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# MCNAIR SCHOLARS PROGRAM

*Journal of Research Reports*

2016-2017 • VOLUME 22

## the art of DELIBERATE SUCCESS

PRACTICE

PERFORM

ACHIEVE

# MCNAIR SCHOLARS PROGRAM

*Journal of Research Reports*

2016-2017 • VOLUME 21



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WICHITA STATE  
UNIVERSITY

## **Editors**

*David Caylor*

*Ashley Cervantes*

*LaWanda Holt-Fields*

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## Administration

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Associate Vice President for Student Affairs

*Dr. John Bardo*  
*Dr. Teri Hall*  
*Ms. Deltha Q. Colvin*

## From the Director

I am proud to present this Journal of Research Reports, “*The Art of Deliberate Success.*” The articles featured in this journal represent the work of Program participants from the 2016 – 2017 grant year. It is clear that the breadth of research interests is as diverse as the students that we serve and the experiences were varied as well. The staff could not be more pleased with the efforts of both the students and faculty who produced this body of work.

The Program could not achieve such accomplishments without the support of the University faculty, staff and administrators who have mentored students since 1995. We thank the mentors who have guided and supported the McNair Scholars in completing their research projects, writing their manuscripts and presenting their findings. We applaud each of the research mentors for investing their time and effort to make undergraduate research a reality for the students in this Program.

Within this journal, the work of 14 undergraduate students is highlighted. Of these Wichita State University students who have shown their commitment to excellence, two (2) students will present full manuscripts, 10 students will be featured with a summary of their research and two students have extended literature reviews. Students also participate in scholarly activities that include monthly mentor presentations, McWrite workshops for writing skill development and a research seminar. These activities assist students to develop research skills as they prepare to enter graduate studies. These experiences as well as the newly developed skills make a McNair Scholar very attractive to admissions committees of graduate programs.

A special word of thanks is directed to the Program staff for their keen ability to motivate the students to produce the best possible document for publication. Appreciation is given to our writing tutor, Mr. David Caylor, program counselor, Ms. Ashley Cervantes, and the senior administrative assistant, Ms. Neshia Greene. Without their support and persistence in making sure that things get done, and in a timely manner, none of this would be possible. These individuals are invaluable and their dedication and commitment are valued qualities. I feel fortunate to have found staff members who possess them. Lastly, I thank Ms. Deltha Q. Colvin for her support and trust in me to serve and support the students of this Program.

Finally, I would like to congratulate the students for going beyond the classroom and putting their research interests into practice. Their efforts will not go unnoticed and will prove to be something they can be proud of for many years to come. We are most proud of our students and their accomplishments; this is a well-deserved recognition. These students are our future educators. Thank you for the opportunity to serve as your director and work with such inspiring students.



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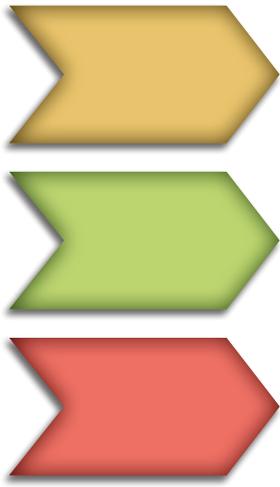
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RESEARCH MANUSCRIPTS





# Under Pressure: Understanding the Determinants of Fiscal Distress in the Michigan School Districts

*Amanda Johnson*

Jodi Pelkowski, Ph.D.

Chase M. Billingham, Ph.D.

Wichita State University

## Abstract

Under School Choice 105(c), Michigan school districts are given discretion to participate in inter-district open enrollment. Proposal A allows per-pupil funding to transfer as students moved between districts. This ties revenue to enrollment and incentivizes the public school districts to manage increasing expenditures and tight budgets through participation in School Choice 105 (c). Like many school districts across the nation, Michigan school districts have faced financial hardship and have noted a rise in private educational institutions. This paper seeks to examine the likelihood that school choice, student characteristics and resource allocation contribute to fiscal distress in public school districts in Michigan. Through a logit regression analysis, our study analyzed district level data from the 2010-2011 through 2015-2016 school years. Our findings illustrated charter penetration increased the odds of a district becoming fiscally distressed by 4.26%, while net inter-district transfers reduced the odds by 2.71%. While these variables are not in a district's control, our results indicated that a district's expenses on benefits, which is within their control, had the greatest odds of causing fiscal distress at 10.64%.

## Introduction

In the early to mid-1990's, the state of Michigan made major changes to the way their K-12 education was financed. Historically, local taxation, state, and federal funding resources financed Michigan's schools. Of the local/state split, local taxation and state funding contributed approximately 69% and 31%, respectively, to school financing in 1994 (Summers, 2017). Many residents were unhappy with this model, as the local property tax burden on Michigan residents was 33% higher than the national average. Michigan schools heavily relied on local property taxes to fund schools, which led to steadily increasing funding disparities among districts (Lockwood, 2002).

In the height of political pressure in 1993, the Michigan Legislature voted to retract property tax as the primary source for Michigan public schools. The tax amendment known as Proposal A aimed to provide "minimum per pupil foundation allowance, more equity among local school districts, lower property taxes, and more school accountability" and was passed on March 15, 1994 (Lockwood, 2002, p. 1). The new proposal rebalanced the financial liability of education between local, state, and federal sources in an effort to alleviate the property tax burden on Michigan residents while equalizing the funding between districts. After Proposal A, the amendment shifted the local taxation and state funding approximately to 20% and 80%, respectively (Summers, 2017).

Prior to the passing of Proposal A, local districts operated under a power-equalization system. A power-equalization school finance system is an approach to raising local funds through an increment of property taxation as a supplement to state aid. This approach led to a disparity in local funds across districts. Through this, a district could raise additional revenue by imposing higher local taxes. However, the revenue generated from property tax was greatly unequal between low-wealth and high-wealth districts. Proposal A centralized funds at the state level by executing a foundational system. Under a foundational school finance system, the state specifies a per-pupil funding amount in addi-

tion to a specified local tax rate that each district must levy; the state then provides the differential funding needed (Carey, 2002). The state of Michigan would set a minimum rate per-pupil, a target rate that districts should maintain and a 'ceiling' that districts cannot exceed (Summers, 2017). Essentially, this limits the authority of local districts to raise local taxes for additional school funding; given school funding would be tied to pupil count within a district rather than property tax.

Shortly after the change in school financing, Michigan loosened enrollment rules providing students and parents more latitude to participate in its school choice program - inter-district choice. In 1996, Michigan legislature gave every local district the option of voluntary participation in the school choice program through Section 105 or Section 105 C. The provision allows districts to enroll non-resident students without prior approval from the student's residential district. As defined by Michigan Department of Education, under Section 105, a local school district could "enroll students who reside in other local school districts within the same intermediate school district" (Michigan Department of Education, 2015, p.1). Section 105 C, which is the focus of this study, permits the enrollment of students "who reside in school districts located in contiguous intermediate school districts" (MDE, 2015, p.1). Out of all of the public K-12 students in Michigan, approximately 8% are enrolled in charter schools and over 7% participate in Section 105 C (Arsen, DeLuca, Ni, Bates, 2015). Under the provisions of school choice, a student's foundational grant funding transfers with the student to their school of choice. Proposal A created a strong fiscal incentive for local districts to compete for students. As of 2016, there were 540 local school districts and 302 charter schools in the state of Michigan and over 80% of districts accepted nonresident students (Pogodzinski & Addonizio, 2016). In the last two decades, the number of charter schools and student participation in school choice has steadily increased. Almost all funding transfers as a student leaves their residential district to attend another local district or charter school under

a foundational system. As the supply of education increases and more parents exercise their choice, this creates the potential for financial distress for districts that have difficulty retaining students in a competitive market.

## Related Literature History of School Choice

Inter-district open enrollment has become one of the most popular forms of school choice in the United States. Though the conditions may vary state-to-state, inter-district open enrollment refers to the students' ability to transfer to a school outside of their residential district. Essentially, open enrollment allows students to cross assigned districts, in an effort to mitigate the socioeconomic, racial and educational inequity by providing educational choice. Currently, 22 states have mandatory inter-district policies, while 36 states (including Michigan) allow local district voluntary participation in the inter-district transfer (Education Commission of the States, 2016).

Inter-district transfers are one of the few school choice programs where a district's decision to "opt in" or "opt out" of participation has a direct impact on surrounding districts. The interdependent relationship influences the choices made by local school districts, therefore it has consequences on the interaction of the whole education system (Arsen, Plank, Sykes, 2002). For example, if District A decides to participate in the school choice program, this subtracts students from surrounding District B. Over time, the loss in students begins to create declining revenues in District B. Without District B participating, District A may continue to attract students from District B. As a result, District B now has an incentive to enter in on the competition for students to mitigate declining revenues. Advocates for open enrollment have argued that school choice would promote healthy competition and innovation on the educational market while increasing access to quality schools across all socioeconomic classes. Opponents have argued that negative financial impacts for neighborhood districts when students

transfer out make it increasingly difficult to manage annual budgets as districts lose state aid (Mikulecky, 2013). With the mainstream growth of school choice, there has been a growing interest to understand the transactional dynamic between districts.

## Understanding Inter-District Flow

Fossey (1994) and Fowler (1996) sought to understand the characteristics of districts that were net receivers and net senders under inter-district transfers. Fossey (1994) conducted a descriptive analysis with data from the Massachusetts Department of Education to compare specific characteristics of 'sending' and 'receiving' districts in the fall of 1992. Fossey (1994) focused on districts of which 20 or more school-choice students transferred from one district to another. The analysis indicated that parents chose to enroll their child(ren) in districts with greater socioeconomic status relative to the district they left. Students moved from districts with lower median family incomes and lower education levels of the adults and into districts with a wealthier and more highly educated base of adults. Additionally, per-pupil expenditures and standardized test scores of high school seniors were higher in receiving districts compared to sending districts.

