Figure 1 shows how the procedure handles the problem of multiple-hypothesis testing for a fake-but-reasonable data set. The column entries across the top are the numerical values of 10 different “signal” observations. These were generated from a bell curve with a mean of 0 and a standard deviation (a measure of how spread-out the distribution is) of 3. I then added different amounts of “noise” genes to the data set, represented by the row entries along the left. These numbers were drawn from a bell curve with mean 0 and standard deviation 1. They were meant to simulate genes whose mean expression level is actually 0 and that conform to the exact assumption I made above—that successive observations of these genes will yield values between –2.0 and 2.0 about 95% of the time.

I then asked the question, “Given all the data, what is the probability that each individual gene is a signal?” The entries in the chart give my procedure’s answer to this question for each of the 10 signal genes.

You'll notice a couple of things about the chart. First, even with only 25 noise genes in the mix, the procedure has a hard time identifying the signal genes that are very close to 0 in absolute value. For example, it says that, given the data, there's only a 20% chance that the –0.15 gene is a signal.

In a strict sense, this is a “wrong” answer—we know that the gene is a signal because we created the data set that way, and the procedure tells us that it’s probably noise. Yet the figure of 20% says that this wrong answer is an exception. That number means that if you counted up all of the situations with 10 signal genes and 25 noise genes distributed according to these particular rules, only one in five observations of –0.15 would correspond to a signal gene. The other four out of five such observations would be noise genes. So, while the procedure gets the answer wrong in this instance, it’s playing the odds. Classifying this observation as a noise gene will be the right thing to do 80% of the time, and that’s what the procedure does.

Second, you'll notice that as the number of noise genes increases, the probability that the marginal observations are signal genes goes way down. This is exactly what a good multiple-hypothesis testing procedure ought to do. As the total number of observations (both signal and noise) goes up, so does the number of opportunities for a rare event to happen by random chance alone. So, with more observations, the threshold for declaring something a signal ought to get harder and harder to meet—that is, further and further from 0.

The price you pay, of course, is ignoring some signal genes that are themselves close to 0. But you really don't have much choice in the matter. If you don't adjust the acceptance threshold for the total number of observations, your experiment will rapidly be overwhelmed by false positives. You'll be stuck in the lab forever trying to sift through them.

Now look at Figure 2 for a closer look at four individual observations. Here, we don't know beforehand which ones are signals and which are noise genes—we only know what the procedure tells us. The number at the top of each frame is the actual observation. The bar at 0 represents the probability, given all the data, that the observation is just noise. And the curve represents the distribution of likely values of the gene’s mean expression level, given that the observation is actually a signal. At a glance, you can determine two things from one of these figures. First: how likely is it that the gene is just random noise? Second: if it's not random noise, is it likely to be far enough from 0 to be worth the time it would take to pursue it further?

Conclusion

I hope you now understand why analyzing data from DNA microarrays is hard. The combination of multiple-hypothesis testing and mixture models is a tough nut to
crack. Even an optimal procedure like Bayesian hierarchical modeling often gets the answers wrong for genes that live close to 0.

The lesson here is one we’d all do well to learn. Sometimes the answer to a scientific problem isn’t a fancy statistical procedure. It’s to get back into the lab to take more data.

References
Sales Tax On Electronic Commerce Consumption—Issues of Equity

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Abstract

Sales tax on electronic commerce in the United States represents a quite unexploited source of revenue, as state and local governments are currently unable to require most Internet firms to collect and remit sales tax levies. In principle, sales taxes should apply to total personal consumption, but the taxation of Internet trade has been proved controversial. One argument is that the exemption of sales taxes on Internet transactions results in substantial revenue losses to states and localities, as existing taxable sales migrate to an effectively tax-free e-market. The opposing view is that electronic commerce is an activity that deserves preferential treatment and taxation would cause devastating effects to the growth of the online industry. As doubts remain about the desirability of
applying sales taxes to electronic commerce the same way it is done to equivalent activities in the bricks-and-mortar market, it is clear, however, that an equity issue underlies systems that tax some firms while exempt others. Such inequity seems likely to distort market competition by compelling taxed local firms to reduce their costs to compete with untaxed Internet companies. Also, in the presence of sales tax exemptions for electronic commerce, low-income individuals without resources to perform online transactions might have to pay a disproportionate share of state and local sales taxes as opposed to high-income ones. Based on some theoretical considerations, this research paper inquires to which extent government decisions towards taxation of electronic commerce consumption might affect the horizontal equity of individuals and firms.

