stirrings

Stirrings

A Journal of Exploratory Research and Analysis

When the stirrings of research emerge from curiosity and personal investment, there is always a danger that what we already believe we know will deter us from asking important questions, and that the research will be constrained by an aversion to intellectual risk. Good research demands an interest in probing for the right questions to pose. Good research questions are the true stirrings of exploratory research and analysis. But the stirrings of good research questions are less obvious and often more difficult to tap into.

This is where a good research mentor comes in handy, as well as established research practices that model the cultivation of those questions that proved most fruitful in arriving at productive research outcomes. The articles published here reflect attempts to grapple with research problems of special interest to the students conducting the studies. They have been encouraged to work initially from a position of personal interest and investment, and then to push beyond this to discover issues and questions to reshape the initial scope of their focus. The stirrings of personal interest are a crucial element in the cultivation of sound research practices, but they should not be confused with the stirrings of sound research. The stirrings of sound research emerge from a growth in perspective.

In the process of acquiring perspective in life, we cultivate attunements, attitudes and convictions. But do we always recognize how these orientations sensitize or desensitize us to the blind spots in our understanding? Are there not issues, concerns, opportunities and challenges relevant to our lives that we can only appreciate *from somewhere else?* As we grow older in life, we clearly discover points of entry to our surrounding world, but only by closing off or eclipsing *other* points of entry.

To see the world in a new light, to acquire new *entries* to the world, is to become responsive in a new way. The capacity to respond to issues and concerns otherwise masked from view demands a special openness and attention to what we find strange and challenging. We seldom see the world in a new light without first having the curiosity and willingness to explore unexpected or marginalized phenomena; nor without learning to discern otherwise hidden facets of our filtered social and personal constructions.

The call to see the world in a new light -- to "open the universe a little more," as Salman Rushdie has urged in *Imaginary Homelands* -- calls for critical voices, exploratory minds and the empowerment of creative forms of expression carefully interwoven with sensitive analysis and personal concern. It calls for attending to complexities in life that are all-too-often eclipsed from view by more dominant ways of thinking, feeling and speaking. Above all, it calls for *an attentive ear,* the first condition for generating an attentive *response.*

We trust this collection of articles will not only stir your interest in timely topics but that it will also offer some insights into how one might come to grips with a deeper level of what is at stake once the research process gets off the ground. The goal of these writings is to integrate an awareness of what is at stake into the formation of sound research questions and to present findings based on an analysis of criticism and exploratory questions, and to suggest how these findings might influence further developments in the research. These are not finished products. They represent only the stirrings of research. But as such, they reflect significant efforts to raise curiosity to the level of sound research with respect to topics and issues that should spark interest in the minds of our readers. We hope they do so!

HONORS PROGRAM
COMMUNITY STATEMENT

The Honors Program at CSU Stanislaus is a community of scholars

bound together by vital principles of academic openness, integrity,

and respect. Through focused study and practice involving

exploration and discovery across a variety of disciplines, the

Honors Program upholds these principles of scholarly engagement

and provides students with the necessary foundations

for further research and inquiry.

Our interdisciplinary curriculum is integral to this work,

and is intended to facilitate creative understanding of the

irreducible complexities of contemporary life and knowledge.

Personal and intellectual honesty and curiosity are essential to this

process. So, too, is critical openness to difficult topics and respect

for different perspectives, values and disciplines. The Honors

Program aims to uphold these virtues in practice, in principle,

and in community with one another.

Honors Program Advisory Committee

May 14, 2004

Acknowledgements

*Seniors in the Honors Program are encouraged to tackle complex problems using methods and knowledge from related disciplines. Honors Program faculty and research mentors offer critical feedback and guidance along the way. The main objective is for students to explore, gather and analyze information effectively, and to reflect on the implications of what they have discovered. Group discussions help to promote thoughtful questions. The goal is to communicate knowledge, judgments and original perspective derived from careful inquiry, exploration and analysis. Seniors discussed the results of their research at the **Senior Honors Conference** on **Friday, May 22, 2009**, in the John Rogers Faculty Development Center. We hope you can join us for our next conference, in **May 2010!***

Table of Contents

Liquid Filter

LA ESPAÑOL-INGLÉS ALTERNANCIA DE CÓDIGOS: PERCEPCIONES DE BILINGÜES Y MONOLINGÜES
by Mark Scholl (Honors Scholar)

MEASURING THE IMPACT OF BRAND-NAME CLOTHING ON PERCEPTIONS OF THE WEARER
by Teresa Madruga (Honors/McNair Scholar)

THE INFLUENCE OF CHILDLESSNESS ON FEMALE EMPOWERMENT
by Sarah Doornenbal (Honors Scholar)
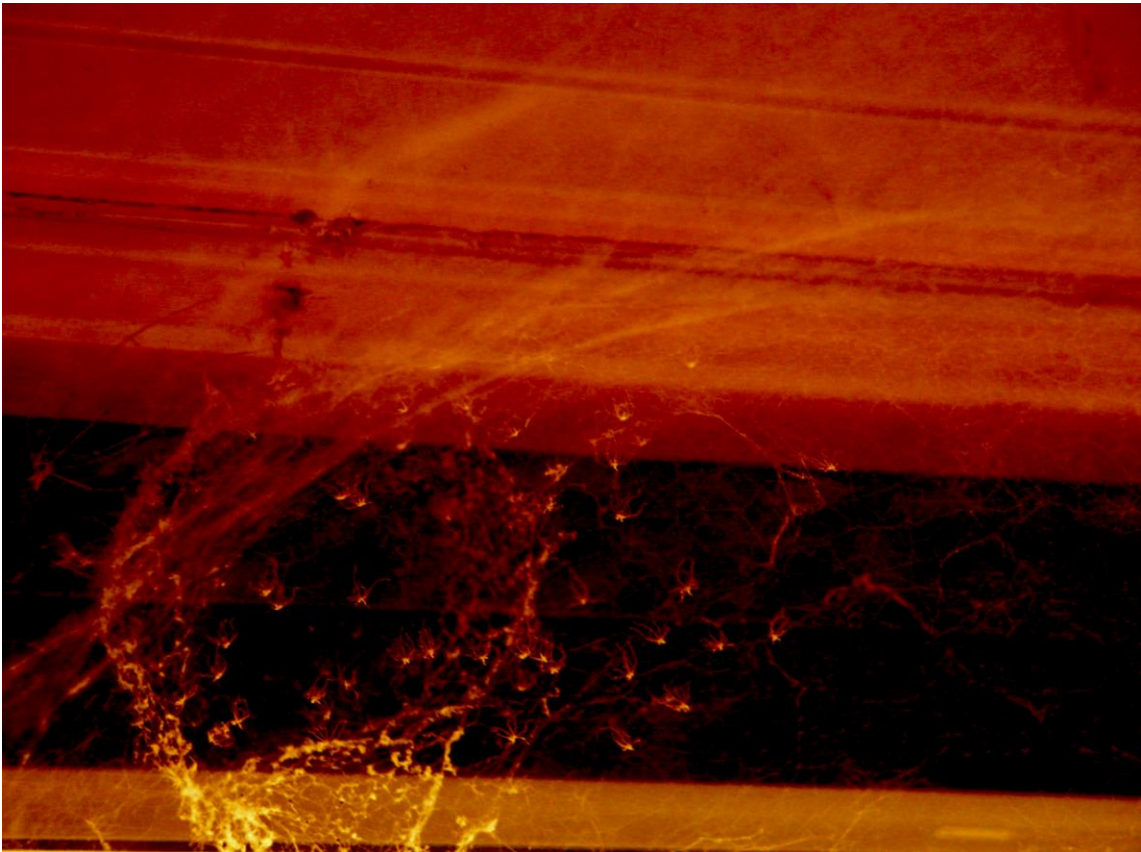
"Web Nebula"
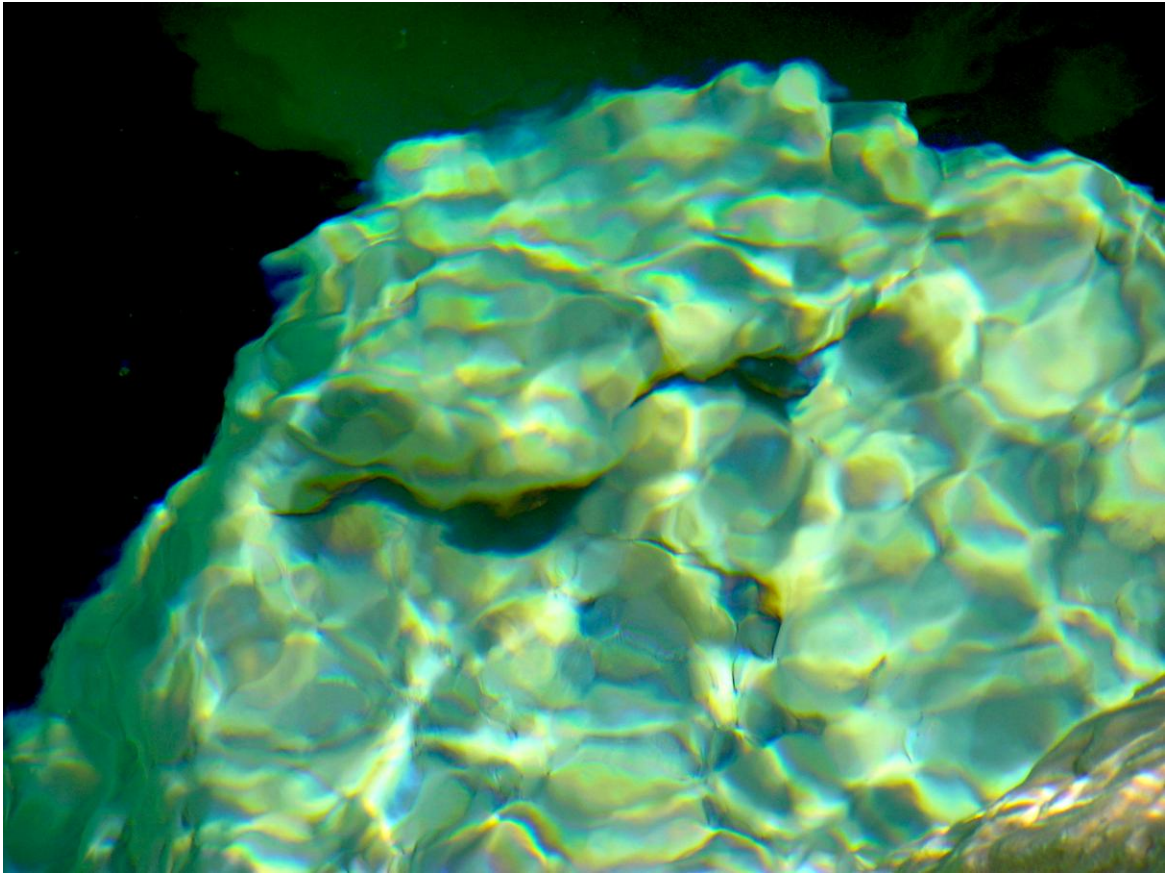
"Eagle Eye"
Queen's Laundry
Yellowstone National Park

HYDROGEN: FUEL OF THE FUTURE

Rachel Chamousis

Abstract

Hydrogen is an energy carrier that can transform our fossil-fuel dependent economy into a hydrogen economy, which can provide an emissions-free transportation fuel. Literature reviews and independent research were the main methods of research. Hydrogen storage and transport are issues of intense research due to hydrogen's characteristic low density. Is hydrogen a justifiable means to the attainment of an environmentally beneficial transportation fuel when methods of production are not utilizing clean, renewable energy sources? What exactly are the completely emissions-free methods of producing and utilizing hydrogen in transportation? Can hydrogen be the fuel of the future?

Hydrogen is the fuel of the future. As an avid researcher of alternative fuels and an ambitious chemistry student, this researcher understands the importance of a shift to a hydrogen economy. Hydrogen is an energy carrier that can be used in internal combustion engines or fuel cells producing virtually no greenhouse gas emissions when combusted with oxygen. The only significant emission is water vapor. Hydrogen production and storage is currently undergoing extensive research. A solar-hydrogen system can provide the means of a totally emissions-free method of producing hydrogen. Although steam reformation of methane is currently the major route to hydrogen production, the emissions involved can also be controlled much more efficiently than our current system of transportation fuel.

Climate change is a serious issue becoming increasingly evident to much of the population. Rising CO_2 levels have directly contributed to the global warming phenomenon. As shown in Figures 1 and 2, the CO_2 levels have rising dramatically in the past 200 years, along with the global average temperature.

Figure 1 - CO_2 Concentration since 1880

Figure 2 - Global Average Temperature since 1880
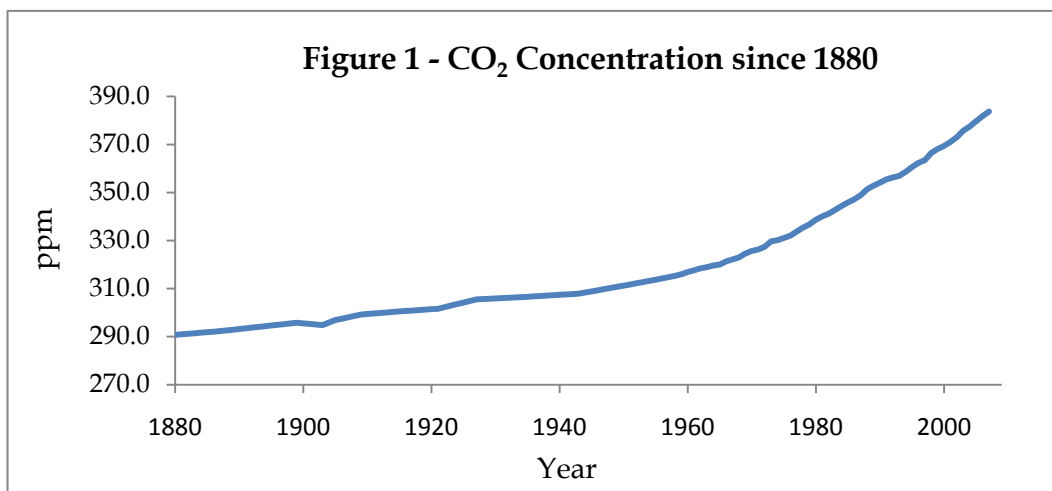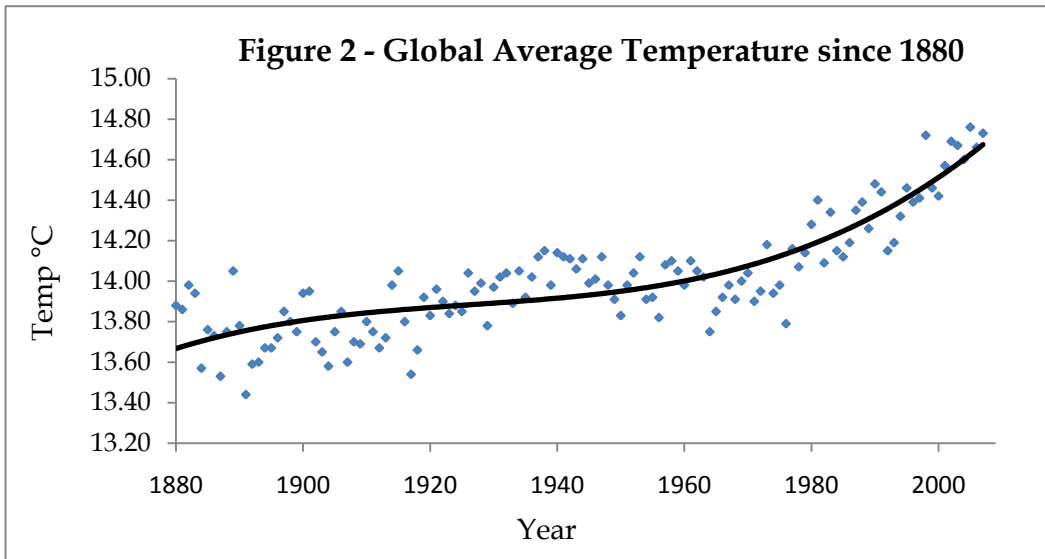
Source: Compiled by Earth Policy Institute, with long term historical data from Worldwatch Institute, Signposts 2001, CD-Rom (Washington, DC: 2001); 1960 to 2007 from NOAA/ESRL, "Atmospheric Carbon Dioxide - Mauna Loa," at: www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html.

While I will examine numerous aspects involved in the hydrogen economy, I will not compare hydrogen to other alternative fuels. Government policy will be briefly referenced, but not detailed. The core of the research concerns the advantages of hydrogen and the current progress related to the disadvantages of hydrogen as a transportation fuel. Much work is in progress to initiate a shift from a fossil-fuel economy to a hydrogen economy. What are the advantages and disadvantages of this hydrogen economy? Who is funding this research and what are their true intentions? Is there a possibility that hydrogen will be the

fuel of the future and also accomplish the goal of being emissions-free?

Materials and Methods

This research is based on independent research and literature reviews. The various sources of research include recent journal articles from opposing sides of the hydrogen economy. The United States Department of Energy website was referenced for current statistics relating to the transportation sector and the various alternative energy sources being researched.

Table 1 - Use of Hydrogen as a Transportation Fuel	
Advantages	**Disadvantages**
High energy yield (122 kJ/g)	Low density (large storage areas)
Most abundant element	Not found free in nature
Produced from many primary energy sources	Low ignition energy (similar to gasoline)
Wide flammability range (hydrogen engines operated on lean mixtures)	Currently expensive
High diffusivity	
Water vapor is major oxidation product	
Most versatile fuel	

Results

Hydrogen is an energy carrier that can be produced and converted into energy through a variety of ways. Table 1 provides a brief explanation of the advantages and drawbacks of hydrogen as a transportation fuel. Electrolysis of water is deemed to be the cleanest route to the production of hydrogen. However, the advantages of this proposed hydrogen economy is dependent on the use of clean, renewable resources as the source of electricity. Today burning coal and nuclear fission generates 68% of the US electricity. For instance, the major routes to employable hydrogen gas involve the use of electricity. Until a dramatic shift is made toward renewable energy sources, the production of hydrogen cannot be emissions free.