Fowler (1996) investigated the demographic characteristics associated with open districts and closed districts in Ohio through the supply-side rational choice theory. The assumption of the theory states: "1. School leaders wish to maintain or increase enrollment. 2. School leaders wish to increase revenues. 3. If threatened by the loss of enrollment or revenues, school leaders would be willing to compete with other districts for students and revenues. 4. School leaders will be able to expand their district's supply of high quality programs to meet parental demands. 5. The parents and communities served by districts that currently offer high-quality programs will be willing to accept children from outside their district" (Fowler, 1996, p.520). Using survey data, Fowler analyzed

demographic characteristics, total enrollment, enrollment trends, percentage of minority enrollment, location and per-pupil expenditures to understand districts' motivation for participation. The responses were from 144 open districts and 112 closed districts. The survey research study supports the assumptions held by supply-side of school choice, as "82% of districts with declining enrollment had decided to participate in the program (p.527)", indicating enrollment and finances as a factor (Fowler, 1996). However, the political and social implications for participation undermine aspects of the assumption of supply-side rational choice theory. Regarding the expansion of the supply of education in "so-called better districts", superintendents from high-spending districts (93%) and suburban districts (72%) stated opposition and pressure to not opt to accept outside students. This undermined the fifth assumption, that parents and communities would be willing to accept children from outside their district.

Both Fowler and Fossey concluded that, prior to the transfers, net receiving districts had higher socioeconomic status and academic achievement relative to net sending districts. This research set the baseline for understanding the determinants of inter-districts flow.

In later research, Carlson, Lavery, and Witte (2011) analyzed the factors that affected the aggregate number of students' transfers and determinants of the "transaction" among districts by sampling Colorado and Minnesota during the 2003-04 school year using a zero-inflated negative binomial model. The analysis highlighted a clear consequence for poor-performing districts. For example, Minnesota's Minneapolis School, a notably troubled district, lost \$28 million of revenue (Carlson, Lavery & Witte, 2011). Similar to Fossey's (1994) results, Carlson, Lavery and Witte's research found that poor-performing districts lose more students relative to higher-performing districts. Furthermore, the study indicated key determinants such as demographics and commute as drivers of open enrollment participation.

## Michigan Context

Arsen, DeLuca, Ni, & Bates (2015) sought to explain why specific districts experienced financial distress through a fixed-effect model on a state-wide dataset of Michigan school districts from 1995 to 2012. By analyzing a range of variables corresponding to school finance and district allocation decisions, the basic model included factors such as revenue, enrollment, choice, student characteristics, and resource allocation. The study concluded that 80% of district fiscal trouble in Michigan is attributed to variability in enrollment as decline in district funding does not adequately cover the expenditures of high-cost students (Arsen et al., 2015, p.2). Enrollment-declining districts were more afflicted with financial distress by school choice policies than enrollment-increasing districts, especially those with high levels of charter schools in the area. Rather than encouraging competition among districts to compete for student retention, it resulted in cuts to programs, services, and compensation to counterbalance the loss in revenue by declining enrollment districts.

It is important to note that Michigan has undertaken one of the most transformative measures of school finance by shifting funding responsibility away from local districts to the state government in 1994. Under Proposal A, the purpose was to equalize the equity between school districts, this "modified foundation system replaced district power equalization as the mechanism for distributing basic aid to school districts" (Cullen, 2004, p. 1). As a result, spending per pupil among low-spending districts increased, while spending per pupil in high-spending districts remained fixed. Though the findings in Arsen et al. (2015) do not provide conclusive results for all school choice programs and are conditional to Michigan, the study does provide a working model in understanding how school districts are affected financially.

## Understanding Fiscal Distress

Bidin (2012) analyzed 550 public school districts from 2001 to 2010 in Michigan using a fixed-effects model to analyze districts' fund balance. The study considered the impact of enrollment, student characteristics and district expenditures on their end-of-the-year fund balance. In addition, the author seeks to examine the movement of school district's in and out of fiscal distress. Bidin (2012) established fiscal distress as a fund balance below 8% of its total expenditures. From 2001 to 2010, 289 districts, at least once, had a fund balance below the 8% threshold (Bidin, 2012, p. 49). He examined how many schools are fiscally distressed, but his estimated models focused on fund balances at the end of the school year. In his pooled regression analysis, it was revealed that foundation allowance, property taxable value, pupil-teacher ratio and number of English language learning students led to larger district fund balances.

## Research Questions

This study is a continuation of Bidin (2012) and Arsen, DeLuca, Ni, & Bates (2015), which seeks to understand the factors that impact the fiscal health of a district. This study will include additional district characteristics to answer the following questions:

- 1) What is the impact of factors relating to school choice, students' characteristics and resource allocation on the likelihood a school district is in fiscal distress?
- 2) Do inter-district transfers impact the likelihood of fiscal distress?

## Data, Model Specifications and Empirical Results

The data used in this analysis was provided from the Michigan Department of Education (MDE) and Michigan's Center for Educational Performance and Information (CEPI) to create a panel dataset from 2010-11 to 2015-16 school year. The Michigan Department of Education provided district-level data on fund balances and revenue sources in Bulletin 1011<sup>1</sup> and Bulletin 1014<sup>2</sup> and was the source for district enrollment and operational expenditures. Additional financial data regarding district's balance sheet, revenues and expenditures was provided from the CEPI's Financial Information Data<sup>3</sup>. Information on inter-district transfers, transfers to charter and student characteristics were sourced from CEPI.

In 2015-2016, the State of Michigan had 56 intermediate school districts, 548 public school districts and 300 public school academies. Public school districts that did not have complete data for all years or closed public school districts over the time frame analyzed were omitted. Additionally, similar to Bidin, public school academies, charter schools, state facilities and intermediate school districts were also omitted. Therefore, 540-545 public school districts from 2010 to 2016 were included in this study.

## Definition of Fiscal Distress

To determine fiscal distress, this study examines a district's general fund balance. Analyzing the general fund provides an illustration of a district's fiscal health as the fund highlights key revenues and expenditures related to its operations. Districts that have more assets than liabilities experience

<sup>1</sup> Source: Michigan Department of Education. (2017). *Bulletin 1011 – Analysis of Michigan Public and Expenditures*. Retrieved from [http://www.michigan.gov/mde/0,4615,7-140-6530\\_6605-21539--,00.html](http://www.michigan.gov/mde/0,4615,7-140-6530_6605-21539--,00.html)

<sup>2</sup> Source: Michigan Department of Education, (2017). *Bulletin 1014 – Michigan Public Schools Ranked Select Financial Information*. Retrieved from [http://www.michigan.gov/mde/0,4615,7-140-6530\\_6605-21514--,00.html](http://www.michigan.gov/mde/0,4615,7-140-6530_6605-21514--,00.html)

<sup>3</sup> Source: Michigan's Center for Educational Performance and Information, *Additional K-12 Data Files, Financial Reports, Balance Sheet Revenue & Expenditures (2010-2016)*. Retrieved from <https://www.mischooldata.org/Other/DataFiles/FinancialInformation/HistoricalFinancialReports.aspx>

a positive fund, while districts that have more liabilities than assets have a negative fund balance. Given schools in Michigan vary widely in terms of size and, therefore, how much revenues they have available during the school year, the fund balance is standardized. Standardized fund balance is calculated as percentage of total expenditures as defined by Bidin (2012).

Standardized Fund Balance = (District's Fund Balance/District's Total General Fund Expenditures)\*100

In this study, Bidin's definition of Fiscal Distress is used.<sup>4</sup> A district is considered to be in Fiscal Distress when its fund balance falls below 8% of its total expenditures. The threshold is set at 8% as this is the lowest amount a district may carry before needing to borrow funds to cover one month of operational costs (Bidin, 2012). It should be understood that a deficit occurs when the district fund balance is below zero.

A logit regression model is used to estimate the impact of school choice, characteristics of the district's student body, and the allocation of financial resources on the fiscal health of school districts.

The basic estimated model is given by:

## Dependent Variable

In the logit regression, the dependent variable, Fiscal Distress, is a binary variable. Districts that do not experience fiscal distress (Standardized Fund Balance greater than 8% are valued as 0 and districts that do experience fiscal distress (Standardized Fund Balance less than 8.0% are valued as 1.

Our model is different from Bidin's in that he estimated the impact of enrollment, student characteristics and district expenditures on Standardized Fund Balances at the end of the school year while our dependent variable is the binary measure of whether a district is fiscally distressed or not at the end of the school year.

## Independent Variables

Factors that may lead to school districts struggling financially are included as explanatory variables. District characteristics, student demographics and specific expenditures are included in the model to understand their likelihood of causing fiscal distress.

### School Choice Characteristics

#### Total Enrollment (*Total Enroll*)

This indicates the number of full-time pupils (in thousands) attending a district as reported by CEPI. As school districts receive dollars per pupil, the number of students directly impact revenue. School districts that experience larger enrollments receive more state revenue. However, given enrollment could also impact the cost of servicing students, there is uncertainty on the overall expected impact of total enrollment on Fiscal Distress.

#### Percent of Enrollment Change

##### (*%Change Enroll*)

This variable measures the change of enrollment annually. In the last two decades, there has been an increase in participation in charter schools and school choice. Enrollment changes also occur with the entrance of kindergarteners and departure of 12th grade students. Change in enrollment is expected to have a positive relationship to fiscal distress, as fluctuations in enrollment cause variability in revenues. As Bidin (2012) notes, costs may or may not decrease at the same rate as revenues with enrollment changes.

#### Percent of Net Inter-District Transfers

##### (*%Net INDC*)

This variable indicates the net gain/loss of students under School Choice 105(c) as a percentage of students that reside in a district. %Net INDC is computed as (incoming non-residential students) – (residential students enrolling in outside districts)

<sup>4</sup>For a review of how other research has measured Fiscal Distress, see (Bidin, 2012, p.20-23). Fiscal distress and fiscal stress are used interchangeably in this study.

as a percentage of students that reside in a district. A net 'positive' indicates a net receiver (a district that received more students than left the district) and a net 'negative' indicates a net sender (a district that sent more students than entered the district). As students move from their residential district, per-pupil funding also transfers to the new operating districts. It is expected that a district identified as a 'net receiver' would be less likely to experience fiscal distress than a district identified as a 'net sender.'

