Oshkosh Scholar Volume II, 2007

University of Wisconsin Oshkosh

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Preface

We are excited to launch this second edition of *Oshkosh Scholar*, a journal of UW Oshkosh undergraduate student research. This publication gives us the opportunity to explore and celebrate the scholarly achievements of our undergraduate students and the faculty who mentor them in their research projects.

Undergraduate research opportunities such as those reflected in this volume immeasurably enhance the University experience for our students. We are pleased to be able to showcase some of the finest examples of faculty-mentored research.

I want to extend my personal thanks to faculty adviser Jennifer Mihalick and student editors Tracy Rusch and Jonathan "Leviathan" Whitfield for taking on the challenge of producing this second volume. Their energy and creativity are evident.

– Linda S. Freed
Director
Office of Grants and Faculty Development

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The cover art is a result of Hegge’s imagination at work: “I had my black light turned on in my bedroom, so I turned down the shutter speed on my camera and just started waving the light around. Took the shot and this is what came of it.”

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Poverty Rates and Spending on Public Education at the K-12 Level: Is There a Correlation?

S. Larry Chomsisengphet, author
Dr. Kevin McGee, Economics, faculty adviser

Abstract

Many academics and policymakers argue that increases in spending on public education will reduce poverty. The goal of this paper is to evaluate whether increases in current spending on public education at the K-12 level lowers poverty rates in the United States. Using public education expenditure data from government and census Web sites describing cities throughout the U.S., empirical analysis shows a significant negative relationship between spending on public education and the poverty rate. This implies that increases in public education expenditures would lead to decreases in future poverty rates.

Introduction

Poverty indicates a failed country and world as a whole. Organizations such as One.org and UNICEF are devoted to eliminating poverty. Nearly 3.4 billion people worldwide live under or at an inconceivably low poverty threshold of $2 per day. The United States' poverty threshold is not as low as $2; however, it is difficult to believe that a family of five can survive today on $23,613 a year. To break that down, each individual in that five-person household must live day-to-day on $12.93 or less. With steady inflation, one can imagine how difficult it would be to not only get by day-to-day, but also attempt to accumulate wealth to move out of poverty and move higher up on the socioeconomic ladder.

Furthermore, the U.S. Web site for census data shows that poverty rates have steadily risen for the past six years. Thus, we can see that poverty is a problem that will continue to hinder the world's potential if we do not do something to stop it now. Therefore, many economists and policy makers would like to determine the root causes of poverty to determine appropriate polices to lower this failure rate.

This paper specifically looks at poverty in United States and attempts to uncover the impact of K-12 public education spending on the poverty rate. If a negative correlation occurs between expenditures on public education and poverty rate, this might suggest that increasing our spending on public education per child may lead to a reduction in the country's rate of poverty. To preview the results, the regression model shows that a 10% increase in spending on public education at the K-12 level will decrease poverty rates by a little more than 3.5%.

This paper proceeds with the second section discussing previous research done on similar topics. The third section reviews this paper's econometric model. The fourth section analyzes the data and its basic statistics. The fifth section studies the regression model and its findings.

Literature Review

One particular study by Jha, B. Biswal and U.D. Biswal (2001) discusses the same topic and how the increase in public expenditures on education affects

poverty in India. They claim that government implemented strategies to increase public expenditures in three key areas, one of them being education, is stated to have "benefited the low-income people," and decreased poverty over time, meaning the actual returns from the increase in education expenditures would be intergenerational (2001, p. 5). However, Jha concluded that India should make its investment in higher education, as opposed to primary education, to help eradicate poverty (2001, p. 20). The reasoning is that the returns from higher or secondary education would be quicker. For example, an individual who attended a vocational school would be able to pursue a job right after completing his or her schooling and immediately become a productive member of the workforce.

An additional study, by Jung and Thorbecke for the International Monetary Fund (IMF), discusses the impact of education expenditures on poverty in Tanzania and Zambia. The authors argue that each country needs to evaluate its own situation and find which sectors are growing and then begin investing in educational programs that will benefit those specific growing sectors (Jung, 2001, p. 24). By doing so, the authors' claim is that increases to economic growth and decreases to the poverty rate are achievable. However, the increases in public education expenditures cannot be frivolous; Jung and Thorbecke argue that to achieve the most success, policy makers should target these increases in education at underprivileged areas. Basically, Jung and Thorbecke suggest that a country should analyze its labor demands and make investments into an educational system that produces the type of labor force to meet those labor demands; doing so will allow for more economic growth. Moreover, to optimize the amount of economic growth, countries should target educational systems in more underprivileged areas. In turn, the increase in economic growth will allow for higher human capital, increasing the value and demand for more educated laborers. This will ultimately lead to poverty alleviation. Thus, the Jung and Thorbecke study supports the classic hypothesis—that the correlation between poverty and education expenditures is negative. Even though this study looked specifically at two developing African countries, the study could be applied to any country or city and would receive similar results.

Model

Our goal is to determine the effect of spending on public education on poverty in the United States. Using a standard econometric model, the independent variables are tested to determine their effects on the dependent variable. Therefore, the poverty rate is the dependent variable while the public education expenditures (current and lagged) are the independent variables in our model. We also control for other factors that could affect poverty such as the dropout rate, unemployment rate, median family income, and teen pregnancy. Furthermore, because the dependent variable and two of the explanatory variables are ratios, the logs of the other four variables were used to make it easier to read the coefficients as percentage changes. This semi-log model also gave a slightly higher R^2 than the corresponding linear model. The econometric model is specified as follows:

$$povrate = \beta_0 - \beta_1(lnexkid) - \beta_2(lnexkid)_{t-1} + \beta_3(droprate) + \beta_4(unemprate) - \beta_5(lnmedfinc) + \beta_6(lntbirths) + u$$

Where:

β_n	=	is the coefficient value that will be found after running the regression
povrate	=	rate or percentage of poverty
lnexkid	=	log of total expenditures per child on public education (current and lagged)
droprate	=	total dropout rate for grades 7-12
unemprate	=	the unemployment rate
lnmedfinc	=	log of median family income
lntbirths	=	log of total live births to mothers ages 10-19
u_t	=	error term

Family income (lnmedfinc) and expenditures per child on public education (lnexkid) are expected to be negatively correlated with poverty rate—the hypothesis is that an increase in education expenditures per child would cause a decrease in the poverty rate. This is important because the focus is on the issue of poverty, something the world as a whole would like to reduce or ideally eradicate. The model most importantly incorporates the lag effect, so we can see if this will lead to a decrease or eradication of poverty over time by investing more in the education system.

Data

First, three cities from each state were chosen, in addition to the District of Columbia. Selection of cities from each state required a metropolitan city, suburban city, and rural or urban city as the sample data. This method for choosing the sample was a better method for getting a wider range of data. Moreover, even though this causes the model to have a nonrandom sample biased, this method of data collection ensured that the skewing of the data in one direction to represent one type of city or population did not occur. The goal of the data is to represent the U.S. population in its entirety—not only rich or poor areas. Thus, by collecting the data based on one city of each type, rural/urban, suburban and metropolitan, from each state, we get data that is not skewed to represent any social class.

In addition, each chosen city was broken down to the county level so that school districts could be determined for data of educational variables. If more than one school district was available for the county or area in question, then the school district with the largest enrollment was chosen.

The variables containing educational data or data regarding dropout rates, expenditures per child, and students per teacher were collected from The National Center for Education Statistics, http://nces.ed.gov. Because we are assuming that spending on public education, expenditures per child, has a delayed effect on poverty rates, collection of data for a lagged variable was necessary. Thus, data for expenditures per child for the year 1999–2000 was also collected. Collection of all other data occurred for the year 2000–2001. The other variables included poverty rates, unemployment rates, live births to mothers between the ages of 10–19, and median

family income, which were gathered at the county level through other census Web sites. I also gathered data for the unemployment rate from the Bureau of Labor Statistics Web site, ftp://ftp.bls.gov, while the data for median family income and poverty rates came from the Small Area Income and Poverty Estimates section of the United States Census Web site, http://www.census.gov/hhes/www/saipe/county.html. Lastly, I collected the data for teen pregnancy from the Interactive Atlas from the Center for Disease Control and Prevention, http://apps.nccd.cdc.gov.

Eight cities were not used because of missing data; therefore, the sample size was reduced to 143. New cities were not chosen to replace the cities with missing data due to a time constraint. A summary of the data for the given variables is displayed in Table 1 (this is before logging was done on the variables):

Table 1
Basic Statistical Information From the Data

	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
povrate	11.671%	4.334%	4.3%	28.3%
droprate	4.1%	3.44%	.1%	27.5%
exkid00	$7,497.8	$2,106.9	$4,093	$17,182
exkid99	$6,976	$1,853.6	$4,040	$15,109
unemprate	3.99%	1.416%	2%	8.8%
medfinc	$41,541	$8,791.1	$24,089	$74,652
tbirths	64.5/1000	10.079/1000	35.1/1000	93.8/1000

Moreover, because the cities were divided into population area type, we are able to look at the frequencies of the population area types within the data, which were encoded so that 0 ≡ suburban area; 1 ≡ metropolitan area; 2 ≡ rural area; and 3 ≡ urban area. Urban area was included as a substitute for rural area because certain states did not have rural areas, or data was unavailable for those areas. Urban areas were substituted due to similar economic conditions, which were based on median family income. Examples of urban areas would be Macon, GA; Fort Wayne, IN; and Timmonsville, SC. The observations were broken down so that there were 51 suburbs, 49 metropolitan cities, 39 rural areas, and 4 urban areas.

Also derived were correlation coefficients for the variables. The only real significant correlations that occurred were that unemployment rates and median family income were highly correlated with poverty rates. Surprisingly, there was not a great deal of correlation between any of the independent variables themselves with the exception of exkid00 and exkid99. The two expenditure variables are correlated because education expenditures in the current year are dependent upon expenditures from the previous year.

Regression Analysis

The estimation of the regression model required the use of the Ordinary Least Squares (OLS) method. The directions of correlation between the independent and

the dependent variable are as expected; however, the correlation between exkid00 and poverty is opposite of what was hypothesized. It appears as though an increase in current expenditures is associated with an increase in poverty rates. This is the opposite of what we would first assume; however, this is understandable because an increase in per child expenditures for education is also a decrease in spending for other socially beneficial programs helping to eradicate poverty, which leads to an increase in poverty rates. The results are in Table 2:

Table 2
Regression Numbers

Dependent Variable: povrate	
Independent Variable	Estimated Coefficient (t-stat)
constant	131.52 7.563
lnexkid00	2.6296 3.396
lnexkid99	-0.37426 -1.627
droprate	0.18754 4.303
unemprate	0.62411 2.933
lnmedfinc	-15.043 -10.26
lntbirths	3.9505 3.332
No. of Observations Degrees of Freedom R-Squared	143 136 0.7779

The table presents the final regression results after removing statistically insignificant variables and correcting for any heteroskedasticity. We can see from the equation that droprate, unemprate and lntbirths are all positively correlated with poverty rates, as we would expect them to be. Each coefficient says that a 10% increase in these variables will respectively cause a 1.9%, a 6.2% and a 4% change in poverty rates. These percent changes in poverty rates may not seem like significant changes, but if interpreted in real numbers for actual human beings, these seemingly insignificant percentages become significant in the actual number of individuals impoverished.

Conclusion

Our regression results agreed with our hypothesis, which states that an increase in spending on public education at the K–12 level will reduce poverty rates. However, there are some weaknesses with the data, and they need addressing in order to create a more robust model.

One of the main weaknesses is that the delay in the lag variable is only for one year. This may be a reason why the lag variable does not appear to be extremely statistically significant. If the delay between the lag variable data and current year data could have a difference of at least 10 years, the results might show an increased level of significance. A delay of only one year for the lag variable does not allow for the benefits or effects from the increase in education expenditures to take their full effects.

Moreover, spending on education is an investment in human capital. Thus, the returns on this investment will not be seen immediately or even after a few years. The returns from this investment will not be evident until after these children move on into adulthood and into the workforce.

However, the problem with the education expenditure data is that the data does not go back more than a few years. Thus, the possibility of testing a 10-, 15-, or even 20-year lag is not feasible as of yet. I hope that in the following years, data will be available, and a minimum 10-year delay in the lag variable will be possible. Nevertheless, we should not disregard the results of this model and view this paper as insignificant. My hope is that this paper sparks some discussion on public education expenditure reform. In addition, I hope that society begins to view the value of education and understand that education is an investment in all of our futures. Therefore, when budget cuts occur and affects the education sector, we should be worried about how this will affect our children and us.

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A Cross-sectional Analysis of Research and Development Expenditures

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Abstract

Long-term economic growth is sustained by research and development activities conducted by private firms, and therefore, understanding how firms make R&D choices is important. In this study, Compustat data is used to econometrically analyze firm choices about research and development (R&D). Examined are both the total amount of money firms spend on R&D activities and the portion of sales revenue firms spend on R&D. Our interpretations are as follows. The model predicts that larger firms, determined by sales revenue and number of people employed, spend more money on R&D activities. In addition, firms whose operations include more business segments commit fewer revenues to innovation, while firms that operate in more geographic areas typically spend more on R&D. Finally, if a firm owns more intangible assets, such as franchise rights and patents or copyrights, it will likely spend more on R&D.

Introduction

It is widely recognized that innovation is one of the most important factors that drive long-term economic growth (Schumpeter, 1994). One common way to measure the amount of innovation in an economy is by looking at the amount of money private firms report as research and development (R&D) expenditures. This study used cross-sectional data from 2005 to examine the characteristics of firms that conduct R&D. To identify the key characteristics of firms, we developed two least-squared regression models that examine different factors that could influence R&D choices.

The first model studied inter-firm variation of R&D expenditure in attempt to better identify the characteristics that indicate which types of firms fund the most innovation. The second model worked to explain the variation in normalized research and development expenditures. We calculated normalized research and development expenditures by dividing the amount of money each firm spent on R&D in 2005 by the sales revenue the firm earned in the same year. Thus, normalized R&D expenditure was thought of as the fraction of revenue a firm spent on R&D. This approach had the advantage of controlling for firm size, and allowed us to more carefully examine what types of firms conduct R&D.

First, however, we provide a brief survey of some recent research on R&D. Second, we describe the data analyzed in the study. Third, we develop two different models to explain R&D decisions. Finally, in the conclusion, we examine some of the most interesting results of our analysis and make policy recommendations.

Literature Review

Schumpeter suggested that entrepreneurship and innovation are the keys to economic growth over the long run (1994). However, while there is extensive literature

on innovation going back in economic history to the 1920s, we focused on three recent articles that are related to the particular econometric approach used in this paper.

One particular policy problem is that identified by Shah (2006). He explained firms cannot capture all of the benefits from R&D activities. Specifically, private corporations cannot prevent competitors from utilizing the fruits of the innovative discoveries. Even though sharing new innovations would likely produce greater economic gains, firms in competitive situations should intuitively keep their advances private in order to maximize profits. Thus, Shah deduced private firms are driven to perform innovative activities in pursuit of competitive advantages, but that firms are deterred by their inability to completely exclude competitors from utilizing the new innovations.

Much like Shah (2006), Moris (2005) stressed the importance of policies, both direct and indirect, that can be implemented to stimulate private R&D investment. Direct policies included grants and government contracts. Indirect policies included a wide variety of different types of tax credits and allowances. In his discussion of tax credit claims, Moris showed that corporations in the manufacturing, information, and professional, scientific and technical-services industries accounted for the most tax credit claims. In all three of these industries, most of the tax credit claims were in sectors adopting or producing advanced technologies, such as computers and computer-related technologies.

Wu (2005) wrote about policies which, at the state-level, induced marginal increases in R&D investment. Evidently the most significant policies Wu studied were state investment tax credits and the substantial state funding of higher education. While Wu discussed the merit of tax credits, he proposed the federal government would provide a more effective service to the private sector by creating a national standard and eliminating the incentives for firms to continually move to different states to take advantage of new and better R&D policies. Schumpeter (1994) made a similar argument.

Given the findings of these recent studies, we decided to include many similar explanatory variables in our model. For example, based on Shah's findings, we included a measure of intangible assets in our econometric model. We also included dummy variables for different industries in our model because of Moris's (2006) study. However, while using several similar variables, our use of a very large cross-sectional Compustat data set allowed us to examine these purported relationships in a new and different context.

Data Collection and Description

This study examined cross-sectional data collected from Standard and Poor's Compustat data set. The Compustat data set contains a vast amount of economic and financial information on nearly 10,000 companies. Ultimately, eight quantitative variables were chosen for this study: total assets, book value, number of employees, intangibles, sales, normalized R&D expenditure (created from R&D and sales data), number of business segments, and geographic region. The definitions of these variables are given in Table 1.

The variables in Table 1 were either used directly in a final regression equation or combined with other variables from Table 1 to generate compound variables (rates,

proportions, etc.). In summary, Table 2 displays the mean value of each variable used, along with the standard deviation. Note, from Table 2, some of the data have significant variation. We considered regressions both with and without the outliers. Elimination of outliers did not fundamentally change the regression results and, therefore, we chose to leave all the values in the model, following the methodology of Wooldridge (2004). Excluding the number of business segments and the number of geographic regions, the standard deviation for each variable was quite large compared to its respective mean value. This fact is not surprising because there are thousands of small firms and many fewer extremely large firms.

R&D expenditures were far from evenly distributed across industries. Therefore, we employed a dummy variable for each industry, as defined by the North American Industry Classification System (NAICS).

Characteristic of Firms that Engage in R&D

The first model we examined is designed to identify the characteristics of firms that spend the most on R&D in absolute terms (Model 1). The natural logarithm of each company's R&D expenditure, measured in millions of dollars (LNXRD), is used as the dependent variable. The log-log model has a number of advantages, including ease of interpretation, because all variables can be interpreted as percentage changes (Wooldridge, 2004).

The first key independent variable of this model was the natural log of each firm's sales revenue, in millions of dollars (LNSALE). Sales figures are used as a proxy for the size of the firm. In a study that used time-series data, sales, profits, or retained earnings could be used to portray the relationship between profitability in one year and R&D expenditures in the next. Since the data used in this study is cross-sectional, sales is used as a metric of each firm's size.

As shown in Table 3, the dollar value of a company's sales in 2005 was statistically significantly related to the amount of money it spent on R&D ($p < 0.01$). Therefore, we can confidently state that larger companies tend to spend more money on R&D than smaller companies. A 1% increase in sales will be associated with a 0.56% increase in R&D expenditures. This suggests that polices developed to grow the size of companies may have a positive impact on the amount of R&D private firms conduct. As an example of a policy contrary to encouraging R&D, businesses in some European Union countries are taxed on a highly progressive scale to encourage small business ownership. Based on this study, such policies would be considered detrimental to R&D expenditures.

Another key explanatory variable was the natural logarithm of the value of all intangible assets owned by a company, in millions of dollars (LNINTAN). This variable represented the unamortized value of assets such as patents, copyrights, licenses, franchises and franchise rights, and shelter from import quotas. As evident from Table 3, the amount of intangible assets owned by a company was positively and statistically significantly related to the amount of money a company spends on R&D ($p < 0.01$). Therefore, policies should aim to increase ownership of intangible assets, make such assets more accessible to private organizations, or at least not discourage firms from owning intangible assets. For example, if a firm's patents are protected by statute, the firm would likely invest more money in R&D, leading to the development

of new business opportunities, all else equal. However, perhaps more daunting obstacles are the excessive disclosure requirements and lax enforcement faced by firms abroad (Schumpeter, 1994).

The number of business segments in which an organization operates (SEGNUM), as identified by Standard and Poors, is negatively and statistically significantly related to the amount of money a firm spends on R&D ($p < 0.01$), holding other factors constant. Thus the estimation results of Model I suggest that the firms investing the most in R&D are large organizations that specialize in only a few business or industry segments.

In the Model 1 regression, the number of geographic regions (GEONUM) in which a company operates is positively correlated with the amount of money the company will spend on R&D, as determined by the sign on the estimated coefficient. However, this relationship is not statistically significant. The number of geographic regions is measured as a categorical variable, ranging from 1 to 5. Thus we do not log this variable.

The final key explanatory variable examined in Model I is the number of workers each company employs (EMP), measured in thousands of employees. Despite the positive correlation between the number of employees and the amount of money spent on R&D (as determined by the estimated coefficient), the relationship is not statistically significant. Other explanatory variables were included in the regression and Table 3 to control for firm size, market, and sector, but we do not discuss them because the results are not central to understanding R&D choices.

Normalized R&D Expenditures and Firm Characteristics

So far we have discussed characteristics of the firms that are associated with the most innovation activity. This section of the paper focuses on which firms spend the largest portion of their sales revenue on R&D. In this model, we utilized each firm's normalized R&D expenditures as the dependent variable. Normalized R&D expenditures were calculated as total R&D for a firm, divided by the firm's total sales.

Before conducting additional regression analysis, Tables 4 and 5 are examined to determine whether any broad relationship can be identified between the size of a firm and the amount it spends on R&D. Note that the tables display summary statistics for all of the firms in our dataset that reported a positive value of R&D expenditures. The data in the tables are ranked by sales revenue, ascending, and the amount of R&D expenditures reported. From the median values in Table 4, the smallest firms, with respect to sales revenue, account for the highest values of normalized R&D spending. From Table 5, we understand that this phenomenon is not due solely to sales revenue. If this were the case, when the firms are ranked by R&D expenditures, the firms with the largest median normalized R&D expenditure would account for the largest R&D expenditure.

The log of the percent of sales spent on R&D, or normalized R&D expenditure (LNXRDSALE), was our dependent variable in Model II. The first explanatory variable of Model II was the logarithm of the ratio of sales divided by the number of people a firm employs (LNSALEMP). This ratio describes how much sales revenue each employee generates. This is a widely used measure of firm productivity. We found that this productivity measure is negatively correlated with normalized R&D

expenditures, as determined by the estimated coefficient reported in Table 6. This relationship is statistically significant ($p < 0.01$). Perhaps an explanation is that although innovation leads to impressive efficiency gains, the process by which to achieve innovation is highly inefficient due to high upfront investment costs and the indeterminacy of future benefits.