Figure 1 – Electricity Consumption (2006)
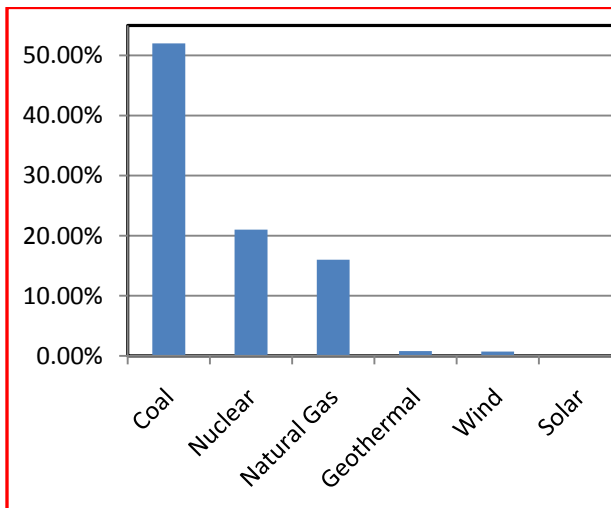
Figure 2 – CO$_2$ Emissions for Electricity Generation (2006)
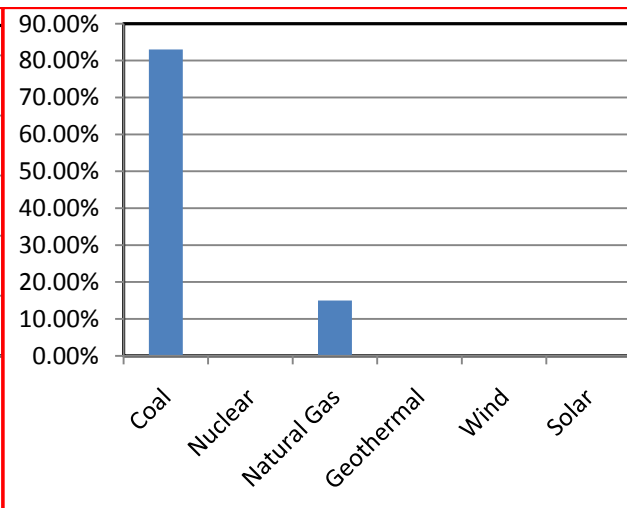
Source: US Dept of Energy

Hydrogen can be produced from several different methods, with only a couple being environmentally beneficial. Electrolysis of water requires electricity, which can be provided by clean and renewable energy sources. Tables 2a and 2b provide a summary of the various ways to produce hydrogen.

Table 2a – Various Methods to Produce Hydrogen		
Method	Process	Implementation
Steam reforming of methane gas	In presence of nickel catalyst & at 700 – 1100 °C: $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$ Next reaction at lower temperature: $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$	Current major source of hydrogen
Hydrogen from coal (Gasification)	At high temperature and pressure: Coal + $H_2O_{(g)} + O_{2(g)} \rightarrow$ syngas Syngas = $H_2 + CO + CO_2 + CH_4$	Current method of mass hydrogen production
Electrolysis of water	Electric current passed through water: $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$	Not in widespread use due to cost of electricity
Solar – Hydrogen system	Electric current passed through water: $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$	Not in widespread use due to cost of renewable energy sources

Table 2b – Various Methods to Produce Hydrogen		
Method	Advantages	Disadvantages
Steam reforming of $CH_{4(g)}$	65 – 75% efficiency Economical (least expensive method) Established infrastructure	Nonrenewable resource Produces CO_2 emissions
Gasification	Large supplies of coal in US Inexpensive resources	Produces CO_2 emissions Carbon sequestration would raise costs 45% efficiency
Electrolysis of water	Depend on electricity source	Input into production may require more energy than released Produces CO_2 emissions if coal is energy source
Solar – Hydrogen System	No emissions 65% efficiency	Expensive

Hydrogen storage and transport is a critical issue involving intense research. The problem is the low density of hydrogen gas. Three possible solutions have been proposed. These potential hydrogen delivery systems include compressed tube trailers, liquid storage tank trucks, and compressed gas pipelines. One major disadvantage of each system is the high capital costs.

Table 3 - Possible Storage Forms for Hydrogen		
Storage Form	**Advantages**	**Disadvantages**
Compressed Gas	Reliable Indefinite storage time Easy to use	Higher capital & operating costs Heat can cause container rupture
Liquid	High density at low pressure	High cost Low temperatures needed Escape can cause fire or asphyxiation
Metal Hydride	High volume efficiencies Easy recovery Very safe	Expensive materials Heavy storage tanks

The use of metal hydrides is the most promising storage material currently. The advantages are high volume efficiencies, easy recovery, and advanced safety. The most common metal hydrides in current research are listed in Table 4.

Table 4 - Hydrogen Storage Properties of Metal Hydrides				
Metal	**Hydride**	**% Hydrogen by mass**	**Equilibrium Pressure (bar)**	**Equilibrium Temperature (K)**
Pd	$PdH_{0.6}$	0.56	0.020	298
LaNi$_5$	$LaNi_5H_6$	1.37	2	298
ZrV$_2$	$ZrV_2H_{5.5}$	3.01	10^{-8}	323
FeTi	$FeTiH_2$	1.89	5	303
Mg$_2$Ni	Mg_2NiH_4	3.59	1	555
TiV$_2$	TiV_2H_4	2.60	10	313

Source: Kraus T; "Hydrogen Fuel – An Economically Viable Future for the Transportation Industry?" Duke J., Economics Spring 2007; XIX.

Hydrogen can be used as the primary fuel in an internal combustion engine or in a fuel cell. A hydrogen internal combustion engine is similar to that of a gasoline engine, where hydrogen combusts with oxygen in the air and produces expanding hot gases that directly move the physical parts of an engine. The only emissions are water vapor and insignificant amounts of nitrous oxides. The efficiency is small, around 20%. A polymer electrolyte membrane (PEM) fuel cell produces an electrical current from hydrogen fuel and oxygen in the air. Hydrogen is split into hydrogen ions and electrons by a platinum catalyst at the anode. The PEM allows only the hydrogen ions to pass through to the cathode where these ions react with oxygen to produce water. The electrons travel down a circuit creating an electrical current. The fuel cells are arranged in stacks in order to provide enough electricity to power a vehicle. The use of a fuel cell eliminates the nitrous oxide emissions. Furthermore, the fuel cell is 45-60% efficient.

Internal Combustion Engine	PEM Fuel Cell

Figure3[1]

Figure 4[2]

[1] Hydrogen-engine.gif; http://hydroxene.net/images/hydrogen-engine.gif (Nov 12, 2008)
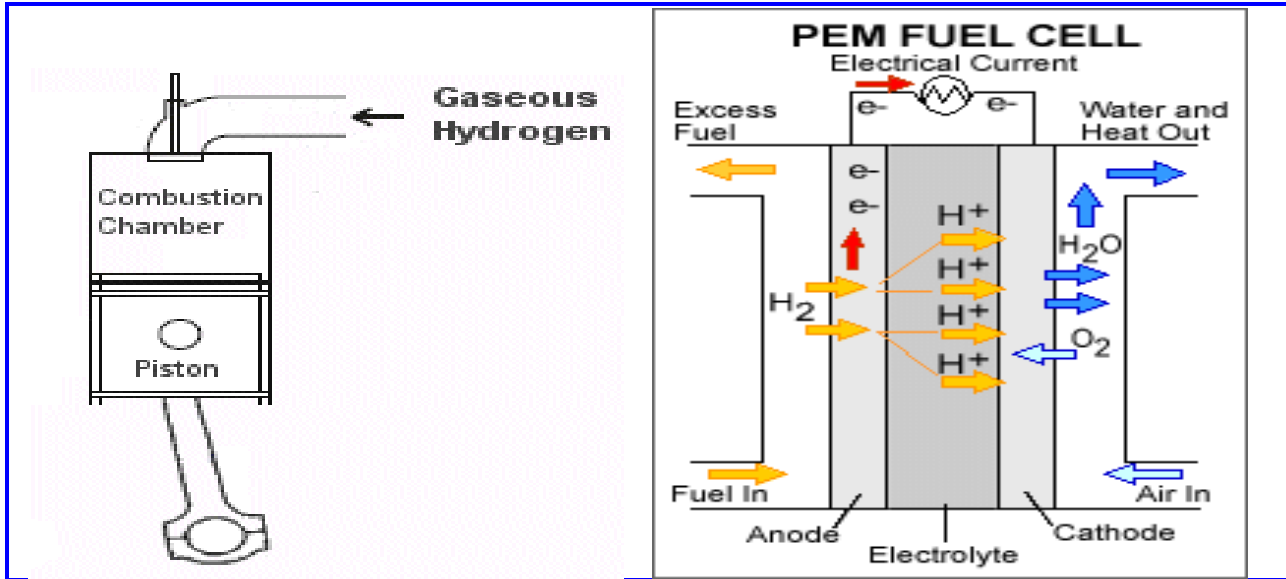[2] PEM Fuel Cell; http://www.lbl.gov/Science-Articles/archive/assets/images/2007/Jan/24-Wed/Fuelcell.gif (Nov 12, 2008)

Discussion

An alternative fuel must be technically feasible, economically viable, easily convert to another energy form when combusted, be safe to use, and be potentially harmless to the environment. Hydrogen is the most abundant element on earth. Although hydrogen does not exist freely in nature, it can be produced from a variety of sources such as steam reformation of natural gas, gasification of coal, and electrolysis of water. Hydrogen gas can used in traditional gasoline-powered internal combustion engines (ICE) with minimal conversions. However, vehicles with polymer electrolyte membrane (PEM) fuel cells provide a greater efficiency. Hydrogen gas combusts with oxygen to produce water vapor. Even the production of hydrogen gas can be emissions-free with the use of renewable energy sources. The current price of hydrogen is about $4 per kg, which is about the equivalent of a gallon of gasoline. However, in fuel cell vehicles, such as the 2009 Honda FCX Clarity, 1 kg provides about 68 miles of travel [3]. Of course the price range is currently very high. Ongoing research and implementation toward a hydrogen economy is required to make this fuel economically feasible.

The current focus is directed toward hydrogen being a clean alternative fuel that produces insignificant greenhouse gas emissions. If hydrogen is the next transportation fuel, the primary energy source used to produce the vast amounts of hydrogen will not necessarily be a renewable, clean source. Carbon sequestration is referenced frequently as a means to eliminate CO_2 emissions from the burning of coal, where the gases are captured and sequestered in gas wells or depleted oil wells. However, the availability of these sites is not widespread and the presence of CO_2 may acidify groundwater.

Storage and transport is a major issue due to hydrogen's low density. Is the investment in new infrastructure too costly? Can our old infrastructure currently used for natural gas transport be retrofitted for hydrogen?

The burning of coal and nuclear fission are the main energy sources that will be used to provide an abundant supply of hydrogen fuel. How does this process help our current global warming predicament? The U.S. Department of Energy has recently funded a research project to produce hydrogen from coal at large-scale facilities, with carbon sequestration in mind. Is this the wrong approach? Should there be more focus on other forms of energy that produce no greenhouse gas emissions? If the damage to the environment is interpreted into a monetary cost, the promotion of energy sources such as wind and solar may prove to be a more economical approach.

The possibility of a hydrogen economy that incorporates the use of hydrogen into every aspect of transportation requires much further research and development. The most economical and major source of hydrogen in the US is steam reformation of natural gas, a nonrenewable resource and a producer of greenhouse gases. The electrolysis of water is a potentially sustainable method of producing hydrogen, but only if renewable energy sources are used for the electricity. Today, less than 5% of our electricity comes from renewable sources such as solar, wind, and hydro. Nuclear power may be considered as a renewable resource to some, but the waste generated by this energy source becomes a major problem. A rapid shift toward renewable energy sources is required before this proposed hydrogen economy can prove itself. Solar photovoltaic (PV) systems are the current focus of my research related to the energy source required for electrolysis of water. One project conducted at the GM Proving Ground in Milford, MI employed the use of 40 solar PV modules directly connected to an electrolyzer/storage/dispenser system. The result was an 8.5% efficiency in

the production of hydrogen, with an average production of 0.5 kg of high-pressure hydrogen per day. Research similar to this may result in the optimization of the solar-hydrogen energy system.

Furthermore, the infrastructure for a hydrogen economy will come with high capital costs. The transport of hydrogen through underground pipes seems to be the most economical when demand grows enough to require a large centralized facility. However, in places of low population density, this method may not be economically feasible. The project mentioned earlier may become an option for individuals to produce their own hydrogen gas at home, with solar panels lining their roof. A drastic change is needed to slow down the effects of our fossil-fuel dependent society. Conservation can indeed help, but the lifestyles we are accustomed to require certain energy demands. Transportation is a necessary part of our current world and the switch to a hydrogen economy can provide a sustainable solution. Is hydrogen the fuel of the future? The research presented here encourages one to answer yes.

REFERENCES

1) United States Department of Energy. Annual Energy Review 2007. http://www.eia.doe.gov/emeu/aer/contents.html (October 20, 2008).
2) Veziroglu TN, Sahin S. 21st Century's energy: Hydrogen energy system. *Energy Conversion and Management*. **2008**, *49*, 1820-1831.
3) Balat M. Potential importance of hydrogen as a future solution to environmental and transportation problems. *International Journal of Hydrogen Energy*. **2008**, *33*, 4013-4029.
4) Dougherty W, Kartha S, Rajan C, Lazarus M, Bailie A, Runkle B, Fencl A. Greenhouse gas reduction benefits and costs of a large-scale transition to hydrogen in the USA. *Energy Policy* (2008), doi:\10.1016/j.enpol.2008.06.039
5) Baschuk JJ, Li X. A comprehensive, consistent and systematic mathematical model of PEM fuel cells. *Applied Energy,* **2009**, *86*, 181-193.
6) Gasification Technologies Council. http://www.gasification.org (October 20, 2008)
7) Committee on Alternatives and Strategies for Future Hydrogen Production and Use, National Research Council. *The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*. Washington, D.C.: The National Academy Press. 2004.
8) Kelly, N.A.; Gibson, T.L.; Ouwerkerk, D.B.; A solar-powered, high-efficiency hydrogen fueling system using high-pressure electrolysis of water: Design and initial results. *Int. J. of Hydrogen Energy*. **2008**, *33*, 2747-2764.
9) Kim J, Lee Y, Moon I. Optimization of a hydrogen supply chain under demand uncertainty. *Int. J. of Hydrogen Energy*. **2008,** *33,* 4715-4729.

ARTIFICIAL INTELLIGENCE:
AN APPLICATION OF REINFORCEMENT LEARNING

Michael Darmousseh

Artificial Intelligence (AI) has advanced quickly through the decades from the first programs to play Chess to modern robots that can perform complex tasks liking learning to walk effectively. The evolution of board games is an interesting and dynamic topic within the field of AI. Some of the advances have been the result of modernization of classical AI algorithms. Algorithms are simply methods of solving a problem. My project involves adapting a modern algorithm to a classical board game and comparing it to a classical algorithm. In order to explore this, I have chosen the game of Connect Four. Perhaps by using Reinforcement Learning (RL), a new program will be able to effectively play against a computer in the game of Connect Four. If this is possible, it might be possible to apply Reinforcement Learning to more complex games like Go or Chess or even to help provide more efficient to problems where the state space is tremendous.

Connect Four

Connect Four is a board game involving two players taking turns placing pieces onto a board in allowed locations. The game is won when four pieces in a row are of the same color. Because simple board games have been traditionally played using the Mini-max (a classical algorithm, see Russell and Norvig), it will likely work for Connect Four. In fact, as a previous project I applied using the Mini-max algorithm and won 95% of the 40 games it played against members of my class. Although this is an effective algorithm for board game AI, I believe that a more modern algorithm called Reinforcement Learning will be more effective and win more often than using the Mini-max algorithm.

Previous Research

The classical algorithm I used is called the Mini-max. This algorithm works by examining the next immediate moves and attempting to determine how likely the program is to win in that particular situation. To determine the likelihood of wining a situation it evaluates the board with using a specified method. This method can be simple such as "If I win the game, then I have 100% chance of winning, or if I lose then I have a 0% chance of winning". Sometimes, when this is not immediately known, an established method will try to approximate the value instead. If there is not enough information about the value of the chance of winning or if it is possible the value can be better approximated than for each of those moves, the algorithm will look at all of the possible counter-moves and examine how likely the opponent is to win. This process will continue back and forth until some maximum number of moves, or some time limit, is reached. The algorithm always assumes that each opponent will choose the best possible move. So the computer will attempt to maximize the minimum gain and minimize the maximum loss from the opponent's perspective hence the name Mini-max. This algorithm excels in situations where the problem is well defined, results are easily understood, and the maximum number of moves is very small. Faster computers and more memory drastically increase the performance of the program.