Introduction

The issue of equity has always been a major factor in political and academic debates about reforming the sales tax in the United States. Recently, an additional concern has engaged scholars and government officials across the country: the taxation of e-commerce consumption. At least in theory, sales taxes should be paid on all online transactions, but the taxation of Internet sales has proven to be controversial.

State and local governments consider sales taxes on electronic commerce a potential means of increasing their revenues. However, due to legal and operational impediments, tax authorities are currently unable to require most e-commerce firms to collect and remit sales tax levies. One major concern is that the inability to tax online consumption results in substantial revenue losses. The combination of ineffective tax compliance by consumers and a limited tax collection on the part of e-commerce companies is believed to diminish the sales tax base of many subnational governments.

Additionally, proponents of online taxation view the exempt status of Internet consumption as a distortionary subsidy for electronic commerce, as existing taxable sales migrate to a virtually untaxed environment. But there is also widespread support for preferential tax treatment for e-commerce firms. Opponents of online sales taxes argue that the electronic commerce is still a relatively new industry deserving special protection. In their view, taxation would have a negative impact on consumers’ decisions, dramatically reducing online profits. Moreover, e-companies would face compliance difficulties that could interrupt the growth of their activities and the economy itself.

Questions remain, however, about whether sales taxes should apply to electronic commerce the same way they do to equivalent activities in the bricks-and-mortar market. Therefore, an equity issue must be addressed. Based on some theoretical considerations, this research paper inquires as to what extent government decisions regarding taxation of electronic commerce consumption might affect the horizontal equity of individuals and firms.

Equity-based Theoretical Considerations

Horizontal equity is the notion that “equals be treated equally” (Kaplow, 1989). While vertical equity in taxation requires that different people and things be taxed differently, the principle of horizontal equity implies that individuals with a similar ability to pay taxes should pay the same amount.

Despite the common argument that sales taxation is barely compatible with accepted standards of equity, sales taxes can be evaluated in part by the degree to which they satisfy the objective of horizontal equity. In principle, sales taxes should be imposed in a way that treats individuals equally. A major concern, then, is the extent to which taxpayers are discriminated against by the system, with...
reference to the fact that some individuals may not be able to avoid sales taxes, while others may. Thus, the level of horizontal equity indicates whether tax burdens are fairly distributed in society, protecting individuals and firms from arbitrary discrimination.

While the issue of equity is easily perceived in relation to individuals, it is less obvious with regard to firms (Holtz-Eakin, 1995). Nonetheless, taxation of business activity must also be consistent with basic principles of equal worth. Sales taxes apply to the consumption of goods, whether the consumer is an individual or a firm. Thus, a particular treatment of one firm requires the same treatment of other businesses that are identical in respect of tax incidence, although some unequal treatment might inadvertently occur, especially in the course of enforcement procedures.

In the context of e-commerce consumption, there are differing perspectives on how sales taxes should be structured. Previous work by Charles Mclure Jr. (1997) finds that exemption of all sales made over the Internet would be biased and unfair, but it would also be inappropriate to tax e-commerce sales made to businesses. Fox and Murray (1997) argue for an inclusive approach to taxing e-commerce. In their view, neutrality and horizontal equity are the appropriate reasons to tax products sold over the Internet, rather than solely increasing tax revenues. Thus, consumption over the Internet and at local stores would not seem to warrant different treatment.

**Electronic Commerce and Horizontal Equity of Firms**

In theory, sales taxes should be due on all sales for consumption purposes, even those carried on by means of a computer network. However, a major complication to such general consumption rule is that sales taxes usually apply to transfers of tangible property, while electronic commerce involves predominantly services or intangible products. As a matter of fact, distinct concepts of tangible and intangible commodities were widely used in the past, especially for avoidance of double taxation. With the proliferation of electronic transactions, however, differential treatment of products has become unacceptable as the notion of tangibility loses importance for practical reasons.