### **Percent of Students from the Resident District Attending Charter Schools** **(%Charter)**

This variable is the percent of students that reside in a district that do not attend their residential school district, instead, opting to attend a charter school. This variable is generated by the data provided by CEPI. It is expected that districts that are faced with high levels of charter penetration would experience greater levels of fiscal distress. As a result, %Charter should have a positive association to fiscal distress as districts lose per-pupil funding to charters.

### **Student Characteristics**

#### **Percent of African-American Students** **(%AAstudents)**

This measures the percent of students who identify as African-American as reported by CEPI. Arsen, et al., 2015 found districts that had taken forms of emergency intervention in Michigan had higher percentages of African-American students and were significantly poorer school districts. It is expected that districts with a relatively high density of African-American students would increase the likelihood of fiscal distress as districts experience lower enrollment and higher levels of transfers.

#### **Percent of Economically Disadvantaged Students** **(%Econdis)**

This variable is the percent of students who qualify for free or reduced price lunch as reported by CEPI. A student's family income relative to the poverty level set by federal law is a commonly used a

benchmark to determine a student's socioeconomic status. It is expected that high levels of economically disadvantaged students would signify communities with less equity, causing fiscal distress.

#### **Percent of Special Education Students** **(%Special)**

This is the percent of students in the district who utilize special need services as reported by CEPI. It is expected that the additional cost of providing special education services have a positive relationship with fiscal distress.

#### **Resource Allocation** **Revenue per Pupil (RevenuePP)**

This variable is the summation of local, state and federal revenue per pupil reported in Bulletin 1014. It is expected that an increase in the revenue per pupil should decrease the likelihood that district would experience fiscal distress as a district's fund balance increases.

#### **Fringe Benefits as a Percent of Current Operating Expenditures** **(%Benefits)**

This measures the Fringe Benefits paid out as a percentage of total current operating expenditures as reported in Bulletin 1014. It is anticipated that this would have a positive relationship with fiscal stress.

#### **Property taxable Value per Pupil** **(HomesteadvPP)**

This variable is the property taxable value per pupil (in thousands) reported in Bulletin 1014. Homestead property value is an indicator of property wealth, which supports local school districts through taxation. It is expected to have a negative association with fiscal distress.

#### **Average Pupil-Teacher Ratio (AVGPTCHR)**

This variable is the average number of students per teacher in district classrooms as reported in Bulletin 1014. Larger classrooms may be used to mitigate the cost of hiring additional teachers as a way to reduce expenditures. Therefore, it is ex-

pected that this will have a positive impact on a district’s fund balances.

**Average Teacher Salary (AVGTSAL):**

This is the average teacher salary in thousands, as reported in Bulletin 1014. Similar to the fringe benefits measure above, all else equal, if districts pay their teachers more in wages (or fringe benefits) overall expenditures may be higher for the district. It may be that districts with higher costs of living have to pay faculty relatively more. It is expected that average salaries have a positive association to fiscal distress as this expenditure adds pressure onto a district’s fund balance.

**Administration Expenses as a Percent of Current Operating Expenditures (%Admin)**

This variable is total of cost of administration as a percentage of current operating expenditures data provided in Bulletin 1014. Higher levels of administration cost and potential mismanagement of resources is expected to have a positive relationship with fiscal stress.

**Hypothesis**

Table 1 summarizes the predictors’ likelihood of causing fiscal distress and the associated coefficient sign in the regression.

**Summary Statistics**

Tables 2a and 2b provide the descriptive statistics for fiscally distressed and not fiscally distressed school districts in the 2010-11 school year. The statistics illustrates the large range in the *FundBal* which is used to determine if a school is fiscally distressed. Distressed districts have a Standardized Fund Balance ranging from -47.83% to 7.90% with an average of -0.67%. Not Stressed districts average *Fundbal* is higher than Stressed school districts by 22.13%.

Fiscally distressed districts experienced an average net loss of students of 0.09% in comparison to districts not in fiscal distress, which had an average net gain of students of 0.50%. It is important to note that the fiscally distressed districts average charter school was 3.08% larger than the average of not distressed districts. The average percent of economically disadvantaged, special education, and African-American students were all higher in fiscally distressed districts. While the summary statistics indicate there may be some differences in the factors for distressed versus fiscally healthy districts, the logit model is used to estimate the impact of the factors on the likelihood of fiscal distress, holding all else constant.

Table 3 indicates the number of school districts that are identified as fiscally distressed for school years 2010-11 to 2015-16. In 2010-2011,

**Table 1 Distress Predictors**

Indicator	Expected Impact on Fiscal Distress	Expected Sign of Coefficient
Total Enroll	Ambiguous	?
% Change Enroll	More likely to be distressed	+
% NET INDC	Less likely to be distressed	-
% Charter	More likely to be distressed	+
% AAstudents	More likely to be distressed	+
% Econdis	More likely to be distressed	+
% Special	More likely to be distressed	+
% Benefits	More likely to be distressed	+
RevenuePP	Less likely to be distressed	-
HomesteadvPP	Less likely to be distressed	-
AVGPTCHR	Less likely to be distressed	-
AVGTSAL	More likely to be distressed	+
%Admin	More likely to be distressed	+
%Benefits	More likely to be distressed	+

**Table 2a Descriptive Statistics:  
Not Stressed and Stressed Districts, 2010-11**

	Not Stressed			Stressed		
	Mean	Min	Max	Mean	Min	Max
FundBal	22.8	8.02	349.67	-0.67	-47.83	7.9
Total Enroll	2.48	0	29.05	3.3	0.15	77.59
% Net INDC	0.5	-24.97	30.13	-0.09	-8.58	38.44
% Charter	2.08	0	20.73	5.66	0	35.5
% Econdis	46.32	0	92.5	53.39	6.56	93.8
% Special	11.6	0	27.91	13.77	4.85	28.05
% AAsstudents	4.62	0	95.19	17.2	0	99.69
RevenuePP	9793.61	6893	63788	9590.48	7889	20482
AVGPTCHR	21.52	2	42	22.63	15	32
AVGTSAL	56955.73	22016	94703	58676.28	35211	79599
% Admin	12.57	4.62	25.26	12.44	8.32	21.22
% Benefits	27.83	13.12	38.34	28.18	18.48	33.33
HomesteadtvPP	165.82	16.82	1945.58	126.12	22.62	401.05

**Table 2b. Descriptive Statistics for All Variables, All Years**

	Mean	Std. Dev.	Min.	Max
%FundBal	16.3382	28.49171	-71.18	349.6746
Total Enroll	2.570213	3.915509	0.002	77.594
%Change Enroll	-1.35198	19.89214	-50	948.96
%NET INDC	0.245483	5.457912	-39.2176	44.44444
%Charter	3.666467	6.143224	0	51.63126
%Econdis	49.42244	18.76667	0	100
%Special	12.01801	4.363798	0	40
%AAsstudents	7.567299	16.86514	0	99.68652
RevenuePP	10068.3	4745.391	0	83367
AVGPTCHR	21.90108	4.024745	0	42
AVGTSAL	57124.3	9116.209	0	94703
%Benefits	28.91842	3.043739	7.835967	38.34448
HomesteadtvPP	167298.9	186883.4	0	3584426

**Table 3 Number of School Districts in Fiscal Distress, 2010-2016**

School Year	Not Distressed		Distressed		Total
	Frequency	%	Distressed	%	
2010-11	412	75.60%	133	24.40%	545
2011-12	382	70.10%	163	29.90%	545
2012-13	351	64.60%	192	35.40%	543
2013-14	355	65.70%	185	34.30%	540
2014-15	351	65.0%	190	35.18%	540
2015-16	390	72.22%	151	27.96%	540

approximately 1 in 4 schools were identified as fiscally distressed as we have defined it. The number of school districts experiencing fiscal stress increased in the next three school years, hovering around 35% of all districts being fiscally distressed. The largest increase of fiscally distressed districts occurred in 2012-13. The amount of fiscally distressed schools decreased in 2013-2014 and 2015-16. In 2015-16, the number of schools identified as distressed reached its lowest levels since 2010-2011 at approximately 28%.

## Results

The basic logit regression model defined above is estimated separately for each school year. The estimated coefficients and t-statistics are given in Table 4a. The estimated logit coefficient provides the rate of change in the “log odds” as the independent variable changes by one unit, all else held constant. While the signs of the coefficients provide insight into whether the explanatory variable is directly or inversely related to the likelihood a school is in Fiscal Distress, it is not easily interpreted. Therefore, the estimated coefficients are converted into Odds Ratios provided in Table 4b.<sup>5</sup>