Reinforcement Learning

One of the many problems in Artificial Intelligence is machine learning. Teaching a computer program how to do something well or optimal has been a problem since computers first came out. In machine learning the computer program uses algorithms to

learn the optimal set of actions in a given situation. In supervised learning this usually means a human teacher giving positive or negative feedback as a means of teaching or even devising a table of states and actions for the specific problem. This methodology has been used extensively in chess. However, supervision comes at a cost. Occasionally, humans do not understand the best actions in a given situation even if they are able to perform them. For example, balancing a pole in a hand is a simple task for humans to learn, but almost impossible to explain to a computer. In response to this obstacle, unsupervised learning or unbiased learning has become increasingly more popular. Instead of trying to explain to a computer how to balance a pole, this type of learning allows the computer to learn it on its own by sensors receiving input from the environment and performing actions. More completely, "Reinforcement Learning is defined not by characterizing learning methods, but by characterizing a learning problem. Any method that is well suited to solving that problem, we consider to be a reinforcement learning method." (Sutton and Barto, 1998, p. 4) Reinforcement Learning is a type of machine learning in artificial intelligence used to optimize computer learning in certain environments without supervision. It was developed initially around 1979 and has evolved over time. This goal of this paper is to examine the history, theory, and applications of Reinforcement Learning and examine an example to understand it more completely.

Artificial Intelligence and Reinforcement Learning

Reinforcement Learning Problems tend to be vast and can cover many ranges of problems. In fact "Reinforcement Learning might be considered to encompass all of AI: an agent is placed in an environment and must learn to behave successfully therin". (Russell and Norvig, 2003, p. 764)

The Basic of Reinforcement Learning

The definition of Reinforcement learning could be summed up as a method of learning designed to perform the best actions in given environments, with the purpose of maximizing a reward value and most importantly without human supervision. The reward of taking an action does not always have to be immediate, in fact the reward may not happen until the final state. Also Reinforcement Learning must be able to predict the reward of any possible action in any given environment. The Reinforcement learning algorithm, in all of its forms, presents a solution to this problem that other types of learning have failed to achieve. The makings of a reinforcement problem include these basic elements: the agent, the agent's environment, a reward function, a value function, and a policy. The agent is the actor in an environment. Typically this represents a program, but this could represent any object not limited to robots, vehicles, or an entire computer itself. The environment of the agent is the place or conditions it must face. In chess the environment would be the board, in robotics perhaps the floor, in a traffic light system this would be all the conditions that apply like car collisions are not allowed. The reward function is the goal of the problem. This reward is numerical and represents the desirability of the state. The goal of the reinforcement program would be to maximize this reward. In chess, winning would be given a score of 1, and losing or tying would be given a score of 0. The rewards do not need to be immediate. In chess the reward is not achieved until someone has been checkmated, resigned, or declared a draw. Finally, the policy is the agent's way of learning to perform certain actions in given situations. The policy could be simply defined as a mapping of environments to actions. In learning to balance a pole this could be something like "If pole is leaning left by 20 degrees or more, move left 3 units".

A More Complete View of Reinforcement Learning

Reinforcement Learning can be applied to any number of artificial intelligence problems of any environment (fully observable or partially observable, deterministic or stochastic, sequential or episodic, static or dynamic, discrete or continuous, and single agent, or multi agent.) The only requirements of Reinforcement Learning are that the environment can be quantified or described in some fashion, a finite number of actions are possible in each state, and that a quantifiable reward can be given at some point of the process (can be as simple as success = 1, failure = 0). With some environments this requires creativity on the programmers part to define the environment in a finite number of ways. As an option, the learning process can be online or offline. What this means is that the learning can take place at a certain time and then use a greedy algorithm once a function evaluation has been trained or that the program can be learning as it is performing the actions.

Temporal DIfference Learning Theory

There are many different equations that can describe a method to Reinforcement Learning. The most basic understanding of Reinforcement Learning can be understood through the Temporal DIfference learning method, which was one of the first to be created. Scholarpedia.com offers a great description of this method:

We consider a sequence of states followed by rewards: . The complete return to be expected in the future from state is, thus: , where is a discount factor (distant rewards are less important). Reinforcement Learning assumes that the value of a state is directly equivalent to the expected return: , where is here an unspecified action policy. Thus, the value of state can be iteratively updated with: , where is a step-size (often =1).

Though this equation seems complex, it can be explained rather simply. Since states and rewards can be thought of as discrete events states, can be assigned rewards. The reward of a state is the value of expected reward of the next state with a discount factor to make sure that distant rewards are not as important as immediate rewards. The algorithm then evaluates the value of each state in a given environment and determines the value of the state based on the current policy being used. This state can then be updated as the sequence continues by adding the value of the current state to some fraction of the difference between the reward actually received and the supposed value. The most important part of this algorithm is that policy will eventually converge to the optimal policy. Another very important part of the Temporal Difference method are eligibility traces. In chess usually there will be one or two moves in the game that determines the outcome of the game. A simple mistake or an ingenious move can be the key to winning or losing. For the temporal difference method, part of the solution is finding out which moves specifically caused the change of the expected outcome of the game.

There are many other forms of reinforcement learning such as Q-Learning and SARSA, but these are just specific algorithms for specific situations. Essentially they are all the same in nature, but the algorithms work differently to emphasize certain parts of the algorithm. Some techniques include limiting the depth of the search for the expected reward, using a fixed policy for the learning algorithm rather than an undetermined policy, or SARSA learning which learns while it is performing actions.

Temporal DIfference Learning Psuedocode

To better understand the temporal difference algorithm it is often best to use psuedocode. The following example demonstrates the temporal difference method of learning. (Stuart and Russell, p. 769)

We consider a sequence of states followed by rewards: $s_t, r_{t+1}, s_{t+1}, r_{t+2}, \ldots, r_T, s_T$. The complete return R_t to be expected in the future from state s_t is, thus: $R_t = r_{t+1} + \gamma^1 r_{t+2} + \ldots + \gamma^{T-t-1} r_T$, where $\gamma < 1$ is a discount factor (distant rewards are less important). Reinforcement Learning assumes that the value of a state $V(s)$ is directly equivalent to the expected return: $V(s) = E_\pi(R_t | s_t = s)$, where π is here an unspecified action policy. Thus, the value of state s_t can be iteratively updated with: $V(s_t) \rightarrow V(s_t) + \alpha[R_t - V(s_t)]$, where α is a step-size (often =1).

What is happening is that using an estimate of the expected reward for all of the states possible given the current one, the value of the previous state is updated its value. Initially the reward is completely unknown and is just a guess, but over time these guesses converge towards the correct values. The alpha and gamma values can be changed for each problem and tend to have different values depending on the problem. The Temporal DIfference method can also look any given number of plys deep or move ahead. This simplest example is TD(1) where it searches 1 ply deep, or TD(2) which searches 2 plys deep, but could be set to any number.

Why Temporal DIfference Learning Works

The Temporal DIfference Learning algorithm does not tell the entire story of how it learns. Part of the problem with greedy algorithms, algorithms that always attempt to perform the best move based on a fixed policy, is that once the algorithm finds an optimal solution they never look back to see if another solution could have been better. To compensate for this an approach using Temporal DIfference learning is using guesses and a method called

e-greedy to determine which move to make next. Often it is not the best approach to always take the best current perceived move at the time. Using e-greedy solves this problem. A boundary called e is set to be the maximum amount of exploration that can be done. This e often has to be tuned to fit the specific problem. A problem with a small state space will have a very small e, but with a large state space will have a large e. Thus when a program is trying to decide which move to take next, once in a while it will take an exploratory move instead of the first choice. Since the states visited have often not been evaluated guesses are given to their values. From these guesses more guesses are made about the state. After a number of trials these guesses are tuned more towards their actual values and go towards the optimal state.

Variations and Range of Reinforcement Learning Problems

Reinforcement Learning can be abstracted to cover a wide range of problems and techniques already used. In the Temporal DIfference method α helps define the amount of knowledge learned. If it is set to 0, then this becomes a greedy algorithm and can be defined as the expectiminimax algorithm which is the traditional algorithm. If it is set to 1, the policy is set to anything, and the search is a full depth search, then this becomes the Monte Carlo method.

Approximation Functions

One of the key parts to the Reinforcement Learning problem is evaluating a state. In Reinforcement Learning developing approximate value of a state is a vital part of the method. There are many ways to do this. A table with a list of all the possible states can be made and be given a score. This requires a finite amount of states and preferably a small number since two similar states will not share any information. Another method would be to use an Artificial Neural Network. By constantly backing up the values of the ANN,

a function approximation can be made. The ANN has the advantage of being able to cover a large state space. If the state space, for example, is a chessboard forcing the program to learn every different state would be impossible, but with a neural network it is able to handle these situations.

Approximation functions are the key to solving large state problems. "However, using function approximators requires making crucial representational decisions (e.g. the number of hidden units and initial weights of a neural network). Poor design choices can result in estimates that diverge from the optimal value function (Baird, 1995) and agents that perform poorly. Even for reinforcement learning algorithms with guaranteed convergence (Baird and Moore, 1999; Lagoudakis and Parr, 2003), achieving high performance in practice requires finding an appropriate representation for the function approximator". (Whiteson, 2006, p. 878)

Scope of Project

The challenges and possibilities of making the best Connect Four program are ultimately what the project is about, however, in order to research the problem I will test my program in multiple fashions to see if there are any insights that would be useful for all AI. My project consists of developing a Connect Four program using the temporal difference learning method and ANNs. Once developed, the program will be tested with multiple parameters to determine if it can be improved. This project will allow me to look at the viability of reinforcement learning when compared to deep search algorithms in Connect Four, which can lead to usefulness in other games.

My research incorporates an AI program for Connect Four using the Mini-max method and comparing it to the Reinforcement Learning algorithm. I tested many different factors in order to determine the optimal

Neural Network size, the learning rate for the algorithm, and finally the difference of hardware and memory that will affect the performance of the Mini-max algorithm. The Reinforcement Learning Program will first begin by training itself how to play. After a set number of games it has trained, it will then begin to play against the Mini-max program to see how it does. Data will be recorded and training will continue. These steps will take place until no improvement is seen in the increase of the number of games played. Likely there will be a breaking point at which the Reinforcement Learning Program will vastly improve against the Mini-max program. Arthur Samuel used reinforcement learning in backgammon and were able to train it to defeat even the best masters (Sutton & Barto pg. 267). The hope is that it also applies to games that are more topological or positional in nature like Connect Four, Chess, and Go.

Results

After conducting research, even after trying multiple parameters, my results were negative. The Reinforcement Learning program simply did not perform well enough. My program was tested against my earlier program using a variation of 4 different parameters and won few games except for the occasional fluke derived from a flaw in the first program.

Analysis

My analysis of the program emphasizes that the reinforcement learning, when applied to positional games, does not take advantage of the dynamic situations that are present. It is very rare that two games are played exactly alike, and thus the reinforcement learning algorithm does not have any time to adapt to new positions and is not capable of learning positional moves. Further study and thought makes me believe that a dynamic version of reinforcement learning, like Monte Carlo, will succeed on the basis of its ability to learn each position dynamically instead of relying on

memory. In conclusion, although my program was not a success, my project demonstrates that, even in a simpler game like Connect Four, reinforcement learning does not appear to be the best method for play.

BIBLIOGRAPHY

Alpaydin, Ethem. Introduction to machine learning. Cambridge, Mass: MIT P, 2004.

Russell, Stuart J., and Norvig, Peter. Artificial intelligence a modern approach. Upper Saddle River, N.J: Prentice Hall/Pearson Education, 2003.

Sutton, Richard S., and Andrew Barto. Reinforcement learning an introduction. Cambridge, Mass: MIT Press, 1998.

Tesauro, G. 1995. Temporal difference learning and TD-Gammon. Commun. ACM 38, 3 (Mar. 1995), 58-68. DOI= http://doi.acm.org.ezproxy.lib.csustan.edu:2048/10.1145/203330.203343

Whiteson, S. and Stone, P. 2006. Evolutionary Function Approximation for Reinforcement Learning. J. Mach. Learn. Res. 7 (Dec. 2006), 877-917.

LITTORINA SNAIL (GASTROPODA) PREFERENCE FOR *MAZZAELLA FLACCIDA* OVER *CHONDRACANTHUS CORYMBIFERA* AND *CHONDRACANTHUS EXASPERATA* (GIGARTINALES, RHODOPHYTA)[1]

Hilary Johnston

Abstract: I collected ten samples of *Mazzaella flaccida* (Setchell *et* N. L. Gardner) Fredericq *in* Hommersand, Guiry, Fredericq & Leister and ten samples of *Chondracanthus corymbifera* (Kutzing) Guiry *in* Hommersand, Guiry, Fredericq & Leister and *Chondracanthus exasperata* (Harvey *et* Bailey) Hughey *in* Hughey, Dudash & Kjeldson at Pigeon Pt, San Mateo County, California during low tide on November 13. Each of the samples was weighed and snails were extracted from the blades and counted. I ran a 2 sample paired t-test to test for the difference between the ratios of snails per wet weight (in grams) for both types of algae. The relatively small p-value of 0.01339 supports the claim that there is a significant difference between the ratios. This difference may be due to preference of snails towards *M.flaccida* as a superior food and/or habitat option to *C. corymbifera and C. exasperata*.

Introduction

Ecological studies on an animal, its food and its habitat can become complex when an animal's food and habitat cannot be separated. Examining the life histories of various parasites and their adaptations to sparse and temporal habitats sheds some light to food-as-habitat solutions. Animals whose habitat is also their food are not necessarily parasites. Such is the case for a *Littorina* snail, whose body is extremely small in comparison to some of the macrophytes it consumes and whose pace is relatively slow. At least for a certain period of time its habitat and its food are one in the same. It is quite possible that the snail weathers both desiccation and wave action attached to its habitat. This study is based on the difference in food-as-habitat preference of *Littorina* snails to *Mazzaella flaccida* compared with *Chondracanthus* – species *Chondracanthus corymbifera* and *Chondracanthus exasperata.* These two algal choices are based on their distinct morphology differences. *M. flaccida* is thin and rubbery with a relatively smooth surface. Both *C. corymbifera* and *C. exasperata* are much thicker than *M. flaccida*, have a waxy and unbending texture and have large bumps all across the blades. *C. corymbifera* and *C. exasperata* are very similar in morphology and thus I did not separate them, but placed them into the same category to be compared with *M. flaccida.* (Kim and DeWreede 1996, Harley 2003, Thornber et al. 2006).

Biological factors such as herbivory and competition have been known to affect distribution of various algae in the low to mid intertidal zones. In a study on the upper intertidal zone, *Littorine* snails preferred *Mazzaella flaccida* to two fucoids (Kim and DeWreede, 1996). *M. flaccida*, *C. corymbifera* and *C. exasperata* are closer in morphology. Both consist of clumps of blades (or singular blades) attached to rocks by small holdfasts and both share the common characteristics of Phylum Rhodophyta. Studies based on these two types of algae might shed some light into the distribution of the algal species in the low to mid intertidal zone. The goal of this study was not to define algal distribution in the area, but simply to determine whether there was a preference of the snails for one or the other algae species.

Methods

I collected my samples on November 13 during low tide at Pigeon Point, San Mateo County, California. It took several hours to collect all twenty samples which were then transported back to the lab at Moss Landing.

The samples were determined using Microsoft Excel random numbers generator; ten samples were collected of *M. flaccida* and ten samples were collected of both *C. exasperata* and *C. corymbifera*. I lay down a thirty foot transect with both ends about equidistant from the shore. The length of the transect traveled roughly the same topography throughout, and *M. flaccida*, *C. exasperata* and *C. corymbifera* blades were found nearby the transect. Each sample consisted of all the blades attached to a single holdfast. At each random sample point on the transect, I located the closest sample of *C. exasperata* and *C. corymbifera* (if it was one of the first ten sample points) or *M. flaccida* (if it was one of the last ten sample points). Samples were labeled M1-10 and C1-10, placed in separate plastic bags within a cooler, and taken back to Moss Landing Marine Laboratories. Each sample was examined individually, one after the other. Snails were first removed and counted and then the algal blades were blotted with paper towels and weighed. There are several species of *Littorina* snails throughout California. Since they can all be easily distinguished as small black snails, I did not concern myself with identifying individual species but placed them into one category. I recorded wet weights of algal blades with and without epiphytes.
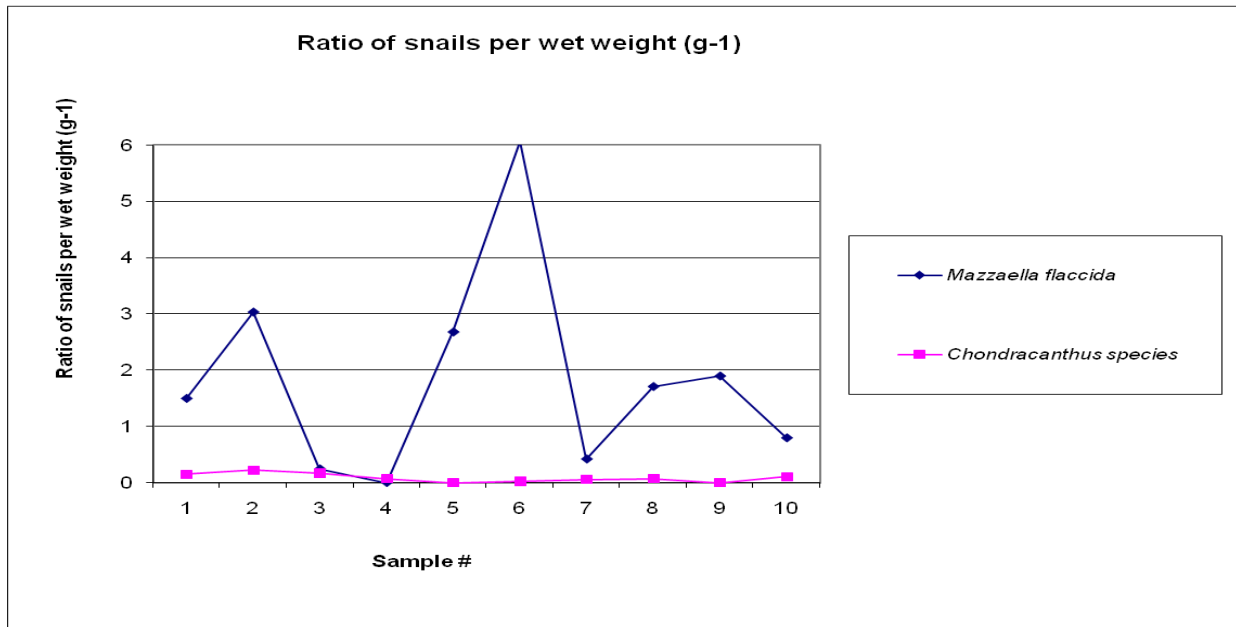

Figure 1 – Ratio of *Littorina* snails per wet weight for each type of algae. The *Chondracanthus* species ratio is more uniform and smaller than the *M. flaccida* ratio.