Yet Internet companies cannot be required to charge consumers for the tax unless the company has a physical presence or “nexus” within the state of destination. At the present time, determining what is qualified as a nexus is not an easy task. As markets have become more closely integrated, e-trade has lessened the perception of borders between states and even countries. In any case, e-commerce enables more types of transactions to be completed in tangible, as well as intangible, ways, that is to say, without the need to provide physical property to consumers.

The difficulties involving taxation of e-commerce sales are also of a practical nature. The current structure of 50 state tax systems and around 7,500 taxing jurisdictions across the country could be too complex and burdensome for online firms to comply with sales tax legislation. In general, bricks-and-mortar stores charge sales taxes at a single rate and face rules passed by one location. If the existing tax structure is maintained, however, taxation of e-commerce could require online firms with businesses nationwide to face multiple administrative obligations. The amount of tax charged would depend upon many factors, which might turn out to be overlapping and conflicting. Therefore, subjecting Internet consumption to conventional sales taxes might generate a number of practical problems, particularly to transactions carried out across state borders.

Additionally, horizontal inequity in sales tax distribution can also distort market competition. The percentage of sales taxes added to prices is likely to influence demand, leading consumers to make purchases based on tax savings. In such circumstances, taxed bricks-and-mortar firms could face the risk of losing profits to untaxed Internet companies. The standard of horizontal equity, however, would require the elimination of this tax advantage for online firms, which is identical to local stores in every relevant respect. An equitable business competition could then be encouraged, creating a level playing field for all firms.

Nevertheless, requiring tax collection on online sales could turn the playing field in another direction, causing Saulo Santos de Souza
Internet firms to lose income. As a rule, local businesses are required to collect sales taxes for a single jurisdiction. Thus, the administrative costs they face are relatively low. For e-businesses, however, those costs could be much higher in terms of services and resources needed for compliance with differing tax rules. Ultimately, such costs could be transferred to consumers in the form of higher prices and less consumption options. As taxes could cause Internet prices to rise, demand for online commodities would likely decrease. Therefore, if a single sales tax collection regime is adopted, e-commerce firms could be placed at a competitive disadvantage against local stores.

Of course, some public policy implications of e-commerce sales taxes could also be expected. If government spending does not benefit out-of-state e-commerce firms in the same manner they do local businesses, tax provisions could disproportionately favor the latter group. And to the extent that Internet companies might not be able to affect the political process in distant jurisdictions, mandatory tax collection for other states could lead to a system of taxation without representation, further violating the fundamental conception of horizontal equity.

Electronic Commerce and Horizontal Equity of Individuals

The U.S. Constitution demands “equal protection under the law.” Following such a principle, legislation must be designed so that tax burdens are equitably distributed among individuals and each taxpayer assumes a fair share. Moreover, individuals with equivalent incomes should pay an equivalent amount of taxes. By the same token, tax burdens should be assigned to taxpayers according to differences in the amount of benefits they receive from public goods and services. Altogether, these notions enforce the idea of horizontal equity.

The principle of horizontal equity presumes that if two individuals differ only in consumption preferences, the government policy towards taxation must treat them identically. Therefore, in a situation where sales taxes are imposed to online consumption, the parity of utility of the taxed commodities must be maintained for all individuals as it was before the tax, regardless of their ability to engage in e-commerce transactions. However, the differential impact of online taxation on consumers’ behavior cannot be disregarded.

Obviously, most individuals can be expected to react to the idea of paying online sales taxes as they may face reduction in income. For example, a six percent tax is added to online purchases. Even though all other benefits of performing online transactions remain the same, such as selection, privacy, and convenience, the consumer would now have an additional six percent incentive to reduce online consumption. Accordingly, individuals would perceive online taxation as an increase on the price of the commodity. As a rule, if prices increase, demand would decrease. At the same time, online taxation would further decrease the income of individuals as it produces compliance and non-compliance costs.

Some degree of inequity can also result. As far as the probability of possessing a computer, an Internet account, and a credit card to purchase over the Internet increases with income, lower-income consumers are less likely to routinely engage in online purchasing of goods. As a result, consumers in the lower income groups would tend to spend higher percentages of their incomes on taxed consumption than those in the higher income groups. Therefore, individuals with easy access to online transactions would pay less in taxes than consumers who do not have the same access. Ultimately, low-income consumers might be forced to devote more income to sales taxes instead of to the purchase of essential goods and services. This situation would impose burdens on consumers disproportionate to their amount of consumption, but according to their lack of ability to perform online purchases.