**Table 4a Cross-Section Logit Regression, 2010-2016**

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Constant	-4.596 (-1.77)	-7.273** (-3.14)	-4.615* (-2.03)	-3.081 (-1.28)	-2.602 (-1.14)	-4.617 (-1.86)
Total Enroll	-0.0124 (-0.48)	-0.0407 (-1.48)	-0.0109 (-0.31)	0.0195 (0.52)	0.0258 (0.69)	0.0565 (1.48)
%Net INDC	-0.036 (-1.36)	-0.0309 (-1.45)	-0.018 (-0.91)	-0.00901 (-0.44)	-0.0418* (-2.04)	-0.0354 (-1.84)
%Charter	0.0610* (2.25)	0.0645* (2.41)	0.0412 (1.72)	0.0419 (1.89)	0.0415* (2.05)	0.0352 (1.87)
%Econdis	0.000558 -0.06	-0.00403 (-0.50)	0.00768 -1.02	0.00012 -0.02	-0.00844 (-1.12)	-0.00665 (-0.85)
%Special	0.119*** (3.40)	0.0601 (1.90)	0.0829** (2.73)	0.0810* (2.41)	0.0728* (2.32)	0.0479 (1.57)
%AAstudents	0.0352*** (3.56)	0.0364*** (3.62)	0.0289** (2.94)	0.0253** (2.69)	0.0211* (2.37)	0.0149 (1.72)
RevenuePP	-0.0002 (-1.84)	-5.3E-05 (-0.71)	-0.00017 (-1.88)	-0.00017 (-1.54)	-0.00016 (-1.68)	-9.3E-05 (-1.15)
AVGPTCHR	-0.0364 (-0.65)	0.072 (1.43)	-0.0217 (-0.43)	0.0309 (0.57)	-0.00577 (-0.11)	0.0381 (0.71)
AVGTSAL	0.00001540 (0.83)	0.0000033 (0.19)	0.0000209 (1.22)	-0.0000028 (-0.15)	0.0000053 (0.28)	-0.0000092 (-0.47)
%Admin	0.0352 (0.61)	0.0715 (1.48)	-0.0225 (-0.42)	-0.0609 (-1.12)	-0.00089 (-0.02)	0.0237 (0.44)
%Benefits	0.1 (1.85)	0.114* (2.35)	0.118* (2.37)	0.0973 (1.93)	0.0821 (1.71)	0.102* (1.97)
HomesteadvPP	0 (0.04)	0 (0.15)	0 (0.29)	0 (0.21)	0 (0.06)	0.001 (0.43)
N	545	545	542	540	540	540

t statistics in parentheses \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

<sup>5</sup>The odds ratio =  $p/(1-p)$ , where p is the probability of being fiscally distressed.

**Table 4b Odds Ratio – Cross Section**

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Constant	0.0101	0.000694**	0.0098*	0.0459	0.0741	0.0099
Total Enroll	0.9876	0.9601	0.9892	1.0197	1.0262	1.0581
%Net INDC	0.9646	0.9696	0.9821	0.9910	0.9591*	0.9652
%Charter	1.0629*	1.0666*	1.0421	1.0428	1.0423*	1.0359
%Econdis	1.0006	0.9960	1.0077	1.0001	0.9916	0.9934
%Special	1.1263***	1.0619	1.0864**	1.0844*	1.0755*	1.0491
%AAstudents	1.0359***	1.0371***	1.0293**	1.0256**	1.0213*	1.0150
RevenuePP	0.9998	0.9999	0.9998	0.9998	0.9998	0.9999
AVGPTCHR	0.9643	1.0747	0.9785	1.0314	0.9942	1.0388
AVGTSAL	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
%Admin	1.0358	1.0741	0.9778	0.9409	0.9991	1.0239
%Benefits	1.1054	1.1204*	1.1253*	1.1022	1.0856	1.1073*
HomesteadtvPP	1.0001	1.0002	1.0004	1.0003	1.0001	1.0006

t statistics in parentheses \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Among student characteristics, *%Special* and *%AAstudents* were statistically significant. Districts with larger populations of African American students or students needing special education were more likely to be distressed. For the 2010-11 school year, a one-percent increase in students with special education needs increases the odds of a district being distressed from 1 to 1.13, or 13%. In that same year, a one-percent increase in African-American students increased the odds of a district being distressed from 1 to 1.04, or 4%. The coefficients on *%Econdis* and total enrollment indicated a mixed association with no statistical significant impact on the fiscal health of the school district. The resource allocation predictors were inconsistent and not statistically significant, except for *%Benefits* which held a positive relationship (districts with larger fringe benefits being more likely to be distressed) and significance in years 2011-2012 and 2012-2013 at the 5% level, but still significant at the 10% level for the other years.

Two of the variables of interest have to do with students leaving their district school to attend a different school. As expected, an increase in the

percent of students in a district attending a charter school increases the likelihood a district is financially distressed and was statistically significant in the years 2010-2011, 2011-2012 and 2014-15 at the 0.05 level (95% confidence level). In the other school years, the significance declined slightly with significance at the 10% level. For the year 2010-2011, a one-percent increase in students leaving a district for a charter school increases the odds of a district being stressed from 1 to 1.06, or 6%. A 10% increase in students leaving a district for a charter school increases the odds of a district being stressed from 1 to 1.84, or 84%.<sup>6</sup>

As per-pupil funding transfers with students who enter and leave their residential districts, it was anticipated that *%NET INDC* would be a significant factor in the regression. It was significant in 2014-15 and 2015-2016 at the 0.05 level and statistically significant at the 10% level in other years. Consistent with expectations, a district that had more students transfer in than transfer out of a district was less likely to be in distress, and vice versa.

In the pooled regression with all school years included in one logit model, *%Change Enroll* is added

<sup>6</sup>Exp(coefficient of *%charter*) = 1.0629 is the change in the odds ratio for a one-unit increase in the percent of students attending a charter school. The odds of being distressed are therefore 6% higher. Exp(10\*coefficient of *%charter*) = 1.84 is the change in the odds ratio for a one-unit increase in the percent of students attending a charter school. The odds of being distressed are therefore 84% higher with a 10 percent increase in charter school attendance.

to better understand the likelihood that overall enrollment changes may cause fiscal distress. The estimated coefficients and t-statistics are provided in Table 5a while the Odds Ratios are provided in Table 5b. To analyze this, *%NET INDC*,

*%Charter*, and *% Change Enroll* are interchanged. Model 1 considers all three enrollment related factors, Model 2 excludes *%Change Enroll* and Model 3 includes only the *%Change Enroll*. Year dummies are included in the model using 2010-2011 as the

**Table 5a. Pooled Regression Analysis, School Choice Variable Variation**

	Model 1	Model 2	Model 3
Constant	-4.939*** (-4.90)	-5.093*** (-5.43)	-4.961*** (-4.98)
Total Enroll	0.00788 -0.5	0.00281 -0.22	0.0212 -1.41
%NET INDC	-0.0229* (-2.57)	-0.0275** (-3.29)	
%Charter	0.0373*** -3.84	0.0418*** -4.63	
%Change Enroll	-0.0502*** (-4.96)		-0.0549*** (-5.51)
%Econdis	-0.00338 (-0.99)	-0.00173 (-0.55)	-0.000341 (-0.10)
%Special	0.0629*** -4.5	0.0758*** -5.9	0.0741*** -5.46
%AAsStudents	0.0259*** -6.36	0.0274*** -7.47	0.0301*** -8.06
RevenuePP	-0.000120** (-3.15)	-0.000128*** (-3.60)	-0.000114** (-3.11)
AVGPTCHR	0.0265 -1.14	0.00877 -0.41	0.0265 -1.16
AVGTSAL	0.0000685 -0.84	8.7E-06 -1.19	0.0000691 -0.86
%Admin	0.00439 -0.19	0.0124 -0.58	0.00231 -0.1
%Benefits	0.108*** -4.96	0.107*** -5.37	0.0979*** -4.55
HomesteadtvPP	-0.0000368 (-0.06)	0.00026 -0.41	0.0000843 -0.14
t2		0.241 -1.66	
t3	0.318* -2.3	0.564*** -3.95	0.323* -2.34
t4	0.234 -1.67	0.458** -3.18	0.271 -1.95
t5	0.153 -1.03	0.390** -2.58	0.213 -1.45
t6	-0.321 (-1.95)	-0.102 (-0.62)	-0.21 (-1.30)

t statistics in parentheses \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**Table 5b. Odds Ratio - Pooled Regression Analysis**

	Model 1	Model 2	Model 3
Constant	0.0072***	0.0061***	0.007***
Total Enroll	1.0079	1.0028	1.0214
%NET INDC	0.9773*	0.9729**	
%Charter	1.0380***	1.0427***	
%Change Enroll	0.9510***		0.9466***
%Econdis	0.9966	0.9983	0.9997
%Special	1.065***	1.07871***	1.0769***
%AAstudents	1.0262***	1.0277***	1.0305***
RevenuePP	0.9998**	0.9998***	0.99**
AVGPTCHR	1.0268	1.0088	1.0268
AVGTSAL	1.0000	1.0000	1.0000
%Admin	1.0044	1.0125	1.0023
%Benefits	1.1140***	1.1132***	1.1030***
HomesteadtvPP	1.0000	1.0003	1.0001
t2		1.2722	
t3	1.3741*	1.7583***	1.3815*
t4	1.2636	1.5808**	1.3114
t5	1.1648	1.4777**	1.2374
t6	0.7253	0.9032	0.8102

t statistics in parentheses \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

base year. The inclusion of time controls for year effects and allows unobserved variations in the model to be attributed to specific years.

*%Change Enroll* was statistically significant with districts that experienced a positive change in enrollment being less likely to be distressed. In Model 2, a one-percent increase in *%Charter* increased the odds of a district becoming distressed by 4.26% while a one-percent increase in *%Net INDC* decreased odds by 2.71%. The impact of residential students attending charters has nearly 50% more weight on the likelihood of a district becoming fiscally stress than students attending districts outside of where they reside.

The impact of student characteristics were quite similar to the previous results in Tables 4a and 4b with *%Special* and *%AAstudents* increasing the odds that a district would face fiscal distress being statistically significance at the .01 level (99% confidence level). A one-percent increase in students receiving special education services would

increase a district’s odds from 1 to 1.065, or by 6.5% in Model 1 while a one-percent increase of African-American students would be increase the likelihood from 1 to 1.026, or by 2.6%. Given the outcome of African-American students, it was expected that *%Econdis* would have a greater significance in the models. The *%Econdis* was the only student characteristic that did not hold statistically significant in all models. Total enrollment was not a statistically significant factor in fiscal distress. This follows the findings in the cross-sectional analysis in Table 4a.