A second explanatory variable was the ratio of assets-to-sales (LNATAL), which is an important measure in financial studies. According to financial theory, more efficient firms should have smaller assets-to-sales ratios because this denotes economically efficient production. This result was confirmed in our study. The estimated coefficient of assets-to-sales is positive and statistically significant (see Table 6).

A firm's book value measures the accounting value of its equity. We use the log of this ratio (LNCSTK) as an explanatory variable. Book value was negatively related to a firm's normalized innovation expenditures. In Table 6, we find that a 1% increase in book value was associated with a 0.09% decrease in R&D expenditures. By revisiting Tables 4 and 5, this relationship is easily identified. Obviously, small firms will have lower book values than large firms. Since we expect normalized R&D expenditure to decrease as firms' sales revenues increase, this concept should be intuitive.

Last, just as in Model I, Model II introduces industry sector dummy variables, along with regional and other firm characteristic controls. The industry sector dummy variables are informative, indicating that firms in high-tech industries are much more likely to engage in R&D than firms in other industries, holding other factors constant. This result is statistically significant. Again, as with Model I, these variables are important for econometric reasons, but are not especially interesting to discuss in relation to R&D decisions.

Conclusions

From the industry dummy variables, the most obvious conclusion we draw from this study is the differing propensity of firms to invest in R&D across different industries. In particular, firms within the manufacturing industry, the information industry, and the professional, scientific, and technical services industry are more likely to engage in R&D. This is similar to the finding of Moris (2005). These industries spend more on innovation than companies in other industries, controlling for size, number of employees, and other firm characteristics. Moreover, companies from these three industries invest a greater portion of their sales revenue in R&D, holding other factors constant.

Another key finding is that firms owning more intangible assets are more likely to conduct R&D activities, or those which conduct more R&D own more intangible assets. In addition, a firm's book-value-per-share is found to be inversely related to a firm's level of R&D intensity. One way to understand this finding is that firms conducting innovative research incur significant risk from an investment with undetermined cash flows. Furthermore, the cost of R&D will be expensed much earlier than any return a firm generates from its innovative activities.

When combining the results from the first and second models estimated, we identify a new and intriguing relationship—what we call a growth or buy-out effect.

When a company is small, in terms of sales revenue, a large portion the sales revenue is reinvested in growing the business. Thus the firm's R&D intensity should be greater early in a company's life. Likewise, innovative firms should *appear* less efficient than less innovative firms due to delayed returns to investment of capital.

Over time, however, we speculate innovative firms will likely become more profitable or be purchased by large multi-sector conglomerates. As sales revenues and available capital grow, R&D expenditures may not increase as fast as sales at this point in a firm's lifespan. Moreover, larger firms have the advantage of scale, and as the innovative products mature, the firm will become more profitable. This hypothesis may explain the inverse relationship between normalized R&D and the measures of efficiency in the second model. This is an interesting result not previously examined in the literature, and more research should look into this topic. However, an important caution is that this is a cross-sectional study, with no method to examine the influence of time. Further research using time-series data could outline a growth pattern for firms that would help evaluate our theory of a growth or buy-out effect.

In terms of policies to promote growth, the protection of intangible assets should continue to be important, both in the U.S. and abroad, as our model finds that intangible assets are a key explanatory variable in determining R&D expenditures. Trade partners, such as China, should be encouraged to adopt legislation that facilitates the protection of intangible assets and intellectual property. With augmented trade liberalization and protection of intangible assets abroad, businesses could grow to serve more geographic segments. Therefore, through access to a larger market, businesses could both take advantage of increasing returns to scale and comparative differences in production. Ultimately, increased international trade would likely lead to further specialization, which the first model suggests is positively correlated with R&D expenditure.

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Appendix

Table 1
Description of the Variables

Variable (Abbreviation, Units)	Description
Total Assets (AT, $ Million)	Current assets plus net property, plant, and equipment plus other non-current assets.
Book Value (CSTK, $ Million)	The value of assets, less intangible assets and debt.
Employees (EMP, Thousands)	The number of employees each firm has reported to shareholders.
Intangibles (INTAN, $ Million)	The value of intangible assets such as patents, blueprints/ design, copyrights, licenses, etc.
Sales (SALE, $ Million)	The amount of money a company spent to develop new products or services.
Research and Development Expenditures (XRD, $ Million)	The amount of money a company spent to develop new products or services.
Business Segments (SEGNUM, Number)	The number of industry segments available to a company, as determined by Standard and Poor's, from one to ten.
Geographic Segments (GEONUM, Number)	The number of geographic segments available to a company, as determined by Standard and Poor's, from one to ten.

Table 2
Descriptive Statistics *

Variable	Mean	Standard Deviation
AT	8199.54	655.44
CSTK	147.34	902.12
EMP	7.88	36.76
INTAN	603.68	3820.71
SALE	2595.79	1228.79
XRD	93.10	523.58
XRD/SALE	7.48	152.84
SEGNUM	2.15	1.63
GEONUM	3.12	1.23
SALE/EMP	552.20	252.31
AT/SALE	22.61	754.31

*Abbreviated names for variables are provided in Table 1.

Table 3
Regression Results of Model 1

Dependent Variable: LNXRD
Number of Observations: 527

Variable	Estimated Coeff.	Std. Error	t-statistic	p-value
C	-1.239813	0.228875	-5.416994	0.0000
GEONUM	0.052810	0.046963	1.124499	0.2613
SEGNUM	-0.129866	0.036266	-3.580915	0.0004
EMP	0.007468	0.002152	3.470406	0.0006
LNSALE	0.565411	0.039360	14.36497	0.0000
LNINTAN	0.212332	0.029200	7.271570	0.0000
*MAN3133	0.281263	0.113378	2.480755	0.0134
*INFO51	0.364274	0.164721	2.211452	0.0274
*FININ52	-4.121875	1.917874	-2.149190	0.0321
*PROSER54	0.547133	0.253383	2.159314	0.0313
*HEALTH62	-0.552263	0.403685	-1.368054	0.1719
αAR(1)	0.383457	0.042785	8.962315	0.0000

R-squared	0.699291		
Adjusted R-squared	0.692868		
Log likelihood	-820.5838	F-statistic	108.8744
Durbin-Watson stat	2.063738	Prob (F-statistic)	0.000000

Table 4
Average R&D by Sales, Ranked by Total Sales (Ascending by Quartile)

	Arith. Mean	Std. Dev.	Maximum	Minimum	Median
1Q	37.51519	342.61501	7098.00000	0.00012	**0.53740**
2Q	0.27266	0.69158	11.96657	0.00012	**0.11409**
3Q	0.10657	0.13216	1.26322	0.00051	**0.06829**
4Q	0.05203	0.07416	0.63103	0.00015	**0.02138**
1H	18.89392	242.98048	7098.00000	0.00012	0.19062
2H	0.07941	0.11059	1.26322	0.00015	0.03730
Total	9.49020	172.10316	172.10316	172.10316	172.10316

Table 5
Average R&D by Sales, Ranked by Total R&D (Ascending, by Quartile)

	Arith. Mean	Std. Dev.	Maximum	Minimum	Median
1Q	1.93200	16.51518	292.00000	0.00012	0.04869
2Q	17.05397	285.75051	7098.00000	0.00049	0.08746
3Q	11.28776	121.00463	2830.25000	0.00039	0.13387
4Q	7.68434	147.57031	3755.00000	0.00077	0.09691
1H	9.49298	202.53450	7098.00000	0.00012	0.07036
2H	9.48021	134.89365	3755.00000	0.00039	0.11632
Total	9.49020	172.10316	7098.00000	0.00012	0.09024

Table 6
Regression Results of Model II

Normalized RD Expenditures With Sector Dummy Variables
Dependent Variable: LNXRDSALE
Number of Observations: 1730

Variable	Estimated Coeff.	Std. Error	t-Statistic	p-value
C	-2.508717	0.260182	-9.642146	0.0000
LNSALEMP	-0.287021	0.041496	-6.916904	0.0000
LNATSAL	1.111356	0.037712	29.46947	0.0000
LNCSTK	-0.089290	0.010016	-8.915061	0.0000
AG11	-1.269797	0.811460	-1.564830	0.1178
INFO51	1.448761	0.148237	9.773255	0.0000
MAN3133	1.068970	0.124906	8.558167	0.0000
PROSER54	1.006416	0.185294	5.431444	0.0000

R-squared	0.616069		
Adjusted R-squared	0.614508		
Log likelihood	-3017.668	F-statistic	394.7401
Durbin-Watson stat	1.812978	Prob (F-statistic)	0.000000

Hand-Use Lateralization in Ring-Tailed Lemurs *(Lemur catta)*

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Abstract

As a part of a zoo enrichment program, this study examined hand preference for two captive adult (one male, one female) ring-tailed lemurs in order to determine whether bimanual hand preference was consistent with unimanual hand preference. Three different conditions (tube fixed high on cage, tube fixed low on cage and free rolling tube on cage bottom) determined unimanual hand preference. The bimanual condition used a tube hung vertically with a side hole for food extraction. This condition required the lemurs to hold the tube with one hand to prevent swinging while extracting with the other hand. Binomial *z* tests for each condition indicated significant ($p < .001$) left-hand preference for both lemurs across all conditions. Both lemurs exhibited 100% left-hand use for bimanual tasks, which supports research with other primates that has shown a greater degree of lateralization for bimanual tasks.

Introduction

The study of handedness in primates provides researchers with the opportunity to examine asymmetrical lateralization of brain function and how it evolved. It is important to establish where and when during evolution these tendencies toward asymmetrical lateralization first appeared, and to discover what purpose they serve (Papademetriou, Sheu, & Michel, 2005).

Macmeilage, Studdert-Kennedy, and Lindblom (1987) proposed that arboreal (tree-dwelling) prosimians used their right hands for grasping branches and their left hands for visually guided reaching and grasping of food because their brains' right hemispheres were better suited for visuospatial processing. Macneilage et al. (1987) also stated that as terrestriality (ground-dwelling) evolved, primates continued to reach using their left hands for grasping, and they began to manipulate objects with their right hands. They hypothesized that this right-hand bias for manipulation eventually led to an overall right-hand bias for both reaching and manipulating. This theory is called the postural origins theory (POT) for the evolution of right bias in human handedness.

Other researchers have proposed different hypotheses for the origin of hand biases. Fagot and Vauclair (1991) proposed that the presence of hand preferences was dependent on the tasks being performed. This theory stated that low-level manual tasks (familiar, well-practiced actions with low levels of cognitive processing like reaching) do not result in hand preference, whereas high-level manual tasks (novel, finely coordinated actions involving complex cognitive processing) would exhibit not only handedness, but also a population bias in handedness that reflected the underlying cerebral hemisphere specialization.

Previous research has determined that a majority of ring-tailed lemurs have a left-hand preference. These studies used unimanual (one-handed) free-feeding (Ward, Milliken, Dodson, Stafford & Wallace, 1990) and unimanual extraction from

a clear Plexiglas® box (Milliken, Forsythe & Ward, 1989), but did not employ a coordinated-bimanual (requiring the coordinated use of two hands) condition. The hand used for extraction of food from the apparatus is considered the dominant hand for a coordinated-bimanual task. Determining bimanual hand preference is important because coordinated-bimanual tasks require higher-order cognitive processing (Hopkins, Stoinski, Kukas, Ross & Wesley, 2003), and there are other factors, such as posture, that may influence a unimanual task (Westergaard, Kuhn, & Suomi, 1998).

This study used four measures of hand preference, each with a different posture as described in the method section. An addition is the first condition, which requires the subject to hang while retrieving the food. Previous studies have only used free reaching. This is important because the subject could use the dominant hand to grasp the cage or reach for food. Another addition is the fourth measure, a bimanual task, which has never been used in the study of lemur hand preference.

The purpose of this study was to provide additional evidence in support of the existing research that showed a left-hand preference in ring-tailed lemur handedness by adding a bimanual task as well as additional unimanual tasks. The first hypothesis for this experiment was that the hand preference exhibited by the subjects would match data from previous studies that showed left-hand bias (Papademetriou, et al., 2005). The second hypothesis stated that the bimanual task would show a greater degree of lateralization than unimanual free-feeding.

Method

Subjects

One adult female, one adult male, and one juvenile male ring-tailed lemur (*Lemur catta*) lived in a 10 m diameter and 7 m high corn-crib style cage at the Menomonee Park Zoo in Oshkosh, WI. The juvenile subject exhibited a preference for using its mouth when extracting food from the apparatus, and therefore did not produce usable data. This finding is consistent with Ward et al. (1990) who noted lack of hand use in juvenile lemurs. The Menomonee Park Zoo leased animals with unknown histories.

Apparatus

In Condition 1, a 25 cm PVC plastic tube was held in a fixed position by two, 10 cm square pieces of 6 mm thick Plexiglas®. The two Plexiglas® pieces had holes in the center matching the outside diameter of the PVC tube to hold the tubes in place. I placed one of the Plexiglas® pieces on the tube inside the cage and the other on the outside, and then secured them to each other using bolts and nuts. Condition 1 had the tube mounted 150 cm above the bottom of the cage. A plunger, made with a circular piece of Plexiglas® with a metal rod inserted through the center, pushed pieces of food into the PVC from outside the cage. Condition 2 used the same apparatus mounted 30 cm above the bottom of the cage.

Condition 3 used a 20 cm PVC tube on the cement floor of the subjects' cage. The tube, containing banana slices held in place with peanut butter, rolled freely on the cage bottom.

In Condition 4, a 60 cm PVC tube with covered ends hung vertically in the subjects' cage by a chain in a position that allowed the apparatus to swing freely.

A 4 cm round hole was cut in the side of the tube, 4 cm from the bottom, to allow for food extraction. Each condition is illustrated in Figure 1.

Figure 1

Photos of each condition taken during pretesting. (a) Upper left: Condition 1 (Tube mounted low on cage side). (b) Upper right: Condition 2 (Tube mounted high on cage side). (c) Lower left: Condition 3 (Rolling tube). Tube was placed on cage floor for testing. (d) Lower right: Condition 4 (Hanging tube used for bimanual condition).

Materials

The food used for this experiment was a portion of the lemurs' regular daily diet (with the exception of the peanut butter used in Condition 3 to adhere the bananas to the apparatus). This diet consisted of a variety of fruits and vegetables, as well as Purina® 64100X Monkey Chow®.

Procedure

Pretesting occurred prior to data collection by placing the apparatus in the cage for 5 to 30 min with all lemurs present. Pretesting provided familiarization of the subjects with the apparatus and how it worked. This pretesting also helped me to assess whether the lemurs would use the apparatus as intended. No data were collected during pretesting sessions.

At the beginning of each data collection session, the focal subject was isolated in the cage. The other lemurs moved to a lock-out cage through a tunnel connected to the primary cage in order to prevent them from competing for food with the focal lemur. Only the two adults were suitable for use in the study because the juvenile attempted to use its mouth to extract food from the apparatus. This lemur received its portion of the food separately after data collection was finished. The order of subject testing varied daily because when I shifted the subjects to the lock-out cage the last lemur remaining in the primary cage became the first focal subject.

Conditions 1 and 2 were tested simultaneously. These conditions required the lemurs to take food from a tube mounted in a fixed position on the side of their cage. Food placement required lemurs to go back and forth between the high and low tubes. This procedure forced the subjects to reposition themselves between each reach. The lower tube was more difficult to fill because the subjects could reach out of the cage and swat at me as I tried to place food in the tube. When this occurred, I went back to the high mounted tube. This resulted in an uneven number of reaches for each condition. Food preference also contributed to uneven reaches because subjects would not always reach for less desirable foods. Data collection continued until the focal subjects lost interest in the food or their portion of the food had been exhausted.

In Condition 3, the free-rolling tube containing pieces of banana held in place with peanut butter rolled freely on the cement floor of the cage. I initially thought the subjects would have to use two hands to extract the food, and planned to use this condition as a bimanual task; however, the weight of the tube allowed the subjects to extract food without holding the tube with the other hand. Although it could not be used as a bimanual condition, the condition was included because it required a crouched squat-like posture, which was different from the posture for the other conditions (sitting for Condition 1 and hanging for Condition 2). Each lemur received 20 min with the apparatus for five data collection sessions.

In Condition 4, the lemurs were shifted to the lock-out cage. I then filled the apparatus with food and hung it in the cage, and allowed the focal subject to return the primary cage. Data was collected until all of the food was extracted from the apparatus. At this time, I again shifted all of the lemurs to the lock-out cage to refill the apparatus, and then allowed the second subject to return to the primary cage for data collection. Repetition of the procedure resulted in two data collection sessions per lemur each day, for five consecutive days. Limited space for available food in the apparatus forced me to repeat the procedure each day. Satiation of animals and dietary limitations prevented additional daily replications.

Results

Separate binomial *z* tests, nonparametric statistics that evaluate frequency differences from chance, were done for each lemur in each condition. Significant ($p < .001$) left-hand preference emerged for both lemurs across all four conditions (see Table 1). This supports previous research with lemurs that showed left-hand lateralization (Papademetriou, et al., 2005). Both lemurs showed 100% left-hand use for the bimanual task.

Table 1
Frequency of Hand Use for Each Condition

Subject	Task	Total Observations[a]	Total Extractions[b]	Percent left	Binomial *z*
A. Male	High Tube	8	106	99.0	10.00*
A. Male	Low Tube	7	92	96.7	8.00*
A. Male	Rolling Tube	5	84	99.2	8.18*
A. Male	Hanging Tube	5	84	100.0	9.06*
A. Female	High Tube	8	157	96.9	11.00*
A. Female	Low Tube	7	111	97.3	9.87*
A. Female	Rolling Tube	5	138	97.1	10.98*
A. Female	Hanging Tube	5	69	100.0	8.00*

[a] Number of separate observation days
[b] Number of lemur reaches
* $p < .001$

Discussion

The lemurs in this study showed a significant left-hand preference in all reaching tasks, which supports previous research (Papademetriou, et al., 2005). The degree of hand lateralization was greater for bimanual conditions than unimanual conditions, which is consistent with research on other primates that has shown a greater degree of lateralization for bimanual tasks (Papademetriou, et al., 2005). These findings extend the knowledge of hand-use lateralization in the ring-tailed lemur. In addition, the apparatus and procedure provide a model for future hand-bias testing in lemurs and other primates.

Although the small sample size is typical of captive primate studies, testing of additional animals is needed before drawing firm conclusions about the species' hand bias. Also, I did not know the history of the subjects, so the subjects could be related with the same left-hand bias due to genetics. Another limitation was the setting in which the research took place. This study was part of a zoo enrichment program, and provided the animals with varied activities while providing visitors with information about the species. As such, I may have missed data points because of distractions from various sources. For this reason, videotaping data collection sessions would be advised for future research. Distractions from other animals and zoo patrons may have also affected the way the lemurs behaved.

More research is needed in order to determine a species-wide prevalence of hand lateralization. In order to do this, future researchers need a larger sample size consisting of subjects from different lineages. The cages at the zoo were small and not at all like the lemurs' natural habitat. The best subjects would be free-ranging lemurs in their natural habitat. However, in order to achieve this, the apparatus would have to be modified and the wild lemurs would have to cooperate by using the apparatus. The required field study would involve considerable expense and travel. In addition, wild populations of lemurs could become habituated to human presence. This could endanger these populations by decreasing their wariness for large predators.

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The Effects of Enriched and Typical Laboratory Environments on Object Investigation in Old Sprague Dawley Rats

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Abstract

The purpose of this study was to observe the differences in object investigation between two groups of aged Sprague Dawley rats reared in an enriched and a typical laboratory environment. Research has shown that enrichment has a positive effect on behavior of young and mature rats. Our research question was: Will this positive effect on behavior be retained into old age? Object investigation was measured by recording exploratory activity and overall time spent with objects in an open field. Twelve rats were tested with six in each group. There was no significant difference found in bouts of behavior between the typical and enriched group on Day 1 or Day 2. However, there was a significant difference between the time engaged with objects on Day 1 but not on Day 2. Overall, the results of the study did not support the hypothesis that the enriched group would engage in significantly more object investigation, measured by bouts of behavior and time duration, than the typical laboratory group. Further research on the effects of environment on behavior of the old is important to understand how to maximize functioning through environmental stimulation in old age.

Introduction

Dating back to the time of Darwin, there has been a fascination with the general curiosity of animals and humans alike (Renner & Seltzer, 1991). Darwin studied this curiosity by “placing a live snake in a bag into the cages in the monkey house and the London Zoological Gardens” (as cited in Renner, 1987). Darwin’s description of the monkey’s reactions was that “they could not resist taking a momentary peak” (as cited in Renner, 1987). Over time, psychologists have further investigated curiosity and have called it animal exploration or investigation.

Thinus-Blanc et al. (1987) investigated exploratory behavior in hamsters placed in an open field by manipulating the distances between objects and topological relationships. The results indicated a renewal of exploration after the experimenters affected the spatial relations of the objects but not after they affected the distance. Similarly, a study done by Dubois et al. (1999) measured behavioral bouts of Wedge-capped Capuchin monkeys directed toward objects to address whether location affects activity. Overall, results showed a great deal of between- and within-subject variability. Renner and Seltzer (1991) defined several exploratory and investigative behaviors in rats in terms of their molar characteristics (e.g., large units of behavior) and studied how these change as a result of repeated opportunities to explore the same environment. The results indicated the activity levels remained the same over the period of observation, and the amount of time spent interacting with objects increased initially followed by a decrease. In an additional study, Renner and Seltzer (1994) suggested that behavioral grammars can be used to predict individual animals’

interactions with stimulus objects. They defined behavioral grammars as the bouts of specific object interaction observed in different rats. Overall, they found there were no stereotypical object-investigation behaviors. Rather, they observed many individual differences in the rats' behaviors.