Data Analysis

For my data analysis, I decided to compare the average ratio of amount of snails per wet weight in grams for the two types of algae (See Figure 1 above). The average ratio for *M. flaccida* was 1.831452507 with a standard deviation of 1.706702654. The average ratio for *C. corymbifera and C. exasperata* was 0.085761274 with a standard deviation of 0.074740231. I used MacAnova 5.03 Release 1 program to conduct a 2 tailed 2 sample t-test. The test results were: t-value of -3.0659, df of 9.0311, and a p-value of 0.01339. The p-value shows a significance of < 0.05 chance that there is no difference in the data sets. I also used scatter plots of amount of snails per wet weight in grams for *M. flaccida* and then separately for *C. corymbifera and C. exasperata.* I ran a linear regression line, and found an equation of $y = 1.084x$ and an R^2 value of 0.5084 for *M. flaccida* For *C. corymbifera and C. exasperata* the equation is $y = 0.0598x$ with an R^2 value of 0.3012. Finally, I ran a linear regression for a scatter plot of wet weight of both algae types in grams (with epiphytes) verses wet weight of both algae types in grams (with epiphytes removed). The equation of the linear regression is $y = 0.968x - 0.213$ with an R^2 value of 0.9974.

Results: The small p-value obtained from the 2 sample t-test supports the claim that there was a difference between the ratio of snails per wet weight for *M. flaccida* to the ratio of snails per wet weight for *C. corymbifera and C. exasperata*. There didn't seem to be a direct correlation to the number of snails and the weight wet for either *M. flaccida* or *C. corymbifera and C. exasperata.* However, in Figure 1 there appears to be a uniform distribution of the ratios for *C. corymbifera and C. exasperata.* Finally, epiphytism was not a huge factor as evidenced by the direct correlation and equation with x-coefficient close to one, and so I did not run tests for both values with and without epiphytes, but only ran the t-test for the wet weight values with epiphytes.

Discussion: The significant difference in ratios of amount of snails per wet weight suggests that *Littorina* snails prefer *M. flaccida* to *C. corymbifera and C. exasperata.* However, since there seemed to be no direct correlation between number of snails and the wet weight (at least obviously for *M. flaccida*), there may have been a number of factors overlooked. Thornber et al. 2006 conducted a study on selective herbivory on *Mazzaella flaccida* which demonstrated that the snail *Tegula funebralis* greatly preferred gametophyte reproductive tissue over other types. I did not examine different types of tissues but considered the whole alga. I took the liberty of using the wet weights with epiphytes but without snails because the weights were so similar to those with epiphytes removed. Unfortunately using mainly tweezers and razor blades I was not very skillful at removing epiphytes which sometimes also burrow a little into the seaweed thallus so I considered the wet weights including epiphytes to be more accurate than the wet weights excluding them. However in <u>Monitoring Rocky Shores</u> Murray et al. suggest not including epiphytes in wet weight values. One thing to keep in mind is that epiphytes are a variable which cannot be controlled in the field, but perhaps in a laboratory setting. In order to make sure that epiphytes are not a contributing factor to snail preference I would need to conduct laboratory experiments with epiphytized verses non-epiphytized *M. flaccida* specimens and *C. corymbifera and C. exasperata* specimens (different containers for each).

Another factor which may have been overlooked is the position of the snails on the blades, as well as the size of the blades. This could of course be remedied by conducting another study, this time using surface area instead of biomass as a variable, and also measuring the position of each snail on the blade. Of course this is very tedious and

would need to be done at very low tide with plenty of available sunlight and people to help take measurements. My simple experiment took most of the low-tide period which at that point was several hours in the early afternoon at a fairly decent low tide. Obviously this would take a lot of planning. Also, one of my samples contained 57 snails, so I can imagine this study would be time-consuming and thus measuring the biomass is a better option for a general, quick overview of snail preference. I cannot imagine measuring distances for 57 different snails I thought it was tedious enough picking them off the algae. Also, since I was only interested in comparing the morphological differences between the two types of algae, I overlooked the age and degradation of blades. However most of the blades appeared to me to be healthy in appearance though many of the edges of the *M. flaccida* were ragged from being worn down by waves. (Mach et al. 2007) I am not sure if this raggedness has an effect on the snails, one would guess the snails would be found farther away from the ragged edges and closer to the holdfast possibly safe from waves and predators.

I chose to compare the *C. corymbifera and C. exasperata* and *M. flaccida* specimens not only because they are morphologically distinct from each other and I observed snails on blades of both algal types, but also because as members of Phylum Rhodophyta they share similar characteristics including chemical properties. Algae are divided into three groups – Rhodophyta, Chlorophyta and Phaeophyta, although classification varies depending on which phylogeny model is used. These groups are commonly referred to as the reds, greens and browns respectively. Members of Rhodophyta share similar life history, morphology and chemical characteristics that are different than the other two groups. Many of the algae on the Pacific Coast at Northern California locations belong to the group Rhodophyta. The kelps however belong to Phaeophyta and are also prominent along the Pacific Coast. There is much greater diversity of reds along the coast than either of the groups. Rhodophyta has about thirteen orders, some of which of course are subject to change. *M. flaccida* and *C. corymbifera and C. exasperata* both belong to the order Gigartinales of Rhodophyta which is considered a more derived group than others. Rhodophyta is considered the most primitive of the algal groups but Gigartinales is one of the less primitive groups among the most primitive algal phylum. While members of Gigartinales are mostly distinct from other groups they do not share characteristics that define them as a group.

For example one group might have a defining characteristic of cruciate tetrasporangia (shape of a reproductive structure) but Gigartinales will include members which have different shapes of tetrasporangia. Basically, if it is unknown what group a red algae belongs to, and it is a less primitive algae, it is thrown into the category Gigartinales. Therefore the fact that *C. corymbifera and C. exasperata* and *M. flaccida* belong to Gigartinales is of no consequence in determining similar characteristics between them. However, the fact that both of these algal types are in the Phylum Rhodophyta means that there are characteristics, including chemicals, they share and which differ to the other two phyla. While I am hypothesizing that morphology might be a factor the snail takes into consideration when choosing one algal blade over the other, I cannot rule out chemical, life history and other factors without conducting more research. (Rhodophyta)

Because of taking Marine Botany at the time of the study, I was much more familiar with knowledge of algae as compared to knowledge of snails. I basically used my algal knowledge as the basis for the study. I have also taken invertebrate zoology both semesters but it is not as fresh in my mind. However, the snails part of this experiment needs to be taken into greater consideration. Snails eat by using a radula – basically teeth

are attached on a ribbon which rolls as the snail moves along, similar in concept to an old fashioned lawn mower. Based on that analogy, one can see why it might be easier for the snail to consume a flat blade like *M. flaccida* rather than a bumpy blade like *C. corymbifera and C. exasperata*. However *M. flaccida* is more stretchy and could possibly be hard for the snail to grip. Lab experiments are required to test the snail's teeth and the amount of energy required to use those teeth to tear the two algal type. D. K. Padilla, in his paper "Structural resistance of algae to herbivores," reminds researchers that the biomechanics of the teeth are important, not just the algal morphology.

Originally, researchers had assumed hard coralline algae were the hardest for herbivores to consume because of the hardness of the those algae compared to most other algae. Coralline algae often form hard crusts or brittle branches and their hardness comes from calcium carbonate which they use for structure. Padilla argues that this argument does not stand on it's own because limpets have teeth which contain iron and/or silica, much harder minerals than coralline algae (nearly twice as much). While limpets are not snails and neither of the algal types are calcified, Padilla's observation is important to this study. In order to understand deterrence or preference of the snail for algal types, the snails morphology also needs to be known thoroughly and how it interacts physically with its possible food. This information needs to be taken into consideration under the hypothesis that preference of one algal type above the other is due to food and not habitat. (Padilla 1985)

There is a significant difference in the ratios of the snails per wet weight algae. The next step in this research would be to perform experiments and determine why there is a significant difference. The two basic categories are food and habitat. Do *Littorina* snails prefer *M. flaccida* blades to *C. corymbifera and C. exasperata* blades

because they prefer to eat or to live on them? Is this due to morphology (perhaps it is just too tough for the snails to eat *C. corymbifera and C. exasperata* or to habitat? One problem with determining this is the fact that there were a lot more *M. flaccida* blades in the area I performed my study than *C. corymbifera and C. exasperata* blades. *M. flaccida* blades are simply more abundant in that area and though I was able to find a transect with both *M. flaccida* and *C. corymbifera and C. exasperata* blades with similar lengths away from the transect, they was definitely a greater number of *M. flaccida* blades. The snails might just be more familiar with *M. flaccida* blades than with *C. corymbifera and C. exasperata.*

In order to test this idea laboratory experiments can be made testing various amounts of *M. flaccida* to *C. corymbifera and C. exasperata* blades with a control being equal amounts of both. Also different test sites in the field can be used as well if there is more *C. corymbifera and C. exasperata* in the area compared to *M. flaccida* etc. After conducting the same experiment in areas of varying abundance of the algal types statistical analyses can be made to determine if there is a significant difference between data sets indicating familiarity as a factor. Again, I would say *M. flaccida* was a dominant algae at Pigeon Point and therefore it would be unlikely for me to find an area with mostly *C. corymbifera and C. exasperata* compared to *M. flaccida.* Also the two different seaweeds, competitive for rock space, may thrive at different physical conditions. In this case, the conditions *M. flaccida* prefers might just coincide with the conditions the *Littorina* snails prefer as well.

While the results of this study suggest that *Littorina* snails prefer *M. flaccida* to *C. corymbifera and C. exasperata,* further studies should be done to support or refute the claim. Studies that will shed light on the other variables such as age and position of snails (to estimate minimum length of time in habitat)

should also be conducted to further understanding of the habitat-as-food for *Littorina* snails. This study is just a stepping stone for further studies about food verses habitat dilemmas. There are many studies undergone to understand relationships between small herbivores and their food/habitats which provide ample methodologies to use in determining preference based on food or habitat. These questions are an integral part of understanding principles in ecology as they also apply to insect-plant relationships on land. As humans we try to eliminate insects from crop plants and increasing concern for the environment allows many people to be skeptical of common pesticides. Better understanding of these ecological relationships has many applications for the well-being of mankind. (Cronin et al. 1996)

Bibliography

Cronin, Greg, and Hay, Mark E. "Susceptibility to herbivores depends on recent history of both the plant and animal." *Ecology (Washington D C)* 77.5 (1996): 1531-1543.

Duffy, J. E. and Hay, M. E. "Food and shelter as determinants of food choice by an herbivorous marine amphipod." *Ecology (Washington D C)* 72.4 (1991): 1286-1298.

Duffy, J. Emmett and Hay, Mark E.. "Herbivore resistance to seaweed chemical defense: The roles of mobility and predation risk." *Ecology (Tempe)* 75.5 (1994): 1304-1319.

Gabrielson, P.W., Widdowson, T. B. and Lindstrom, S. C. *Keys to the Seaweeds and Seagrasses of Oregon and California North of Point Conception.* Phycological Contribution Number 6 (2004), 121-123.

Harley, Christopher D. G. "Abiotic stress and herbivory interact to set range limits across a two-dimensional stress gradient.." *Ecology (Washington D C)* 84.6 (2003): 1477-1488.

Hay M. E., et al. "Seaweed-herbivore-predator interactions host-plant specialization reduces predation on small herbivores." *Oecologia (Berlin)* 81.3 (1989): 418-427.

Hay M. E., Renaud P. E., and Fenical W. "Large mobile versus small sedentary herbivores and their resistance to seaweed chemical defenses." *Oecologia (Berlin)* 75.2 (1988): 246-252.

Heaven, Christine and Scrosati, Ricardo. "Feeding preference of Littorina snails (Gastropoda) for bleached and photosynthetic tissues of the seaweed Mazzaella parksii (Rhodophyta)." *Hydrobiologia* 513.1-3 (2004): 239-243.

Henderson, P. A. *Practical Methods in Ecology*. Malden, MA: Blackwell Pub, 2003.

Kim, J. H. and Dewreede, R. E.. "Distribution and feeding preference of a high intertidal littorinid." *Botanica Marina* 39.6 (1996): 561-569.

Littler, M. M. and Littler, D. S. "The evolution of thallus form and survival strategies in benthic marine macro algae field and laboratory tests of a functional form model." *American Naturalist* 116.1 (1980): 25-44.

Mach, Katharine J. et al. "Death by small forces: a fracture and fatigue analysis of wave-swept macroalgae." *Journal of Experimental Biology* 210.13 (2007): 2231-2243.

Murray, Steven N. *Monitoring Rocky Shores*. Berkeley: University of California Press, 2006.

Padilla, D. K. "Algal structural defenses form and calcification in resistance to tropical limpets." *Ecology (Washington D C)* 70.4 (1989): 835-842.

---. "Structural resistance of algae to herbivores a biomechanical approach." *Marine Biology (Berlin)* 90.1 (1985): 103-110.

Rhodophyta, In-Class Notes. Marine Botany. MS 131. Prof. Michael Graham.

Rothaeusler, Eva, et al. "Laboratory experiments examining inducible defense show variable responses of temperate brown and red macroalgae." *Revista Chilena de Historia Natural* 78.4 (2005): 603-614.

Thornber, C., Stachowicz, J. J., and Gaines, S. "Tissue type matters: Selective herbivory on different life history stages of an isomorphic alga." *Ecology (Washington D C)* 87.9 (2006): 2255-2263.

Wakefield, R. L. and Murray, S. N. "Factors influencing food choice by the seaweed-eating marine snail Norrisia norrisi (Trochidae)." *Marine Biology (Berlin)* 130.4 (1998): 631-642.

"Liquid Spectrum"
Queen's Laundry
Yellowstone National Park

ELASTASE INHIBITION KINETICS AND THE PREVENTION OF CHRONIC PULMONARY OBSTRUCTIVE DISEASES

Mark Lazari and Erik Todd

Enzymatic activity is the driving force for all biological systems. Enzymes allow for the most specific and efficient use of nutrients and energy required for living systems to maintain their homeostatic environment while other stresses in the environment threaten them. One such environment humans in industrialized societies face is the oxidation caused by pollution. The burning of carbon containing substances releases carbon dioxide (CO_2) and water (H_2O), but if the compounds burned were processed with other chemicals, the products may be more harmful than the natural CO_2 and H_2O human bodies are accustomed to dealing with. These products may contain oxidizing agents that can cause unnatural oxidation, which is the removal of electrons from one species or chemical to another. This is often done by the introduction of oxygen, as with rust. Iron is oxidized naturally by an oxygen rich environment, because iron is oxidized to iron oxide. This can also happen with biological species as well. Enzymes are one example of these biological species.

Enzymes work by acting as catalysts for the biochemical reactions that occur within a given biological system. Reactions that would occur naturally would still occur within the body, but enzymes help facilitate and speed up the reaction by acting as the sites of reactions. Enzymatic activity can be activated and inhibited in many ways, because each enzyme is specific for a single species or group of species. Lactase, for example, aids in the breakdown of the sugar lactose. An enzyme can be likened to a well organized and stocked operating room. If a surgeon has all the tools and other materials necessary to perform the operation within easy access, efficiency increases while keeping the chance of error at a minimum. Therefore, all that is really necessary for the operation to happen is to have the surgeon and the patient come together, and having this occur in an operating room makes a successful surgery more likely and in some cases more possible. Other factors affect the procedure just as the presence of nurses also greatly improves the surgeon's efficiency, but in the end, certain key requirements are needed for surgeries (or chemical reactions) to occur and the operating room (or enzyme) can aid in making the process the fastest and easiest possible.

The enzyme this study analyzed was elastase. Elastase is a type of protease, which is a class of enzymes that break down proteins, and it gets its name from its ability to break down the protein elastin. Elastin is a key component in keeping parts of the body elastic, such as the elasticity in the skin and in the lungs. The loss of this elasticity can have drastic effects on the body. The lungs rely on their elasticity to be able to expand and retract, giving a person the ability to breathe regularly. If elasticity is lost, the lungs can no longer function properly, which ultimately leads to death. Mild loss of elasticity is a key component to Chronic Pulmonary Obstructive Diseases (COPDs) such as emphysema and bronchitis. Each disease has its own deadly nature, but both are linked to the inhalation of pollutants such as cigarette smoke. As mentioned earlier, these pollutants often contain oxidizing agents that create an oxidative environment in the lungs. Elastase, an enzyme that cleanses the body of damaged proteins, is naturally activated by oxidation via the presence of hydrogen peroxide (H_2O_2). The pollutants can also activate elastase, activating it unnaturally at a times when the body did not intend to do so. This leads to unnatural break down of healthy proteins such as elastin, reducing the amount

of elasticity in that region of the body. Smoking, then, by causing an oxidative environment within the lungs, promotes the destruction of elastin, which eventually leads to COPDs.