Taxing online purchases may have another implication: consumers could be stimulated to avoid online taxation by shifting consumption towards untaxed activities, reducing the sales tax base. Under these circumstances, state and local governments might be induced to raise conventional sales taxes to preserve the level of the overall tax revenues. However, if a tax rate is raised excessively, consumers will further attempt to take advantage of exempt online consumption. A vicious cycle leading to higher tax burdens on low-
income individuals could result. Tax rate increases could encourage more online consumption by high-income individuals, forcing further rounds of rate increases. As a consequence, low-income consumers limited to buying goods sold at bricks-and-mortar stores would be further burdened in absolute, as well as relative, terms.

The same reasoning could apply to the hypothesis of non-uniform e-commerce taxation. Individuals searching across multiple online firms might avoid sales taxes by choosing one retailer over another, intent on paying lower taxes, or no taxes at all. Again, higher-income individuals, with easier access to online transactions, would have more opportunities to avoid taxation, as opposed to lower-income ones.

In an ideal situation, tax rates would only be high enough to fund essential government services, and consumers would be limited in their capacity to avoid taxation whether shopping online, or at bricks-and-mortar establishments. Finally, low-income consumers without the resources to purchase online would not have to pay a disproportionate share of sales taxes as compared to high-income individuals, regardless of their consumption preferences. The alternative scenario would be that the tax system would have to be amended if the horizontal equity issue were to be taken seriously.

Conclusions and Final Comments

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Decisions towards the adoption of sales taxes on electronic commerce must take into consideration the consequences of equity to individuals and firms. Since the rule of horizontal equity requires equal treatment of equals, it is clear that an equity issue underlies government provisions aimed at taxing local market consumption while exempting e-commerce sales.

One common concern is that local stores paying taxes face unfair competition from exempt online firms. Nevertheless, taxing e-commerce companies doing businesses in a variety of states might introduce new distortions in terms of compliance obligations and costs. Also, it is doubtful whether simplified administrative procedures would suffice to prevent e-commerce companies from facing excessive burdens in order to remain competitive in the market. Moreover, the current structure of different state, local, and county taxes could not be changed overnight.

With respect to consumers, a precise assessment of the sales tax in terms of equity must take into account differences in the ability of individuals to shop online. Such an argument is based upon the assumption that the exempt status of electronic commerce is the main incentive for online consumption. Given the distribution of the tax burden by income group, lower-income consumers would be less likely to use the Internet for purchasing, and thus more likely to spend income on sales taxes than higher-income individuals. As a consequence, applying sales taxes to both e-commerce and local market consumption would make the tax system more equitable, at least in relation to income.

The equity of any tax structure can be determined by how the burden of taxation is distributed among individuals. In the long term, however, the inclusion of Internet sales in the sales tax base would not necessarily make the system more equitable. A reduction in the cost of computers and Internet access services could make differences in income irrelevant in evaluating the horizontal equity of individuals. In any case, equity considerations will continue to play a major role in the structure of personal taxation.

Also, substantial reductions of sales tax bases resulting from shifting to online consumption could compel states and localities to raise sales tax rates to preserve a desired level of revenues. Yet, non-compliance effects could be mitigated by adopting uniform sales tax rules for both online and bricks-and-mortar transactions. Moreover, creating a single tax rate might lead all firms to bear the tax burden equally. However, it is not clear that a single rate would necessarily solve the administrative problems posed by the complex interaction with numerous governmental rules and regulations. In addition, such uniform system could possibly generate unforeseen consequences for both national and state economies.

Attention must be given to the varying concerns and interests of affected taxing jurisdictions and taxpayers. In fact, as tax structures differ for each level of government, issues raised by e-commerce taxation can

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also differ among states and localities. Likewise, tax policies that might seem ideal for a particular state might not be in the best interest of others, given differences in tax systems and in sales tax rates across the country. Similarly, as e-commerce taxes may have different impacts in the behavior of every firm and individual consumer, a uniform system might not be the appropriate instrument for achieving the desired goals of horizontal equity.