Many neuroscience studies have used exploration as a dependent variable for their research in order to look at brain functions (Patra, Mohanty, & Das, 1984; Ricceri, Calamandrei, & Berger Sweeney, 1997; Young, Wintink, & Kalynchuk, 2004). Todorovic et al. (2003) examined both behavioral and immunological functions to find a possible link between the two during the aging process. The study found a significant correlation between age-related reduction in exploratory activity and reduced capability of the immune system, suggesting such a link exists.

Increased object exploration has been studied in relation to enriched and typical laboratory environments. Enrichment generally consists of housing animals together in a complex and stimulating environment, which has been shown to enhance interactions with littermates and objects. "The behavioral activity of interactions with objects in the enriched condition has been shown to lead to a relatively enduring change in behavior, that of alteration in exploratory behavior" (Renner & Rosenzweig, 1987, p. 89). Renner (1987) studied the plasticity of exploratory behaviors in adult male rats raised either in a typical laboratory environment or an enriched environment and found that rats from the enriched environment participated in a greater diversity of behaviors related to objects, as well as longer interactions with the objects, than the typical laboratory group. Also, the enriched subjects climbed more than the typical laboratory group on the objects that were nonmanipulable.

Enrichment studies have focused on the effects of enrichment on the developing brain and behavior in the young or mature rat but not in the old rat. A computerized literature search located 30 articles using a keyword search of "rats" <and> "exploration" <and> "enriched" in the following data bases: PsycINFO *(Psychological Abstracts)*, (1887 to present); EBSCOhost, (1985 to present); and Wilson Web, (1983 to present). However, when using the keywords "old rats" or "aged rats" along with "exploration" <and> "enriched," no articles were located, which indicates a gap in the literature knowledge base about how enrichment in young life affects behavior in the old rat.

In this study, one aspect of exploratory behavior was investigated—object investigation. The purpose of this study was to observe the differences in object investigation between two groups of aged Sprague Dawley rats reared in either an enriched or typical laboratory environment. Research has shown that enrichment has a positive effect on behavior of young and mature rats. Our research question was: Will this positive effect on behavior be retained into old age? In order to examine the positive effects of an enriched environment on aged rats, object investigatory behavior of an enriched group and a typical laboratory group was recorded and compared. These observations were conducted in an open field where each subject was allowed free rein of the field which consisted of manipulable and nonmanipulable objects. It was hypothesized that the enriched group would engage in significantly more object investigation, measured by bouts and time duration, than the typical laboratory group.

Method

Participants

The subjects used in this study were 12 female Sprague-Dawley rats (*Rattus norvegicus*). Of these 12 rats, 6 served as the control group raised in a typical laboratory environment, and 6 served as an experimental group raised in an enriched environment. During the course of this experiment, all subjects had access to food and water ad lib, except during the brief observation periods. Lights were on from 0700 to 1900 hr daily, until two weeks prior to testing when the light-dark cycle was changed to 0500 to 1700 hr daily for testing purposes.

Apparatus

Observation Area

The observation area, known as an open field, was a 111.76 cm circle surrounded by 43.18 cm high wooden walls. Subjects were transported to the observation area individually in a Plexiglas® cage and placed in the center of the circular area as determined by the pre-measured diameter. The arena was illuminated by a red light, which is virtually undetectable to rats, allowing the researchers to view the rats' activities.

Stimulus Objects

Objects were classified as either manipulable or nonmanipulable depending upon the rat's ability to move each object. Objects consisted of random household items such as a spoon, a sock, and a textbook. A total of four different objects, two manipulable and two nonmanipulable, were present in the open field area during each testing block. Each of the eight objects was replaced by a similar object for Day 2 of testing.

Videotaping Equipment

Behaviors were videotaped on a Sony 990-Handycam Camera, serial number 308928901, which was placed directly above the area of observation.

Procedure

The rats used in this study were subjects of a prior study. Although there was a clear difference between the enriched rats and the typical rats as seen in their interactions with humans, the enrichment condition would have been constant if there had been control of their environments since weaning for this study. At 32 days the enriched rats ($n = 6$) were placed in a Plexiglas® cage measuring 70 cm x 70 cm x 46 cm. It was filled with wooden toys, nibble bars, a running wheel, and golf balls. The typical laboratory rats ($n = 6$), also at age 32 days, were housed in pairs in 28 cm x 21 cm x 19 cm empty metal cages. All rats were tested four times in a six-unit T-maze during the prior study (Rauscher, 2005). At age 62 days the enriched rats were housed in the same conditions as the typical laboratory rats until the conclusion of the study. At this time the enriched rats were returned to their previous enriched condition. All rats were held daily during the previous study to accustom them to human contact, which ended at age 122 days.

It is important to note for this study that there was a difference in the ages of the enriched and typical laboratory rats. The typical rats were born approximately

September 13, 2004, and the enriched rats were born approximately January 7, 2005. Despite the age difference, both groups were considered to be old rats, as supported by rat study literature. Throughout the present study, the typical laboratory rats were housed in empty metal cages. The enriched rats were housed in the communal Plexiglas® cage and were exposed to spontaneous bouts of interactions with humans lasting no more than 20 minutes at any one time.

Rats in both groups were held for 2-minute intervals for 8 days. Three days before testing, all rats were acclimated to the open area three times for 5 minutes each and held for 2-minute intervals each. Each rat was tested on two separate consecutive days for 10-minute blocks each day between the hours of 1800 and 2100. The 10-minute block began when we left the observation room. After 10 minutes, we reentered the room and the recording stopped. The testing area was cleaned as necessary to remove waste, but no solvents were used during the 2-day testing period. Operational definitions used to code behaviors are listed in Table 1.

During testing, we were blind to whether we were observing the enriched or typical laboratory rats to eliminate the possibility of experimenter bias. Additionally, coding of the recorded tapes did not begin until a 90% interrater reliability was established using practice rats.

Results

The total bouts of behavior were tallied for each rat in the typical laboratory and enriched condition. Bouts on Day 1 were calculated independent of Day 2. The means of the typical laboratory and enriched groups on Day 1 were analyzed with a one-way analysis of variance; there was no significant difference: $F(1, 11) = 0.06$, $p > .05$, as seen in Table 2 (see the Appendix for an explanation of statistical abbreviations and symbols). Similarly, as shown in Table 3, the means on Day 2 were not significantly different: $F(1, 11) = 0.52$, $p > .05$. The total time engaged with objects was also recorded. The means of the typical laboratory and enriched groups on Day 1 were analyzed with a one-way analysis of variance, and these means were found to be significantly different: $F(1, 11) = 5.96$, $p < .05$, as seen in Table 4. However, as seen in Table 5, a difference was not observed on Day 2: $F(1, 11) = 0.52$, $p > .05$.

Discussion

Despite previous research findings indicating that enrichment had a positive effect on behavior of young and mature rats, the results suggested that the behaviors observed in the typical laboratory old rats and in the enriched old rats did not significantly differ. Although there was a significant difference between the groups in time spent interacting with the objects on Day 1, that difference disappeared on Day 2. Overall, the results of the study did not support the hypothesis that the enriched group would engage in significantly more object investigation, measured by bouts of behavior and time duration, than the typical laboratory group.

Our unique research question was: Will this positive effect on behavior be retained into old age? Given the results of this study, two plausible explanations exist. It is plausible that any gains in behavior as a result of an enriched environment are lost in old age. This would suggest that cognitive slowing occurs regardless of what environment a rat is in for the duration of its life. Alternatively, given that there was a

significant difference in time duration between the groups on Day 1 which disappeared on Day 2, it is plausible that the plasticity of the typical laboratory old rat's brain can account for the lack of differences in behavior bouts and time duration on Day 2. This explanation would suggest that although old rats were subjected to a typical laboratory environment for the duration of their lives, there remained sufficient brain plasticity for them to show as high a level of exploratory behavior as the enriched rats on Day 2. The results could also indicate that the dependent variables were not sensitive to the treatment and that other dependent measures should have been chosen, which could have revealed findings more in agreement with literature on the positive effects of enriched atmospheres. Future research is needed to test these possible explanations.

There are several limitations of this study and suggestions for further research. As mentioned in the procedure, the rats used in this study were subjects of a prior study. Although there was a clear difference between the enriched rats and the typical laboratory rats as seen in their interactions with humans, it would be advisable to have constant control over the environments of both groups of rats from weaning. Also, there were only six rats in each treatment condition. To further generalize the results, a larger *n* should be used. Furthermore, a within-groups calculation was not conducted in this study, which limited the analysis. This information may have provided further explanation for the results found in the present study and would allow for individual differences to be analyzed in future studies. A specific suggestion of additional research on enrichment would be to raise a group of rats all in a typical laboratory environment until old age and then divide the group equally between the typical laboratory and an enriched environment to see if enrichment in later life only has an effect on object investigation.

Past studies focused primarily on enrichment environments for young or mature rats and failed to compare old rats raised in enriched and typical laboratory environments with respect to object investigation. This study has contributed to the science of psychology by expanding the body of research on enrichment to find out if positive effects on behavior are retained into old age. Additional studies on the topic of aging in relation to environment are needed to determine the most adaptive environment for older individuals. Research on the effects of environment on behavior is important to understanding how to maximize functioning through environmental stimulation in old age. The results could indicate how a stimulating nursing home environment can impact behavior. Overall, this type of research has increasing importance as age demographics change and the baby boomer cohort moves into older adulthood.

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Appendix

Table 1
Behaviors Used in Interactions With Objects

Behavior	Description
Sniff	Nose contact with object
Single paw contact	One paw contacts object
Two paw contact	Two paws contact the object
Four paw contact	All four paws on the object
Bite	Teeth contact the object
Lick	Tongue contacts the object
Drag	As rat moves backward, object moves with it
Push	As rat moves forward, object moves with it
Collide	Bodily contact with object (not paw or teeth) resulting in movement of object

Note. All descriptions are derived from Renner and Seltzer (1991).

Table 2
Analysis of Variance Summary Table

Day 1 Bouts

Source of variance	*SS*	*df*	*MS*	*F*	*p*
A	6.75	1	6.75	.06	$p > .05$
S/A	1060.17	10	106.02		
Total	1066.917	11			

Note. Was not significant at $p = .05$ alpha level. A = Enriched v. typical groups; S/A = Variability within groups.

Table 3
Analysis of Variance Summary Table

Day 2 Bouts

Source of variance	*SS*	*df*	*MS*	*F*	*p*
A	102.08	1	102.08	.52	$p > .05$
S/A	1956.83	10	195.68		
Total	2058.92	11			

Note. Was not significant at $p = .05$ alpha level. A = Enriched v. typical groups; S/A = Variability within groups.

Table 4
Analysis of Variance Summary Table

Day 1 Time

Source of variance	*SS*	*df*	*MS*	*F*	*p*
A	12675	1	12675	5.96	$p < .05$
S/A	21270.67	10	2127.07		
Total	33945.67	11			

Note. Was not significant at $p = .05$ alpha level. A = Enriched v. typical groups; S/A = Variability within groups.

Table 5
Analysis of Variance Summary Table

Day 2 Time

Source of variance	*SS*	*df*	*MS*	*F*	*p*
A	140.08	1	140.08	.05	$p < .05$
S/A	25730.83	10	2573.083		
Total	25870.92	11			

Note. Was not significant at $p = .05$ alpha level. A = Enriched v. typical groups; S/A = Variability within groups.

Statistical Abbreviations

Abbreviation	Definition
df	Degrees of freedom
F	Fisher's *F* ratio
MS	Mean square
p	Probability
SS	Sum of squares

Confusion for Cheeseheads: How Contradictory Expert Opinions Have Stalled Wisconsin's CCW Legislation

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Abstract

This study argues that Wisconsin's failure to pass any concealed carrying of weapons (CCW) legislation stems from the multitude of differing opinions and findings on CCW. This assertion is made by focusing on three studies on CCW with contradictory conclusions, coupled with a history of CCW in the United States. I show that the multitude of opinions and findings offered by the experts has delayed Wisconsin in passing CCW legislation.

Introduction

Twice in the last three years, in 2004 and more recently in 2006, a concealed-carry weapons (CCW) law has passed both the Wisconsin state Assembly and Senate—only to be vetoed by Governor Jim Doyle. In 2006, though, the Senate overrode the veto, and the Assembly nearly overruled the veto, failing by only two votes. In the United States, Wisconsin and Illinois are the only two states that do not have laws on record that allow individual citizens to carry a concealed handgun in most public areas. With its tradition of hunting and shooting sports, Wisconsin is on the short list of states without a CCW law. For much of the rest of the United States, CCW appears less controversial in the recent political climate, and after years of discussion, the debate may soon reach a close in much of the United States.

Concealed carry hardly qualifies as a new idea. New Hampshire enacted CCW law in 1923, and Georgia, Vermont, and Washington followed suit (Squires, 2001, p. 82). However, by 1986 only eight states had shall-issue concealed carry laws (citizens with no criminal record and adequate training can carry a concealed weapon), and 21 states did not allow concealed carry at all (NRA, 2006). In the past 20 years, states with shall-issue CCW have increased more than fourfold to 35, and only Wisconsin and Illinois lack any form of CCW (NRA, 2006).

CCW has expanded for many reasons. For instance, many interest groups have spent much time and money on influencing states to adopt CCW. According to Packing.org (2006), a group dedicated to the passage of CCW, national groups such as the National Rifle Association have voiced and financed their support for CCW, while groups such as the American Association of Retired Persons (AARP) and the American Bar Association have opposed its passage. Grassroots groups also have played a large role in supporting and opposing CCW legislation. In Wisconsin, groups like the Wisconsin Concealed Carry Association have pushed for the passage of CCW legislation, while groups like the Wisconsin Grassroots Democrats have remained strongly opposed. The involvement of such groups makes it obvious that CCW has remained a highly contested issue for some time.

Economist John Lott poses one rationale for passing CCW legislation. In his controversial book *More Guns Less Crime: Understanding Crime and Gun Control*

Laws (1998), Lott proposes the theory that the citizenry arming itself would deter crime. Lott (1998) argues, with statistical support, that the passage of CCW legislation has led to a reduction in murder, rape, and other violent crimes. This book has sparked many studies in response to Lott's findings. Although detractors argue that Lott's county-by-county analysis is flawed, an *Economist* book review (1998) observes that "Mr. Lott's arguments seem to have prevailed with many politicians." If, indeed, many politicians have accepted Lott's theory, the large increase in states (nine) that have allowed for concealed carry since 1998 may have been influenced by Lott's work (NRA, 2006). Lott's inconclusive findings, and the works of supporters and critics who have followed, have contributed to Wisconsin's continued ban on concealed-carry weapons by failing to give politicians and citizens a unified theory. Studies have failed to offer a unified belief that CCW law lessens violent crime. In fact, some have argued that an increase in firearms may lead to an increase in crime. Most agree that, at worst, CCW legislation simply has no effect on violent crime. Due to the multitude of findings offered by experts, Wisconsin lawmakers have failed to give CCW the bipartisan support it needs to become law. Without one unified accepted study, Wisconsin lawmakers must choose whether or not they favor Lott's results derived from his county-by-county level analysis, or if they support the results of state-by-state level analysis touted by others.

Literature Review and Methodology

To examine the potential effect of Lott's and others' findings, I selected recent studies that responded to Lott's highly influential theory. I selected these articles from among those indexed in two scholarly journal databases: JSTOR and Social Sciences Full Text. The articles I chose respond to Lott's theory by offering either a critique, or posing an alternative explanation, or expanding upon "the more guns-less crime" theory. I also chose an article that took the middle ground in the CCW debate, for many have argued that, at the very least, violent crime does not increase or decrease.

To understand alternate explanations and expanded theories, I first needed a better sense of Lott's theory. Jens Ludwig's (1999) book review of John Lott's *More Guns Less Crime* outlines Lott's theory that many of the articles I studied challenge: an armed population would lead to a decrease in violent crime. I chose Ludwig's review for his strong critique of Lott's theory. To expand the range of scholarly opinion on the issue, I then read Ian Ayres and John Donahue's (2003) *Stanford Law Review* article challenging Lott's proposed idea. I chose this article over the many other anti-Lott articles because the authors have written several articles supporting their argument for the state-by-state analysis that they claim has greater credibility than the county-by-county analysis favored by Lott. The differences between their study and Lott's show why lawmakers and citizens alike have such difficulty in determining the "facts" when two studies that appear similar differ so greatly in their results. Next, Stephen Bronars and John Lott's (1998) *American Economic Review* article deserves consideration because it both affirms many of the findings in Lott's controversial book and presents their notion of geographic spillover, the idea that areas without CCW may see an increase in crime in areas neighboring those with CCW laws as criminals move to areas where they feel a smaller likelihood of losing their life to an armed citizen. Finally, a *Journal of Law and Economics* article by David Olson and Michael Maltz (2001) both

affirms and denies many of the arguments made in the other articles, underscoring the difficulty in swaying the citizenry enough to vote for politicians who will provide the bipartisan support needed for CCW legislation to pass.

Findings

Lott's book *More Guns Less Crime* (1998) sparked political interest in the effects of CCW on a population. As the title suggests, Lott argues that if the citizenry would arm itself, crime would be reduced due to increased "costs" (health, safety, freedom, etc.) to the criminal (Ludwig, 1999, p. 466). Ludwig questions Lott's findings for a few key reasons. For example, Lott found that between 1977 and 1994 CCW led to a decrease in murder by 67% (Ludwig, 1999, p. 466). However, the Department of Justice states there were 4,210 more counts of murder in 1994 than in 1977 (U.S. D.O.J.; see Table 1). Accurate or not, a search in any research database proves that Lott's findings have led more researchers to study the CCW phenomena and to present their own theories and challenges to his analysis. Lott's "more guns-less crime" theory has greatly increased the amount of literature on the subject, and with so many varying conclusions, citizens on either side of the debate can easily find some data to support their opinions. The range in recent conclusions by other researchers establishes a situation where any person with any view of CCW can support that view with scholarly works. Scholarly evidence to support any opinion has resulted in the lack of a unified call by citizens for the implementation of CCW.

Table 1
Murder and Nonnegligent Manslaughter 1977–1994

Year	United States—Total Murders and Nonnegligent Manslaughter*
1977	19120
1978	19560
1979	21460
1980	23040
1981	22520
1982	21010
1983	19310
1984	18690
1985	18980
1986	20610
1987	20100
1988	20680
1989	21500
1990	23440
1991	24700
1992	23760
1993	24530
1994	23330

From "FBI, Uniform Crime Reports" by the National Archive of Criminal Justice Data.

*State offense totals are based on data from all reporting agencies and estimates for unreported areas.

Lott supported his theory further in 1998 with the assistance of Bronars. Lott and Bronars (1998) studied the phenomenon of geographic spillovers. They attempted to determine whether the adoption of CCW law by a state alters crime in the surrounding area without a CCW law (p. 475). Lott and Bronars argued that when a state begins a CCW program, bordering counties in neighboring states without CCW almost always suffer from a spillover of criminals moving to these areas, leading to an increase in crime, especially property crime (p. 479). They claim that this occurs because criminals prey on defenseless victims, and when a state has implemented CCW, the criminals fear that their potential victims might be carrying a concealed weapon. Further, Lott and Bronars argue that the adoption of CCW causes a greater spillover rate than a state choosing not to implement CCW and simply increasing arrest rates would (p. 479). Finally, Bronars and Lott indicate a rapid decrease in all violent crime except rape once the area affected by the spillover adopts CCW laws of its own (p. 479). It can therefore be argued that if geographic spillover does occur, then both Wisconsin and Illinois may have to deal with an increase in crime that could be curbed by enacting a CCW law, giving the CCW debate even more importance. However, one could say their argument may be flawed because it uses the same county-level numbers opposed by many. Debate about the methodology of a county-level study leaves open the possibility that this study is flawed, too.

Ayres and Donohue's (2003) article in the *Stanford Law Review* markedly differs from Lott's. The authors used a different regression model than Lott, one that used a state-by-state level analysis rather than Lott's county-by-county level analysis. This different methodology leads Ayres and Donohue to call into question Lott's arguments in all of the states (p. 1375). Ayres and Donahue believe that more states have seen an increase in crime as opposed to a decrease and that states have seen a $1 billion yearly increase in costs related to crime. Further, the authors argue that county-by-county analysis leaves itself open to criticism because it disproportionately gives equal weight to counties with starkly different populations. This criticism garners particular relevance in states like Wisconsin that have uneven population distributions. For example, Lott could argue that in Wisconsin all but three counties saw a decrease in murder with the adoption of CCW law. The three that didn't see the decrease, however, might include areas like Milwaukee and Madison, which are highly populated urban areas. Such results might not be relevant throughout the state's less populated regions. Ayres and Donahue offer convincing findings, but they did not find the same results as Lott because their analysis utilized a different level of measurement, as well as a different regression model. Further, Ayres and Donahue failed to specify why a state-by-state level of study is superior to county-by-county. However, had they included any credible reasons for preferring the state-by-state level of study, they could have strengthened their argument. They could have gone even further and set this model as the standard for further CCW studies.

David Olson and Michael Maltz (2001) appear to take the middle ground, where the "truth" likely lies. Like Ayres and Donahue, Olson and Maltz attempt to replicate Lott's work, but with a different data source. First, Olson and Maltz found that firearm homicides decreased by more than Lott had found, although non-firearm homicides saw an increase (p. 760–761), which they suggest could have resulted from the different datasets (p. 767). They argue that in states with CCW laws "individuals

involved in a spontaneous altercation may respond as though the other person is carrying a concealed handgun and be triggered into a more lethal attack" (p. 767), which could explain the increase in non-firearm homicides. A study such as Olson's and Maltz's could be used by Wisconsin politicians on both sides of the CCW debate if the study does not receive the criticism other studies have faced—legislators and citizens must ask themselves what is more important, a decrease in the overall murder rate or a decrease in gun murders? Other criticism of the Olson and Maltz article might arise from their focus on murder only, leaving open inquiries about other crimes. The authors might have decided to focus on murder because it remains the most violent form of violent crime. The article also predicts a positive outcome from CCW: a decrease in murder. But, one could ask, if people are brutally beaten to death, due to fear of a concealed weapon, would politicians and their constituents view this as an acceptable trade-off? And is their data sufficient to support such a claim?