In all models, *%Benefits* remained statistically significant and matched expectations as benefit expenditures increase by one-percent the likelihood a district faces fiscal stress increases by nearly 10%. In regards to enrollment, student characteristics and resource allocation, *%Benefits* has the greatest likelihood of causing fiscal stress. However, *%Admin*, *AVGPTCHR*, *AVGTSAL* and *HomesteadtvPP* were not significant predictors. In the pooled re-

gressions, *RevenuePP* was statistically significant with schools receiving more revenues per pupil being less likely to be distressed. However, the estimated impact is relatively small.

Model 2 includes *%Charter* and *%NET INDC*. Based on the likelihood ratio test statistic, overall Model 2 is the best fit and is statistically significant at the 0.01 level ( $df=17$ ). The likelihood ratio chi-square of 395.65 determines the overall model as statistically significant.

## Analysis Findings and Conclusions

The research findings indicated the majority of the statistically significant predictors of fiscal distress were out of a district's direct control. Based on the pooled regression, the following variables increased the likelihood that a district would suffer from a fund balance below 8%: percent of charter, percent of special education students, percent of African-American students and percent of benefits of total operating expenditures. Of these variables, *%Benefits* had the greatest odds of causing fiscal distress at 10.64% and is within a district's control. The fringe benefits consider costs of instructional personnel beyond wages, such as insurance, retirement benefits, paid holidays and medical/family leave. In a strategy to reduce to fiscal distress and maintain an equitable fund balance, a district may consider cutting benefits. However, a district must consider the outcomes as it impacts salaries and wages, teacher quality and instruction.

It is important to note, total enrollment was not statistically significant. All things considered, districts that have higher levels of enrollment receive more revenue and per-pupil funding. Despite this, total enrollment's positive association to per-pupil funding may not mitigate the complete expenditures incurred with additional students.

Notably, *%Charter* and *%Net INDC* indicated statistical significance in the study. The magnitude of *%Charter* was nearly doubled the weight of *%Net INDC*. This implies that charter penetration has a greater likelihood of causing fiscal distress than a

net 'receiver' district had in decreasing the odds of the same occurrence. The consistency of these results illustrates the emergence of charter schools places pressure on districts to manage their fund balance as funding leaves the district.

In conclusion, the predictors that increase the odds of fiscal stress are beyond a district's control. Enrollment variability and student characteristics are nearly impossible for districts to manage; however, these factors substantially impact financial wellness. Despite this, benefits, which has the greatest odds of causing fiscal stress is with a district's control to manage their expenditures.

### Limitations

The scope of this study focuses on public school districts and does not consider the likelihood of predictors' causation of fiscal distress in public school academies, charter schools nor private educational institutions. The findings within this analysis should only be reviewed in the scope of Michigan and cannot be universally applied to other states. The brief time period from 2010-2016 may only offer a 'snapshot' and not accurately illustrate greater trends in school funding.

### Further Research

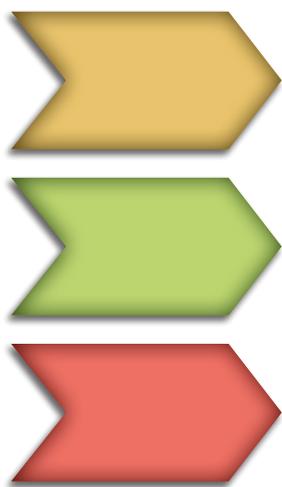
It is important to note that *RevenuePP* is not analogous to the foundational revenue that districts receive per-pupil. Future research could include foundational revenue to better analyze the predictors of fiscal distress. Furthermore, the findings in this study reflect public school districts in the state of Michigan. This study could extend its parameters to analyze the likelihood of these predictors causation of fiscal distress in private educational entities. Such an extension could make greater conclusions about the trends within the educational market by including public school academies and charter schools.

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# Use of Cyano-Substituted Scorpionate Ligands to Model Nickel Superoxide Dismutase Active Site

*Elvin Salerno*

David Eichhorn Ph.D.

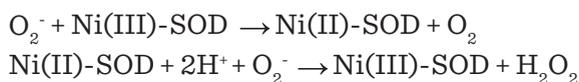
Wichita State University

## Abstract

Superoxide dismutases (SOD) catalyze important reactions for the decomposition of dangerous reactive oxygen species. Nickel superoxide dismutase (NiSOD) is a unique enzyme in that the active site modulates the Ni(III)/Ni(II) reduction potential from +2.26 V for aqueous nickel to 360 mV, and the active site may possess variable four- and five-coordinate modes. This study aims to model the NiSOD active site using small synthetic nickel compounds containing cyano-substituted poly(pyrazolyl)borate (scorpionate) ligands. These ligands have a geometry lending themselves to the modeling of NiSOD, as well as an ease of customizability useful for probing the effects of substituents.

## Introduction

Superoxide Dismutase (SOD) enzymes are a family of ubiquitous metalloenzymes that catalyze the dismutation of superoxide radicals into benign species (Ma et al., 2008). Types of SODs include iron SOD, manganese SOD, nickel SOD, and copper-zinc SOD. Although each of the SODs are quite different structurally, they perform similar chemistry with notable specificity (Sheng et al., 2014). In animal lab tests, mutant or null CuZnSOD has been associated with various pathologies, including cardiovascular and neurodegenerative disorders, infertility, vision problems, aging, and specifically the neuromuscular disorder ALS in humans (Sheng et al., 2014). Nickel superoxide dismutase (NiSOD) may be a useful target for biomimetic studies to learn more about SOD chemistry. The reaction for the superoxide radical with NiSOD is formalized as



NiSOD possesses an interesting active site in that the nickel ion is coordinated to a terminal amine, peptide amide, and cysteine residues. The geometry may change from square planar to square pyramidal during the course of reaction with the variance due to the addition of a histidine nitrogen at the fifth position (Ma et al., 2008). Furthermore, catalysis of the dismutation reaction requires a voltage potential between the oxidation and reduction potentials for the superoxide radical, which is  $\sim 0.36$  V, while the reduction potential for aqueous  $\text{Ni}^{3+}/\text{Ni}^{2+}$  is  $+2.26$  V (Sheng et al., 2014). Therefore, the coordination sphere alters the nickel ion's electronic properties sufficiently to perform the reaction, which is executed similarly for each of the known SOD enzymes (Sheng et al., 2014). Study of the NiSOD active site may yield useful information about the chemistry of natural antioxidant enzymes, as well as insight into the unusual shifting coordination environment of NiSOD, and the biological alteration of electronic properties of metals.

Poly(pyrazolyl)borates and their derivatives serve as useful ligands in coordination chemistry due to their ease of modification with sterically and electronically active substituents. These so-called scorpionates normally bind to the central ion via two separate pyrazole nitrogens and another tooth at a third constituent on the boron (Pettinari, 2005). The customizability of the ligand coupled with its useful geometry lends itself to modeling the NiSOD active site. Ma et al., 2009, have used scorpionates to model the NiSOD active site previously, and have isolated three different compounds using hydrotris(3-phenyl-5-methylpyrazolyl)boratonickel(II) complexes and sulfur providing co-ligands (Ma et al., 2008; Ma et al., 2009). While complexes with four- and five-coordinate environments were isolated, they were not in an equilibrium as is observed naturally.

Eichhorn and coworkers have successfully synthesized 4-cyano-3-phenyl substituted bis- and tris-pyrazolyl borates and isolated the ligands, a feat previously hindered by the interconnectivity of the cyano constituents. The substituted phenyl appears to resolve this by interfering with the cyano groups'

inter-binding through steric effects (Siemer et al., 2001). Use of the cyano-scorpionates may prove a valuable chelate to model the NiSOD active site due to the electron withdrawing properties of the group, which can modulate the properties of the central ion-particularly the reduction potential. The main focus of the present study will be the use of cyano-scorpionates as a biomimetic for the active site of NiSOD, in particular the attempt to create a structure that is capable of undergoing the reversible transition from a four-coordinate to a five-coordinate environment with a reduction potential of  $\sim 300$  mV required for catalysis of superoxide dismutation. The study of this metal coordinate system should provide novel insight into the form and function of the natural NiSOD active site, as well as into chemistry of cyano-substituted scorpionate ligands. In the future, knowledge gained from this research might be used to create therapeutics designed to supplement defective SOD systems in the body and combat related illnesses.

## Method

Project steps involve synthesis of the scorpionate ligand, then complexation with nickel, and finally the addition of sulfur-providing co-ligands. Analysis of the biomimetic may entail that of structural, magnetic, electronic, and kinetic properties. Nickel complexation requires some experimentation, but methods for scorpionate synthesis have previously been undertaken by other lab members, and are described essentially per other protocols. Synthesis progress will be described with representative results.

### Synthesis of 3-oxo-3phenylpropanenitrile (benzoylacetonitrile)

NaH (60% in mineral oil, 5.55 g, 138.8 mmol) was placed in an ice-bath-cooled, round-bottom flask with  $\text{N}_2$  added via Schlenk line. 4 mL DMSO was injected using gastight syringe, followed by 6.876 mL dried acetonitrile (131.8 mmol). This reaction was stirred on ice for 20 minutes, then 14.6 mL methyl benzoate was added and the reac-

tion was stirred for an additional 2.5 hours. The mixture thickened and turned yellow during this time. Then ~250 mL deionized water was added to quench excess NaH, followed by a dilute acid solution (277.6 mmol HCl into ~500 mL deionized water). A white, fluffy precipitate formed. The compound was then extracted via 3-150 mL portions of ethyl acetate, followed by washing with 1-150 mL portion brine solution. The organic layer was then dried over anhydrous magnesium sulfate. Reaction was then filtered to remove  $\text{MgSO}_4$  and solvent was evaporated under reduced pressure. This was run through a chloroform-silica gel column for gross purification. 64.1% mass yield. IR ( $\text{cm}^{-1}$ ): 2251 ( $\tilde{\nu}$  CN). Mass spec 144 m/z.