So far, it is unknown to what extent taxation of online consumption would affect e-commerce activities. Although state and local governments need to remain capable of financing public goods and services, sales taxes on the Internet might prove to be a means of reducing online sales without producing much in the way of tax revenue. Indeed, there are many issues that must be properly addressed in applying tax systems to electronic commerce, however, one thing is certain: the necessity of guaranteeing reasonable standards of horizontal equity increases the urgency of designing public policy initiatives along these lines.

References

Nitric Oxide Involvement in Unisexual Whiptail Lizards—Facilitation of Male-like Pseudocopulatory Behavior

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Abstract

The unisexual whiptail lizard *Cnemidophorus uniparens* reproduces without fertilization, creating eggs genetically identical to each other and the mother. True copulation does not occur in this species of lizards, but *C. uniparens* lizards perform both male-typical and female-typical courtship behaviors. Androgen, mainly testosterone, is usually responsible for triggering male typical sexual behavior in vertebrates, but *C. uniparens* is an all-female species and secretes no androgen. Both testosterone and progesterone treated ovariectomized lizards exhibit the male copulatory behavior in the laboratory, suggesting that the lizards possess the neural circuitry for both male and female behavior. Nitric oxide
performs significant functions in peripheral and central control of reproductive behavior; testosterone and progesterone cause nitric oxide induced sexual behavior in male and female rats. We hypothesize unisexual lizard pseudocopulatory behavior also involves nitric oxide. The current experiment tested whether nitric oxide played a role in the male-like pseudocopulatory behavior of whiptail lizards under the influence of circulating androgens. One group of lizards was treated with a nitric oxide inhibitor, while the control group was treated with an inactive isomer of the inhibitor. The results show lizards treated with the inactive isomer responded in a similar manner to untreated controls. Male-typical behavior in C. unipares can be suppressed with nitric oxide inhibitor in some whiptail lizards. Nitric oxide synthesis appears to play a role in the induction of male-like behavior, and the role of this neurotransmitter in mediating steroid dependent activation of male-typical copulatory behavior merits further study.

Males and females behave differently during breeding as a result of different factors affecting their individual fitness. Females do better, from a fitness standpoint, to be choosy with their limited, nutrient rich gamete. Males have highest fitness by inseminating as many females as possible with their almost endless supply of sperm. From a mechanistic point of view, this leaves us with questions: how did the behavioral suites that accompany these two different strategies evolve; and what differences resulted from this evolution of the male and female brain? The first question is a difficult one, and our understanding is increased by studying the reproductive differences of closely related sexually dimorphic species. The second question is understood to a greater extent. We now know neural differences between males and females result from two kinds of processes. First, gonadal steroid hormones act during embryogenesis to organize the brain in a male-typical or female-typical pattern of neural connectivity. Then, later in the organism’s life cycle when it is mature enough to breed, the gonads again become active and secrete the hormones associated with gametogenesis and pregnancy, which also serve to activate the sex-typical circuits that were organized during embryogenesis. In most organisms, the activational effects of steroid hormones are hard to study in adults, because it is very difficult to distinguish the effects of adult hormones from previous, embryogenic effects. A unisexual whiptail lizard, from the southwestern U.S. offers ways to address this problem experimentally. It does not have males, but some females do exhibit male-like sexual behavior. These lizards may help increase our understanding of the physiology and evolution of the neural basis of sexuality.

The unisexual whiptail species *Caenidophorus unipares* serves as a great test subject in evolutionary behavioral studies. *C. unipares* is relatively young species and is thought to have been formed by hybridization of two closely related species (Crews 117). The extant maternal ancestor of *C. unipares* was discovered by comparing DNA sequences, and a living ancestor provides a control group to test the differences of descendant reproductive strategies (Crews 117). *C. unipares* also reproduces without fertilization, creating eggs genetically identical to each other and the mother. True copulation does not occur in this species of lizards, but *C. unipares* lizards perform long courtship behaviors identical to sexual whiptail lizard species (Lindzey and Crews 411). One lizard behaves as a normal female and the other lizard acts as if a male in this “pseudocopulatory” behavior. A major confound in the study of sexual dimorphisms is the fact that males and females differ in several ways. Sex differences may be due to genotypic differences, hormonal backgrounds, or even experiences particular to each. The fact that all individuals in the descendant parthenogenetic species are identical genetically and develop the same female phenotype, yet display both male-like and female-like pseudosexual behavior, provides a unique system in which to examine the neural substrates underlying sex-typical behaviors.