Conclusions

These articles show the lack of certainties in the data and methodology in studies of CCW. The many varying opinions on the CCW topic are exacerbated by a lack of concrete answers. As the articles studied here indicate, researchers have not arrived at the same results, and no one has yet released a study that other researchers—or a majority of politicians, or the general public—have come to accept. With this uncertainty, groups have simply chosen the study they prefer and have used those data and conclusions to support their opinions. Therefore, this issue requires further study to find more concrete answers so the citizens and legislators in Wisconsin can make more informed decisions. In particular, future research should focus on justifications for the methodologies employed. If researchers and theorists find one methodology superior to the others, conclusions resulting from the superior methodology should and would have greater credibility. If county-by-county studies stand superior, the possibility for Wisconsin to lower the amount of violent crime could be increased through CCW, as Lott has suggested. By contrast, if state-by-state studies are more accurate, the passage of CCW legislation could lead to an increase in crime and money spent to thwart crime, as Ayres and Donahue and others have suggested. Only further study will allow Wisconsin to reach a consensus and for lawmakers to make a decision that will work—not only for a majority of Wisconsin counties, but also for the state as a whole.

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Combating Invisibility: Older Women Stereotypes Revised

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Abstract

This essay discusses the difference between television and literary portrayals of middle-aged and older women in the last 30 years of the 20th century. TV writers rarely included older women in programming, and when they did, the older women were often characterized as useless, undesirable, and passive. The popular and critically acclaimed novels, *Song of Solomon* and *Paradise*, by Toni Morrison, and *The Weight of Water* and *The Pilot's Wife*, by Anita Shreve, revise the TV stereotypes, creating central, vital, and complex older female characters. These novels illuminate that a mother is to the family what a shaman is to his or her community. The methods are different, but their goals to preserve their tribe or family and their functions as healer and storyteller are the same. The authors' expansion of the older women stereotypes creates a new paradigm for measuring the value of older women.

If you were a superhero, what would your superpower be? Besides flying and X-ray vision, invisibility often captures popular choice. Imagine the mischief possible—with no fear of getting caught! On the other hand, negative complications could develop if no one could see you: people might inadvertently sit on you, kick you around, or ignore you completely. If no one knows you are there, you may not be appreciated as a person or acknowledged for the work that you do. A person without the ability to control invisibility may find it to be a hindrance rather than an asset.

Middle-aged and older women who lived during the last 30 years of the 20th century found themselves rendered thus invisible by society. Even feminists of the period largely ignored female seniors. Television writers frequently depicted this significant percent of the U.S. population as useless, undesirable, and passive—if they portrayed them at all (Davis, 1985). Television, as a major means of enculturation, will serve as the standard against which literary portrayals can be measured. Two female authors, Toni Morrison and Anita Shreve, themselves middle-aged during the last 30 years of the 20th century, highlight older women in their novels *The Pilot's Wife*, *The Weight of Water*, *Paradise*, and *Song of Solomon*, revising the stereotype of sidelined mother by giving their mature female characters shaman-like roles and functions, which revise the negative value judgments concerning older women.

One may ask, "Why these novels, why these authors?" We were interested in what middle-aged or older women, for our purposes defined as 50 years or older, had to say about themselves. But we did not want to read just anything. We wanted to read critically acclaimed literature and novels that have achieved a significant degree of popularity. So we developed criteria for selecting books for this study. They had to be written by a middle-aged or older female author, on Oprah's Book Club list, on *The New York Times*' bestseller list, and respected in academic circles. Two authors met the age requirement: Toni Morrison was 46 when she wrote *Song of Solomon* and 67 when she wrote *Paradise*; Anita Shreve was in her 50s when she wrote both *The Weight of Water* and *The Pilot's Wife*. Oprah's Book Club list stood out as a reasonable measure

of popularity. Winfrey's endorsement usually increases the sales of titles she selects (Day, 2003). The *New York Times*' long-standing list of best sellers is another measure of popularity that tells us many people are at least buying the selected novels. All selected novels have met the established criteria for popularity except for *The Weight of Water*, which instead of having gained notoriety from being included in Oprah's Book Club list has gained celebrity from being made into a movie directed by Kathryn Bigelow and starring Sean Penn, a film which won the Film and Literature Award at the Film by the Sea International Film Festival 2001. Morrison and Shreve both have won critical acclaim; their respected reputations are reflected in the collective awards they have received including PEN/L.L. Winship award, Nobel Prize for Literature, and the Pulitzer Prize. Each of the novels selected met the desired criteria.

In order to see if literature reflected or deviated from the average portrayals of popular media, it is important to look at what the standard portrayals were. Since television is the means of mass communication and is highly influential for enculturation within American society, we looked primarily at television statistics and research (Melamed, 1983). No matter when the television shows or novels were set, the fact that they were all created within the last three decades of the 20th century allows us to compare television and literary portrayals of older women.

Just as a census can be taken of a country's population, a census can also be taken of the population of the characters on TV in order to compare fact with fiction. Also keep in mind that some of the following research is decades old—on purpose. Since the novels chosen for the purpose of this study were written in a span of 30 years from 1977 to 1999, media research for those years is more applicable. A 1978 study done by Ansello revealed that 6% of characters from 238 half-hour segments and commercials were elderly (Davis, 1985). Compared with actual census information, the elderly are noticeably underrepresented. Other studies show a similar trend of underrepresenting the elderly population (Davis, 1985). The older a person is, the less likely they are to see a reflection of themselves on television. Elissa Melamed has called the disproportion "symbolic annihilation" (1983, p.116). Discrimination of middle-aged to elderly people exists in TV shows and commercials, rendering older generations invisible.

Older people are not the only underrepresented group on television; women also suffer discrimination. Studies done in the mid 1980s show that for every one woman there are three men on television (Davis, 1985), even though women outnumber men in U.S. society, notably in the age categories above 65 years. In fact, the gap between the amount of men and the amount of women widens significantly as people age. The 1990 census showed that in the 80 to 84 years of age category, women outnumbered men 2-to-1 (U.S. Census Bureau, 1990). Astonishingly, however, research says that TV characters older than 65 were more than 90% men (Davis, 1985). In TV land, women are most likely to be in their 20s. After age 30 women start disappearing from television. Being a woman compounds the discrimination already heaped upon older people in electronic media.

The few older women characters on TV during that time period also tended to be peripheral (not a main character) and are characterized as past the most useful and important stages of life. They serve not as heroes and leaders; the women are primarily in comic relief and victim roles (Melamed, 1983). Of course, there are exceptions, such

as *The Golden Girls*. The repetitive portrayal of older women characters as peripheral and trivial reflects many television viewers' perceptions of older women. According to Davis, there are six common generalities in America concerning older people: 1.) they are rigid and inflexible; 2.) they decline in intelligence; 3.) they are less productive as workers; 4.) they are institutionalized and dependent; 5.) they are senile; and 6.) they are sexless (1985). These perceptions all have negative connotations which suggest the devaluation of older generations in American society.

In contrast, Toni Morrison in her novels *Paradise* and *Song of Solomon* and Anita Shreve in *The Weight of Water* and *The Pilot's Wife*, rather than creating older women characters who are peripheral, insignificant, and devalued, established older women characters that are visible, vital, and complex. The revisions they make instruct the reader on how to value older women's contributions to society in a new way. An examination of each author's style, an inspection of each individual novel, and an introduction to individual characters will illuminate their revisions.

There are numerous interesting and significant older women characters in several of Toni Morrison's novels, but we will highlight Consolata, age 60, and Lone DuPres, 86, from *Paradise*. In *Song of Solomon*, the character Pilate Dead, 68, illuminates the revision of older women's value within American society. The source of these women's visibility and vitality is worth considering.

In both of these novels, Morrison draws upon a convention of African-American folklore: the shaman. It is through the use of the shaman character that she is able to transcend cultural stereotypes and perceptions of older women. Shamans, because of their function and power, stand out as the most prominent member of the community. There are three important commonalities to know about when considering a shaman character.

Every shaman's main goal and purpose is to preserve the culture and heritage of his or her tribe. It is his or her responsibility to transfer the tribe's heritage from the past to the future. According to shamanistic tradition, dead ancestors are considered to be very much alive by the members of the community: "...death is not the end of existence, but merely another phase" (Vitebsky, 1997, p.1). The ability to communicate with dead tribal ancestors is the cornerstone of a shaman's power; his or her proficiency to speak to the dead is directly related to his or her power as a shaman (Vitebsky, 1997).

Shamans use their powers to heal as one of several methods to preserve their tribe. As medicine men they mitigate disease, ensure fertility, and heal the sick; if these responsibilities are successfully accomplished then the tribe prospers and continues. The ability to act as a healer to the tribal members preserves the tribe's future generations and the passing on of their heritage and culture.

A second method a shaman uses to preserve his or her tribe is the passing on of culture by relating the ancestor's wisdom, heritage, stories, and songs to younger generations. This oral tradition teaches children the values of the tribe. Shamans help young men and women transition from childhood into adulthood, helping them accept their responsibilities and roles in the tribe. This guarantees the perpetuation of the culture through the generations (Vitebsky, 1997).

In a tribal society where one might encounter a shaman figure, these clan leaders function in their tribes as the embodiment of the culture. As such, they are

uniquely qualified to speak about that society's past and present identity and to offer modes of healing in times of adversity. Their power and function give them a highly visible position in the tribe and makes them vital to the survival and health of the group (Vitebsky, 1997). When a shamanic character is encountered in one of these novels, it is a significant signal as to that character's importance.

One begins to see shaman characteristics in Lone DuPres from *Paradise*. Orphaned, unmarried, and childless, Lone has been a midwife in a rural town for 75 years with the amazing record of never losing a patient. Some of the townsfolk underestimate the intelligence of this toothless senior, who learns how to drive a car at age 79. She functions as a healer in *Paradise* by tending to pregnant women, their babies, and sick people, contributing to the overall well-being of the town. Lone helped countless women in Ruby through pregnancy and childbirth: "She taught them how to comb their breasts to set the milk flowing; what to do with the afterbirth...searched the county to get them the kind of dirt they wanted to eat...massaged their stomachs with sweet oil for hours" (Morrison, 1997, p. 271). Though not a doctor, Lone has knowledge of natural and spiritual remedies of healing. When Consolata experiences her first signs of menopause, the old midwife is there to administer herbal tea. More than these everyday remedies, she also possesses a special power—the power to raise the dead. This shaman character uses her healing power for the good of everyone in her community for more than eight decades and passes on her craft to others.

Another orphaned, unmarried, and childless character in Morrison's *Paradise*, Consolata, lives in an ex-convent near a rural community where she shelters destitute and abused women, to whom she functions as a mother. Taken by a nun from the streets at age 9, she sells vegetables and rents land to farmers to ensure that the convent-turned-safe-house stays open to whoever needs it. The healing process Consolata walks her daughters through enables them to live outside the convent after her death. Consolata's realm of influence is small, but the impact she makes on the people around her is vast. Her tribe of daughters engages in relationships with their own children, relatives, and friends as a living embodiment of the knowledge that Consolata taught them. In this way Consolata becomes a tribal preserver. Her mentor, Lone, taught her how to use spirituality to physically and emotionally heal others, and they then return to their families as whole individuals to help their children learn similar lessons.

Consolata also plays the part of a healer perfectly. Mentored by Lone, Consolata discovers and develops her supernatural abilities as a healer:

> Consolata looked at the body and without hesitation removed her glasses and focused on the trickles of red discoloring his hair. She stepped in. Saw the stretch of road he had dreamed through, felt the flip of the truck, the headache, the chest pressure, the unwillingness to breathe...Inside the boy she saw a pinpoint of light receding. Pulling up energy that felt like fear, she stared at it until it widened. Then more, more, so air could come seeping, at first, then rushing rushing in...Scout opened his eyes, groaned and sat up. (Morrison, 1997, p. 245)

Just as a shaman identifies the source of a problem and then communicates with the ancestors for a solution, Consolata interacts with the dead boy's spirit in the spiritual realm, restoring his life. Lone uses this crucial moment to pass on knowledge to the next generation; and both older women have positively contributed to the larger community.

A strong shaman figure emerges in Morrison's *Song of Solomon* as well. Born without a navel, Pilate Dead is outcast from many superstitious communities. She, her daughter, and granddaughter end up living in a primitive home together in Detroit, Michigan, where they make wine for a living. Pilate uses her skills as a medicine woman to assist her sister-in-law Ruth in conceiving a son with her estranged husband. Ruth recalls, "Even before his birth he [her son] was a strong feeling—a feeling about the nasty greenish-gray powder Pilate had given her to be stirred into rainwater and put into food. But Macon came out of his sexual hypnosis in a rage and later when discovering her pregnant, tried to get her to abort" (Morrison, 1977, p. 131). Pilate created a potion that made Ruth's husband desire her after many celibate years and then stepped in to protect the unborn child from his father: "...don't take no more mess off Macon and don't ram another thing up in your womb" (Morrison, 1977, p. 132). Pilate's knowledge as a medicine woman produced a son for the Dead family, ensuring that the family name and heritage would be preserved in the community.

Pilate functions as a successful storytelling shaman. She tells Ruth's son, Milkman, stories about his grandfather's farm and his dad as a small child, introducing him to his family connections and pieces of his heritage. On his path to self-discovery, it is Aunt Pilate's song that becomes the clue to his family's past:

> *Sugarman done fly away*
> *Sugarman done gone*
> *Sugarman cut across the sky*
> *Sugarman gone home* (Morrison, 1977, p. 49)

Upon hearing children singing the song he heard Pilate sing when he was a child, Milkman connects the pieces of his family history. Pilate's song gives Milkman the information he needs to discover his heritage. Carmean comments on the importance of Pilate's stories in Milkman's life: "Pilate's stories form the nucleus of Milkman's integrating past...These stories inspire interest in other and provide a way for Milkman to discover where he might belong...Milkman can begin to think in terms of stories he might tell his own" (1993, p. 49). Milkman is introduced to his family heritage through the legend of his grandfather and then relays the legend to his relatives in Detroit, becoming a storyteller himself. Pilate achieves the passing on of culture with Milkman, preserving the family's heritage for another generation.

Morrison has found a way to develop her older women characters in a visible and vital way, helping readers to reassess their value within American society. Despite the fact that the characters still exhibit stereotypical characteristics about older women, such as physical unattractiveness and limitations, their shaman role gives them valuable means by which to impact their community. Morrison's inclusion of older women as a focal point revises the perceptions of the stereotypes, creating a new paradigm that can be used to measure the value of the older generations.

There are no shaman characters in the selected novels by Anita Shreve. Her older women characters descend from traditional American middle-class roles for women. Julia, a super grandma in *The Pilot's Wife*, is 78 years old. In *The Weight of Water*, Maren Hontvedt, age 52, is the central character. They both operate primarily in a domestic realm as housewives and/or mothers.

In the novels, a mother is to the family what a shaman is to the community. The methods are different, but the function is the same. They are both entrusted with

the preservation of their tribes. Holding a vital and visible position in their tribe, each is the embodiment of the heritage they represent. Children as well as tribe members find comfort and security in the capabilities of their respective leader. Acting as a healer is an important part of each of their roles; both women provide spiritual and physical healing and protection to those under their care. For example, if a child is sick, the mother will take him or her to a doctor or feed him or her chicken noodle soup; if a tribe member is ill, the shaman consults the ancestors and performs an appropriate rite. Both shamans and mothers pass on ancestral stories. Shamans obtain their information directly from the source, while mothers receive their information second hand. In shamanistic cultures the shaman is the mediator between the living dead and the physically living (Vitebsky, 1997), but a mother is the genetic link between grandparents and children. The main difference between the two character types is that the source of power for the shaman lies more in the spiritual realm, while the motivation and ability of a mother can vary. In both cases, the surrounding community benefits and thrives because of the elder's active participation.

When her grandson-in-law passes away, Julia functions as a healer for his surviving wife, Kathryn, and their daughter, Mattie. This New England antiques dealer is familiar with tragedy, having first lost her husband years earlier, and then later a son and daughter-in-law in a drowning accident. Julia continually feeds her granddaughter and great-granddaughter, making sure they have basic sustenance despite their grief. She serves them both tea with brandy and Valium so they can sleep, keeping up their physical strength. While they sleep she watches over them, making sure they are disturbed by nothing. Her own grief is put aside in order to be a strong caretaker for her family. Kathryn and her daughter Mattie recognize Julia's wisdom and follow her advice. Amid their grief, Kathryn and Mattie spend too much time together feeding off each other's sorrow. Julia recognizes this and addresses Kathryn:

> 'You don't normally spend time with her like that.'
> 'This isn't normally.'
> 'Well, maybe we could all use a bit of normally right now...'
> She [Kathryn] sighed. It was always difficult to refute
> Julia's wisdom, especially as Julia so often turned
> out to be right. (Shreve, 1998, p. 190)

She sets them both on the path to emotional and physical wholeness during this trying time, helping to heal their emotional grief and preserve their mother-daughter relationship.

The similarities between a mother and a shaman are ingrained directly into the African language Yoruba (Washington, 2005). The word Àjẹ́ refers to a spiritual force that is believed to be innate in African women. The Àjẹ́ women are highly respected and feared within the Yoruba culture. It is believed that they are "astrally-inclined human beings" (Washington, 2005, p. 171) having special powers and connections to the earth and nature. These women are honored as personal and communal mothers. The linguistic link between supernaturally powered humans or shamanic figures and women serves as a link between the role of a mother and that of a shaman.

Daughter of a poor fisherman, Maren Hontvedt, from Shreve's *The Weight of Water*, is a highly complex character. This Norwegian immigrant to America grudgingly exchanges family, lifestyle, and home, for life on a small, rock island with her husband, John. Here she leads a lonely life, made worse by her inability to conceive a child. Though she is neither a mother nor a shaman, she has a strong storytelling and healing function. It is Maren's storytelling ability that allows her to play a highly visible role in the novel. In *The Weight of Water* there are two stories being told side by side, one from the late 19th century and one from the late 20th century. On her death bed, Maren writes a confessional journal about significant events in her past: the murder of her sister, Karen, and sister-in-law, Anethe. Aging has brought her insight about herself, her family, and the limitations of humanity. Her reflections on her youth show a greater understanding and wisdom of her own life and the way human nature works. With this journal she is able to relate her legacy to Jean, passing on a positive heritage by relating her negative story. Jean goes on to make better choices than Maren did: extending forgiveness and getting out of an unhealthy situation. Maren's life, especially her reflection as an older woman, impacts a future generation.

The common element in each of these older women characters is their shaman function, which allows middle-aged or older women in these stories the opportunity to preserve their tribe through healing and storytelling. Like superheroes, these women are visible and vital both to the story and the other characters in the novel. This raises the reader's perception of the value of older women, in contrast to the perceptions presented on television.

The lack of older women characters and their limited portrayal on television created a gap between reality and TV land, resulting in a skewed perception of what it meant to be an older woman in American society during the last 30 years of the 20th century. By creating visible and important older female characters in these four books, Morrison and Shreve are themselves acting as shamans, showing the next generation how to better value women as they age and offering older women alternative role models to those previously on television. Morrison and Shreve did not allow the invisibility bestowed by television on their generation to dictate their ideas of older women; instead, they control the visibility of older women through the shaman function of their characters.

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The Invisible Woman: Eve's Self Image in *Paradise Lost*

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Abstract

This article is a feminist, deconstructive analysis of John Milton's *Paradise Lost*. Taking the perspective of the story's main female character—Eve—the article seeks to understand how gender affects interpretation and how Milton's interpretation of the old biblical story hints at some of the problems of gender roles and "institutionalized misogyny" that are so much a part of our Western tradition. Milton's Eve has been created from a man, subjected to his rule, and punished for her alleged inferiority. She has been placed in a world that is not her own, her intellectual powers limited, her ability to define herself and her world prevented. Hers is an existence defined by men, and this is a paper dedicated to understanding her perspective—the female perspective. Is she the foil that tradition says she is? Or is she the hero, the first great seeker of knowledge?

Let's talk about sex—about the gulf between the feminine and the masculine, about the ways the sexes work and the ways they help to shape perceptions. How is a man's world any different from a woman's? Focusing on thought and interpretation, an undeniable otherness comes to clarity, revealing one of life's first oppositions—the male and the female. This paper doesn't seek to examine the biological differences; instead, the purpose is to briefly examine socially constructed gender roles and the role they play in literary interpretation, specifically in classical literature. The examination is meant to pose crucial questions and stimulate discourse.

Firmly rooted in the Western tradition of literature is the biblical story of Adam and Eve. This widely recognizable story is a keystone work, part of the system of thought and belief, an episteme. The infamous bite in a utopian garden, taken by lips feminine, has been said to be the root of all of our woe; has been inextricably planted in our culture and in our ways of understanding sex and gender roles. It is a story of power and where it comes from and how it is to be distributed. That Western tradition has seen many attempts to flesh out this short section on the Old Testament book of Genesis is a fact; that none have achieved the notoriety and esteem of Milton's *Paradise Lost* is more fact. *Paradise Lost* is a fictional work of alleged fact: pagan and poetic and prophetic. In his epic rendition of the old tale, Milton further complicates sex and gender roles, filling in the gaps with reason and with the inescapable touches of patriarchy and misogyny that have shaped and are still shaping Western culture. The language, the imagery, the religious claims—all conjured in a male mind. But what about the female reader? How does she interpret a work like this? How does she determine the meaning? For the male reader, this is a story of affirmation, a story of authoritarian origins. Milton's elaboration of the story of Genesis brings attention to the topic of female subjugation and creates a view of women that has an unmistakably inherent male bias. For the female reader (and the careful male reader), this bias and the way it creates meaning challenge the traditional interpretation, forcing readers to consider some tough questions about the sexes.