How does elastase get activated by oxidation? The answer lies within the inhibition of elastase. Elastase is a type of enzyme that will continue to work unless inhibited. This inhibition can be likened to a muzzle on a hungry animal. While inhibited, elastase will not break down proteins, because the inhibitor occupies the active site or site of reaction on elastase. Some inhibitors bind to another part of the enzyme, often called an allosteric site, to change the shape of the active site. This, however, is not the case for elastase. The active site is where the compounds meet to undergo the required reaction. Elastin would bind to the active site on elastase if the inhibitor were not there. Active sites are very specific, which is why enzymes are very specific, so that a single change to the site causes the intended response to be halted. The inhibitor specifically involved in the natural inhibition of elastase is alpha-1 protease inhibitor (α1PI). Inhibition only works as long as the inhibitor is bound to the enzyme, therefore to activate elastase, α1PI must be removed from the active site. Just as a change to the enzyme via bound species changes its shape and role, oxidation of the α1PI causes it to change and thus fall off the enzyme. Thus oxidation is the mode in which α1PI is removed and elastase is activated.

The inhibition of enzymes has been categorized into three groups. The first group is competitive inhibition. Here, the inhibitor and the substrate, which is the species to be reacted, compete for the active site. If the inhibitor reaches the active site before the substrate, the enzyme is considered to be competitively inhibited since the reaction of the substrate will not occur. Competitive inhibition is the type of inhibition that α1PI exhibits on elastase. Another group of inhibition is uncompetitive inhibition. With this group, the inhibitors bind to another site on the enzyme, causing a conformational change and thus changing the shape of the binding site. Due to the change in shape, the substrate can no longer bind since the specificity of the site no longer matches the substrate. Competitive inhibition is stronger than uncompetitive; the active site is not completely blocked off in uncompetitive. With uncompetitive, the active site, though changed, may still bind to another substrate. Therefore, the third group of inhibition is called noncompetitive inhibition. Here, a mixture of competitive and uncompetitive inhibition occurs. These types of inhibition can be studied by analyzing the rates in which the reaction will occur at various concentrations of substrate and inhibitor in the presence of the enzyme.

This study uses the substrate n-succinyl-ala-ala-ala-p-nitroanilide (SANA), due to its release of color when hydrolyzed by elastase. When elastase hydrolyzes SANA, there is a change in the color of the SANA solution from a clear solution to yellow. This allows for Ultraviolet-Visible (UV-Vis) spectroscopy to be used in order to study the kinetics, or reaction rate, of the reaction between enzyme and substrate. In this study, the kinetics experiment allowed for the collection of absorbance data at the given wavelength over time. This wavelength was found by scanning a range of wavelengths in order to determine which wavelength yields the maximum absorbance. All subsequent scans were run at this absorbance.

The scans were plotted in terms of absorbance versus time, where absorbance is directly proportional to the concentration of the product from the enzyme/substrate reaction. From this graph the initial rate of the reaction was measured through taking the slope of the initial straight line portion of the graph. The Michaelis-Menten equation: [Your browser may not support display of this image.] ;where [S] is the concentration of the

substrate, SANA, V0 is the initial rate of the reaction, Vmax is the maximum rate of the reaction, and KM is the Michaelis constant; was then transformed into the Lineweaver-Burk equation: [Your browser may not support display of this image.]. Using this equation, the inverse of the initial rate was plotted against the inverse of the concentration of the substrate. From a series of these graphs produced from the use of several concentrations of the inhibitor, the mode of inhibition was determined.

A buffer was created using Trizma base with concentrated hydrochloric acid to adjust the pH to 8.0. Several liters of buffer were made up at a specific time. This buffer was then used as the solvent for the SANA and inhibitor solutions. The SANA and inhibitor solutions were made up each day that the trials were run. For the trials, all chemicals were left at room temperature, which means that the solids were left to stand for one hour prior to massing and that the buffer was also allowed to reach room temperature before diluting the solutions. Once stock solutions of the substrate and inhibitor were prepared to their proper concentrations, the data collection began. Using a Varian Cary 100 Bio Ultraviolet-Visible spectrometer, the absorbance of the reaction was measured for a thirty-second interval. In a given session, there were four concentrations of inhibitor run with five concentrations of SANA, which were kept constant across inhibitor concentrations. These data were then processed through the Lineweaver-Burk plot to determine the mode of inhibition.

The inhibitors used came from the cruciferous family of vegetables. The effects that each inhibitor had was tabulated with reference to both the mode of inhibition, competitive, uncompetitive, or noncompetitive, and the value of α, which is a measure of the inhibitor's affinity for the enzyme. The larger the α value, the greater the affinity the inhibitor has, which results in greater binding of the inhibitor to the enzyme,

and therefore lowering its concentration in the given sample. The different forms of inhibition all have a different equation for how to calculate the value of α. This study aimed to locate inhibitors that were competitive with a large value of α.

Beers Law, a key concept of this study, comes with a hefty price. In order for the equation, and the assumptions that come from it, to be valid, the value of the absorbance must be less than 1. This is very important because of its relation to other factors such as concentration and temperature. This was taken into account when first choosing the concentrations. In order to maintain the absorbance less than 1, concentrations of both enzyme and substrate were adjusted.

Temperature played an important part in the data collection of this study. By adjusting the temperature, the rate at which the reaction took place changed. Therefore, choosing the temperature at which to run the experiment was crucial. However, each temperature range had its own consequences associated with it. The choice to run at a lower temperature meant that the rate proceeded more slowly, which allowed for a larger number of viable points. The problem associated with running at a low temperature was that as the machine ran, the temperature in the cell compartment rose, which caused a sufficient temperature difference between cell and cell surroundings. This caused the formation of condensation on the surface of the cell. With the formation of this layer, the ability of light to pass through was impeded which caused the absorbance readings to become inaccurate.

In response to this concern, the temperature was raised to eliminate the creation of condensation. However, with this adjustment came the problem of the increased rate of the reaction. An increase in the rate of the reaction gave way to the problem of the absorbance reaching a value of 1 more quickly, which limited the amount of data points used to calculate the initial rate of the

reaction. Another possible source of error was that the temperature could still vary in each subsequent trial with no efficient way of measuring the change.

It was the nature of massing out tiny amounts of the solid chemicals that resulted in reproducibility becaming very difficult. A change in concentration among trials made comparisons more difficult. As a result, maintaining a constant concentration of both the inhibitor and the substrate took some adjusting. This problem was solved by either varying the volume added to the cuvette during spectroscopy readings or by varying the volume of buffer used to create the solutions. Varying the volume of the buffer used involved the use of a class A buret, which accurately measured a volume to 0.02 milliliters. This failed to be an efficient method of compensating variability in massing, mainly due to the maintenance and calibration required to quantitatively use a buret. However, by varying the volume added to the cuvette, another issue was encountered in adjusting the volume pulled by the Eppendorf pipettes. The reliability and tolerance allowed by these pipettes limited the choices of usable volumes. The latter method did, however, prove to be a better balance of limiting systematic error and improving efficiency in order to compensate for the changes in substrate and inhibitor masses.

This study offers a collection of inhibitors that have been studied in vitro in the presence of elastase and a model substrate, n-succinyl-ala-ala-ala-p-nitroanilide (SANA). SANA was chosen as the model for its release of color when hydrolyzed by elastase. The color was then measured via UV-Vis spectroscopy, and using Beer's Law a relationship between concentration and time was correlated. This allows for the study of the effectiveness of each inhibitor, in order to find a suitable replacement for α1PI, whose uses are hindered by an oxidative environment. Smoking and pollution eventually build an oxidative environment in the lungs, leading to COPDs, so this study builds a path to finding a pharmaceutical way to help those who suffer from COPDs caused by over activation of elastase. Though inhibition will not actively repair the damage, it will prevent or lessen further damage from occurring, allowing more time for the body to heal. The inhibitors in this study were isolated from cruciferous vegetables, and if a suitable inhibitor is found in them, the consumption of these vegetables would most likely decrease one's chances for acquiring a COPD. This research opens the door for possible relief for those who suffer from COPD, as well as for a greater understanding of elastase activity and COPD prevention.*

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AN EVALUATION OF INSTRUCTIONAL METHODS
FOR TEACHING RECURSION

Tia Shelley

In most fields of study, there is some topic that students historically struggle with. In some, this subject may force students to remain at that level until understanding dawns, or more ominously, until they choose to switch fields. Other topics challenge students to a different extent, in that the student may manage to squeak by for a semester without ever really grasping the topic. There are some ways in which this second group of topics is more dangerous, and it is more interesting in regards to how those students manage to continue within the discipline after that class. Will they side-step that topic through their entire undergraduate career and manage to graduate without some building block of knowledge that is considered fundamental by their instructors?

In computer science, the building block most often left out of this metaphorical tower of learning is recursion. Students typically struggle with this topic, forming models that incorrectly represent how recursion works, while applying the primary rules correctly. Painful as it is to consider, a small number of computer science majors may graduate without real comprehension of how recursion works, because of such "working" models that are formed early on and are difficult to replace. It is the intent of this research to explore recursion and how it is currently being taught in the American university system.

This work will be of value primarily to those students seeking a comprehensive explanation of recursion and to Computer Science educators. However, those interested in education generally may find this study interesting as an exploration of instructional methods. Many disciplines have subjects that students repeatedly struggle with, and educators in those fields may also benefit from an exploration of the teaching of complex material in the field of Computer Science.

The research presented here will synthesize a selection of works that relate to recursion, generally studies performed by computer science educators on methods of teaching recursion, as well as referencing texts that are used in introductory courses. If there is some method of teaching recursion that results in a higher success rate of students who continue on within a degree program in computer science, clearly that method needs to be supported. Additionally, methods that result in semi-viable or non-viable models should be shown to be ineffective. If recursion is not being taught in a manner that results in viable models, then computer science as a field will suffer from a lack of powerful alternative problem-solving methods. The researcher has found that it is quite possible to complete an undergraduate education in Computer Science without a fully functional model of recursion. This study aims to address this issue.

The specific purpose of the study is to describe fully the recursive concept and to discuss methods that instructors use to teach recursion. Correction of non-viable models will not be offered here; instead, this paper presents some discussion of contemporary forms of teaching recursion and the advantages or disadvantages those current methods may provide to students. Though certainly of interest to the topic, questions of a technical nature such as the recursion-first versus iterative-first debate have been excluded as somewhat divergent from the primary focus of this paper. Similarly related to Computer Science instruction but also not

included in this study is a discussion of which language or types of language are of maximum benefit to aid student comprehension.

Terminology

Mental Model (also simply Model) – This term is typically used to describe or define the perception of a process by a particular individual (Norman)/

Recursion - A more complete discussion of recursion will follow, but the simplest definition is that it is a process that is capable of calling additional instances of itself to perform other portions of some task.

Active Flow – This process is the flow of control as a recursive process calls the additional instances of itself.

Passive Flow – This process returns control to the process that initially created that instance once the task has been completed.

Methods - In computer science, "methods" are portions of code that can be called with different parameters that can perform an action and output or return a value. A method is non-functioning until it is instantiated. An instance of a method implies that it has been given some parameters and will perform some actions on those parameters and possibly output a certain value based on them.

Pseudocode – This planning step is used in computer science before the coding process begins. As writers use outlines to plan their papers, programmers use pseudocode to plan programs. Just as an outline does not have complete sentences, pseudocode is not computer-readable.

Methods

The research on recursion has been primarily conducted by university instructors, and examination of student comprehension is the primary focus of their research. Most of the sources consulted were published in the last

decade, though the information referenced in the brief discussion of recursion below, designed for those unfamiliar with computer science, spans an additional three decades. This particular selection of sources was designed for an inductive approach, aiming to find a unifying theme in recursion instruction. Thus the analysis performed on the texts was largely comparative, focusing on how effectively the concept of recursion was explained within the text.

Presentation of Findings

I willl begin with a summary of how recursion works, as described both in the textbooks and in the articles discussing methods of teaching recursion. I will also discuss some additional findings on recursion instruction.

Recursion is a process capable of calling additional instances of itself to complete a task. To explain this concept, an metaphorical example is possibly the best way of conveying a recursive-type task. Rather than using a mathematical example, this paper will attempt to use some of the lessons learned from other studies to explain recursion through more natural models, and then link the subject to computer science more specifically.

When a task is sufficiently large, it can often be difficult for one individual to complete the task. Rather than attempting to complete the entire task, the individual may choose to delegate parts of the task to other people. When the chunks of the task have been handed off, the delegating individual must then wait until those chunks of the task have been completed. The people who received the smaller tasks might still find them too large, and thus hand off portions of their task to more people, and have to wait for those sub-tasks to be returned.

At the very bottom of this chain of command, the individuals have very small problems to solve. These can no longer be

broken down any further, so these individuals are at what will be called the base case. They simply do their part of the task, and hand their completed sub-task back up a level to the one who asked them to complete the task. That person takes all of the data handed to them and performs whatever action is needed to complete whatever task was given them and hands that back up. This continues until the original delegating individual has performed their final action on the completed tasks returned to them.

This passing of tasks to other methods and the implied dependencies generated by it is a schematic introduction to recursive concepts. Figure 1 illustrates what is described above in a simplistic fashion. At this point, it is important to flesh out these concepts and apply them to computer science. This will be accomplished through exploring the pseudocode of a classic recursive problem and then following a trace of that problem.

Quite possibly the classic recursion problem is that of "n-factorial," written henceforth as n!. Defining the problem in a forward thinking format provides: $n! = 1 * 2 * 3 *...* (n-1) *n$. Defining the solution to this mathematical function in a recursive format provides: $n! = n * (n-1)!$. There is one additional part of the definition: $0! = 1$. This base case provides an end situation so that calculations do not become infinite (and thus meaningless here). Some pseudocode follows that could be used as a planning tool for an n! problem:

factorial (n)

 if n = 0, then 1 is returned.

 else, n * factorial (n-1) is returned.

This pseudocode closely resembles the definition provided previously. To gain additional understanding of the principles that are being shown, a trace of the "program" being called with an n value of four will be shown. The complete article includes a visual trace of the process described below.

In the first step of the process, the method recognizes that the value of 'n' is not equal to zero. Therefore, it must call another method to do the next step. The control passes from the first factorial method to the second, calling on the second to do additional work. At this stage, n still does not equal 0, and thus, factorial is called additional times. When the base case is arrived at (which is to say, when n =0), the active control flow is halted. Control no longer passes "downward." Now it begins to head back "up."

From this point, passive flow is in effect. Each method returns the value it evaluated "up" as it receives the appropriate information from the method it called. Note that each instance returns the value to the instance that called it initially.

Tracing the process in this way provides a good deal of information about how recursion works in programming. First, that when a call is made, additional instances are created. This implies that these instances will need space to exist. Secondly, it shows that the instances do not stop existing while waiting for the "lower" methods to perform their calculations. The instances all coexist, which increases memory use during the recursive process.

After this introductory explanation of recursion, it is now appropriate to discuss recursion instruction as it currently exists. There seem to be several schools of thought as to how recursion is best taught, which incorporate at least three similar models of presentation arranged in different orders.

The first model of presenting recursion is through metaphor (Edginton, 2007, Wirth, 2008). The strength in using metaphors is primarily in their accessibility to students who may not have been exposed to recursion in mathematics or linguistics or who have only been introduced to the topic tangentially. Critical to whether or not metaphor use aids

the student to obtain a correct mental model of recursion is how closely the metaphor can be mapped on to the process. Metaphors that do not demonstrate all of the aspects of recursion may cause incomplete models to be formed.

A second model of presenting recursion is through classical mathematical problems. This method is seen most typically in textbooks (Liang, 2005, Carrano & Prichard, 2006, Shiflet & Nagin, 2003). Towers of Hanoi, n!, Fibonacci numbers, reversing a string...all of these problems have been frequently used to introduce students to problems for which recursion can be a simpler solution than iteration. Recursion taught through induction principles builds on a strong mathematical background. However, students with weak mathematical backgrounds may struggle with both the problems and the problem-solving concepts underlying them.

Thirdly, there is the visual/kinesthetic method of presenting recursion (Carrano & Prichard, 2006, Shiflet & Nagin, 2003). By tracing recursive programs during instruction as in the above diagrams or by having students act out recursion in skits, instructors can better assist learners who benefit from other modes of presentation in order to grasp abstract topics in general. Once again though, there is the risk of misunderstanding if the dialogue that guides or accompanies the traces or the acted-out skits is not clear.

It is rare that any one of these models is used without the accompaniment of at least one of the others. The strength of the multiple-model lesson plan is in the number of students to whom it can communicate clearly: if multiple methods are used and time is spent on the presentation, it is more likely that a larger number of students will be able to form correct mental models of the topic.

Conclusion

The exploration of recursion and how it is being taught is part of an ongoing discussion. Education is a complex process in any subject, and doubtless many more variations on traditional instructional methods will continue to arise as today's students become the teachers of the future.

Works Consulted

Carrano, F., & Prichard, J. (2006). Data Abstraction and Problem Solving with Java. Boston: Pearson/Addison Wesley.

Edgington, J. (2007). Teaching and viewing recursion as delegation. J. Comput. Small Coll. 23, 1 (Oct. 2007), 241-246.

Fox, J., (1982). Software and Its Development. Englewood Cliffs: Prentice-Hall.

Ginat, D. (2004). Do senior CS students capitalize on recursion?. In Proceedings of the 9th Annual SIGCSE Conference on innovation and Technology in Computer Science Education (Leeds, United Kingdom, June 28 - 30, 2004). ITiCSE '04. ACM, New York, NY, 82-86

Götschi, T., Sanders, I., and Galpin, V. (2003). Mental models of recursion. In Proceedings of the 34th SIGCSE Technical Symposium on Computer Science Education (Reno, Navada, USA, February 19 - 23, 2003). SIGCSE '03. ACM, New York, NY, 346-350.