Androgens, mainly testosterone from the testes, are usually responsible for triggering male-typical sexual behavior in vertebrates, but *C. unipares* is an all-female species and secretes no detectable levels of androgen. Testosterone-treated, or progesterone-treated, ovariecotomized lizards exhibit the male-typical copulatory behavior in the laboratory, suggesting that
the lizards possess the neural circuitry for both male and female behavior, and that this circuitry can be activated by either hormone. An obvious question to ask is how progesterone, normally not associated with male-typical sexual behavior, has been able to take on this role in these all-female lizards.

A possible answer may lie in the similarity of the receptors that bind the two steroids. All vertebrates share a set of conserved nuclear steroid receptors derived from an ancestral estrogen receptor at least 600 million years ago (Thornton 5,673). Steroid hormones act mainly through binding with nuclear receptors which change conformation once bound with the steroid. The hormone-receptor complex then binds to DNA and serves as a transcription factor resulting in an up-regulation of neurotransmitters facilitating sexual behavior. In the wild, progesterone is thought to cause C. uniparens to exhibit male-like behaviors (Grassman and Crews 331). Female C. inornatus, the maternal ancestor of C. uniparens, do not display male-like pseudocopulation, and exogenous progesterone administrations cannot induce male-like behavior. How is the physiology of C. uniparens different from that of C. inornatus to the effect that progesterone is capable of engaging the normally androgen-dependent behavior in the former but not in the latter? We hypothesize that female C. uniparens are unique because they express progesterone receptor in cells of the circuits mediating male typical behavior, while C. inornatus (and most female vertebrates) do not. So, progesterone-receptor complexes bind to androgen response elements in the control regions of genes involved in the expression of behavior. This non-specific binding occurs because androgen and progesterone receptor binding sequences are similar. Normally, androgen and progesterone receptors have different cellular expression patterns, and an ectopic expression of the progesterone receptor in the C. uniparens brain enables this example of cross-talk.

Nitric oxide synthase (NOS) is androgen responsive and could be responsible for the male typical behavior. Nitric oxide, formed when arginine is converted to citrulline by NOS, performs significant functions in peripheral and central control of reproductive behavior. In male rats, testosterone causes an upregulation of NOS in the medial preoptic neurons and increases nitric oxide levels. Increasing nitric oxide concentration boosts extracellular dopamine levels, and dopamine then increases the chance of copulatory behavior (Hull et al. 110). Progesterone-mediated nitric oxide release in the hypothalamus of female rats causes a release of luteinizing hormone-releasing hormone (LHRH). LHRH facilitates a mating posture, lordosis, characterized by a raised head and rump and a downward arched back (Mani et al. 6469). Testosterone and progesterone cause nitric oxide induced sexual behavior in male and female rats. We hypothesize unisexual lizard pseudocopulatory behavior involves nitric oxide and to test this we designed a set of three experiments.

The first experiment used a pharmacological blockade of the enzyme responsible for nitric oxide synthesis to test whether nitric oxide plays a role in the male-like pseudocopulatory behavior of whiptail lizards under the influence of circulating androgens. Fifteen gonadectomized female C. uniparens were each implanted with one 12 mm Silastic capsule of dihydrotestosterone (DHT). We used DHT as a proxy for testosterone because DHT does not readily convert to estrogen and its effects can be confidently attributed to the androgen receptor. We fed a group of female C. uniparens one wax worm injected with 10 microliters (0.6 micrograms) of estradiol benzoate in oil each day to establish a group of receptive female lizards. Three weeks after implantation, all fifteen lizards were subjected to three baseline tests to confirm the establishment of male-like pseudocopulatory behavior. Animals were eliminated from the study if they failed to pseudocopulate in at least two out of three tests. All remaining animals were then given the same pre-test without drug administration, three drug tests, and three control tests. Each test, including the baseline, consisted of one 10-minute exposure to a receptive female in the experimental subject’s home cage. We placed estradiol treated females in a long-term testosterone treated female lizard’s cage to check for receptivity before being placed in the presence of the test subject. A nitric oxide synthase inhibitor, Nω-nitro-L-arginine methyl ester (L-NAME)
ester (L-NAME), was the drug administered. D-NAME, an inactive isomer of L-NAME, served as the control. For the drug test, we injected 600 micrograms (100mg/kg) of L-NAME dissolved in reptile saline intraperitoneally into the test subject one hour before the drug test. The lizards received the same dose of D-NAME one hour before each control test. A total of nine tests—three pre-tests, three drug tests, and three control tests—were performed on every lizard, each on a different day. We randomly assigned the lizards to the drug or control group for each test. Whiptail male-like pseudocopulatory behavior consists of three main stages: approach, mount, and intromissive position (Crews 118). For every test, latencies at each stage of the behavior were recorded as a time in seconds. Immediately following each test, we dropped a cricket (the normal prey of these lizards) into each subject’s tank in order to assess possible drug effects on general motor and arousal systems. All experimental animals, regardless of treatment, seized crickets following their tests within one or two seconds, suggesting that the pharmacological treatment was not generally debilitating.