Through the eyes of the epic poem's only major female character, the problem of image makes itself known. How she comes to interpret herself and the world around her is centered on a male-dominated ideology, brought to life by a male—a dominant literary male—in a field of male-dominated tradition. Given these circumstances, Eve can't see herself for herself; she becomes the problematic signifier, the allegorical figure that brings the problem of image to the forefront of discourse. Hers is a definition of self that comes from a male, an understanding of self framed in and by masculinity.

One of the very first things that the Bible makes concrete, and that Milton's rendition of the Genesis account most certainly builds on, is the idea that females were created from the rib of a man, specifically from the left-hand side of a man—a side notorious for evil. The Judeo-Christian God of the first Genesis account creates his male and female and tells them to prosper in Gen. 1:27 (Revised Standard Version). The second account in Gen. 2:23, is where God brings forth the woman from the man, *from* his rib, Adam naming her woman because she came *from* him, *from* his image. Eve is thus twice removed from God. Out of Adam's loneliness, she was thus created. Milton takes the idea and elaborates on it. Noticing the pairs of the other animals of creation, Milton's Adam comments to God, saying: "So fitly them in pairs thou hast combin'd" (Milton, 1674, 8:394). Adam seems to sense an "imperfection" in man (Milton, 1674, 8:423), an incompleteness in his being, a problem that can be corrected by the creation of another being—a significant other. He senses that the world that was created for *him* isn't ordered right: Adam needs a companion. He then asks his creator, "Among unequals what society/Can sort, what harmonie or true delight?" (Milton, 1674, 8:383-84). He asks, and he receives. Formed and fashioned from his rib, Eve, a creature "Manlike, but different sex, so lovly faire" (Milton, 1674, 8:470), came to be. This account has a great impact on the way that Milton's Eve sees herself and her or rather his (Adam's) world. She was created *from* Adam and *for* Adam. Hers is a man's world, a world fashioned for men by a father-figure type God—a great ladder of patriarchy. She recognizes her secondary status, her inferiority to Adam, her duty to look to him as her "Guide and Head."

In her account of creation, Eve is interrupted from her first frolic in the new world by the cosmic voice of masculinity, urging her out of the symbolism of shadows and the vanity of her reflected image in the water and into the arms of Adam, her new master, the holder of "manly grace," a quality superior to beauty. Her reflected image, the first recognition of the self, is presented to the reader as an action filled with "vain desire" (Milton, 1674, 4:466). She looks at her form in the pool and is pleased by what she sees, curious about the new being that is staring back at her. But the charged words of the narrative foreshadow Eve's predisposition to loving an image above that which created it. With these, her "submissive charms," coupled with her attractive graces, God answers Adam's loneliness, and helps to spur the fruitfulness of the world, the spreading of the seeds of humanity, all the while hinting that her preoccupation with the exterior beauty will lead to future problems. For the female reader, Eve seems to be a novelty for Adam. She is relegated to a role of inferiority in the male hierarchy, and this is the point from which she perceives herself and the world, a perception that began with her taking notice of her physical appearance (Milton, 1674, 4:461), a perception of herself that concentrates on her features and later recognizes the limits of

her inner dimensions, her intellect. It's a good thing that Milton's God warned her of loving herself, her image too much, coaxing her away from her reflection, which after all is just a distortion of reality.

Eve can't imagine, is even prevented from imagining, herself outside of the eyes of the supernatural patriarch and his man Adam and the textual trappings of Milton; she is a woman thrice removed from the female perspective—a problem for female readers, which then becomes the male reader's problem. The female reader of *Paradise Lost* will sense this not so subtle subversion of female gender, this subtle poetic use of language that surfaces long-held assumptions about women and long-held traditions of power. Her self image is a masculine one, or at least one that needs to be defined by masculinity, by the tradition of institutionalized misogyny.

The misogynic nature of the old Christian story that Milton builds on creates a separation between the sexes: it is the earthly myth that obscures the views of the two worlds—the male and the female—coming between their orbits of understanding. The old episteme becomes the scope that Eve uses to place value on herself, through which she shapes her values. The feminist Fetterly's notion of the old "Consciousness-is-Power" maxim holds true in the character of Eve. Her consciousness is limited, her idea of self is not self-determined, her power of perception and literary psychology, both are always on the periphery of male-dominated ideology—the phallocentric ideology—both are in the unfocused background of the big picture, the male picture.

The astute female reader, focusing on Milton's representation of Eve, will no doubt be embittered at times. Eve's beauty, her most esteemed trait, "Heav'ns last best gift" (Milton, 1674, 5:19), is transformed by Milton into a weapon, shooting "Darts of desire" (Milton,1674, 8:563); the reader in general is constantly made aware of Eve being naked, her delectable fruits showing, and how she frolics, innocently, in her own nakedness. Eve represents a kind of simplistic, dangerously delectable creature, whose very delectability is dangerous to Paradise. Her strengths leave her vulnerable. The female reader might behold in Milton's descriptions of Eve the sensual imagery and the pleasure-filled vocabulary: "more lovly faire/Then Wood-Nymph" (Milton, 1674, 5:381); she inspires "amorous delight" (Milton, 1674, 8:476) for Adam; and her "Ornaments, in outward shew/Elaborate, of inward less intact" (Milton, 1674, 8:539-40)—all ornamentation, all inwardly flawed.

Adam's views are also problematic for the female reader. His dialogue throughout the poem is riddled with misogynistic remarks. In his account of his creation, he recounts to the angel Raphael:

> For well I understand in the prime end
> Of Nature her th'inferiour, in the mind
> And inward Faculties, which most excel,
> In outward also her resembling less
> His Image who made both, and less expressing
> The character of that Dominion giv'n
> O're other creatures (Milton, 1674, 8:540-47)

In the actual biblical account, Adam isn't so vocal. So what's Milton's point? Why have the "Patriarch of mankind" so chauvinistic, so full of himself? Adam is fine with Eve's ornamentation when it comes time to light her "bridal lamp," when it comes time for "amorous play." But he's quick to point out that Eve is less of the image of God

than himself, and he's even quicker to place the blame on Eve after the fruit is eaten. God himself admonishes Adam for having "resigned thy manhood" to a woman, when his (Adam's) "perfection farr excell'd/Hers in all real dignitie" (Milton, 1674, 10:628). Milton scholar Flannagan commented that "Adam's perfection outranks Eve's in the hierarchy of nature ... he resigns his manhood and violates his position in nature ..." (Flannagan, 1998, p. 628). Adam's guilty of having given up his "God-given authority" to his inferior: "Was shee thy God, that thou didst obey" (Milton, 1674, 10:145).

While Adam is busy cowering and distributing blame, covering himself with a metaphorical fig leaf, Eve is officially on the Biblical record as being a subordinate: "... to thy Husband's will/Thine shall submit, hee over thee shall rule" (Milton, 1674, 10:196-97). But this is all just Biblical ornamentation: she was already the inferior, the property of Adam, the intellectually challenged flaw of humanity—or so the story goes. This is the woe-making event, the great documentation and dictation of gender roles. This is the event that culminates into what feminist Gilbert calls "institutionalized and often elaborately metaphorical misogyny" (Gallagher & Gilbert, 1979, p. 321). Eve, the "fair defect/Of Nature" (Milton, 1674, 10:891), thus takes the brunt of the blame, whereas Adam's punishment—to be the head of household, ruler of his woman—comes across to readers as getting off easy. Hers is a kind of domestic slavery, a hard-handed punishment that includes pain in childbirth. She is to be the homemaker, the caretaker of issues domestic; he's to be the breadwinner, whose toiled and sweaty brow will return back to the dust from which it came—God's division of labor, his dictation of the structure of how things should be—the origins of Christian patriarchy—the origin of gender roles.

From the feminist perspective, this "Original Sin" is the root of all women's woe—but not in the same sense as the masculine view would see it. The feminist Showalter refers to women as being "daughters of the male tradition," those who've been indoctrinated and have accepted the dominant male ideology (Showalter, 1979). For women the question of how to critically look at the themes of patriarchy and misogyny in the work of a canonical literary giant—Milton—might seem a bit intimidating. But the work speaks for itself, is itself evidence. What male critics would view as an attack, female critics would view as revealing the latent implications of Milton's work. So, for the sake of continuing discourse, let's realize the fictional nature of *Paradise Lost*, no matter how much it begs to be read as being from a "Divine authority."

Milton's fictional God created hierarchy, created worlds and beings whose primary flaws were refusal to acknowledge the system of authority. Eve was created to be Adam's helper, his *unequal* companion. She can only form her ideas through his ideas, saying to him: "My Author and Disposer, what thou bidst/Unargu'd I obey; so God ordains, /God is thy Law, thou mine ..." (Milton, 1674, 4:636-38). Adam is her interpreter, her Heavenly filter. Eve is born into subjection, created less equal and inferior to her "Guide and Head." She appears to have been set up, inclined to want more, to be equal to her male partner—all things that might have fed her desire to know, to eat of the fruit, thus making her equal if not higher to the males who control her. She basically might've wanted to venture higher than her lot, an inexact reference to the Miltonian Satan's words. Eve shows the readers that she is the first human to have wisdom as a virtue, the first to truly want to know, even in spite of Milton's

attempts to taint her language, writing about her "rash hands in evil hour" (Milton, 1674, 9:780), hands that reached for the forbidden fruit; despite her thoughts not being far from God-head; and despite her "ignoring without restraint" (Milton, 1674, 9:791) the fruit of temptation. Without her, God's plan couldn't work; free will wouldn't have been exercised. True, she is given the role "Mother of the Human Race" and mother of the seed that will bruise the head of the serpent; however, the scale is tipped to emphasize her wrongdoing, her wanting to know, to be equal or surpass.

The epic and the story that preceded it are firmly rooted in Western culture, and to pluck of the fruits of discourse, one must be willing to engage both sides of the story, both perspectives, both male and female. The former is the traditional, the accepted interpretation; the latter is less explored. The way that Milton's Eve takes in her world and interprets it and acts in it is an old link in a chain of "immasculation," a Fetterly term. By realizing that this original woman is written from a male's point of view in a patriarchal mythological narrative that favors men and by not being afraid to ask questions about sexual polarity in the work, we as readers and critics can taste the fruits of debate—no matter how bitter they may be.

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Preservation and Immortality: The Transition From Oral to Written Culture in Iceland

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Abstract

The following article comes from Dr. Barbara Crass's *Anthropology 300: The Viking World* class during the Spring 2006 semester at UW Oshkosh. It is intended to provide insight on the transition from an oral to a written culture in Iceland. A set of necessary achievements appear to have been in place that were consistent with other cultures that have established written cultures. When these pieces were put together around the turn of the last millennium (circa 1100–1200 CE) they allowed the transition to occur. The main items of this change were Iceland's excellent history or narrative storytelling, an exceptional cast of storytellers and poets, and the introduction of the written word to the Icelanders by Christian missionaries.

A fire crackles as it throws a soft, orange and yellow glow onto those who sit around it. Some of the kinsmen sit, spinning and combing wool, others tend to mending their tools and weapons, while some simply sit and pay attention to the elder who speaks to them. The old man recounts the tale of his ancestors who fought valiantly against the Celtic tribes in Ireland; of how they interacted with the gods in attempt to seal their victory in battle; of how they drank every night with Odin in the halls of Valhalla. The storyteller is animated, throwing his arms through the air like flesh-bound specters. He uses his polytonous voice to add emphasis to the parts of the story he wants his audience to remember the most. He is the living and breathing history of his kinsmen; he is their link to the past and their hope for the future. The wrinkled and tired old man is a storyteller.

Such is a scene from Viking houses or camps from days gone by. It is no secret that the Northmen were of an oral culture. Their stories were not recorded in any concrete form, but preserved in the minds of those who told stories around the fire. Even the laws of the Vikings were stored in the consciousness of those deemed worthy to memorize them and proclaim them at the pseudo-governmental gatherings of the Thing. Eventually, though, there was a transition from their oral traditions to the "modern" traditions of the written word. How was such a transition facilitated and why? The Scandinavian peoples had survived for hundreds of years without the advent of the written word, so what made them change? In a word, Christianity.

To understand this transition, it is pertinent to first observe the oral traditions of the Vikings. The paradox, though, comes from the fact that an oral culture leaves no trace as it dies off. Inquisition must then come from either a continuing oral tradition passed down over the generations, or written accounts of a literary culture's past as an oral culture. In the case of the Vikings, it is the former that provides us with our knowledge; these are the sagas. From what we know, the Northmen were an oral culture until roughly 1000CE, but was that culture sufficient? In his book *Homo Narrans*, John Niles (1999) states, "when considered as a special kind of ritual performance, oral narrative has a strong capacity to sustain social memory. Storytelling

helps members of a group maintain an awareness of how the present is the result of past action" (p. 54). It would seem then, that an oral tradition allowed the Vikings to keep, in their minds, a sense of identity as well as their laws and customs. However, the Vikings seemed to have a contingency plan; their runes.

Runes constituted a very basic Viking alphabet. This alphabet, though, was inactive in the culture's narrative history and laws. As *Vikings*: *The North Atlantic Saga* (2000) shows, "The primary function of runestones was for memorial purposes, but their use to record missionary work or document inheritance has also been suggested" (p. 67). It appears then, that runes were not involved in the more consistent or universally important aspects of Viking society. This is not surprising though, as Tony Allan in *The Vikings: Life, Myth, & Art* (2004) adds that runes were perceived by the Vikings to have magical powers. This belief possibly stems from their story of origin in which Odin himself attained the secret of writing by hanging himself on Yggdrasil and gashing his side with his own spear (p. 26–27). In *Ring of Seasons*, Terry Lacy (1998) adds to the runes' mysticism; after they were carved into wood or stone, "the runes were then accentuated with dye or blood and a formula spoken over them to empower them. The rune stick could then be carried for protection" (p. 105). It becomes clear that runes were not viewed as a predecessor of an overarching written language, but something closer to sorcery. Lacy (1998) continues:

> In a day and age when relatively few could write, the mere use of runes or letters, even for normal communication, was magical, and the Latin of the church was similarly a magical code to the uninitiated. Thus many of those reputed to be sorcerers in Icelandic history were churchmen. (p. 106)

Even as they neared a written culture, Vikings apparently viewed literature (or the written word) as more magic than science.

Other aspects of the Vikings' oral traditions were the orations of their myths and the practices of their religion. These too, however, can only be viewed clearly in correlation to the introduction of the society's literacy. It is no secret that this introduction went hand in hand with the adoption of Christianity.

Most (if not all) of the Vikings' written works have come from Iceland. It is then important to study the island's contributions and access to literature. In light of this, Lacy (1998) states:

> With the advent of Christianity in 1000 as Iceland's religion, the church brought the concept of schools, the Latin alphabet, and Gregorian chants as part of the mass...literacy and the ability to write became widespread. Chieftains and others were authors and farmhouses were centers for producing and copying manuscripts. (p. 34)

Common knowledge proposes that the acceptance of Christianity was not an instantaneous event. There are familiar stories of how the Vikings would pray to God on land, but set their fates in the hands of Thor at sea. The transitional pagans also wore two-sided amulets; one side being a Christian cross, the other Thor's hammer. Allan (2004) adds, "the effects of the switch were gradual but profound, affecting all aspects of Norse culture. Conversion was accompanied by a shift...from an oral culture to one based on writing" (p. 113). Eventually (as previously stated) the nation of Iceland adopted Christianity as a whole. Even Thorgeir Thorkelsson, a well respected Law

Speaker at the time, "tossed his images of the old gods over the beautiful falls in the north still called Godafoss, waterfall of the gods," says Lacy (1998, p. 101).

Jack Goody in *The Power of the Written Tradition* (2000) states that, "even cultures without writing may be influenced by the products of written cultures—for example, by their religions of conversion. Features associated with the existence of a text may be transmitted to individuals and cultures that do not posses writing" (p. 48–49). This was certainly the case in late Viking Age Iceland. The introduction of Christianity and subsequent literature had set the wheels in motion. No longer would one have to remember and recount either the people's stories or their laws. In the essay "Eddas and Sagas in Medieval Iceland," Gisli Sigurdsson (2000) proclaims:

> Law texts were among the first secular materials to be put in writing in the early twelfth century. A little more than a century after the coming of Christianity, the professional status of the orally trained *Loegsoegumathu*r had been undermined; he could no longer decide which law was applicable but had to consult a book of law that was kept by the bishop. The direct transfer of power from the secular chieftain to the church is evident in this transition as well as the evolution from oral to written culture, and from the pagan heritage to the Christian world where the book had a central function. (p. 186)

The apparent shift in power to the church looks to be disheartening to the identity of Icelandic natives. They would, however, maintain their sense of identity by taking the Latin alphabet and adapting it to suit their own needs. Lacy (1998) explains, "the important thing is that almost all the extant books are written in Icelandic, not Latin" (p. 34), to which Sigurdsson (2000) adds, "the fact that Latin was not used for this literary production puts these works in the same class as the Irish sagas, the only other secular heroic prose literature in this part of the world that was written in the vernacular" (p. 186). It seems, then, that while the storyteller and the lawgiver were being phased out of Icelandic culture, authors, historians, and a more modern form of the lawyer (drawing their information from books rather than from memory) took their place. Sigurdsson explains that secular chieftains of 12th century Iceland also maintained their historical identity by compiling the *Book of Settlements*, an account of Icelandic settlement. Sigurdsson (2000) also states that Icelandic poets became sought-after commodities and traveled to the noble courts of Scandinavia and the British Isles to spin their tales or write new ones for their patrons. These works were then compiled by Icelandic politician Snorri Sturluson in the 13th century into a singular *Prose Edda* (a.k.a. *Snorra* or *Younger Edda*). The *Poetic Edda* of 1270 then preserved other myths of both Scandinavia and Germany (p. 186–187). In "Literary Backgrounds of the Scandinavian Ballad," Vesteinn Olason (1991) recalls another way these Icelandic people held on to their identity:

> Literacy seems to have been more widespread there in the Middle Ages and in the following centuries than in the rest of Scandinavia. From the fourteenth century on many sagas—narrative prose genres composed or written down chiefly beginning in the thirteenth century—were retold in the uniquely Icelandic rhymed metrical form known as *rimur. Rimur*, which are clearly to be distinguished from ballads of the international type, were no doubt composed and

> preserved with the aid of writing, but they have also been memorized, and in previous centuries they were probably often sung or chanted by illiterate people. (p. 119)

This evidence suggests, then, that the Icelandic people not only retained their heritage by retaining their native language, but that they also continued to preform their narratives in a traditional manner as well as committing them to parchment.

"Of the Vikings' own literature, we have a rich inheritance of saga narratives, but most date from the later Middle Ages, when the distant descendants of the original Vikings huddled around a fireplace in an Icelandic winter, and told and retold tales of the glory days," proclaims Jonathan Clements (2005) in *A Brief History of the Vikings* (p. 15). Clements (2005) also agrees that Sturluson was responsible for transcribing many of these ancient stories (p. 15–16). While it is true that the sagas can be viewed as a potential game of "Telephone" (in which the original message or form may be lost as it travels from person to person), it is undeniable that they hold the key to all we know of pre-literate Viking society. Not only do these sagas recount the histories of the Icelandic peoples, as Sigurdsson (2000) adds, but also, "around 1200 the earls in Orkney also got their saga as did the people of the Faeroes and Greenland, about whom the Icelanders wrote sagas along the same literary lines as about themselves" (p. 187). Sigurdsson (2000) continues that the accessibility to the sagas appeals to not only historians and anthropologists, but the laymen as well:

> These fascinating sagas are not only exceptionally well-composed pieces of literature, but more easily accessible to the modern reader that the medieval literature known from most other countries. The world that the sagas describe is so coherent and often so realistic that many readers are tempted to regard them as descriptions of real life even though they were supposed to have taken place two or three hundred years before they were written. Genealogies in one saga match those in another, and the same chieftains appear in various sagas; the same laws and customs appear in unrelated sagas, which reinforces the impression that they are describing a real society that can be reconstructed by using the sagas as field reports. Characters from the sagas are also not only literary prototypes, as is often the case in heroic literature, but more like people of flesh and blood who seem as familiar as our old schoolmates. (p. 187)

In short, the sagas provide both a semi-reliable (often entertaining) and accessible view of the Viking world. Theodore Andersson adds in *The Problem of Icelandic Saga Origins* (1964):

> The sagas cannot have been written as scholarly exercises for a limited group of literai, and they cannot have contained matter which was foreign to the audience. The numerous parchments of *Njals saga* attest the reception accorded even this genealogical colossus. To account for such a popularity we must assume that there was some kind of rapport between saga and listener (or reader). (p. 89)

Not only are these sagas accessible now, but they were also quite popular in the time of their first production.