### Synthesis of 2-benzoyl-3-oxobutanenitrile

5.63 g NaH (60% in mineral oil, 66.7 mmol) was dissolved in ~200 mL dry toluene in a round-bottom flask; this was placed under  $\text{N}_2$  via Schlenk line, stirred, and cooled in ice bath. 18.57 g benzoylacetone nitrile (127.9 mmol) was dissolved in ~300 mL dry toluene and added dropwise via gastight syringe to NaH reaction flask. The solution immediately produced bubbles and yellowed. The flask was stirred for more than three hours, then 9.13 mL acetyl chloride (127.9 mmol) was dissolved in ~20 mL dry toluene and injected into the flask. The reaction was stirred overnight under  $\text{N}_2$  and cooled in water bath. The next morning, the reaction was quenched with 100 mL deionized water, then a dilute acid solution was added (281.4 mmol HCl into ~400 mL deionized water) to neutralize excess NaH. The compound was then extracted via 3-150 mL portions of ethyl acetate, followed by followed by washing with 1-150 mL portion brine solution. The organic layer was then dried over anhydrous magnesium sulfate. Reaction was then filtered to remove  $\text{MgSO}_4$  and solvent was evaporated under reduced pressure. A syrupy, clear impurity was noted. Mixture was dissolved in methanol, then the grossly insoluble impurity was separated via separatory funnel. The solvent was evaporated from the product, then the product was purified on a chloroform-silica gel column. IR ( $\text{cm}^{-1}$ ): 2222 ( $\tilde{\nu}$  CN). Mass spec 186 m/z.

### Synthesis of 2-benzoyl-3-(dimethylamino) acrylonitrile

20.83 g benzoyl acetonitrile (143.5 mmol) was dissolved in ~350 mL anhydrous toluene then placed under  $\text{N}_2$  via Schlenk line. DMF dimethylacetal (157.9 mmol, 21.13 mL) was injected into the flask, and the mixture was stirred overnight under  $\text{N}_2$ . The solvent was evaporated via rotovap, then the product was purified via flash chromatography using chloroform-silica gel column. The solvent was removed via rotary evaporator.

### Synthesis of $\text{Hpz}^{\text{Ph},4\text{CN}}$

2-benoyl-3-(dimethylamino) acrylonitrile (77.6 mmol, 15.53 g) was dissolved in methanol (250 mL) and hydrazine hydrate (85.4 mmol, 4.18 mL) was dissolved in ~10 mL methanol and added dropwise into the reaction flask. This was allowed to stir overnight. The solvent was removed via rotary evaporator and product was run on 50:50 ethyl acetate: hexanes silica gel column. The solvent was removed and product dried under vacuum overnight. IR ( $\text{cm}^{-1}$ ): 2233 ( $\tilde{\nu}$  CN). Mass spec 168 m/z.

### Synthesis of $\text{Hpz}^{\text{Ph},\text{Me},4\text{CN}}$

8.75 g 2-benzoyl-3-oxobutanenitrile intermediate was dissolved in methanol, then 3.5 mL 64% hydrazine hydrate was added dropwise. This was stirred overnight under room atmosphere. The reaction mixture was then evaporated under reduced pressure, then run on a 40:60 ethyl acetate: hexanes silica gel column. This product was then evaporated under reduced pressure, resulting in a yellow product. <10% yield by mass. IR ( $\text{cm}^{-1}$ ) 2226 ( $\tilde{\nu}$  CN). Mass spec 182 m/z.

### Synthesis of $\text{KTp}^{\text{Ph},4\text{CN}}$

3.46 g  $\text{Hpz}^{\text{Ph},4\text{CN}}$  (20.45 mmol) was combined with 0.3343 g potassium borohydride and ~25 mL tetradecane in a 250 mL round-bottom flask. This was heated in a silicone oil bath to 220°C over the course of ~1 hour. This was allowed to stir at 220°C for another hour, then cooled to room temperature. This mixture was filtered to remove tetradecane, then the reaction was dissolved in acetonitrile

and filtered over the same filter as before to remove  $\text{KBH}_4$  residue. This acetonitrile solution was evaporated under reduced pressure to completely dry, then ethyl ether was added to solvate excess pyrazole but not Tp [Note: methylene chloride can be used in place of ether for same purpose]. The vessel was refrigerated overnight to totally precipitate Tp, then the mixture was filtered. Acetonitrile was poured over the same filter to solvate Tp once more, then this Tp solution was dried. Yielded a white solid. IR ( $\text{cm}^{-1}$ ): 2224 ( $\tilde{\nu}$  CN); 2426 ( $\tilde{\nu}$  BH). Mass spec 516 m/z [ $\text{Tp}^{\text{Ph,4CN}}$ ].

### Synthesis of $\text{KTp}^{\text{Ph,Me,4CN}}$

Synthesis identical to that for  $\text{KTp}^{\text{Ph,4CN}}$ . IR ( $\text{cm}^{-1}$ ): 2228 ( $\tilde{\nu}$  CN). Mass spec 558 m/z [ $\text{Tp}^{\text{Ph,Me,4CN}}$ ].

### Synthesis of $\text{NiTp}^{\text{Ph,4CN}}\text{NO}_3$

0.2 g  $\text{KTp}^{\text{Ph,4CN}}$  (0.36 mmol) was dissolved in ~10 mL acetone. This acetone solution was added dropwise to a stirring solution of  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  (0.1 g, 0.36 mmol in ~5 mL ethanol) in a small, round-bottom flask. This stirred for 5 minutes, yielding a clear, navy blue solution. This was filtered, and a dark blue filtrate was collected then rinsed with ethanol. IR ( $\text{cm}^{-1}$ ): 2229 ( $\tilde{\nu}$  CN); 2527 ( $\tilde{\nu}$  BH). See Table one for solubility data. X-ray quality crystals grown via ethanol/acetonitrile anti/solvent mixture.

### Attempt to synthesize $\text{NiTp}^{\text{Ph,4CN}}(\text{NCS})_2$

0.2 g  $\text{KTp}^{\text{Ph,4CN}}$  (0.36 mmol) was dissolved in ~5

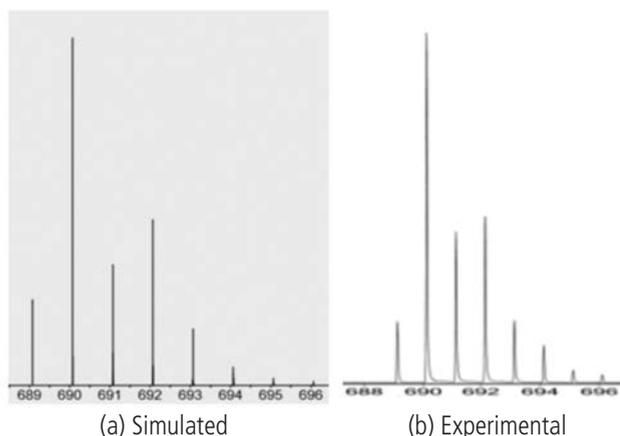


Figure 1. Mass spec isotopic distribution for  $\text{NiTp}^{\text{Ph,4CN}}(\text{NCS})_2$ . (a) shows simulated spectrum, (b) shows experimental spectrum. Performed in MeOH solvent, negative mode ESI-MS.

mL THF. 0.1 g  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  (0.36 mmol) and 0.14 g potassium thiocyanate (1.44 mmol) were dissolved in ~15 mL MeOH and stirred in a small, round-bottom flask. The  $\text{KTp}$ -THF solution was added all at one to this stirred solution. Water and additional methanol were added to yield a precipitate. This led to a whitish/blue colloid, which passed through paper filters. The precipitate was collected via a 30 mL sintered glass funnel and yielded a fine light green powder once fully dry. IR ( $\text{cm}^{-1}$ ): 2236 ( $\tilde{\nu}$  CN); 2489 ( $\tilde{\nu}$  BH). Mass spec showed distinctive pattern in negative mode with a maximum peak at 690 m/z. See Figure 1. for histogram and comparison to isotope calculator. See table one for solubility data. Compound set up for crystal growth for x-ray diffraction analysis.

### Computational chemistry of scorpionate complexes

Computational chemistry is underway to analyze the energetics of scorpionate-nickel complexes. Complexes for four- and five-coordinate, high and low spin, and +2 and +3 oxidation states of nickel complexes are prepared via Gaussview for analysis. Base crystal structures are EGAWEP and EGAWIT taken from Cambridge Structural Database. These are Ma and coworkers'  $\text{Ni}(\kappa\text{-}2)\text{Tp}^{\text{Ph,Me}}\text{S}_2\text{CNet}_2$  and  $\text{Ni}(\kappa\text{-}3)\text{Tp}^{\text{Ph,Me}}\text{S}_2\text{COEt}$ . Structures are modified to produce the following for analysis:  $\text{Ni}(\kappa\text{-}2)\text{Tp}^{\text{Ph,Me}}\text{S}_2\text{CNet}_2$ ,  $\text{Ni}(\kappa\text{-}3)\text{Tp}^{\text{Ph,Me}}\text{S}_2\text{CNet}_2$ ,  $\text{Ni}(\kappa\text{-}2)\text{Tp}^{\text{Ph,Me,4CN}}\text{S}_2\text{CNet}_2$ , and  $\text{Ni}(\kappa\text{-}3)\text{Tp}^{\text{Ph,Me,4CN}}\text{S}_2\text{CNet}_2$ . Each complex will be analyzed using DFT to yield computational understanding of relative stability of each, to understand character of  $\kappa\text{-}3$  versus  $\kappa\text{-}2$  Tp chelation modes on nickel atom. This will also yield an understanding of the capabilities of the cyano group to alter the biomimetic's structure.