Kay, J. S. (2000). Using the force: how star wars can help you teach recursion. In Proceedings of the Fifth Annual CCSC Northeastern Conference on the Journal of Computing in Small Colleges (Ramapo College of New Jersey, Mahwah, New Jersey, United States). J. G. Meinke, Ed. Consortium for Computing Sciences in Colleges. Consortium for Computing Sciences in Colleges, 274-284.

Liang, Y., (2005). Introduction to Java Programming. Upper Saddle River: Pearson Prentice Hall.

Norman, D., (1988). The Psychology of Everyday Things. New York: Basic Books.

Rubio-Sánchez, M., Urquiza-Fuentes, J., and Pareja-Flores, C. (2008). A gentle introduction to mutual recursion. In Proceedings of the 13th Annual Conference on innovation and Technology in Computer Science Education (Madrid, Spain, June 30 - July 02, 2008). ITiCSE '08. ACM, New York, NY, 235-239.

Sanders, I., Galpin, V., and Götschi, T. (2006). Mental models of recursion revisited. Proceedings of the 11th Annual SIGCSE Conference on innovation and Technology in Computer Science Education (Bologna, Italy, June 26-28, 2006). ITICSE '06. ACM, New York, 138-142.

Shiflet, A., & Nagin, P. (2003). Problem Solving in C++. Cambridge: Course Technology.

Weiland, R., & Bauer, C. (1983). The Programmer's Craft. Reston: Reston Pub. Co.

Wirth, M. (2008). Introducing recursion by parking cars. SIGCSE Bull. 40, 4 (Nov. 2008), 52-55.

"Light Palette"
Lake St Mary
Glacier National Park

THE EFFECTIVENESS OF SHORT-TERM STUDY ABROAD PROGRAMS IN THE DEVELOPMENT OF INTERCULTURAL COMPETENCE AMONG PARTICIPATING CSU STUDENTS

Rafael Carrillo

Abstract

Study abroad programs have recently been shortening durations in an effort to recruit students who would not have been able to participate in a traditional yearlong program. While this has successfully augmented the number of applicants, it may undermine the purpose of these programs, to provide students with an educational experience that will build intercultural competence. In today's interconnected world students in higher education need the exposure to foreign cultures that is offered through study abroad programs in order to develop intercultural competence and be competitive in a job market that is icreasingly becoming multicultural. While exposure to foreign cultures is undoubtedly valuable, simply shipping a student off to another country for a short period of time seems to defy the conventional idea of study abroad programs: that longer is better. This study, through interviews of study abroad program directors and students from California State University (CSU) campuses, seeks to evaluate the effectiveness of short-term study abroad programs in developing the intercultural competence of students.

Background and Introduction

As the trends of globalization gain momentum, the ability to communicate effectively in intercultural situations has become ever more important. Businesses have been on the forefront of intercultural development. Since the ability to communicate across various cultures is important for businesses looking to compete in the global economy, thousands of dollars have been poured into the development of evaluation tools. These tools are intended to evaluate the efficiency of overseas immersion programs; through which businesses are able to significantly improve employees' intercultural competence. Because business invest money and time in these employees and programs, it is important for them to quickly identify areas that need improvement.

Several variables have led to the expanding interactions among the world's cultures, including technological advancements in the spread of information. While businesses have responded to globalization in a manner that has allowed them to educate their employees in intercultural communication and develop their intercultural competence rapidly and efficiently, universities in the United States have failed to put forth the same effort. One thing is clear, schools of higher education are expected to respond by providing students with international education programs designed to build their intercultural competence.

One response by universities was the implementation of study abroad programs. Study abroad is not a new idea. In fact, the University of Delaware has began their study abroad program in 1923 (Chieffo and Griffiths 166). According to Chieffo and Griffiths—both faculty at the University of Delaware—the program consisted of "traditional long-term programs" for its first half-century. It was not until the 1970's that the University of Delaware began hosting shorter terms abroad, and that was with the creation of an interim winter semester. With the creation of shorter terms abroad, program enrollment grew significantly, doubling in 1979 and growing rapidly since.

This demographic trend reflects the growing need of programs to be shorter in duration in order to accommodate more

students of varying backgrounds. *The Guide to Successful Short-Term Programs Abroad* quotes a report from 1990 called the *National Task Force on Undergraduate Education Abroad* which remarks that "[f]or students who are older, of minority background, employed (46 percent of full-time students under age 25 are employed at least part-time), disabled, or have limited funds, study abroad is not perceived as an option. The more typical study abroad models and structures mostly ignore the needs of such students" (Spencer xv). Further, the guide notes that just over a decade ago, many students did not study abroad, especially those noted. In fact, fewer than 5% of undergraduates in the US study abroad and "fewer students are participating in traditional 'Junior Year Abroad' programs and are opting for semester programs or—even more frequently—short-term programs that last less than eight weeks" (Chieffo and Griffiths 1). The introduction of short-term programs has created the opportunity for a wider range of students to gain an intercultural experience.

The California State University (CSU) system has a study abroad program that is universally available to all its 23 campuses called International Programs—hereafter referred to as IP. This program only offers study abroad terms that span the academic year, though. The question "why an academic year?" is listed in the FAQ section of the CSU website. The answer lists the following two points: "to get the most out of the study abroad experience, personally and academically" and "to allow time to achieve advanced language, academic and cultural coping skills" ("The California State University"). The website admits "it takes time to go beyond tourism and to undergo the transformation from visitor to resident." Dwyer's conclusion in her research on the impact of study abroad program duration supports IP's claim and states that "long held beliefs that studying abroad for a full year has [a] more significant and enduring impact on students" (161).

Since IP has only academic yearlong programs, most of the CSU campuses have created their own separate programs, which include short-term programs. This study will look at the various short-term study abroad programs—considered in this case to be of an eight week or less duration—of California State University campuses. The focus of this study will be on the ability of the short-term programs to develop the intercultural competence of students, as opposed to a semester or yearlong program.

The American Council on Education has published several reports on international education in the United States. A recent report stated "in spite of an apparent growing national interest in international education, relatively few undergraduates gain international or intercultural competence in college" (Hayward 1). The report cautions that if the United States fails in the international education of its students, it faces the possibility of falling behind other major players in the world in that its citizens will lack the abilities to effectively communicate in multicultural situations (Hayward 1; Deardorff 15). Therein lies a problem, however. Defining intercultural competence and methods by which students can gain it has proven to be difficult. This is also an issue this study will address.

Defining Intercultural Competence

The first step for this project will be to define intercultural competence in a manner that could be used to evaluate the effectiveness of short-term study abroad programs at CSU campuses. Dr. Darla Deardorff has presented what is considered the first definition of intercultural competence reached as a consensus by intercultural experts. Her research arrived at the following definition: "Intercultural competence is the ability to interact effectively and appropriately in intercultural situations based on specific

attitudes, intercultural knowledge, skills and reflection" (Deardorff 5). Applying this definition to a particular evaluation is an area Deardorff admitted would require further research.

For this study, the evaluation will be specifically of students who will engage in and/or have engaged in short-term and long-term study abroad programs through CSU campuses. Based on Deardorff's definition, this study will use the following four points to interpret data gathered and evaluate a specific study abroad program:

1) Attitudes: Students will have attitudes that will vary greatly, but can be measured to a certain degree. Specifically, attitudes of respect (respect of other cultures' beliefs, value systems, etc.), openness, and curiosity and discovery (Deardorff 15) will be measured. It is important to note a student's attitudes before participation in a study abroad program so that they can be compared to the same student's attitudes after. The evaluation on this point will be based on changes in attitudes that promote intercultural competence.

2) Knowledge: Knowledge includes "cultural self-awareness which can be viewed as the crucial starting point for beginning to understand other cultures. Deep understanding and knowledge of other cultures—especially of others' world views— are also key in gaining intercultural competence" (Deardorff 15). Knowledge encompasses several other variables, including an understanding of sociolinguistics, or how language is used in particular contexts in social settings. This type of knowledge can arguably only be gained through the experiential education of study abroad programs.

Many would argue that classroom-based instruction would be sufficient to gaining intercultural knowledge. While this may impact a student's intercultural knowledge to a certain degree, "[a] recent study found that

student level and intercultural competency were virtually unaffected by participation in traditional classroom-based intercultural communication courses…direct experience with people from other cultures is likely the most effective way to improve intercultural competency" (Pennington 1). Evaluation based on knowledge will look at how a student's knowledge and awareness expanded to include very specific information about cultures they experienced as well as their own culture.

3) Skills: Deardorff suggests that, though skills and knowledge were deemed to be separate components of intercultural competence, they are connected and essential to each other. Skills, for this case, are the skills necessary to effectively assimilate and interpret cultural data. This includes communication skills (listening and observing) and cognitive skills (analyzing, evaluating and relating). Though these are skills that are developed through a variety of classes, fundamental in a university student's education, they are not always necessarily related to the development of intercultural competence, thus suggesting that intellectual parameters are critical in this process. Such skills can be developed to respond to an intercultural context, however.

4) Internal and External Outcomes: These parameters are to be measured after participation in a study abroad program and encompass the desired results upon students. Internal outcomes "include elements of adaptability, flexibility, empathy and…adopting an ethnorelative view" (Deardorff 16). These outcomes should effectively result in a change of reference for students. The desired external outcomes should result in a student "behaving and communicating appropriately and effectively in intercultural situations…where appropriateness is the avoidance of violating valued rules and effectiveness is the achievement of valued objectives" (Deardorff 16). This aspect will undoubtedly be the most

difficult to measure and evaluate. By discovering how students have treated intercultural situations since their return from a study abroad program, an accurate measure of the internal and external outcomes should be possible, though.

Methodology

With intercultural competence defined for the purposes of this study, the next step would be to collect data. Since this study will be limited to the California State University system, data will be collected solely from the 23 campuses listed at www.calstate.edu. A questionnaire will be developed to evaluate the four parameters of intercultural competence mentioned above. Using a Likert scale, the questionnaire will be administered to students that had already participated in a study abroad program. Study abroad programs will be divided into three categories—short-term (8 weeks or less), semester long and yearlong. Data will be collected from all 23 CSU campuses, with the surveys administered by the directors of the study abroad programs at each university and will be administered through the US Postal Service for expedience.

Surveys will also be administered to a control group—time permitting. The group will consist of students currently taking (or have taken) courses in intercultural communication. The results will then be compared to determine the effectiveness of study abroad programs as a tool for building intercultural competence versus traditional classroom-based instruction.

The survey administered to all students will also contain an open-ended short response question. The question will ask a student what the single most important thing they learned was (either through the classroom or while abroad) and why. This data can be used to explain significant differences between classroom instruction and study abroad learning. However, the

evaluation of this data is not quantifiable and not as reliable as the survey data.

Limitations

Time is a significant limiting factor in this study. The number of results will be limited, especially in respect to the control group. In order for the control group to be completely accurate, surveys will need to be taken by students in intercultural communications classes at all of the 23 CSU campuses that data is collected from.

Also, this study will be primarily focused on students who have already returned from a study abroad term. So doing provides the fastest way to gather results, but is unable to adequately measure the development of student attitudes that resulted from a term abroad. In order to compromise, the questionnaire will include questions asking students questions in relationship to their "pre-exposure" attitudes.

Another limitation is the manner in which the surveys will be administered. Again, for expedience, the US Postal Service offers the best option. However, this limits the ability to control the issuance of the surveys. Surveys given out in this manner can still be collected and organized according to school, however.

Projected Findings

This study seeks to evaluate the effectiveness of the short-term study abroad programs of CSU campuses in the development of intercultural competence based on a specific definition of the term. The effectiveness of the short-term programs will be compared to that of other semester long programs and the yearlong programs of the IP. Also, results will be compared to a control group taken from students participating in intercultural communication classes.

The data I am collecting and evaluating should yield information that will be helpful

for determining ways to improve the educational quality of short-term study abroad programs, including their ability to build intercultural competence in participants.

Works Cited

Chieffo, Lisa, and Lesa Griffiths. "Large-Scale Assessment of Student Attitudes after a Short-Term Study Abroad Program." <u>The Interdisciplinary Journal of Study Abroad</u> X (2004): 165-177.

Deardorff, Darla K. "Policy Paper on Intercultural Competence." Interdisciplinary Workshop. Guetersloh, Germany. February 2006.

Dwyer, Mary M. "More Is Better: The Impact of Study Abroad Program Duration." <u>The Interdisciplinary Journal of Study Abroad</u> X (2004): 151-63.

Fowler, Floyd J. "Structured Interview." <u>The Sage Encyclopedia of Social Research Methods</u>. Ed. Michael S. Lewis-Beck, Alan Bryman, and Tim Futing Liao. Thousand Oaks, Ca: SAGE Publications, 2004.

Hayward, Frank M. "Preliminary Status Report 2000: Internationalization of U.S. Higher Education." Washington DC: American Council on Education, 2000.

Klemp, George O. "Identifying, Measuring and Integrating Competence." <u>Defining and Measuring Competence</u>. Eds. P. Pottinger and J. Goldsmith. San Francisco: Jossey-Bass, 1979.

Open Doors Online. "Study Abroad Surging Among American Students." 5 May 2008. <http://www.opendoorsiienetwork.org>

Pennington, Barbara, and Susan Wildermuth. "Three Weeks There and Back Again: A qualitative investigation of the impact of short-term travel/study on development of intercultural communication competency." 28 April 2008 <http://www.facstaff.uww.edu/wca/submissions05/113threeweeks.doc>.

Spencer, Sarah E., and Kathy Tuma, eds. <u>The Guide to Successful Short-Term Programs Abroad</u>. Washington, DC: NAFSA, 2002.

The California State University. 7 May 2008. <http://www.gateway.calstate.edu/csuienet/index.shtml>

"Liquid Filter"
through the lens of Lake St. Mary
Glacier National Park

LA ESPAÑOL-INGLÉS ALTERNANCIA DE CÓDIGOS: PERCEPCIONES DE BILINGÜES Y MONOLINGÜES

Mark Scholl

Introducción del estudio

Quizás sea la alternancia de códigos uno de los temas más complicados respecto al bilingüismo. De hecho, algunos lingüistas opinan que "perhaps the central issue in bilingualism research is code-switching" (Milroy & Muysken 7). Este estudio, tal como los antecedentes en la disciplina lingüística, va a tratar de profundizar el tema de esta alternancia bastante complicada que nos rodea. Específicamente, es la meta de este estudio descubrir las percepciones de la alternancia y evaluarlas frente a la realidad.

Razonamiento por el estudio

Muchos estudios sobre la alternancia de códigos se han enfocado en dos temas principales: la sociolingüística y la gramática. Enormes esfuerzos han sido tomados para explorar el fenómeno de la alternancia entre hablantes bilingües. Sin embargo, todavía falta un enfoque específico en las percepciones que tienen las personas monolingües hacia la alternancia de códigos. Es por eso que este estudio se dedica a descubrir los sentimientos que experimentan los monolingües tanto como los bilingües cuando escuchan tales alternancias de códigos.

Definiciones

Antes de seguir, es importante clarificar el término más clave que se usa en este estudio. Alternancia de códigos: esto es el uso alterno de dos o más idiomas en la misma conversación (Milroy & Muysken 7). Algunos lingüistas han clasificado esta alternancia en tres niveles prácticos: el tipo "etiqueta", la alternancia interoracional e intraoracional. Para este estudio, solamente nos importará la alternancia que ocurre a niveles intraoracionales, o sea, que ocurre dentro de una misma oración.

Distinciones entre los términos

Es importante distinguir entre la "alternancia" de que hablamos arriba y las "palabras prestadas" porque muchas personas tienden a confundir los dos términos. Las llamadas "palabras prestadas" son palabras y expresiones cortas y tomadas de un idioma y adaptadas fonéticamente o morfológicamente a otro idioma (Grosjean 263). Éstas son palabras que cualquiera persona sepa a pesar de su nivel de bilingüismo. Este estudio no se tratará de estas palabras.

Metodología

Para abordar esta tarea, cien cuestionarios fueron repartidos a estudiantes en las clases de "ENG 1000" en la universidad de CSU Stanislaus. En los cuestionarios, los estudiantes rellenaron datos básicos como su edad, sexo, etnia y ciudad de origen. En los cuestionarios, se les explicó brevemente el significado de la alternancia de códigos y se les dio un ejemplo de un cambio típico intraoracional de español a inglés. Después, los estudiantes tuvieron que contestar si habían escuchado tal alternancia recientemente o no. Si contestaron afirmativamente, de una lista tuvieron que trazar un círculo alrededor de las palabras que describieran su sentimiento al oír la alternancia de códigos. Finalmente, se les pidió dar una razón explicando por qué la alternancia de códigos ocurriría entre personas bilingües. (Se puede consultar la última página en este estudio para ver el cuestionario entero).

Resultados de la encuesta

De los cien cuestionarios devueltos, cincuenta y dos eran de latinos (catorce hombres y treinta y ocho mujeres), treinta y tres de caucásicos (doce hombres y veintiún mujeres), cinco de negros (un hombre y cuatro mujeres) y diez de asiáticos (un hombre y nueve mujeres). Todos los encuestados tenían entre diecisiete y diecinueve años. Solamente ocho personas escribieron que nunca antes habían oído la alternancia de códigos. Los demás (noventa y dos personas) sí habían escuchado la alternancia de códigos, y entre éstas, setenta y siete la habían escuchado en la universidad de CSU Stanislaus. Cabe mencionar que casi todos los latinos encuestados se clasificaron bilingües salvo cuatro. En los siguientes cuadros, veremos en más detalle cómo todos los encuestados respondieron a las preguntas principales. Cada "x" representa la opinión que tiene una persona encuestada. Bajo cada etnia, se encuentran dos columnas. La columna al lado izquierdo tiene las opiniones de los hombres de dicha etnia, mientras la columna a la derecha tiene las opiniones de las mujeres.