So where did these sagas come from? There are several theories in scholarly circles that both conflict and meld. Lacy (1998) observes:

> The question of how much extant versions of the eddaic poems and sagas owe to oral tradition and how much they were the work of very able authors remains unresolved. Icelandic oral tradition certainly preserved a considerable core of knowledge of past events. Building on this core, the authors of the sagas composed tales as dramatic as any to be found. (p. 38)

Goody (2000) adds, "It is often assumed that classical ritual texts, like recitations such as Homer's epics or the Vedas, went through a previous existence as utterances handed down from the immemorial past in largely the same form, and that these were simply transferred to the new channel when writing became available" (p. 47). There is no doubt then that oral traditions could have at least inspired the authors of the sagas. However, these oral narratives were, perhaps, not the only inspiration for the writers. Andersson (1964) explains that the Landnamabok (another term describing the text of settlement in Iceland) can be seen as inspiration as well. He says, "the de-emphasis of oral tradition in modern saga research has been accompanied by increased attention to the possibility that the thirteenth-century saga writers leaned heavily on written sources. Among the documents available to them Landnamabok occupies a prominent position" (p. 83). The loophole in this argument is that it has been previously stated that these records of settlement were themselves the product of oral traditions. This would lead then to the idea of the sagas still being based on oral traditions, only once removed. Andersson (1964) continues to develop his theory to allow a combination of both oral *and* written traditions:

> This combination of written and oral sources is slippery ground for bookprose. One wonders whether there is more than a difference of phrasing between the hypothesis that a saga and *Landnama* drew on separate oral traditions and the hypothesis that a saga changed *Landnama* on the basis of oral traditions. In either case the deviation is ultimately oral. The latter hypothesis supposes that the author of *Laxdaela saga*, for example, had oral traditions which were so secure that his confidence in them enabled him to disregard his written *Landnama*. In the first place this speaks for a firm, not necessarily reliable, oral tradition. The written legacy stemming from the revered father of Icelandic historiography was with some probability a strictly controlled tradition, which was not tampered with lightly. In the second place it is questionable to what extent a saga writer was really dependant on *Landnama* when he had alternate sources which he felt to be more trustworthy. In calculating the relationship between *Landnama* and the sagas the divergencies should weigh at least as heavily as the congruencies, which may, after all, have a basis in fact. (p. 87)

It seems, then, that Andersson acknowledges the possibility of both oral and written influences on the sagas. Though to what degree either of them played appears to be case specific to each author. He does, however, conclude:

> The writer undoubtedly could and did use written sources, supplementary oral sources, his own imagination, and above all his own

> words, but his art and presumable the framework of his story were given him by tradition. The inspiration of the sagas is ultimately oral. (1964, p. 119)

Now, with the modes of inspiration observed, it is important to inspect the methods or theories of saga inspiration. Lacy (1998) states, "Based on oral tradition but masterfully expanded, these sagas recount events as they were believed to have taken place" (p. 40). This statement suggests that the sagas were at least rooted in actual historical events or people. Andersson (1964) agrees, "The allusions to saga telling in the sagas have always been regarded as genuine in so far as they indicate some kind of oral tradition" (p. 110). He continues, "Let us imagine how much belief a saga of George Washington, ostensibly fashioned from what 'some men say' would enlist. In order to have any power to convince, such allusions must have a basis in reality" (p. 111). In *Principles for Oral Narrative Research*, Axel Olrik (1992) observes:

> Just to declare that a legend has historical basis can cause difficulties. Within the actual 'folk legends' one will, however, find support for such a claim in the features of the legend that approach verisimilitude, in its intimate knowledge of places and circumstances that are unimportant to the plot, and finally, in the fact that people consider themselves to be descendants of the character in question (preferably with a knowledge of the intermediary links). (p. 114)

If what has been observed about the ultimately oral narrative being the inspiration for the sagas, Olrik's statement adds proof to those of Andersson and Lacy. However, Andersson (1964) believes there is more than one slant (other than the author's or patron's) in perspective of the messages and undertones of the sagas, "The new school, consistent with its tenets, places much emphasis on the Christian ground from which the sagas sprang" (p. 113), adding, "how well does the miracle of Njall's saintly glow and unsinged state jibe with the rest of the saga? Phrased another way, is *Njals saga* the work of an Icelander steeped in hagiography?" (p. 114). What he is suggesting is that there may be a subtle (or not-so-subtle) undertone of the justification of Christianity. This is entirely possible as Christianity has often found a way to wedge itself into local (read: pagan) cultures in order to more easily and efficiently convert them.

The sagas portray what could possibly be viewed as a culture's natural progression from oral to written traditions. Whether it was the people of Iceland, the Native Americans, or some other group, it is apparent that any "modern" culture eventually moves into the literate sphere of the world. Yes, there are some cultures on this planet that have yet to develop their own written language, but it is apparent that these cultures could be classified as "primitive" in comparison to others. In the aftermath of attaining their written culture, Icelandic and Norse sagas have become the basis for Scandinavian ballads according to Bengt Jonsson's (1991) "Oral Literature, Written Literature: The Ballad and Old Norse Genres." While not necessarily a regression, this shows that there is a strong tie among the people to their traditional oral culture. It is a tie very similar to those Native American tribes that continue to hold powwows and pass their stories to younger generations even after their assimilation into the written world. Lacy also states that Sturluson's, "*Prose Edda* is required reading in Icelandic schools to this day" (p. 35). Again, a strong link to the rich literary

history of the island nation. As for why the Icelandic people made their transition when they did, Niles (1999) states:

> A poem of both the length and the exceptional verbal artistry of *Beowulf*, I have argued, could not have come into being as a material text without the converging of three things: a well-developed tradition of oral narrative poetry, an individual person with great verbal skills and literary imagination, and an efficient technology of book-making. (p. 196)

Iceland in the 12th and 13th centuries certainly met those criteria. It is clear that it had an oral history stretching back for hundreds of years. The authors of the sagas, court poets, and Sturluson have proven themselves to be exceptionally skilled in literature; and the introduction of Christianity, bringing the written word (and the people to write them) allowed for the ability to produce the works. The final piece of the puzzle was put into place with the adoption of Christianity. Why did the Icelandic people make the transition from oral to written culture when they did? They were simply ready.

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Synthesis of the Pterocarpan Cabenegrin A-II

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Abstract

Cabenegrin A-II is a molecule found in small quantities in the South American plant commonly called Portuguese Snake Herb, and is useful as a snake and spider anti-venom. Cabenegrin A-II occurs in these plants as a mixture of compounds. It belongs to the biologically active class of compounds known as pterocarpans. Synthetic methods for preparing cabenegrin A-II and other pterocarpans are highly valued. This research develops a novel route to construct the core portion of cabenegrin A-II, which is common to all pterocarpans. This method will allow us to synthesize both ends of the molecule separately. The fragments are then bonded together while the pterocarpan core is synthesized. The strategy used in these experiments will be useful for constructing other biologically important pterocarpans.

Introduction

Cabenegrin A-II is a naturally occurring compound that acts as an antidote for snake and spider venom (Da Silva, 1997). South American plantation workers use an alcohol extract from a South American plant that contains this compound as an antidote for the venom of *Bothrops atrox*, the snake commonly known as Fer-de-Lance. Cabenegrin A-I and cabenegrin A-II were isolated from a local antidote for *Bothrops atrox* venom (Nakagawa, 1982) and (Nakaneshi, 2006). Research performed by Da Silvis and coworkers suggest that the identity of this plant is *Harpalyce brsiliana*, known also as Erva' de Cobra, or Portuguese snake herb. They report isolating both cabenegrin A-I and cabenegrin A-II from this plant (Da Silva, 1997).

Acquiring the molecule from natural sources is problematic, and the compound exists in very small, impure amounts. This molecule is a member of a class of molecules known as pterocarpans, which contain a common core substructure of four fused rings. In previous laboratory syntheses the core portion of cabenegrin A-II is synthesized first and the substituents added later (Ishiguro, 1982). These processes have consisted of lengthy linear syntheses with low overall yields. There is no industrially acceptable process to date. Our research focuses on a method to improve the synthesis of cabenegrin A-II. In the study detailed below, we synthesize two halves of the molecule from 1,3-dimethyoxybenzene, succinic anhydride, and seasmol. The two fragments are bonded together and cyclized to form the pterocarpan core in two or three quick steps.

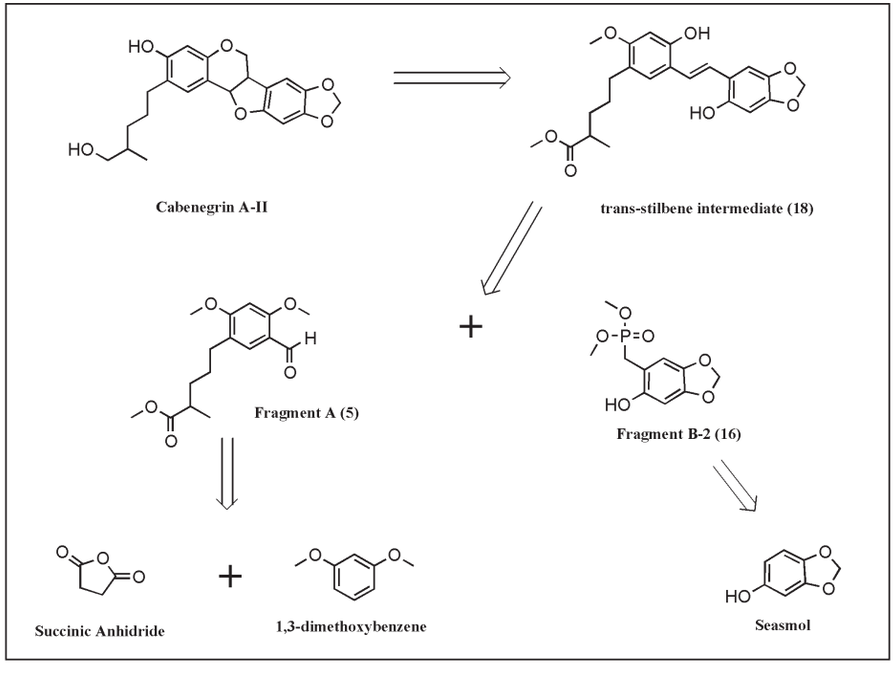
This research will provide an industrially acceptable process for the synthesis of cabenegrin A-II and other biologically active pterocarpans. We can decrease waste, production time, and financial risk by reducing the number of successive reactions as we reduce the complexity of the intermediate compounds.

There are many examples of biologically active pterocarpans. Some act as anti-fungal agents, such as glyceillin-I, glyceollin-II and glyceolin-III. Antiviral properties are reported as well (Bartz, 1992). When the methods developed by this research are established, not only will the synthesis of pterocarpans become more efficient, enhancement of the ability to synthesize other related molecules is also likely.

Research

The research portion of the paper includes figures and schemes. Each figure shows the molecular structure of a compound. Schemes illustrate changes in molecular structure during a series of reactions. In figures and schemes each unique compound is given a boldface number to identify it. Our synthetic strategy for synthesizing cabenegrin A-II is described in Scheme 1 in retrosynthetic format. This type of analysis looks at synthesizing a complicated molecule such as cabenegrin A-II in reverse, moving from the complex target to simple starting materials. Cabenegrin A-II is synthesized from *trans*-stilbene intermediate **18** by cyclizing the pterocarpan core in several steps. Compound **18** is synthesized using a Wittig reaction to combine **5** and **16**. Compound **16** is synthesized from commercially available seasmol using a two-step process, while **5** is synthesized from 1,3-dimethoxybenzene and succinic anhydride (both commercially available materials) in a five-step process.

Scheme 1
Retrosynthetic Analysis

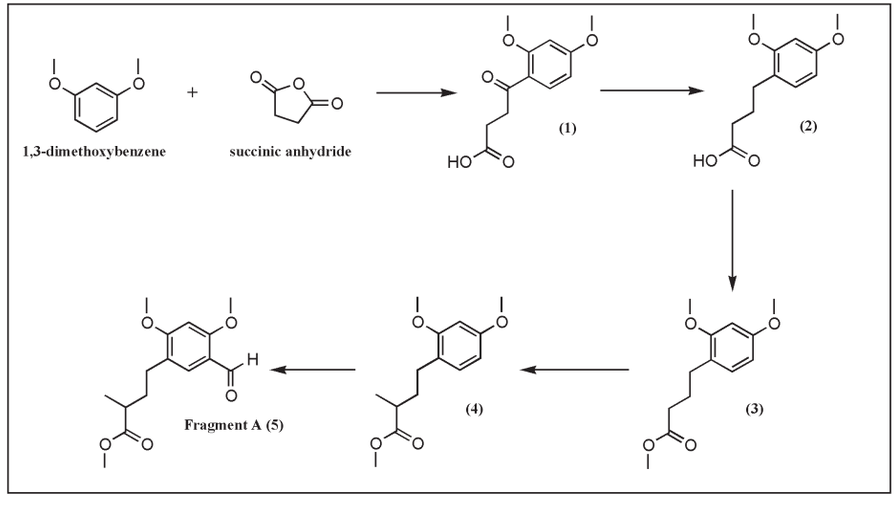


Synthesis of Fragment A

The synthesis of Fragment A (**5**) is described in the forward direction in Scheme 2. A Friedel-Crafts acylation with succinic anhydride and 1,3-dimethoxybenzene produces the carboxylic acid **1**. The newly formed carbon-carbon bond forms selectively between the fourth carbon of 1,3-dimethoxybenzene and one of the carbonyl carbons of the anhydride ring, producing **1**. The carbonyl group (C=O) of

1 is reduced using a Clemmensen reduction employing amalgamated zinc, hydrochloric acid (HCl), ether, and heat, yielding carboxylic acid **2**. The carboxylic acid **2** is next esterified using oxalylchloride and methanol to form **3**. The alpha carbon of **3** is methylated using lithium diisopropylamide (LDA) and iodomethane producing **4**. The final step in Scheme 2 is a Vilsmeier formylation to form the aldehyde **5**.

Scheme 2
Synthesis of Fragment A (5)

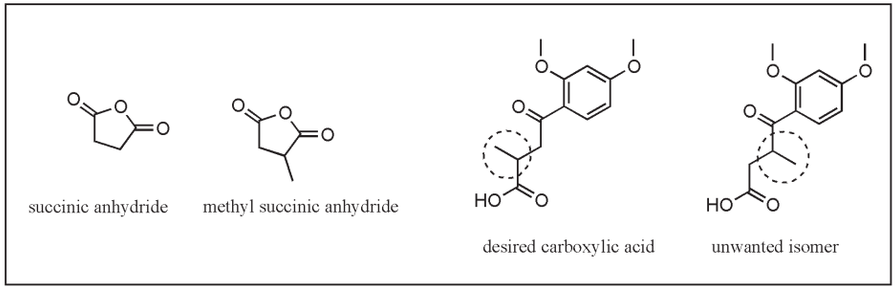


The synthesis of **5** originally started with resorcinol rather than 1,3-dimethoxybenzene (Figure 1). We tried both dichloromethane and nitrobenzene as solvents, but resorcinol is not very soluble in either solvent. Nitrobenzene is a better solvent than dichloromethane, but it is hard to get out of the end product and yields are low. For these reasons, nitrobenzene did not look promising as a solvent. Therefore, its use was discontinued. Several reactions using dichloromethane and resorcinol were explored with limited success. Finally we replaced resorcinol with a 1,3-dimethoxybenzene. This eliminated the solubility issues with resorcinol.

Figure 1
Structures of resorcinol and 1,3-dimethoxybenzene

The synthesis of Fragment A initially used methyl succinic anhydride in place of succinic anhydride (Figure 2). The yields from these reactions with dichloromethane as the solvent were still relatively low. The reactions continued to produce many impurities that were hard to separate from the desired product. Thin layer chromatography suggested the impurities were not starting material, and a workup to remove the impurities was elusive.

Figure 2
Structural Isomers Using Methyl Succinic Anhydride



Recrystallization was explored extensively, but no suitable solvent system was found. Using column chromatography, we purified a very small portion of the overall yield. Analysis of the fractions with proton nuclear magnetic resonance spectroscopy (^{1}H NMR) suggested that the methyl succinic anhydride was not binding to the benzene ring selectively. The reaction was producing two structural isomers, as shown in Figure 2. The first was the desired product with the methyl group on the alpha carbon. The other had the methyl group on the beta carbon. These compounds have similar properties, making separation difficult. Selectivity was very close to 50:50 and much starting material was lost to the undesired isomer regardless of purity after separation.

To solve this problem methyl succinic anhydride was replaced by succinic anhydride (Figure 2). Analysis of a small reaction revealed the expected product. The product was impure, but column chromatography successfully removed most of the impurities.

A one-gram batch of **1** was prepared. During this reaction it was necessary to heat the dichloromethane to 30ºC to dissolve the succinic anhydride. The product was very impure, and the yield was significantly reduced. The reaction was performed again and during the workup I failed to adjust the pH of the solution to basic before extraction. Pure product precipitated out with a yield of 98%.

The research continued until we produced compound **5**. All went well until we attempted a six-gram batch of compound **1**. During this reaction solubilizing the succinic anhydride was more difficult. Large amounts of dichloromethane were required to dissolve the succinic anhydride. The yield of the six-gram batch was only 60%. The yield decreased dramatically as the scale went up. The workup became physically difficult and used a lot of solvent.

Because of these solubility issues we again investigated this reaction using nitrobenzene, succinic anhydride, and the revised, acidic, workup. This produced

a lot of solid product with the familiar impurities. Several unsuccessful attempts to purify the solid were made. Then the breakthrough came. The contaminated solid was dissolved in sodium hydroxide solution and washed with ether. The aqueous layer containing the product was acidified and the product precipitated. After filtering and drying, the product was free from the organic impurities.

The need to remove the impurities led to the current procedure where product is extracted from the nitrobenzene with sodium hydroxide solution. This is washed with ether, acidified with HCl, and then extracted with dichloromethane. When the solvent is evaporated we end up with an extremely pure product. This is a good method that can produce yields as high as 98% and is a scalable procedure.

The next reaction, a Clemmensen reduction of **1** to produce **2**, worked the first time and always works well. The most toxic substance in our procedure, zinc/mercury amalgam, is used in this reaction. Methods to remove mercury from the synthesis may be explored in the future.

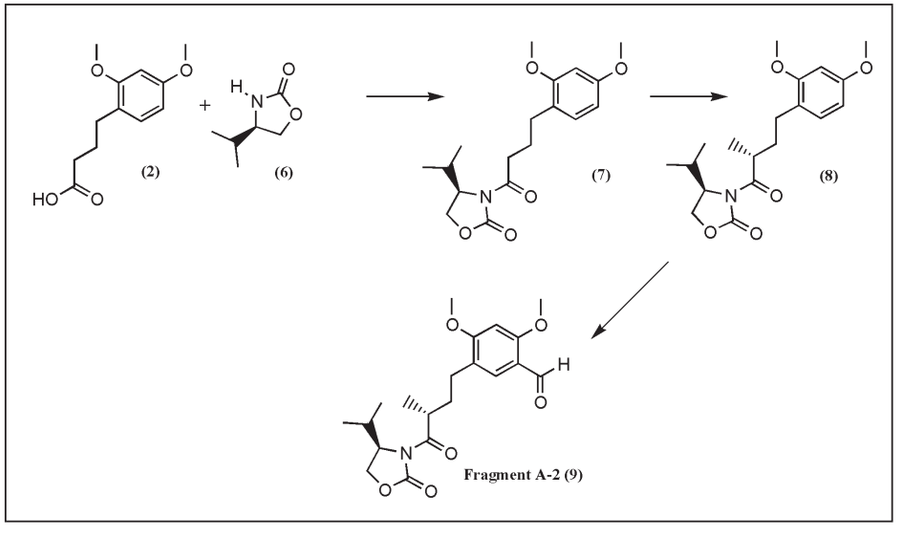
The esterification to produce **3** from **2** is a difficult reaction. The current procedure for the production of this intermediate is sometimes unpredictable. This reaction needs more experimentation and may be replaced in the future. Even though this reaction has problems, it can and does produce useful amounts of product. This reaction uses oxalyl chloride to form an acid chloride. Methanol then displaces the chloride, giving the ester. This nucleophilic substitution gives good yields with reasonably pure product. However, as stated before, this reaction can occasionally produce unexpected results. The ester is a protecting group used to prevent side reactions involving the carboxyl group. It will be converted into the hydroxyl group at the end of the synthesis. We are exploring other protective groups that may improve the synthesis.

The current methylation procedure to produce **4** from **3** is problematic. This reaction uses the base LDA to deprotonate **3**, and methyl iodide to install the methyl group. The reaction is procedurally difficult, requiring a reaction temperature of -78 ºC and a nitrogen atmosphere. It also produces a dimethylation by-product. Many variations in conditions have been explored. The first few attempts at this reaction suggested that it was not proceeding to completion. The reaction time was increased to three days, but thin layer chromatography (TLC) revealed that several compounds were present. Running the reaction for a longer time had little effect. A sample was analyzed by Gas Chromatography/Mass Spectrometry, which revealed fragmentation patterns consistent with dimethylation. The amount of LDA was lowered to a 1:1 molar ratio, but this had little effect on the product. This reaction is productive, but it is operationally difficult and the yields are approximately 50% after column chromatography. The methylation of **4** remains the biggest problem in Scheme 2. We are hopeful that by adjusting the reaction conditions the results can be improved.

The next step is the Vilsmeier formylation to produce **5** from **4**. This reaction, which uses phosphorusoxychloride and dimethyl formamide, is a good procedure. It worked well the first time it was performed.

Scheme 2 does not provide control of stereochemistry. Scheme 3 explores a way to control stereochemistry. Many pterocarpans, including cabenegrin A-II, are found as mixtures of stereoisomers. Stereoisomers are molecules with the same atom connectivity, but different orientations in space, as shown in Figure 3. Their shape differs in a manner similar to left and right hands.

Scheme 3
Control of Stereochemistry in the Synthesis of Fragment A-2

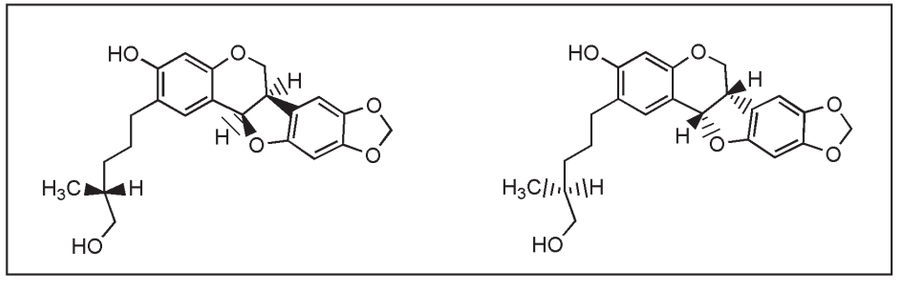


The stereochemistry of cabenegrin A-II does not have an effect on its effectiveness as snake venom antidote. However, molecular shape does affect some biochemical processes. The incorrect stereoisomer will not react with the intended substrate. Therefore, control of stereochemistry may become important in future applications using this synthetic method. Our research explores controlling stereochemistry.

Scheme 3, which is an attempt to control the stereochemistry of the methylation, is currently under development. Steric hindrance provided by an optically pure oxazolidinone is used to control stereochemistry (Evans, 1982). The large substituent will only allow nucleophilic attack from one direction.