## Results and Discussion

Pyrazole and  $\text{KTp}$  syntheses were followed according to schemes worked out by previous lab members. However, minimal success has been achieved in the synthesis of  $\text{Hpz}^{\text{Ph,Me,4CN}}$ . Fresh reagents and dry solvent do not appear to have

**Table 1**

Solubility data for $\text{NiTp}^{\text{Ph},4\text{CN}}(\text{NCS})_2$ and $\text{NiTp}^{\text{Ph},4\text{CN}}\text{NO}_3$ .		
Solvent	$\text{NiTp}^{\text{Ph},4\text{CN}}(\text{NCS})_2$	$\text{NiTp}^{\text{Ph},4\text{CN}}\text{NO}_3$
Acetonitrile	✓	✓
Methylene chloride	X	✓
Acetone	✓	✓
Ethanol	X	X
Methanol	X	✓
Ethyl ether	X	X
Hexanes	X	X
Tetrahydrofuran	✓	✓
Ethyl acetate	✓	Minimally
2-propanol	X	X

~5  $\mu\text{g}$  compound was placed in 1-2 mL solvent and analyzed visually for solubility.

✓ indicates solubility

X indicates non-solubility

**Table 2**

Bond length information for $\text{NiTp}^{\text{Ph},4\text{CN}}(\text{NO}_3)(\text{EtOH})$ crystal structure.	
Bond	Distance ( $\text{\AA}$ )
$\text{Ni}^{2+}$ -Tp N1	2.09
$\text{Ni}^{2+}$ -Tp N2	2.10
$\text{Ni}^{2+}$ -Tp N3	2.08
$\text{Ni}^{2+}$ - $\text{NO}_3$ O1	2.10
$\text{Ni}^{2+}$ - $\text{NO}_3$ O2	2.07
$\text{Ni}^{2+}$ -EtOH O1	2.08

a positive influence on synthetic attempts. Hydrazine monohydrochloride may produce better results than the previous attempts of using hydrazine hexahydrate.

An X-ray quality crystal was grown in the vial prepared in attempt to isolate  $\text{NiTp}^{\text{Ph},4\text{CN}}(\text{NCS})_2$ , however not the crystal which was desired. This powder was placed in an ethanol/acetonitrile anti/solvent mixture. Approximately two months later a  $\text{NiBp}^{\text{Ph},4\text{CN}}\text{Tp}^{\text{Ph},4\text{CN}}$  crystal was isolated and analyzed via X-ray crystallography. However, the structure was not fully solved because Lava Kadel of this group previously synthesized the same compound. Since the starting compound should have been all Tp, and the reaction was sitting on the benchtop

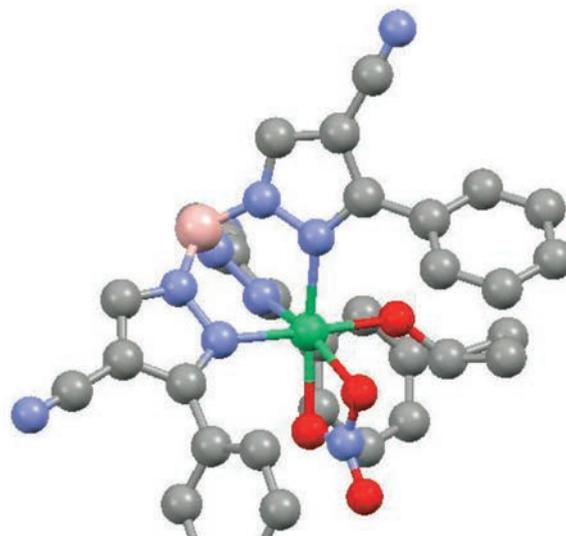


Figure 2. Schematic crystal structure of  $\text{NiTp}^{\text{Ph},4\text{CN}}(\text{NO}_3)(\text{EtOH})$ .

for multiple months, the crystal probably resulted from partial breakdown of Tp to Bp and subsequent complexation of Ni in solution.

A new crystal structure was identified for  $\text{NiTp}^{\text{Ph}_4\text{CN}}(\text{NO}_3)$ . This compound possesses a distorted octahedral structure with an ethanol from solution coordinated as well as the  $\text{N}_3$  Tp ligand and  $\text{O}_2$  nitrate ligand. A magnetic susceptibility experiment and subsequent calculations revealed an  $S=1.1$  ( $\sim 1$ )  $\text{Ni}^{2+}$  metal center. The bond lengths are given in Table 2, and the crystal structure is presented in Figure 2. Notably, the bond lengths are all at least  $2.07 \text{ \AA}$ , whereas in the NiSOD crystal structure all the lateral bond lengths are less than  $2.02 \text{ \AA}$ . The bond lengths of this structure do not, therefore, model the NiSOD protein active site well. However, this is to be expected since this is an  $\text{N}_3\text{O}_2$  ligand set as compared to the  $\text{N}_3\text{S}_2$  set in the native protein.

Ma et al., 2009, had success in creating biomimetic complexes using O-ethylxanthate and  $\text{S}_2\text{CNET}_2$  sulfur providing ligands. Synthetic attempts are under way to selectively complex these ligand to the nickel center while retaining Tp ligand as well.

Computational chemistry is in progress, but results are not available as of writing this manuscript.

## Conclusion

Synthetic attempts at producing a  $\text{NiN}_3\text{S}_2$  complex as a biomimetic of NiSOD using scorpionate ligands are ongoing. A new NiTp complex has been identified and analyzed via X-ray diffraction,  $\text{NiTp}^{\text{Ph}_4\text{CN}}(\text{NO}_3)(\text{EtOH})$ . Attempts to add an  $\text{S}_2$  ligand to complete the model are proceeding but unsuccessful as of yet.

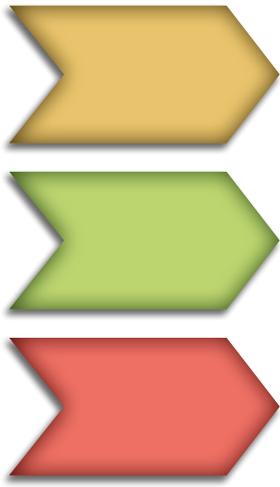
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# RESEARCH SUMMARIES





# The Pelli-Robson Contrast Test and the Effects of Motivational Instructions on Performance

*Nephi Escobar*

Alex Chaparro, Ph.D.

Wichita State University

## Introduction

Contrast sensitivity is a measure of an individual's ability to detect luminance differences between a target and its background and has been shown to be an important measure of visual ability. Contrast sensitivity changes with age, is affected by eye disease and cataracts, and is related to crash risk in older drivers. Measures of contrast sensitivity have become part of the standard battery of tests administered by eye care professionals when they assess the basic visual capabilities of a patient. The Pelli-Robson test has been widely used to assess contrast sensitivity and is shown in figure 1. While this test is clinically relevant, its use poses some challenges given individual differences in patient's willingness to persist when faced with a stimulus that is barely visible. The purpose of this study was to investigate how differences in wording affect performance on a test of visual contrast sensitivity. This study will explore how instructions influence motivation to linger and persevere to reach the threshold of what can be seen by those completing the contrast sensitivity test.



Figure 1

The specific instructions used by health care professionals may affect the accuracy and reliability of the test. No published research exists investigating the effects of instruction on performance using the Pelli-Robson Contrast Sensitivity Test.

However, results of similar testing support the theoretical use of specific instructions to increase motivation and demonstrate the link between medicine and psychology (Elliott, & Handley, 2015).

## Methods

### Participants

Participants over the age of 18 were recruited from the student population Wichita State University. Ten comparative studies of five participants were evaluated using within subject comparative testing. Each participant was tested using the Pelli-Robson Contrast Sensitivity Chart both with standard instruction and with additional instructions. Participants were tested for their bi-ocular (using a general screening of both eyes at the same time) in contrast sensitivity.

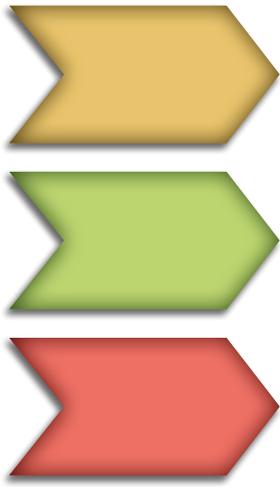
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## Results

Results failed to support a direct link between additional instructions contributing to improved test results. The computed mean in the group varied and the significance was nearly negligible at 0.07 when 0.05 or over was within acceptable limits giving the sample size. One limitation in this study was the small sample size. A larger number of participants may have shown significance.

Further research is needed to explore this topic. Current research on testing and motivational instructions has mostly been focused on children's testing in school throughout adolescence and adulthood. Also, future studies should focus on between subject analysis rather than the within subject testing used for this study.



# Attitudes Toward LGBT Collegiate Athletes

*Christine Fuston*

Greg Meissen, Ph.D.

Wichita State University

## Introduction

Societal attitudes towards the Lesbian, Gay, Bisexual, and Transgender (LGBT) community have gradually improved as LGBT individuals are granted more rights, such as the legalization of same-sex marriage. However, prejudice still exists against members of the LGBT community, affecting not only home, work, and family lives, but also leisure activities such as recreational sports.

In the 1960s, homosexuality was labeled as a disease by the medical community. The people who were said to be suffering from this disease were characterized as having higher levels of addiction and unpredictable, unstable lifestyles (Solomon, McAbee, Åsberg, & McGee 2015). In attempts to avoid the social stigma tied to homosexuality, individuals who identified as members of the LGBT community often hid their identities. Although this may have helped individuals avoid public ridicule, it created dangers to the individuals' well-being. Without social support, LGBT individuals faced more stress with the feeling of living two lives: one where the individual is open about his or her sexuality, and one where the individual is not (Solomon, McAbee, Åsberg, & McGee, 2015).

Homophobia affects individuals in all aspects of life, including extracurricular activities such as sports. In a 2013 study, O'Brien studied current levels of homophobia among both physical education and non-physical education college students. Past studies show that homophobia is more apparent in physical education settings than in other everyday settings. While some studies suggest homophobia is coming to an end in the athletic setting, O'Brien argued that these studies only take into account the blatant expressions of homophobia, which have been replaced by subtler forms. The presence of national programs in the fight to stop anti-gay and lesbian environments suggests that homophobia continues to exist in the modern athletic and physical education environment.