Cuadro 1: qué sentimientos experimentaron al oír la alternancia de códigos

CUADRO 1		Latinos (52)		Caucásicos (33)		Negros (5)		Asiáticos (10)	
1	**Confusión**	xxxxxx	xxxxx	xxxx	xxxxxxx xxxxx	x	xx	x	xx
2	**Sospecha**	xx	xx	xxxxx	xxxxxx	Ø	x	Ø	x
3	**Interés**	xxxxxx	xxxxxxx xxxxx	xxxx	xxxxxxx xxxx	Ø	x	Ø	xx x
4	**Desconfianza**	Ø	x	xx	xx	Ø	x	Ø	Ø
5	**Curiosidad**	xxxxx	xxxxxxx xxxxx	xxxx	xxxxxxx xx	x	x	x	xx x
6	**Incomodidad**	Ø	x	xxx	xxxxxxx x	Ø	x	Ø	Ø
7	**Amenaza**	Ø	Ø	Ø	x	Ø	Ø	Ø	Ø
8	**Aprecio**	Ø	xx	Ø	Ø	Ø	Ø	Ø	Ø
9	**Ofensa**	Ø	x	x	x	Ø	Ø	Ø	Ø
10	**Torpeza**	xxxx	xx	x	xxxxxxx xx	x	x	Ø	x
11	**Aislamiento**	xx	x	xx	xxxxxx	Ø	Ø	Ø	x
12	**Fascinación**	x	xxxxxxx	xx	xxx	Ø	Ø	Ø	xx x

Discusión de cuadro 1

Este cuadro nos revela cómo reaccionaron diferentes etnias al oír la alternancia de códigos. Observamos que existen algunas semejanzas de sentimientos entre los grupos, pero lo más interesante para este estudio son los contrastes. Específicamente, vemos que los grupos no latinos experimentaron proporcionalmente mucho más sospecha e

Cuadro 2: razones asumidas por la alternancia de códigos

CUADRO 2		Latinos (52)		Caucásicos (33)		Negros (5)		Asiáticos (10)	
1	**Sucede naturalmente**	x	xx	Ø	x	Ø	x	Ø	Ø
2	**Lo hacen inconscientemente**	Ø	xxxxxxxx	xx	x	Ø	Ø	Ø	Ø
3	**Ayuda expresarse a sí mismo**	xx	xxxxxxxx	Ø	xx	Ø	Ø	Ø	x
4	**Para decir algo mal de alguien**	Ø	x	xx	xxxx	Ø	Ø	Ø	Ø
5	**Es hábito/Están acostumbrados**	x	xxxxxxxx	x	Ø	Ø	Ø	Ø	xx
6	**Es más fácil**	xx	xx	Ø	x	Ø	Ø	Ø	Ø
7	**Para mostrar algo en común**	Ø	xxxx	Ø	x	Ø	Ø	Ø	Ø
8	**Para ocultar algo**	x	x	xxx	xxxx	Ø	x	Ø	xx
9	**Todavía aprenden inglés**	Ø	Ø	x	xx	Ø	Ø	Ø	x
10	**Si olvidan una palabra**	x	xx	Ø	Ø	Ø	Ø	Ø	Ø

Discusión de cuadro 2

En este cuadro, vemos aun más contrastes entre los diferentes grupos. Primero, solamente una latina creía que la alternancia de códigos servía para hablar mal de alguien. Este dato es relativamente pequeño en

contraste con los seis no latinos que también pensaban que sí. Además, diez personas no latinas pensaban que la alternancia servía para ocultar información de los hablantes monolingües, mientras sólo dos latinos estaban de acuerdo. Esta información nos revela la razón detrás de las sospechas e incomodidades de las muchas personas que no eran latinos. Si estudiamos este cuadro más a fondo, observamos que los latinos proveyeron razones en defensa de la alternancia. Por ejemplo, muchos apuntaron en los cuestionarios que la alternancia de códigos es algo habitual (nueve latinos) e inconsciente (ocho). Además, diez latinos mencionaron que la alternancia sirve para expresarse a sí mismos en una manera mejor. Pocas personas no latinas estaban de acuerdo con estas tres razones previas.

Cómo responder a los monolingües

Vimos claramente en los cuadros arriba que

los no latinos generalmente tienen una perspectiva negativa hacia la alternancia de códigos, y puede ser por una falta de entendimiento. Es obvio que hay una necesidad de explicarles la alternancia de códigos a ellos para que lleguen a comprenderla y a los bilingües bien. Mientras no todos los casos de la alternancia entre dos idiomas se pueden explicar, hay algunas razones claves que los lingüistas han descubierto y que explican tal alternancia. Los puntos que siguen sólo son unos entre otros que pueden ayudar a los monolingües a ver la alternancia de códigos con más aprecio.

1. El estilo

Es importante que los monolingües reconozcan que ellos también suelen expresar su propia "alternancia" dentro de una sola lengua. Esto es difícil reconocer, pero es verdad. De hecho, unos lingüistas admiten que "the act of switching between languages is much more visible than the style-shifting characteristic of the monolingual speaker" (Milroy & Muysken 4). Hay una relación entre los estilos que usan las personas monolingües y bilingües. Otro lingüista aclara que "the same social pressures which would lead a monolingual to change from colloquial to formal or technical styles may induce a bilingual shift from one language to another" (Gumperz 230). Por ejemplo, las palabras "yeah" e "yes" en inglés expresan la misma afirmación, pero el estilo de la primera es informal mientras la segunda es formal. Entonces, el anglohablante monolingüe también tiene que escoger en manera subconsciente que palabra va a usar, dependiendo del contexto y con quien está hablando. Lo mismo ocurre con las frases "I'm gonna eat" y "I am going to eat". Las dos frases revelan el mismo mensaje semántico, pero el estilo entre las dos tiene matices diferentes de formalidad. Si las personas monolingües se dan cuenta de esta incidencia en su propia lengua, pueden entender mejor las semejanzas con la alternancia de códigos entre hablantes bilingües porque un proceso muy similar ocurre en los dos casos (monolingües y bilingües).

2. La identidad

Otra razón fundamental por la alternancia de códigos tiene que ver con la identidad del hablante en un ambiente sociológico. En otras palabras, la alternancia de códigos marca una forma de comunicarse con otros del mismo origen sociológico. Específicamente hablando de nuestra región en los EE.UU., se ha dicho que la alternancia de códigos "can serve as an indicator of group identity. It has done so for many Chicanos in the South-western USA who feel that they are a group distinct from non-Hispanic English speakers and also from Spanish-speaking Mexicans. One way of indicating their group identity as Chicanos is to draw freely on both languages" (McCormick). Entonces, los Chicanos forman parte de un grupo social que se queda entre dos culturas: la mexicana y la norteamericana. Una manera de identificarse con otros miembros del mismo grupo es hablar usando (en manera inconsciente) la alternancia de códigos. Para el hablante monolingüe, sería buena idea tener en cuenta este aspecto cultural.

3. La destreza

Para muchos hablantes monolingües, es corriente pensar que una persona alterna el idioma por una falta de competencia lingüística. Al contrario, esta forma de pensar no es correcta. De hecho, la alternancia de códigos "is a verbal skill requiring a large degree of linguistic competence in more than one language, rather than a defect arising from insufficient knowledge of one or the other" (Poplack 261). Para entender esta idea, los hablantes monolingües deben tener una vista de las destrezas que requiere la alternancia de códigos para poder funcionar. Deben saber que, para poder alternar entre dos idiomas, los hablantes bilingües necesitan tener un fundamento esencial de la sintaxis de ambos idiomas. Más específico, "para poder llevar a cabo la transición de una lengua a otra se tienen que resolver problemas de orden sintáctico" (Zeromska 291). No vamos a

meternos en el aspecto gramatical con mucho detalle, pero los hablantes monolingües deben saber que oraciones mezcladas al azar como "el man que came ayer wants John comprar a car nuevo" no son correctas en la perspectiva bilingüe (Peñalosa 65). La alternancia de códigos no es algo que ocurra al azar, sino hay ciertas reglas gramaticales que determinan donde cambiar los idiomas teniendo en cuenta la sintaxis de los dos. Esto es una maravilla digna de aprecio.

Conclusión

Este estudio nos revela que hay percepciones falsas hacia la alternancia de códigos por falta de entendimiento. La alternancia de códigos no es algo que se deba sospechar o menospreciar, como algunas personas lo hacen. Hay que reconocer que la alternancia es algo inconsciente. Como un lingüista lo resume, la alternancia de códigos "is mainly a subconscious strategy and it is the message on which the speaker focuses rather than the medium -- or media -- in which he conveys it" (Jacobson 188). En nuestra región de California (y más específicamente en CSU Stanislaus), grupos bilingües como los Chicanos y otros grupos monolingües van encontrándose cada día. Es importante que las personas monolingües no prejuzguen las bilingües solamente por escuchar una alternancia que no entiendan. Este estudio nos demuestra la necesidad de aclarar las percepciones que existen en nuestras comunidades.

OBRAS CITADAS

Grosjean, François. "A Psycholinguistic Approach to Code-switching: The Recognition of Guest Words By Bilinguals." Eds. Milroy, Lesley, and Pieter Muysken. One Speaker, Two Languages. Cambridge: Cambridge UP, 1995. 259-275.

Gumperz, John J. Language in Social Groups. California: Stanford University Press, 1971. 230-231.

Jacobson, Rodolfo. "The social implications of intra-sentential code-switching." Spanish in the United States: Sociolinguistic Aspects. Eds. Amastae, John and Lucía Elías-Olivares. Cambridge: Cambridge UP, 1982. 188.

McCormick, K. M. "Code-switching and Mixing." The Encyclopedia of Language and Linguistics. New York: Pergamon Press, 1994. 581-587.

Milroy, Lesley, and Pieter Muysken, eds. One Speaker, Two Languages. Cambridge: Cambridge UP, 1995. 4.

Peñalosa, Fernando. Chicano Sociolinguistics: A Brief Introduction. MA: Newbury House Publishers, Inc., 1980. 65.

Poplack, Shana. "Sometimes I'll start a sentence in Spanish y termino en español": toward a typology of code-switching. Spanish in the United States: Sociolinguistic Aspects. Eds. Amastae, John and Lucía Elías-Olivares. Cambridge: Cambridge UP, 1982. 230-263.

Zeromska, Joanna. "El code-switching en dos cuentos de escritores chicanas; un análisis conversacional." Iztapalapa 23 (2002): 290-304.

MEASURING THE IMPACT OF BRAND-NAME CLOTHING
ON PERCEPTIONS OF THE WEARER

Teresa Madruga

In my early years as a junior high and high school student, brand name clothing, clothing with the company name emblemized on the clothes in a noticeable way, became a focus of my attention. At first I wanted to be like the popular (and often times wealthy) students and wear brand name clothes just as they did. I looked at those wearing brand names as "better" than those who chose not to wear brand names. Shortly thereafter, I rejected the "popular" brand names in favor of "indie" brand names feeling as though this were a slap in the face to the "popular" names, thinking the popular brand names were just stupid. By my later high school years, I felt that by wearing any brand name I was wasting my money and began to view others who wore shirts with large brand name logos as stupid for wasting their money, and often times viewed them as stuck-up as well. All through the end of high school and into college, I have noticed a proliferation of brand names. I began to wonder if other people judged others as I do based on their clothing. This sparked the idea for my senior thesis; Do brand name clothes impact how a person is perceived by others?

Previous research has shown that individuals are perceived differently depending on the types of clothing that they wear (Damhorst & Reed, 1986; Kerr & Dell, 1976). Both clothing style and color affect how others perceive a person. For example, James, Man, and Stout (2006) found that individuals dressed in athletic clothing were at a greater perceived social distance than those in a control group. Several studies have found that the color of clothing affects the perceived level of aggression; specifically dark clothing evokes the perception of aggressive acts (Frank & Gillovich, 1988; Vrij, 1997). A recent study by Fennis (2008) has demonstrated that surrounding oneself in high-status brands causes submissive behavior in a partner during social interactions and affects the person's likeability. Fennis established this by having participants wait in a room with an individual who they were told was another participant; that second individual was in fact a confederate. The confederate was surrounded with branded items, including a sunglass case with a printed brand and a magazine in one's vicinity. The participants were assigned to either a high-status brand condition or a low-status brand condition. The study examined the relationship between various characteristics of brands (competence, prestige, success, wealth, achievement, luxury, and power, as rated on a 5 point Likert-type scale by judges prior to the study) and perceptions of submissive and dominant behavior in the confederate, as well as perceived likeability. Fennis gave the participant and confederate 8 mins to engage in conversation. Then a research assistant took the participant to another room where he was asked to answer on a 5-point Likert-type scale: "To what extent did you like your conversation partner?" Two judges who watched the participant-confederate interactions using a hidden camera rated submissive behavior. The study found that both males and females were more likely to rate a confederate as likable if the confederate was surrounded with high-status brand name products even without attention directed to the product. The judges rated participants as significantly more likely to act in a submissive manner when the confederate was surrounded with items rated as high-status. This suggests that high-status brands of clothing may affect the perception of the wearer.

No study has specifically addressed the perception of a person wearing brand name clothing. One study addressed the competency of the wearer of brand name clothes, but their study was confounded by the location in which the target was photographed (Fennis & Pruyan, 2006). Another study addressed perception of brand name clothing (as well as other items); it did not address the how the wearer of the brand name clothing was perceived, but chose to focus on the clothes themselves (Workman, 1988).

People looking to shape their image could utilize results from the following study if results show that those wearing high-status clothing are perceived differently than those in low-status or no-status clothing. If results were to show that clothing status does not affect how a person is perceived, this information could be used to inform buyers so that they know they can save money on clothing without changing how they are perceived. If results show that such clothing does affect how an individual is perceived, individuals could use this information to shape how they are perceived. The purpose of this study is to evaluate whether brand names on clothes affect how a person is perceived, without attention being called to the brand name in particular.

The participants were 64 California State University Stanislaus enrolled in introductory psychological methods courses. Three different classes were used for each group. Volunteers were treated in accordance with the "Ethical Principles of Psychology and the Code of Conduct" (American Psychology Association, 1992).

A model was photographed wearing three different tee shirts associated with different levels of social status. The photographer used a tripod. In one photo, the model wore an Ambercrombie and FitchTM tee shirt. He then was photographed in a similarly colored and styled Old NavyTM tee shirt. Adobe Photoshop 7.0 was then used to remove the Abercrombie and FitchTM logo on a separate picture to create a control photo. The Abercrombie and FitchTM photo and the Old NavyTM photo were taken in the same location with the same stance and facial expression to control for extraneous variables. The three photos of a male model were shown to participants on an overhead projector. The participants were told they were participating in a survey regarding person perception, so that they would not intentionally look at the brand. They were given a survey that included 50 questions regarding different aspects of personality as well as six demographic questions. Only the questions asking about likeability, attractiveness, competency, trustworthiness, and intelligence were examined in this study.

The collected data were analyzed using a one-way analysis of variance (ANOVA). The simplest statistical analysis would be the t-test. To use a t-test, the standard test in statistical analysis, there must be only two levels (Christiansen). The current study contained three levels. Therefore, the next step was to use what is the simplest expansion of the t-test, the one-way ANOVA. The one-way ANOVA was chosen as the appropriate statistical test because the data to be analyzed had three levels (conditions) but only one independent variable (Christensen). The levels of the present study were the control, the Abercrombie and FitchTM photo, and the Old NavyTM photo. The independent variable was the ratings of the target in the photo (388).

Testing occurred in three introductory psychological methods classes. Participants were randomly assigned to one of three conditions: the Abercrombie & FitchTM shirt condition (high status condition), the Old NavyTM shirt condition (low status condition), or the control (no status) condition. In all conditions, participants were given an informed consent form to read and sign. Participants were told to keep a copy of the informed consent form for their records. A

questionnaire was then given to participants asking them to evaluate the model on a Likert-type scale involving questions regarding likeability, intelligence, attractiveness, personality, competence, and trustworthiness. The participants were allowed to view the picture while they completed the questionnaire, and were allowed as much time as necessary to complete the questionnaire. After completing the questionnaire, participants received a debriefing form to read.

Results of the present experiment do not support the hypothesis that brand name clothing affects how the wearer is perceived. The mean rating for likeability wearing a higher status brand name shirt (Abercrombie & FitchTM), a lower-status brand (Old NavyTM), and the control are 6.04 (SD=0.95), 5.50 (SD=1.65), 6.17 (SD=1.34), respectively. A one-way ANOVA revealed no significant difference between mean group scores, $F(2,62) = 1.45$, $p = 0.24$). The mean rating for attractiveness when wearing a higher-status brand name shirt, a lesser brand, and the control are 3.87 (SD=1.63), 4.44 (SD=1.65), 4.52 (SD=1.88), respectively. A one-way ANOVA revealed no significant difference between mean group scores, $F(2,61) = 0.95$, $p = 0.39$). The mean rating for competency when wearing a higher-status brand name shirt, a lesser brand, and the control are 6.25 (SD=1.57), 6.06 (SD=1.34), 6.35 (SD=1.56), respectively. A one-way ANOVA revealed no significant difference between mean group scores, $F(2,60) = 0.17$, $p = 0.84$). The mean rating for trustworthiness when wearing a higher-status brand name shirt, a lower-status brand, and the control are 5.92 (SD=1.38), 5.33 (SD=1.75), 6.04 (SD=1.36), respectively. A one-way ANOVA revealed no significant difference between mean group scores, $F(2,62)= 1.27$, $p = 0.29$). The mean rating for intelligence when wearing a higher-status brand name shirt, a lower-status brand, and the control are 6.75 (SD=0.99), 6.94 (SD=1.47), 7.00 (SD=1.73), respectively. A one-way ANOVA revealed no

significant difference between mean group scores, $F(2,62) = 0.20$, $p = 0.82$).