The synthesis of **6** begins when L-valine is converted into L-valinol using $LiAlH_4$ (Evans, 1981). This reaction has been performed several times and the results are encouraging, although analysis suggests the reaction is not proceeding to

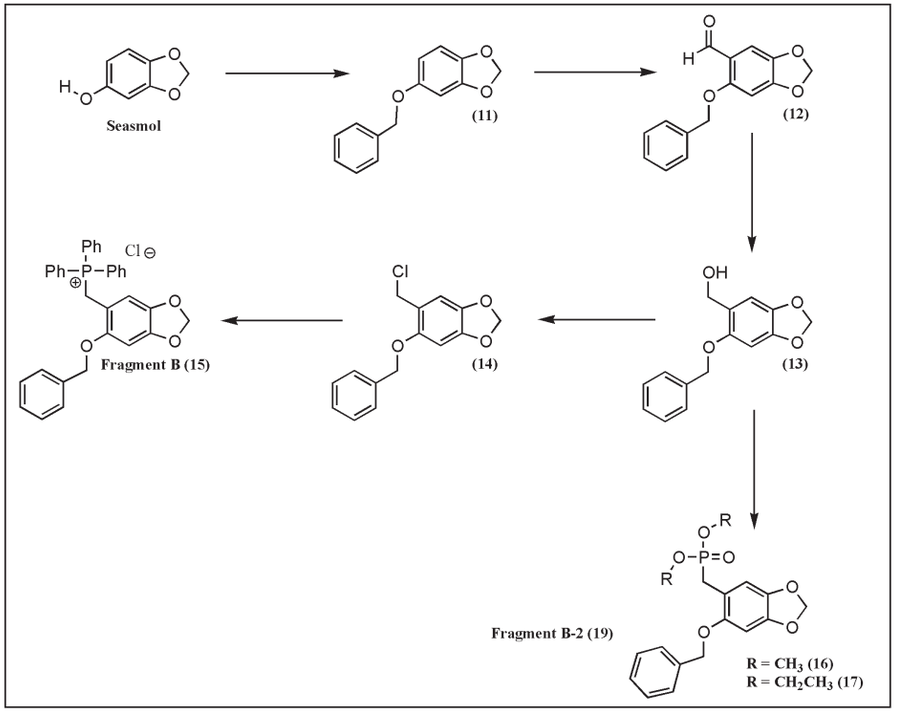
Figure 3
Stereoisomers of Cabenegrin A-II



completion and therefore produces very low yields. In an attempt to improve yields we are lengthening the reaction time. The valinol is then converted to oxazolidinone **6** using carbonyl diimidazole to donate the carbonyl group. This reaction was performed several times. The last attempt produced a yield of 84%.

In the next reaction the oxazolidinone **6** reacts with **2** to give **7**. This will provide the steric hindrance that will allow us to selectively add the methyl group, yielding the single stereoisomer **8**. This synthesis was attempted once; analysis suggested it was successful (Kleschick, 1987). The size of the reaction was so small that determining a yield with the equipment available was not possible. This scheme is showing promise and may be successful at providing control over the chiral center. This may also provide a solution to the dimethylation problem.

Scheme 4
Synthesis of Fragment B



Synthesis of Fragment B

The synthesis of Fragment B from seasmol is described in Scheme 4. Our first attempts used a Duff Formylation reaction to produce **12** directly from seasmol in yields of approximately 45%. Direct chloromethylation of seasmol was also unsuccessfully explored. In the current process, compound **11** is synthesized from seasmol by benzylation. Next, a Vilsmeier Formylation is used to convert **11** to **12** in an 87% yield. A reduction produces **13** from **12**. Sodium borohydride is used to reduce the carbonyl carbon to produce the alcohol **13**. This reaction works well

and in high yield. The next step is to produce **14**. This is done with thionylchloride and dichloromethane. The Wittig reagent **15** is synthesized from **14** using triphenylphosphine in dimethylformamide. ^{1}H NMR analysis showed that compound **14** is unstable. We avoided it by producing Fragment B-2 from **13**, giving compounds **16** and **17**. Compound **13** is treated with iodine and trimethylphosphite to produce the Wittig reagent **16** (McKennon, 1993). We attempted this reaction twice. The first time we tried distillation to remove the excess trimethylphosphite. This was too much heat for the compound and it became a black tar-like mass. By more carefully controlling the temperature during distillation, the reaction was successful and the yield appeared to be good. The product was purified with column chromatography, but the yield was difficult to quantify because of the small amount of product. We also explored using triethylphosphite in place of trimethylphosphite giving a small amount of **17**. This was the molecule used in the first attempt at stilbene synthesis (McKennon, 1993). Removal of excess triethylphosphite was difficult. Because removal of excess trimethylphosphite was easier, the focus remained on compound **16**.

Stilbene Syntheses

The stilbene synthesis is promising, but only a few reaction attempts have been made thus far. These reactions use sodium hydride with dimethylformamide as the solvent (Moody, 1990). A reaction using **15** successfully formed **18** as a mixture of trans and cis isomers. The next several reactions require the trans isomer; attempts to purify **18** were unsuccessful. No further experiments have yet taken place.

The synthesis was more successful using **16**. Tetrahydrofuran (THF) was used as the solvent, and sodium hydride was the second reagent. This reaction looks very promising and it was the first to produce a nice dry solid. Future work will follow. It is clear that this research will produce a useful method to synthesize cabenegrin A-II.

Conclusion

The results of this research are significant in several ways. First, they offer the promise of greater efficiency in the synthesis of cabenegrin A-II. Having a better synthesis of this valuable molecule will improve its accessibility, which is presently limited. Second, the lessons learned from both successful and disappointing reactions help us better understand the chemical behavior of these types of molecules. Finally, this research advances the larger goal of developing a new general strategy for the synthesis of pterocarpans. This new strategy seeks to form the fully substituted core of pterocarpans near the end of the synthesis rather than at the beginning. The synthesis of cabenegrin A-II is a proof of concept case study for this strategy. Thus, the new knowledge generated in the present study may prove valuable in future syntheses of other pterocarpans. Work is continuing on completing the synthesis of cabenegrin A-II.

Acknowledgements

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Rieske Iron-Sulfur Protein Isoforms in a Unicellular Cyanobacterium

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Abstract

Rieske iron-sulfur proteins (ISPs) are integrally involved in photosynthetic electron transport chains and thus closely linked to energy production and its regulation in cyanobacteria and plant chloroplasts. The cyanobacterium *Synechocystis* sp. PCC 6803 has three Rieske proteins, PetC1, PetC2, and PetC3, whose specific roles are not well understood. Here we describe two-dimensional (2D) gel electrophoresis and immunoblotting used to investigate the PetC1 Rieske protein in native *Synechocystis* and to confirm its absence in a mutant with an inactivated PetC1 gene. These studies revealed a "trail" of PetC1 Rieske protein spots migrating at the same molecular weight on 2D gels but at different isoelectric points. This "stuttering" phenomenon suggests covalent modifications that may reflect oxidative damage or modifications of the protein involved in biochemical signaling reactions.

Introduction

Energy is important for the survival of living organisms and the photosynthetic electron transport chain of cyanobacteria and plant and algal chloroplasts is a major source of energy for living organisms on earth. The electron transport system releases energy through a series of oxidation-reduction reactions that must be carefully controlled to prevent the formation of damaging oxygen radicals. These processes are not completely understood. *Synechocystis* sp. PCC 6803 and *Synechococcu*s sp. PCC 7002 are two unicellular cyanobacteria that obtain energy through photosynthesis. Cyanobacteria have also been called blue-green algae because of their physical appearance. The internal thylakoid membranes involved in photosynthesis use water as the electron donor and produce oxygen as an important byproduct of electron transport.

Rieske Iron-Sulfur proteins (ISPs) play an integral role in this electron transport mechanism. Thus further knowledge about their structure and function within photosynthetic cells can help to better understand globally important energy conversion processes as a whole. Rieske ISPs are among the thousands of proteins in cyanobacteria. These ISP proteins are critical components of the cytochrome *bf* electron-transfer complex. These protein complexes are located in the thylakoid membranes of plant chloroplasts and cyanobacteria. Proteins can be described in terms of primary, secondary, tertiary or quartenary structure. Typical Rieske proteins of cytochrome *bf* complexes have two soluble subdomains, one of which binds the iron sulfur cluster, and a membrane-spanning anchor. The 2Fe-2S cluster is a planar structure bound via its irons to two cysteines and two histidines in the protein (Carrell et al. 1997). These Rieske ISPs have a molecular weight of ~19,500 Daltons (19.5 kDa) and an isoelectric focusing point (pI) of ~5.6 (Schneider, 2004). Because they grow rapidly and can be easily manipulated genetically, cyanobacteria were used in the experiments reported here.

The genome of *Synechocystis* PCC 6803 contains three different *petC* genes, which encode different Rieske proteins. It is possible to delete *petC2* or *petC3*, and to a lesser extent *petC1*, without drastically changing functionality or phenotype. Removing both *petC2* and *petC1* results in irreparable damage and loss of function; however, removing either *petC1* and *petC3* or *petC2* and *petC3* still permits some functionality. Although all three *petC* genes are different, they do maintain uniformity to some degree. Thus *petC2* can partially replace *petC1*, but *petC3* is unable to replace any of the other two *petC* genes. For these reasons, it would be interesting to study all three genes, their deletions, and combinations of deletions to better understand the role of these genes and their protein products in cytochrome *bf* complexes and photosynthesis.

Identification, separation, and isolation of individual protein subunits can allow greater insight into individual intricacies of protein function and has been a traditional approach in biochemistry. Separation and identification can be accomplished through a number of techniques including one or two dimensional (1D or 2D) sodium-dodecylsulfate polyacrylamide gel electrophoresis (SDS-PAGE). After such separations, proteins can often be specifically visualized and detected through immuno- or "western-" blotting against specific antibodies. Recently, mass spectrometry techniques such as Matrix Assisted Laser Desorption Ionization Time-Of-Flight (MALDI-TOF) and electrospray ionization (ESI) have become widely available and extremely valuable for identification and characterization of proteins and peptides.

In the present study, these techniques were used to investigate Rieske ISPs of the cyanobacteria *Synechococcus* PCC 7002 and *Synechocystis* 6803. We focused mainly on the PetC1 Rieske protein of *Synechocystis*. Our goal was to test the hypothesis that a mutant strain, ΔPetC1, with a defective *petC1* gene is truly capable of photosynthetic growth in the absence of the predominant, PetC1, Rieske protein of the cytochrome *bf* complex. Data presented here support this hypothesis and most interestingly, provide evidence for the existence of different forms of the PetC1 Rieske protein that may have specific regulatory functions or that may be the byproducts of oxidative damage resulting from electron transfer reactions.

Methods

Cyanobacterial Strains and Culture Conditions

Synechococcus sp. PCC 7002 and *Synechocystis* sp. PCC 6803 were grown as described in Nelson et al. (2005) or Schneider et al. (2004). *Synechococcus* is an abundant unicellular, marine cyanobacterium. *Synechocystis* 6803 is widely used as a model organism and was the first phototroph to have its entire genome sequence determined (referenced in Mulkidjanian et al. 2006). It was isolated from a fresh water lake and is spontaneously transformable, meaning it has the capability of incorporating foreign DNA into its own genome through homologous recombination. Additionally, *Synechocystis* is able to grow under a variety of conditions, including heterotrophically in the absence of light.

Polyacrylamide Gel Electrophoresis (PAGE)

PAGE procedures are widely used for separation of protein complexes, individual proteins, or peptide chains based on their overall conformation, surface charge, or molecular weight (Santoni et al., 2003; Molloy, 2000). SDS-PAGE

relies primarily on the properties of dithiothreitol (DTT), acrylamide, and sodium dodecylsulfate (SDS). Polyacrylamide is a cross-linked polymer of acrylamide that establishes the gel matrix. The higher the concentration, the longer the acrylamide polymers, and the more slowly proteins move through the gel. Although polyacrylamide is non-toxic, acrylamide is a neurotoxin. Thus gels must be handled carefully because of the possible presence of free acrylamide. The 1D gels were done under conditions similar to those reported by Santoni (2003).

PAGE under denaturing conditions most commonly uses sodium dodecylsulfate, or SDS and is referred to as SDS-PAGE. SDS is an anionic (negatively charged) detergent used to denature, or unfold, proteins prior to loading and as they move through the polyacrylamide gel matrix. SDS binds to protein in a ratio of about 1.4 g SDS per 1.0 g protein. Because of this direct proportionality, the mass to charge ratio is also uniform and proteins separate in the gel largely according to their size. Bromophenol Blue dye is added to the gel matrix or directly to the protein solution so a dye front moves down the gel. This allows one to see when the dye is about to exit the gel and provides time to stop the electrophoresis to prevent low molecular weight proteins from running out of the bottom of the gel. Dithiothreitol, or DTT, a reducing agent, is added to the gel loading solution. It helps denature proteins by breaking the disulfide bridges present in many proteins. This disrupts the tertiary or quaternary structures of proteins and can aid in breaking apart subunits.

One-dimensional (1D) SDS-PAGE

This procedure separates proteins only on the basis of their molecular weight but has the advantage of being relatively fast and easy. A critical parameter is the polyacrylamide concentration. Higher percentages result in better separation of high molecular weight proteins but sacrifice resolution of lower molecular weight proteins. Lower concentrations of acrylamide have the opposite effect. The PetC1 Rieske ISP, the protein of interest, has a low molecular weight of about 19,500 Da. Thus a higher percentage of acrylamide yields the best separation in this range. Generally 10–12% single concentration gels or 8–16% gradient gels were used. Discontinuous 1D gels were used, meaning they had a lower resolving gel layer (that actually separates, or resolved, the proteins) and an upper stacking gel layer that allowed proteins to pile up, or "stack," before they reached the resolving gel (Santoni et al., 2003). Before the stacking gel polymerized, a comb with a number of wells was inserted. Once polymerization occurred, the comb was removed and the denatured and negatively charged proteins were loaded into the wells. An electrical current (usually ~ 100 V and 20 mA per 10 cm long gel) was applied causing the SDS-bound proteins to move down the gel to the cathode, or positive end. A lane or well with a set of pre-stained protein standards was run alongside the protein samples to calibrate the relative molecular weights of the protein samples. Proteins appeared as bands on these 1D gels, with each band representing one or more proteins of a particular molecular weight.

Two-dimensional (2D) Isoelectric Focusing (IEF) SDS-PAGE

This procedure uses an immobilized pH gradient (IPG strip) to separate proteins based on their isoelectric points (pI, the pH at which a protein has no net charge) in one dimension, and by molecular mass or size in a second dimension

(Molloy, 2000). 2D-PAGE requires much more time, often several days, and is subsequently more difficult than 1D PAGE. However, it has the advantage of separating proteins not only by their size, but also by their isoelectric points. BioRad ReadyStrip (pH 4-7 or 3-10) IPG Strips were used in this study. Better resolution of PetC1 Rieske proteins (pI ~5.6) was obtained with the narrower range pH 4-7 strips. Most of the 2D protein mini gels (~12 x 10 cm) used in the current study were loaded with ~100 μg of protein to allow optimal resolution. A denatured protein solution was pipetted into a long narrow well and an IPG strip was placed gel side down on top of this solution with electrodes touching each end of the strip. A current was then applied to force proteins to migrate to their isoelectric points on the IPG strip.

SDS-PAGE gels for the second dimension did not use a stacking gel and multi-well comb, but rather one long well for an IPG strip and a small well for protein standards. Each IPG strip from the first dimension was equilibrated in SDS-PAGE sample buffer, then placed horizontally into the long well of an SDS-PAGE gel. The area around the strip was filled with agarose containing a small percentage of Bromophenol Blue to run as a dye front. An electrical current was applied, as in 1D gels, to force proteins to migrate through the gel. Gels were stained either with silver or Coomassie stains (Molloy, 2000; Santoni et al., 2003). Individual proteins appeared as discrete spots on these gels.

Immunoblotting and Mass Spectrometry

These procedures were used to identify which spots on the 2D gels corresponded to proteins of interest, in this case Rieske proteins. After electrophoresis, gels were either stained to visualize proteins, or the proteins were transferred ("blotted") to a membrane for antibody detection. This transfer employed an Owl Blotting Apparatus, which ran a constant current perpendicular to the gel plane and transferred the proteins onto a piece of Millipore Immobilon P membrane. Subsequently, a primary antibody (anti GST/Rieske B4#2, Holton et al., 1996) was used to bind specifically to Rieske proteins on the membrane. A second, enzyme-linked antibody bound specifically to the primary antibody. The secondary antibody was linked to an alkaline phosphatase enzyme. On blots incubated with BCIP (5-Bromo-4-Chloro-3'-Indolyphosphate p-Toluidine Salt) and NBT (Nitro-Blue Tetrazolium Chloride), the BCIP substrate was converted to a visible, purple spot that marked the location(s) of PetC1 Rieske proteins.

Protein spots identified by immunoblotting as Rieske ISPs were excised from gels for possible further characterization by mass spectrometry. Material extracted from these spots was digested with trypsin and spotted onto a MALDI (matrix assisted laser desoption ionization) target plate for attempted MALDI-TOF (time-of-flight) mass spectrometry and protein identification by peptide mass fingerprinting (Pandey and Mann, 2000). Unfortunately, the data obtained were not of sufficient quality to yield significant protein identification scores in searches against the Mascot protein database.

Results and Discussion

Membrane Protein Solubilization

The SDS-PAGE and immunoblotting techniques described above were used to investigate the Rieske iron-sulfur proteins of *Synechocystis* PCC 6803. Most of the

current work focused on characterization of the predominant PetC1 Rieske protein from wild type *Synechocystis* and tests to confirm its absence from a mutant, ΔPetC1, with an inactivated *petC1* gene. Because Rieske ISPs are membrane proteins, they present special problems for gel electrophoresis, particularly for 2D SDS-PAGE where membrane proteins tend to precipitate at their isoelectric points. Such membrane proteins must be kept in solution with detergents but many detergents are incompatible with isoelectric focusing or are ineffective at extracting proteins from membranes (Molloy, 2000). Thus several detergents were tested for membrane protein extraction and compatibility with 2D SDS-PAGE. Figure 1 shows a 1D gel comparing two detergents, CHAPS and ASB14. In these experiments, the less expensive CHAPS proved to be as effective as ASB14 and was used in all subsequent work.

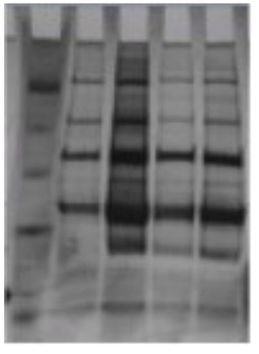

Figure 1

Silver stained 1D SDS-PAGE gel comparing solubilization of membrane proteins with the detergents CHAPS and ASB14. 10-20% acrylamide gradient gel. Wild type *Synechocystis* cells were harvested at either 3.12 OD_{750} units (lanes 2 and 3) or 0.53 OD_{750} units (lanes 4 and 5). From left to right:
1) Protein size standards, 2) membranes extracted with CHAPS, 3) ASB-14, 4) CHAPS, and 5) ASB-14.

Detection of the PetC1 Rieske Iron-sulfur Protein on 2D Gels

To test the hypothesis that the ΔPetC1 mutant of *Synechocystis* is indeed capable of growth in the absence of the predominant, PetC1, Rieske iron-sulfur protein of photosynthesis, 2D SDS-PAGE gels were run of membrane proteins extracted from *Synechocystis* wild type and the ΔPetC1 mutant. In addition, our larger goal was to develop conditions for effective separation of cyanobacterial membrane proteins. Figure 2 shows a representative 2D IEF-SDS-PAGE gel of *Synechocystis* membrane proteins. The overall separation in 2D gels is notably different that in 1D gels, because distinct spots appear on 2D gels, whereas 1D gels produce bands. Each spot represents a unique protein that has migrated to a specific pH (equal to its isoelectric point or pI) and to a specific molecular weight. If the pI and molecular weight of a protein of interest is known, for example, the PetC1 Rieske ISP, it can theoretically be identified on a 2D gel. However, this is often difficult because the resolution of 2D gels is not precise and even simple bacteria have thousands of proteins, many of which may migrate in proximity. Moreover, covalent protein modifications such as oxygen adducts from oxygen radical damage or phosphorylation involved in signaling alter protein surface charge and thus pI and migration on 2D gels.

Figure 2: Section of a 2D IEF-SDS-PAGE gel of wild type *Synechocystis* membrane proteins. Silver stained gel: horizontal dimension, pH 4-7 IPG strip (pH ~4.5 to 6 shown), vertical dimension, SDS-PAGE, 8-16% acrylamide (size range shown ~15,000 – 100,000 kDa).

To identify the *Synechocystis* PetC1 Rieske ISP on these gels, immunoblots were prepared and probed with a PetC1 Rieske antibody as described above. This approach was highly successful and spots corresponding to the PetC1 Rieske protein were readily detected from the native (wild type) *Synechocystis* cells (Figure 3). Note that the PetC1 protein spots migrated at a higher apparent size than the expected ~19.5 kDa. Rieske ISPs have long been known to migrate at higher apparent sizes under some SDS-PAGE conditions (Hurt and Hauska, 1981). In contrast, no signals were detected from 2D gel immunoblots of proteins from the *Synechocystis* ΔPetC1 mutant. In other words, the ΔpetC1 strain did not react against the PetC1 antibody. The ΔPetC1 mutant carries a deletion of the *petC1* gene and these data confirm the absence of the PetC1 Rieske protein, at levels below immunological detection, in this cyanobacterium.