The results show that lizards treated with D-NAME responded in a similar manner to untreated controls (Figure 1). There was a negligible difference in the mean latencies of the pre-test and D-NAME (control) test. A maximum latency of 600 seconds was given to lizards that did not show a behavior (Figure 1). Every D-NAME treated C. uniparens achieved the pseudocopulatory posture, but only half of the L-NAME treated lizards completed the behavior (Table 1). Cochran’s Q test shows significant differences in this categorical response (copulation or non-copulation), between control, D-NAME, and L-NAME (p < 0.0068) (Table 1). In conclusion, pseudocopulatory behavior can be suppressed with L-NAME in some whiptail lizards, suggesting that nitric oxide synthesis appears to play a role in the induction of this male-like pseudocopulatory behavior in C. uniparens.

The second and third experiments will be carried out once the lizards have fully emerged from hibernation in early spring. Experiment two is an extension of the first experiment, following our serendipitous observation that the copulation-suppressing effect of L-NAME appeared to diminish across the nine trials, so that toward the latter half of the lizards’ drug tests the NOS inhibitor had less of an effect on sexual behavior. The experiment will test whether the reduction in response to the NOS inhibitor is due to experience or conditioning. The former possibility suggests the sexual neural pathway became more robust and NOS inhibition did less harm. The second possibility is that the paradigm of receiving an injection before every test conditioned the lizards to expect the presentation of a female one hour after the experience of being injected. This would lead to up-regulation of nitric oxide synthesis in response to the pre-test injection, now associated with the opportunity to copulate one hour later. There would thus be synthesis of nitric oxide before the drug took effect, eliminating the potency of the drug. Experiment two will consist of three groups: practice but no conditioning, practice and conditioning, and a control group without either treatment. Each group will have six total trials with a receptive female. The PRACTICE BUT NO CONDITIONING group will have five untreated trials then a NOS inhibitor injection one hour before the last trial. We will inject the PRACTICE AND CONDITIONING group with reptile saline one hour before the first five trials. NOS inhibitor will be administered one hour before the six trials of the practice and conditioning group. We will not treat the CONTROL group for the six trials. Each trial will be conducted on a different day.

Experiment three will incorporate the results from the second experiment to conduct a test similar to experiment one. The experiment will test whether nitric oxide played a role in the male-like pseudocopulatory behavior of whiptail lizards under the influence of circulating progesterone. The only differences in the third experiment will be progesterone in the place of DHT and a design based on the results of experiment two. The persistence of both female-like and male-like behavior in C. uniparens plus the fact all the lizards are genetically identical provides a favorable testing system. This parthenogenetic lizard will continue to be a fountainhead of experiments on the neural basis of sexual behaviors.

Erik Weissler
**Figure 1**  
Mean Latencies of Sexual Behavior Stages Under Various Treatments

![Bar chart showing latency times for different stages under various treatments](chart.png)

**Table 1**

<table>
<thead>
<tr>
<th></th>
<th>Approach</th>
<th>Mount</th>
<th>Pseudocop</th>
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</thead>
<tbody>
<tr>
<td>untreated</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>D-NAME</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>L-NAME</td>
<td>8</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
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Table 1. Number of lizards that displayed each of the three observed behaviors under each of the three testing conditions. Ten lizards were included in the study.
Works Cited


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