The results of this study did not support the hypothesis that brand name clothing affects how the wearer is perceived among college undergraduates. Specifically, no significant differences were found for the effect of brand names on perceptions of attractiveness, competence, intelligence, likeability, and trustworthiness. The major implication of this finding is that despite the major consumption of brand names, it may not be important to wear brand name clothing to promote one's image to others. These findings do not contradict results from previous studies; but rather, they elaborate that unlike other factors of clothing, such as style and color (Damhorst & Reed, 1986; Frank & Gillovich, 1988; James, Man, & Stout, 2006), the brand name of clothing is not a factor in determining person perceptions.

There were several limitations to this study. It is possible that the manner in which the model was photographed caused participants to focus on the model's face rather than the model as a whole. Perhaps if the assessment were conducted with a photo of a model from head to toe it would have better simulated meeting the model in real life. Another issue was the survey questions themselves, specifically, only one question was used to sample person perceptions in each area (e.g., competence). In my research I am going to consider studying what is a high status brand before conducting the study, as was done in the study by Fennis (2008). My future research regarding brand names and how they affect how a person is perceived should involve more than one question evaluating each area. Future studies could also analyze the difference between how males and females perceive brand name wearers. An alternative investigation could be conducted to discover whether the gender of the wearer interacts with the brand name clothing to produce different ratings among

respondents, since Fennis (2008) showed that brand names affect females more than males in relation to brand status.

REFERENCES

Damhorst, M. L., & Reed, J. A. (1986). Clothing color value and facial expression: Effects on evaluations of female job applicants. Social Behavior and Personality, 14, 89-98.

Fennis, B. M. (2008). Branded into submission: Brand attributes and hierachization behavior in same-sex and mixed-sex dyads. Journal of Applied Social Psychology, 38, 1993-2009.

Fennis, B. M., & Pruyn, A. H. (2006). You are what you wear: Brand personality influences on consumer impression formation. Journal of Business Research, 60, 634-639.

Frank, M. G., & Gilovich, T. (1988). The dark side of self- and social perception: Black uniforms and aggression in professional sports. Journal of Personality and Social Psychology, 54, 74-85.

James, M. B., Man, A. F., & Stout, D. (2006). Athletic style of dress and perceived social distance. North American Journal of Psychology, 8, 541-548.

Kerr, B. A., & Dell, D. M. (1976). Perceived interviewer expertness and attractiveness: Effects of interviewer behavior and attire and interview setting. Journal of Counseling Psychology, 23, 553-556.

Reed, A., & Blunk, E. (1990). The influence of facial hair on impression formation. Social Behavior & Personality, 18, 169-175

Workman, J. E. (1988). Trait inferences based on perceived ownership of designer, brand name, or store brand jeans. Clothing & Textiles Research Journal, 6, 23-29.

Christiansen, L. B. (2004). Experimental Methodology. Boston. Pearson. 388-391. Ninth edition.

THE INFLUENCE OF CHILDLESSNESS ON FEMALE EMPOWERMENT

Sarah Doornenbal

Family structure and gender roles have been dramatically transformed in recent history. In particular, women, have become more empowered as they have withdrawn from the traditional housewife role. Raising children and keeping house is no longer the only option for ambitious, independent females. Particularly in western culture, men no longer dominate society or individual households as they did in the past. In addition, the workforce is changing, and while women seek to empower themselves through different means, some have done so by focusing on their careers rather than on motherhood. These factors may be contributing to a growing trend in childlessness over the recent years. In my research, I plan to study the influence of female empowerment and changing gender roles on childlessness. I project that there will be a clear connection between the two phenomena of female empowerment and childlessness.

Sociologists have been challenged by the question: Why do some individuals choose to have children, while others do not? Growing up, getting married, and having a few rug-rats may seem like the ideal American dream. This dream, however, does not apply to all. Since the pool of the voluntarily childless has grown over the years, it is necessary to study the roots of childlessness to better understand this topic.

Female identity has been wrapped up in motherhood for centuries. This role designation has led to a very unfortunate misperception of women who are not mothers. It suggests that something is absent in the female's life—that they are lacking in some way. The very term "childless" implies that one is missing something essential—something that is the norm (May 182). Such

beliefs can be traced back to mythology and folklore. Women were often childless because they were barren or unmarried, and thus pitied. In some cases, the childless woman was viewed as evil and self-serving, and often played the role of the protagonist. Classical tales affirm similar beliefs. Women without children were portrayed in a deficient or negative light, and cast aside as simply unwilling or unable to fulfill their maternal role (Ireland 7).

This ideological prejudice persisted through the 20th century. If a woman was without children, it was assumed she was either infertile or unfit to reproduce. But with the transition in gender roles, along with growing awareness of female rights, attitudes towards childless women have changed. Movements such as women's suffrage, abortion rights, and improvements in contraception now made childlessness a choice. As a result, women without children were no longer presumed to be infertile or unhealthy. However, their childless state, and women's decision to maintain it, were still met with great criticism from the majority.

During the post-war years and the consequent baby boom, traditional ideology again defined the typical roles of the female and the family. Childlessness was nearly extinct; there was no public affirmation of a life without children (Mary 185). Though women had been encouraged to work during the war, once the time of need had ended, women returned to their proper place - in the home. As the Cold War commenced, it became not only the true role of the female but a patriotic duty to be a mother. However, during the 60s and 70s new ideologies emerged, and a rebellion against traditional domesticity began.

A new wave of feminism occurred during the 1960s, playing a vital role in the childless movement. Unlike the first group of feminists, who championed women's rights through motherhood, this new wave of feminists focused on alternatives to motherhood (Ireland 3). Advocates of the childless lifestyle began to advance the theory that motherhood and romance were incompatible. Furthermore, many women began to experience self-fulfillment in their careers, and view children as simply providing distractions and hindrances from work goals. In the past, to be sexual a woman's only choice was to become a mother. And thus, as romance died with the children's arrival, to become a mother was to become nonsexual (May 5). Abortion and birth control, however, had provided new options. A sexual revolution was taking place, in which feminists of the 60s challenged the postwar belief that motherhood was the only true fulfillment of womanhood. Ellen Peck, in *Baby Trap*, argued that a childless lifestyle was the key to keeping a marriage filled with excitement and sensual adventures. Peck also boldly suggested that children were a deterrent to a marriage's survival, rather than an incitement (Ireland 189), with the implication that fatherhood and infidelity may be directly related.

Some feminists took a very aggressive stance against motherhood. And though a childless lifestyle was becoming more acceptable, activists like Gael Greene, who wrote *A Vote Against Motherhood*, were deemed heretics. The National Organization of Non-Parents, established in 1972, had an environmental focus, but also served lifestyle issues. Eight years later, the organization decided to soften their message, altering their title to the National Alliance for Optional Parenthood. Taking their lead from the NAOP, most childless proponents have made a similar transition—promoting the acceptance and freedom of choice, rather than advocating one particular lifestyle over another.

The childless movement, however, cannot simply be attributed to feminism. So many factors are involved in this growing trend that it is virtually impossible to pinpoint one definitive cause. Several other philosophies have influenced the childless couples' choice not only in this nation but throughout the world. Along with contraceptive improvements and the right to reproductive choice, environmentalism and zero-population growth also played their part. Gay and lesbian rights have also contributed, as well as a growing commitment to public life and careers and the pursuit of personal pleasures. It is a whole new outlook on freedom and self-fulfillment, then, that has caused some couples to remain childless. Ultimately, voluntary childlessness is seen as the main contributing factor for the lower birthrate (May 183).

Since the 90s, voluntary childlessness has become more common. In fact, the quintessential woman is no longer described as the devoted housewife and mother who provides for her husband and children in the home. Although some prefer to continue tradition, and honor the postwar ideology of domesticity, others would describe the ideal woman as happily married, with a good job, and childfree.

"Childfree" is a new term that is becoming popular amongst childless women and couples. This term is an explicit recognition that young people do not want to be viewed as lacking some necessary component in life. Instead, with only their partner in mind rather than an entire family, they should be free to live as they wish and pursue their own goals. Some traditionalists still view this choice as self-indulgent and neurotic. Childfree individuals and couples have often expressed a sense of isolation. Though childlessness is a growing trend, postwar versions of the family and domesticity are still popular, and childless people find themselves in the minority. But just like their more traditional peers, childfree

couples have dreams of marital bliss and domestic stability. They simply feel these goals can be achieved without children (May 185).

A transition in gender roles has also contributed to childlessness. In the past, male domination over the female played a key role in reproduction. Women were dependent on males for survival, and they had little opportunity to support themselves financially or pursue their own goals. Wives were forced to succumb to their husband's wishes, and fertility was often a sign of fitness in the male. Due to the uncertainty of paternity prior to paternity testing, conceiving several children was generally preferred (Aarssen 1769). Thus childbearing, housework, and family ruled the lifestyle of the female. Gradually, women have gained more independence from men, and the choice to remain childless has simply been one result of this new freedom.

In an effort to predict future mating trends, L. W. Aarssen of Queen's University in Canada uses the terms "sex drive", "parenting drive", and "legacy drive" to explain the reasons people have children. While the first two terms may seem rather self-explanatory, the legacy drive involves traits that promote a desire to leave something of oneself for the future. The legacy drive can result from the anxiety that is caused by our awareness of our mortality, and can be fulfilled either through gene transmission or meme transmission (Aarssen 1773).

A meme is any unit of cultural information, and can be transmitted through activities such as education, work, religion, wealth, travel, achievement, or hobbies. These activities compete with the time, energy, and resources required for parenthood. Meme transmission promotes personal legacy, and therefore satisfies our intrinsic legacy drive while avoiding the alternative option, gene transmission. While some choose to fulfill a sense of legacy by producing offspring, others may choose to seek a legacy through other means. Now that more women are given the opportunity to pursue their own goals and careers, meme transmission may be a direct cause of childlessness.

Having provided an understanding of the historical background of childlessness, I now focus on the census data and research literature which supported my analysis. Statistics clearly show that fewer people are having children in the US. In the census data, I searched for declining birth rates in addition to statistics that reflected women's roles in the home and the workforce. In 2004, the proportion of childless women between 15 and 44 was 44.6%, up from 35% in 1976 (Downs).

To study the growth of female empowerment and its relation to childlessness, I investigated US census data over the past 150 years. Women's roles as mothers, wives, and participants in the work force have changed dramatically, which can be demonstrated through these statistics. To ensure that a trend in childlessness does in fact exist, I began my statistical investigation by focusing on birth rates throughout the United States. This research yielded good results. Though the population is steadily increasing, births are not, with immigration increasingly accounting for population growth. Between 1880 and 2000, the birth rate has consistently declined from 41.16 to 14.90 (Carter 1-35). These data clearly support the claim that fewer people are having children.

One study investigated this topic thoroughly, focusing on American women at the age of 44 over the past thirty years. This age group is significant because it is less likely that women will have several more children after age 44. In 1976, only 10.2% of these women were childless, while approximately 20.1% of these women had five children or more (The remaining 69.7% had either one child, two children, or three children.) By year 2000, the numbers had changed. Nineteen percent of these women

were childless, while only 3.3% had five children or more. The largest category of mothers (35%) had two children (Downs). It is important to remember there may be numerous reasons for this transition. Though some of these women may be childless voluntarily, others may not.

I further studied census data in researching statistics involving a change in women's relation to the work force. A shift in the division of labor from agricultural work to clerical and service occupations is evident. Clerical, sales, and service jobs have increased from a 4.9% share of the labor force in 1870 to a 38.4% share in 1990 (Carter 2-5). This opportunity for office work made women's entry into the work force possible. As of 1982, women made up 63.3% of the total labor force. The most drastic transition can be seen in married women with a spouse present – 50% of them worked in 1980, compared to only 14.7% in 1940 (Shortridge 23). As well as other causes such as economic need, this may have resulted from dissatisfaction with the traditional housewife role.

These numbers directly relate to a woman's choice to have children. The *Statistical Handbook on Women in America* offers fascinating data on childless women. These statistics include details on women with careers and an education. Among the 25- to 34-year-old age group, unmarried women, women who participate in the work force, and women with higher education are more likely to be childless. For example, in 1994, only 13.6% of women without a high school diploma remained childless. In contrast, 62.3% of women with graduate degrees are childless (Taeuber 33). And despite the public perception that not that many women pursue higher education, it is important to note that in 1990, the number of women enrolled in college surpassed the number of men by 1.6 million (Taeuber 296).

It has also been noted that the childless population is strictly limited to the white upper-class (May 192). Childlessness is less common in Black and Hispanic groups, as well as in low socio-economic-status groups. Higher incomes and higher education, however, take prevalence over race in this matter. For example, Black women with a college education and higher incomes have similar childless rates as white women with similar circumstances. Thus, the racial differences begin to fade when class is considered. Also, childless individuals and couples tend to have full time jobs, liberal and feminist beliefs, as well as religious skepticism (May 192). Clearly, cultural and philosophical beliefs do affect the childless choice, though income and education also play a role.

Although these factors may not be the only ones involved in the childless trend, it is interesting to note their relation to child-bearing. Women have certainly attained more equality over the past century as they have developed more independence from men. Statistics clearly indicate that women now have more work and life opportunities than they did in the past and can pursue their own interests while fulfilling their careers.

Statistics are also useful by displaying trends and transitions throughout history. But the reasons—the personal convictions which lead to people's choices—cannot simply be defined by historical trends. Statistics provide numbers, but at times can lack explanations for these numbers. The challenge is for the researcher to make conclusions regarding the reasoning behind these statistics.

Records make clear that the transitioning female role is probably a factor which has led to childlessness. Childlessness, nevertheless, is a trend that has developed over centuries. It may be difficult to determine which factors play the most vital roles among the different factors involved. This topic is a very complex and personal one. To fully understand this research topic, one must travel into the hearts of minds of others. The reasoning behind a childless choice may be a sensitive and

intimate one. I am curious to see whether research methods such as surveys and interviews will better grasp the reality of this topic.

I am interested in all factors related to childlessness: to intensively study childlessness, I wish to investigate as many related factors as possible. Though the changing female role will be my main focus and the center of my thesis, I hope to consider other influences while conducting my research. As a result, my conclusions will not simply be limited to the effectiveness of female empowerment on childlessness. I may discover that this is only a small factor in comparison to other factors. In fact, I may even realize that female empowerment is not a cause of childlessness at all—I may learn that the growing childless trend is rather simply another factor that has led to female empowerment.

Of the many ways to consider this issue, I will struggle to narrow the focus of my topic, while at the same time attempting to be as thorough as possible. My research project is still a work in progress, and the scope of my research has been limited by time and resources. I plan to study this topic further by conducting my own original research through surveys and personal interviews. These instruments will study attitudes towards childlessness, female empowerment, and women's roles, in an attempt to attain insight on the validity of my hypothesis.

I plan to combine open-ended and close-ended survey methods, benefiting from the different advantages of both types of survey. I will initially conduct open-ended surveys to gain a broad understanding of the childless choice, as well as current attitudes towards the female role. With these data gathered, I will distribute a close-ended survey, further investigating the causes of voluntary childlessness. This standardized data will be recorded and interpreted more easily. And lastly, I will conduct open-ended interviews to supplement my surveys. These interviews will be smaller in number, but more detailed in their investigation.

Though the childless population may be in the minority, this group is growing. At some point in our lives, we are all faced with the decision to have children: this topic relates to everyone. This study also investigates the tremendous consequences of female empowerment, which affect us all. Other contributory factors to childlessness, such as abortion rights, improvements in birth control, or transitions in the labor force have relevance to our lives, as well as the important issue of infertility. Although my topic does not involve involuntary childlessness, such individuals will still be included in certain statistics. Infertility is another important factor that cannot be ignored.

It is clear that a childless lifestyle is becoming less unusual. Nevertheless, childless individuals and couples are still suffering from a sense of isolation. By providing insight into this phenomenon, research studies such as this one may help the childless population find a voice and the rest of the world better understand and accept their decision.

BIBLIOGRAPHY

Aarssen, Lonnie W. "Some Bold Evolutionary Predictions for the Future of Mating in Humans." Oikos June 2007: 1768-1778.

Carter, Susan B., Scott Sigmund Gartner, Michael R. Haines, Alan L. Olmstead, Richard Sutch, and Gavin Wright. *Historical Statistics of the United States.* New York: Cambridge University Press, 2006.

Downs, Barbara. "Fertility of American Women." US Census Bureau October 2003: 2-6.

Dykstra, Pearl A. "Childlessness and Parenting in Two Centuries." Journal of Family Issues 28 (2007): 1518-1532.

Hagestad, Gunhild O. "Pathways to Childlessness: A Life Course Perspective." Journal of Family Issues 28 (2007): 1338-1361.

Ireland, Mardy S. *Reconceiving Women: Separating Motherhood from the Female Identity.* New York: The Guilford Press, 1993.

May, Elaine Tyler. *Barren in the Promised Land.* Cambridge: Harvard University Press, 1995.

Rowland, Donald T. "Historical Trends in Childlessness." Journal of Family Issues 28 (2007): 1311-1337.

Shortridge, Barbara G. *Atlas of American Women.* New York: MacMillan Publishing Company, 1987.

Taeuber, Cynthia. *The Statistical Handbook of Women in America,* Second Edition. Phoenix: Oryx Press, 1996.

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