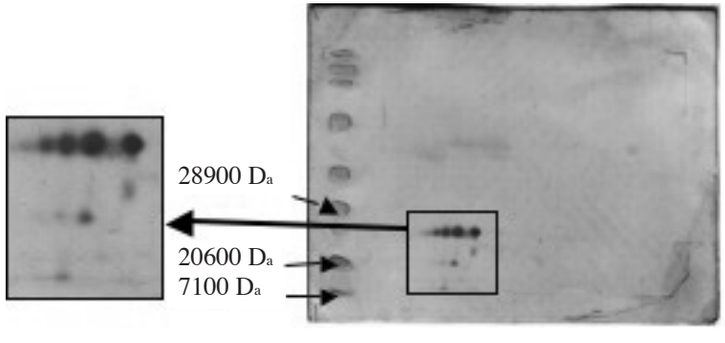

Figure 3: Immunoblot of a 2D IEF-SDS-PAGE gel of wild type *Synechocystis* membranes: Proteins were separated by 2D SDS-PAGE using pH 4-7 IPG strips and probed with an anti-PetC1 Rieske ISP antibody. The spots represent proteins that have reacted against the antibody.

Evidence for Isoforms of the PetC1 Rieske Protein in Cyanobacteria

The most unique and unexpected result from our experiments was the discovery of multiple PetC1 Rieske protein isoforms in the wild type *Synechocystis* 6803. These isoforms are apparent as a horizontal series of spots on 2D gel blots

against the PetC1 antibody as illustrated in Figure 3. This so-called "stuttering" phenomenon is observed in gels or blots as a horizontal series of spots (Ballasteros et al., 2001). On our gels, these very likely represent different forms of the same PetC1 Rieske protein because they all cross-reacted with the Rieske antibody and all migrated at the same molecular weight. They are "isoforms" because they migrated at different pH values in the horizontal, isoelectric focusing, direction. Because they have different isoelectric points (pIs) the surface charges of these protein isoforms must be different.

There are several possible, biologically significant, explanations for such shifts in pI. One is the misincorporation of acidic or basic amino acids into a protein causing a shift in surface charge and pI. Ballasteros et al. (2001) working with non-photosynthetic bacteria, suggested that stasis-induced carbonylation (covalent, double-bonded attachment of oxygen) targets specific proteins. During highly oxidizing conditions leading to oxygen radical formation from electron transport, carbon starved cells may become carbonylated due to the depletion of glucose. In the photosynthetic cyanobacteria, the cytochrome *bf* complex is a major site of oxygen radical production (Horn, 2005). These radicals may be formed during the electron transfer reaction involving the PetC1 Rieske iron-sulfur protein. Thus the Rieske ISP is a likely target for oxygen radical damage. Modifications such as carbonylation would result in a change of the Rieske ISP surface charge and pI, while largely maintaining its molecular weight. As a result, a stuttering pattern would appear on 2D gels.

An alternative explanation for the PetC1 Rieske isoforms is that thse proteins become modified as part of a signaling mechanism that senses and transmits information about the oxidation-reduction potential of the electron transport chain. Rieske proteins have been implicated in redox signaling (deVitry et al., 2004). Phosphorylation, for example, would alter protein surface charge and is widely used in cellular biochemical signaling pathways. Two forms of Rieske ISP have previously been detected from 2D gel analysis of spinach chloroplast proteins (Yu et al., 1994). The significance of such Rieske ISP modifications in that context or in cyanobacteria remains to be determined.

The Rieske ISP spots resulting from immunoblot analysis were excised from the original 2D gels and spotted onto MALDI target plates for mass spectrometry. Several problems were encountered with reliable data collection, mass calibration, and comparisons against the Mascot database, and useable data were not obtained. Since these initial experiments, mass spectrometry procedures have been optimized and these important techniques should now be more readily available for characterization of biologically significant protein modifications.

Conclusions

The present work has contributed to establishing 1D and 2D gel electrophoresis and immunoblot analysis of proteins from cyanobacteria which are model organisms for photosynthesis and globally important for oxygen production and carbon fixation. In this study, we have confirmed that the cyanobacterium *Synechocystis* sp. PCC 6803 is capable of photosynthesis and growth in the absence of the predominant, PetC1, Rieske iron-sulfur protein of the cytochrome *bf* complex. Apparently, the ΔPetC1 mutant lacking the PetC1 Rieske ISP can function, although less efficiently, with an alternative, PetC2, Rieske protein. Our most interesting finding

was the discovery of isoforms, evidenced as "stuttering" patterns on 2D gels, of the major PetC1 Rieske protein in wild type *Synechocystis*. These isoforms represent PetC1 proteins that have similar masses but different surface charges that may arise from oxidative damage or modifications such as phosphorylation with possible roles in biochemical signaling.

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The Labors of a Race: Labor and Leaders in the Twentieth Century

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Abstract

Since the mid-19th century, labor activism in the African American community has shifted from least to most important in the Black freedom struggle. The roles of major figures like Martin Luther King Jr., W.E.B. Dubois, and Booker T. Washington are crucial in understanding the rise of the African American Labor Movement. A trend of merging social and labor goals from the post Civil War era to the late 1960s culminated with the Memphis sanitation strike in 1968.

Introduction

There are shadows in history, of the past which have been overlooked, ignored, or even forgotten. In the discourse on African American history, the Civil Rights Movement has remained a point of interest, while related labor issues have not been fully explored. Few historians have studied how Civil Rights leaders from Booker T. Washington to Martin Luther King Jr. significantly impacted the labor movement in the United States.

The labor struggle in the African American community has changed drastically over time. With the onset of the Industrial Revolution and the Great Migration, African Americans were thrust into a wage-based economy. During the Civil War era, a relationship between labor and the Black freedom struggle developed. Tracking developments through key figures and events reveals several significant transitions.

Frederick Douglass and the Black Freedom Struggle

From the beginnings of slavery, African Americans prioritized abolition. The early goals focused on physical and legal freedom. It was not until Frederick Douglass that the abolition movement had a focused and central voice. In a speech given by Douglass, the goals of the Black freedom struggle were solidified. Douglass stated:

> Do I hear you say you want black officers? Very well, and I have not the slightest doubt that in the progress of this war, we shall see black officers, black colonels, and generals even. But is it not ridiculous in us in all at once refusing to be commanded by white men in time of war, when we are everywhere commanded by white men in time of peace? (Bracey 2003).

Douglas set a trend for the issue of labor; he put it on the “backburner,” so to say, to concentrate on the crucial fight for abolition and the Civil War. With the Emancipation Proclamation and the end of the Civil War, the struggle for abolition was over, yet struggles for Black Americans were far from being finished.

Reconstruction and the Great Upheaval

Reconstruction started the recognized African American labor movement. In the years following the Civil War, many African Americans used their new freedom

to travel north to the industrial and urban centers of the Union. Although African Americans had been involved in industrial labor prior to the Reconstruction period, under the umbrella of slavery a free labor movement on the side of Blacks was near impossible and highly improbable. The Reconstruction period offered opportunities as well as challenges for African Americans in the workforce. This duality is represented in the earliest labor action on the part of African Americans. This period in American labor history is defined by a nation-wide labor movement called the Great Upheaval.

The Great Upheaval, as Brecher (1997) wrote, was a period of massive social unrest, and it "mark[ed] the first great American mass strike, a movement that was viewed at the time as a violent rebellion" (p. 13). At this time there was not a unionized labor front. A group of laborers fought for concessions from the B&O Railroad Company. In the Great Upheaval of 1877, the strike spread to most other industrial activities. In the town of Piedmont, West Virginia, African Americans as well as Whites organized in response to the B&O wage cut (p. 19). The incident with the B&O was not an isolated incident, and the 1877 strike wave continued.

African Americans led the charge in other industries as well. Brecher (1997) wrote that there was a trend with the general strikes of 1877: they would "often [start] with black workers and [spread] to whites" (p. 31). This trend was prevalent in Galveston, Louisville, and St. Louis. In Galveston, "black longshoremen...struck for and won pay equal to their white fellow workers" (p. 31). In St. Louis and Louisville the front was united—Black and White laborers called for better pay. This event portrays the underlying problem in the labor force. Galveston happened as a result of the inequality between Black and White workers. African Americans were fighting for the respect and equality which White workers already expected. The incident of the Great Upheaval displays two critical facts of the early African American labor activism: first, it shows how even though Blacks could strike and win, there was still segregation in American labor, harbored in racial prejudice in the workplace; second, Black labor activists worked separately from the Black freedom struggle. Where Black labor activists were usually fighting for concessions on a local level, the Black freedom struggle was focused on political gains on the state and federal level. The two would remain separate for many years to come.

The unsuccessful nature of Reconstruction led African Americans to adopt new strategies to deal with racial inequality. The rise of Jim Crow laws in the 1890s in the South led to a new set of goals in the Black freedom struggle as a way to cope with the hardships Blacks faced. Out of this period Booker T. Washington arose. Washington gained authority in 1895 as a conservative and a focused race leader. Hailed as influential and praised by both Blacks and Whites, Washington preached self-improvement through basic mechanical and agricultural skills; he also accepted segregation as a reality. Washington defined the Black freedom struggle in similar terms to Douglas, basing many of his goals in mere survival. He advocated to raise the standards of living for African Americans. His school, the Tuskegee Institute, offered Blacks the ability to learn a trade or skill that would benefit them in the labor force. Washington saw the struggle as freedom from violence and freedom to exist as a community. These beliefs led Washington to have a negative view of labor activism, and pushed him to place little significance on the advancement of labor.

Washington was a staunch believer in employer-based labor policy, and

his views on strikes and unions reflected his "don't-rock-the-boat" mentality. He advocated for an anti-union South, and felt strongly that labor organization would lead to increased violence and turmoil. His ideology led to the growing number of Blacks acting as strikebreakers. This view, however beneficial to employers, led to increased tensions between Black and White workers and Marshall (1965) wrote that "The resentment fostered among Negroes by the action of White unionists was reinforced by anti-union Negro leaders such as Booker T. Washington" (p. 17).

Washington's platform on labor and race became central to the labor community and to the African American community as a whole. As Marshall (1965) notes, Washington expressed these views openly to the glee of business owners everywhere, and nowhere more poignantly than in his Atlanta Exposition address in 1895, where he "advised Negroes to shun politics and to acquire agricultural, mechanical, commercial, domestic, and professional skills to meet the competition of whites" (p. 18). In Washington's 1895 address, he said:

> Cast down your bucket among these people who have, without strikes and labour wars, tilled your fields, cleared your forests, builded your railroads and cities, and brought forth treasures from the bowels of the earth, and helped make possible this magnificent representation of the progress of the South. (Wheeler & Becker, 2002, p. 39)

Washington felt labor activism and advancement were not priorities in the Black freedom struggle. His ideas on labor affected the actions of the public: African Americans acted as strikebreakers, Black union membership was low, and White unionists resented Black workers.

African Americans acted as strikebreakers as early as the 1850s, which became a prominent issue in the labor movement at the turn of the century. In longshoremen's groups, Nelson (2001) discovered that early strikebreaking activities were rationalized in that "blacks had come to see strikebreaking as the only means to regain access to a field of labor where they had once been prominently represented" (p. 19). At the turn of the century strikebreaking was the central issue involving Blacks and unionized labor. In the longshoremen's occupation strikes were common:

> African Americans served as strikebreakers...and were able to establish a more secure foothold in 1895, when the Ward Line employed a contingent of blacks to break a local in Brooklyn and thereafter relied on Negro labor 'to the exclusion of all races.' (p. 25)

It was popular belief that "companies were deliberately attempting to turn the Negroes into a race of strikebreakers, with whom to hold the white workers in check" (p. 166).

The animosity that built up between White unionists and Black strikebreakers was furthered by segregated union organizations. Both the Knights of Labor (KOL) and the American Federation of Labor (AFL) had problems with segregation at the local and federal level. Tensions between local union members and African Americans weakened the federal status of these still-young national organizations and drove a wedge between White unionists and would-be Black members. Washington's model of no resistance had been widely accepted and put into practice. By the early 1900s, however, Washington's views were not the single opinion in the Black freedom struggle. W.E.B. Du Bois became a staunch critic of Washington and a beacon of activism in the labor movement.

Change on the Horizon: W.E.B. Du Bois

Du Bois' theories on race and equality were opposite of Washington's. A social scientist and brilliant thinker, Du Bois inferred that there was a different solution to inequality. Where Washington accepted segregation as part of society, Du Bois saw segregation as a major problem and obstacle to racial equality. He was widely popular for his ideas on the "Talented Tenth," his theory on social uplift utilizing the top 10% of the African American race. He is noted for his role in founding of the National Association for the Advancement of Colored People (NAACP) in 1909. Du Bois' activist and progressive ideas made him unpopular with White America. The Black community, however, was inspired by his call to abolish segregation and political inequality. Du Bois founded the Equal Rights League, and as Taylor and Hill (2000) found, "the voter registration campaign of the Equal Rights League...tended to emphasize the ways in which a moral working class could change whites' views concerning blacks" (p. 118). Du Bois advocated for the abandonment of the "American Negro culture" in an attempt to gain a "concept of world humanity" (Nelson p. 140). This translated to just the opposite of what Washington was advocating.

Du Bois knew the opposition Black laborers faced with racially unequal labor unions like the AFL. He called for Black activism and Black organization. Even though many of Du Bois' ideas concerned a potent message of organization, he never fully advocated labor activism as a main goal in the Black freedom struggle. Many of the ideas Du Bois expressed were used by the labor community. This local push toward organization was a turning point in the Black labor community, and helped establish Du Bois as a leader. This turning point focused on inclusion into White labor unions.

"Double Crossed" by American Industry

For labor the years leading to WWI, the 1920s, and the Great Depression tended to represent the "real life" conflict of goals expressed by Washington and Du Bois. There were still conservative moves to break strikes and remain unorganized. The steel industry represented what was happening in the nation. African Americans had been relatively successful in their unorganized state and, as Nelson (2001) found, many rose to "semiskilled and even skilled jobs" (p. 162). With the onset of WWI and the Great Migration north, the Black population in the steel industry grew phenomenally. This wave of Black laborers added to the old pattern of African Americans as strikebreakers in the Great Steel Strike of 1919. The common theme was "that African Americans entered the iron and steel industry mainly as strikebreakers" (p. 164). Again, Washington's ideology seemed to hold, now with a strong sense of revenge tied to it. The idea that African Americans had their own motives in acting as strikebreakers is common. The notion that "the opportunity for steady employment in better-paying jobs" (p. 166) was hard to pass. Another notion was that African American's "own vivid recollections of how the aggression of white workers had helped structure their marginal access to industrial labor markets" (p. 166) was an underlying cause for the strikebreaking. Even with a large majority of important mills seeing very little organization from Black workers, there were instances of overwhelming support for the unions.

Alongside the conservative anti-union notions of Black labor in the steel industry, the ideas of Du Bois were slowly creeping into the minds of unorganized

Black labor. In the years leading to WWI, both activist and conservative Blacks shared floor space in the mills of the steel industry. As early as 1881, African Americans had organized in the steel industry under the Amalgamated Association of Iron and Steel Workers. Nelson (2001) found that in areas like Cleveland and Chicago, 85 to 100% of the Black labor force organized within the Great Steel Strike of 1919, though the important mills at Gary and Pittsburg saw almost no strike participation. The Great Steel Strike of 1919 was pivotal, however. The event would prove to African Americans the need for organization and a change in labor ideology, one that would lean on Du Bois' ideas and foster new leaders in the labor movement.

In the economic highs of the 1920s and the crash of the Great Depression, African Americans realized the possibility of unionization. After the steel strike, labor in general was doing well. Rates were up, and the United States was riding the high tide of wartime boom. However, the African American laborer was less well off than his White counterpart. African Americans were earning lower wages and working more dangerous jobs. During the Great Depression, feelings of inequality were solidified when African Americans were laid off before Whites. Many African Americans felt "double crossed" by the mills. The 1919 actions of Black strikebreakers led to resentment by other African Americans because, as Nelson (2001) discovered, "even though they stood with the company in the strike of [1919]...they did not benefit" (p. 184). These feelings, along with the actions of the desegregated and openly equal labor organization, the CIO, led to widespread participation of African Americans in unions.

Federal action, including the Wagner Act and several New Deal programs, fostered pro-union ideas in the African American community. One major proponent of organized labor was National Negro Congress Secretary John P. Davis. In 1936 he adamantly declared the Black and White issue that faced African Americans. As Nelson (2001) wrote, "he was telling black workers that they faced a clear and momentous choice between joining the union with their white fellow workers and taking the side of their slave driving employers" (p. 191). Davis cemented the notion of Black activism into the labor movement. From conservative strikebreaking efforts to becoming unionized Black workers, the shift in goals becomes clear-from Washington to Du Bois. On the horizon, however, was arguably one of Black labor's greatest leader yet: A. Phillip Randolph.

A Shift in Goals: A. Philip Randolph

From 1941 to 1960, one major figure led a new generation of African Americans in the labor movement. Randolph was a courageous labor leader who blended the struggle of labor, class, race, and equality into one cause. He contrasted starkly with Washington and Du Bois in that his main focus was labor, not politics. Where Du Bois had focused on a top-down advancement through organization (NAACP for example), Randolph reversed this by organizing at the working class level to change inequality from the bottom up. In 1929 Randolph became the president of the Brotherhood of the Sleeping Car Porters (BSCP), an important and largely Black union. His actions made him an important figure in the AFL-CIO. He was critical of the AFL-CIO leadership and made it a point to call out unions that perpetuated segregation. Randolph declared, "I don't believe that...Negro members of a union have a right to maintain a Jim Crow local," a telling statement of Randolph's feelings

on what Nelson (2001) referred to as the "separate but equal mentality that was still prevalent in certain unions" (p. 134).

Organized by Randolph, the March on Washington showed public outcry for legislation regarding employment barriers on the grounds of race. Marshall (1965) noted, "Randolph organized a movement to lead 50,000 Negroes in a protest march on Washington" (p. 212). Randolph had been outraged by the inequality in the workplace: "this sense of outrage must surely have been intensified by the realization that the nation was preparing for a war against fascism, an ideology based in part on racism" (p. 212). Taylor and Hill (2000) found that Randolph criticized the nation when he stated, "If American democracy will not give jobs to its toilers because of race or color...it is a hollow mockery and belies the principles for which it is supposed to stand" (p. 255). The threat of a march was a success; President Franklin D. Roosevelt created the (FEPC) or Fair Employment Practices Committee. Randolph represented the new phase in the Black freedom struggle based in civil rights and labor activism. His achievements as a labor leader brought together the civil rights and labor movements. Honey (1999) noted that in the words of factory worker Matthew Davis, Randolph was more than just a labor leader. Davis states, "People give Martin Luther King a lot of credit, but A. Philip Randolph was way ahead of Martin Luther King" (p. 252).

Turning Point: King and the Sanitation Workers

The labor and civil rights movement headed by Randolph was not well established until the 1960s, as can be seen in the Sanitation Workers Strike of 1968. Despite the civil rights movement, much of the South was still segregated. Leaders in the Black community pushed for equal rights and opportunity, and some legislation passed. During the 1950s and 1960s the Black sanitation workers in Memphis, TN, dealt with a multitude of racial problems in the workplace. For example, Estes (2005) wrote, "white supervisors openly discriminated against black employees in job assignment, pay scale, and advancement...In addition to paying miniscule wages, the city attempted to save money by refusing to modernize ancient equipment" (p. 133). The situation was severe by the early 1960s, and attempts to bring union action against the city failed—once in 1963 and again in 1966. The unequal treatment of Black sanitation workers reached a boiling point in 1968, when "an old garbage truck malfunctioned, killing two black workers...The *Commercial Appeal*, one of two white dailies in Memphis, reported that the workers had been 'ground up like garbage'" (Estes 2005, p. 134). When the walkout began, it gained national attention, and soon after Martin Luther King Jr. arrived and led the civil rights wing of the strike.

King had become a national presence in the fight for civil rights. He had established his reputation with involvement in the Southern Christian Leadership Conference and the NAACP, along with success in the peaceful protest in the Montgomery Bus Boycott and the March on Washington. Like his predecessors, King had not focused on the issue of labor activism and advancement. His goals in the Black freedom struggle were to end all forms of inequality and racial segregation by using non-violent protest. In the summer of 1968, King would focus all his efforts on issues of labor and class in Memphis.

The strike in Memphis merged the civil rights movement and labor. The goals of labor and civil rights met at the forefront of racial prejudice. Though the Memphis

Sanitation Strike was unsuccessful and King lost his life in Memphis, the implications of the Sanitation Strike of 1968 are important. For the first time, civil rights and workers rights shared the same stage. Randolph had concluded this was the only option for African Americans in society, a united fight starting with labor rights. King's presence at the strike strengthened the ties that Randolph created, the unification of civil and worker's rights. In the end though, the strike of 1968 foreshadowed a decline in labor activism.

After King's murder in Memphis, Black leadership was in disarray, and the push for equality in labor faded. The assassination of King dispersed Black ideology. In the 1970s the Black freedom struggle split, with one side favoring the continued work of King and the other movement concentrating on Black Power ideology. This split clearly affected labor.

In 1977 another sanitation worker's strike occurred in Atlanta. Maynard Jackson, the first Black mayor of the city and former supporter of labor organization, laid off 1,000 sanitation workers who participated in a walkout. This incident represents the dissolution and perhaps the end of the era of African American labor rights and a definite low point in African American labor history. Labor activism and the goals of the Black freedom struggle split-poetic injustice. The hostility that labor faced in the aftermath of the assassination of King reveals the retrograde direction labor was moving in the Black freedom struggle. Labor took a back seat to political and cultural goals that the Black freedom struggle began to push as key issues.

The binary that developed from Reconstruction up to the civil rights movement between labor and the Black freedom struggle is clear. Labor activism has always been a part of the Black community but not always at the forefront of the Black freedom struggle. Washington's views on segregation and conservative anti-union sentiments stuck with the African American community until the early 1900s. Du Bois' ideas on activism and Black unification battled Washington's views in the labor movement, especially in the steel industry of WWI. A. Philip Randolph redefined the Black freedom struggle in terms of labor; his views encompassed the ideals and solutions identified by half a century of hardship in society. With Randolph and King labor action and civil action unified. The Black freedom struggle placed labor as its main goal, focusing on class as well as race in what seemed like a time of unlimited opportunity. However, the modern poverty level among the African American community is a tragic reminder of the progress that was so violently halted in Memphis in 1968.

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