## Methods

The present study included three semi-structured interviews with students who had participated in recreational sports in college, in order to discover how or if their LGBT identity affected their experience as part of an athletic team. Four questions were asked of each participant: (1a) What intramural and/or recreational sports have you been or are currently involved in? (1b) How did you become involved in this activity? (2) What sexual orientation do you identify as? (3a) Do your teammates know about your sexual orientation? (3b) If so, how did your teammates respond to learning this information? (4) Do you feel it is important for your teammates to know your sexual orientation?

## Discussion

Three common themes were found between each of the participants. (1) There was no specific coming out moment. Each participant described their sexual orientation disclosure as being implied through clothing-style, social media or relationship status. (2) Support from teammates played an important role in feeling comfortable as an LGBT athlete. Regarding teammate support, one participant stated “Words do really hurt. And if somebody says something on the field, you shouldn’t feel alone. If something is said, your teammates should know and have your back or at least comfort you.” (3) There remains room for improvement in the acceptance of LGBT athletes in collegiate sport-

ing environments. One participant said “It seems like there’s a lot of labels and hurtful words that are just thrown around, whether they mean it or not, in a homophobic way. They just say it and it does hurt, and it really does scare people away.” Another participant stated “I think that kind of negativity is still there, and I think it’s gonna be a long time before it’s not there, just because it’s so ingrained in the culture. But I think we’re on a very good track of that not happening anymore.”

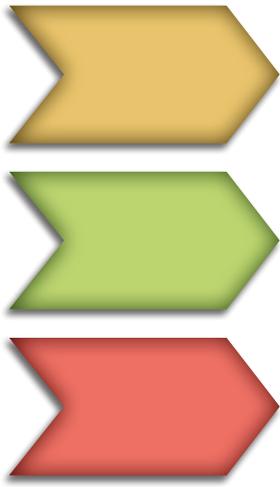
Results suggest that although teammates and coaches are accepting, occasional homophobic slurs from opponents are not uncommon, and there is potential room for growth in the acceptance of LGBT athletes within the collegiate sporting community.

## Limitations

Limitations of the study include a small sample size of three participants, and only two sexual orientations were represented: lesbian and bisexual. A larger sample size would assist in the data reflecting the larger population of LGBT athletes, and should aim to include the gay sexual orientation, as well as new identities encompassed within the queer umbrella. The small sample size was also not representative of gender, with only one female, two males, and no representation from the transgender community. One participant identified as African-American, with the other two participants identifying as White. Future studies should aim to include a larger sample size to encompass more sexual orientations, genders, and ethnic identities.

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# Resilient Grandparents: The Challenges, Stressors and Barriers Involved in Raising Grandchildren

*Vera Gantt*

Eveline Kalomo Ph.D.

Wichita State University

## Introduction

The number of American households where grandparents are raising their grandchildren is on the rise. Grandparents who raise their grandchildren face economic, emotional, social, legal, and financial challenges at a time in the human life span where their days of primary caregiving and parenting should be completed. In 2000, approximately 4.5 million children under the age of 18 lived in homes where their grandparents were the sole providers (Simpson & Webb, 2009). This represents a 30% increase from 1990. Also known as “Grandfamilies,” this phenomenon has emerged as a result of parental substance abuse, incarceration of parents, divorce, mental illness, HIV, and death of a parent (Simpson & Webb, 2009). A grandparent raising their grandchildren is a significant shift from their traditional role. This trend, combined with the growing social problems facing low-income families, has serious implications for the role of grandparents and active involvement in intergenerational relationships (Park, 2005). This study aims to expand knowledge regarding the vital role grandparents play in their grandchildren’s lives, review current policies and make future recommendations for policymakers.

## Methods

A semi-structured focus group was conducted in a small conference room setting. Participants were recruited from a local church and included seven African American grandparents in the Sedgwick County area serving as primary caregivers for their grandchildren. Participant ages ranged from 55 to 85 years. The focus group lasted 1 hour and 30 minutes and included a total of 6 questions regarding participants’ experience raising their grandchildren. Written informed consent forms were obtained from

each participant prior to the focus group. Responses were recorded and transcribed.

## Discussion

There were three major themes and causes that shed light on the lived experience that the grandmothers faced while taking on the primary role of caregiver: (1) Financial hardships & sacrifice, grandparents who raise their grandchildren face economic, emotional, social, legal, and financial challenges, especially on a fixed income; (2) A higher power as their major source of support. In the focus group, grandmothers quoted a certain piece of scripture-Philippians 4:13; "I can do all things through Christ who strengthens me"; (3) Fully grown kids have more of a mental and physical impact on their health than the grandchildren.

Responses supported previous research showing that major causes of grandparents are taking on the primary role of caregiver are parental substance abuse, incarceration of parents, death of biological parents, divorce, mental illness of the parent, abuse by a parent, neglect, and abandonment of the child. The results of this study spoke volumes on the financial hardships, the impact caregiving has on grandparents mental and physical health, and their support systems as a whole.

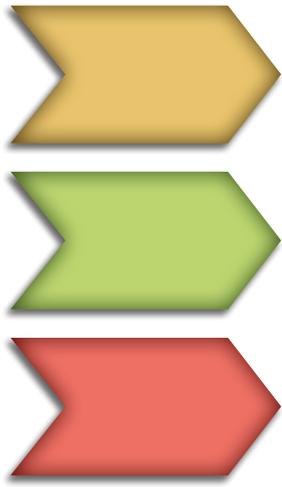
## Conclusion

Families, like any other system in society, may not

operate at their highest level of functioning; therefore, it is imperative that policy makers stay abreast with the current literature and research as it relates to grandparent-headed households. The majority of the research available on this topic has been descriptive in nature, which has helped to achieve better understanding of the family structure and dynamics of grandparent headed-households. Grandparents who serve as the primary caregiver to their grandchildren are a special and unique group that requires both admiration and support as they make an exceptional contribution to children whose parents are unable to raise them (Williamson et al, 2003). The services that are provided need to be targeted so that the needs of the children and the grandparent are met. This can be accomplished by incorporating the voices of grandmothers, and their grandchildren in the service delivery system process (Simpson & Webb, 2009). It is important for mental health workers to understand the myriad of challenges grandparents face: anger, frustration, anxiety, declining health, and economic distress. Nurses should encourage grandparents to have routine check-ups and follow any and all medication regimens prescribed by their physicians'. Nurses should also encourage grandparents to indulge in healthy lifestyle activities such as a healthy diet and regular exercise if capable (Leder et al, 2007). Over the last two decades, much progress has been made in our knowledge of and sensitivity to grandparents who raise their grandchildren; however, there is more to learn about this growing phenomenon.

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# Evaluating Clinical Decision Support in Emergency Medical Services

*Logan Gisick*

Barbara Chaparro Ph.D.,  
Tiffany Leverenz, and Paul Misasi  
Wichita State University

## Introduction

Work protocols are often complex and require experts to follow daunting amounts of information. This is especially true for the medical and aviation professions where protocols ensure the safety of passengers and patients. Professionals in these fields are expected to perform with great accuracy, respond quickly, and improvise when needed. Mistakes are made in every profession, however, in fields such as aviation and medicine, mistakes can have a consequential outcome. Professionals in these fields recognize that individuals are fallible, and that instead of punishing them for the inability to be perfect, methods should be employed to aid these professionals as much as possible. This study will assess the Emergency Medical Services (EMS) protocols from two Kansas counties, Johnson and Sedgwick.

Checklists are only one example of the mnemonic devices referred to as cognitive aids. The purpose of a cognitive aid is to protect against human vulnerability to incomplete memory during time pressure situations. Some of the problems concerning cognitive aids in health care are (1) there are no federal regulations mandating design and implementation of cognitive aids, (2) there are few published guidelines to inform development of design and standards, and (3) there are only a small number of scientifically validated materials available.

Employing the design and implementation strategies utilized in the fields of medicine and aviation, this project will assemble the preliminary data necessary to redesign the medical protocols (Figure 1) for EMS professionals from both counties to increase efficiency, usability, and user satisfaction.



Table 1

Suggested Protocol Changes			
	Sedgwick	Johnson	Quotes from EMS Professionals
Formatting/Sections	41.82%	35.71%	"The pictograph flow charts can sometimes become extremely convoluted and difficult to understand." –Sedgwick
Meds/Drug Doage	21.82%	17.14%	"Reducing the amount of different dosages of the same drug for various treatments/ i.e. Midazolam." –Johnson
More Clarity, Less Wordy	12.73%	20.00%	"I would make the paper pocket version a shorter version with checkbox single line information. The current paper pocket size has pretty small font and is too wordy at times." –Johnson
Flow	10.91%	11.43%	"There is no rhyme or reason as to where things are located and you can get different answers depending on where in the protocol you look." –Sedgwick
Needs to be More Open for Interpretation	9.09%	8.57%	"Make them more of a guideline and allow for ranges in meds based on assessment and condition." –Johnson
More User Friendly	3.64%	7.14%	"I do not like the decision tree flow. It is hard to study and learn." –Sedgwick
	N=55	N=70	

Thematic analysis of possible protocol changes as suggested by EMS professionals. Alterations to the formatting/sections of the protocols showed the highest percentages in each county. It also showed the largest discrepancy in percentages between each county, though the difference was less than 10%. The quotes shown in the table are representative of the majority of responses to this particular question.

69.23% of Johnson County paramedics ( $N=78$ ) felt their protocols were easy to use, while 8.97% believed they were difficult and 21.79% expressed neither. For Sedgwick County ( $N=70$ ), 54.29% of paramedics felt their protocols were easy to use, while 32.86% believed they were difficult and 12.86% expressed neither.

When asked about the clarity of the information in their protocols, 74.68% of Johnson County paramedics ( $N=79$ ) felt their protocols were clear, while 16.46% believed they were unclear and 8.86% expressed neither. For Sedgwick County ( $N=68$ ), 48.53% of paramedics felt their protocols were clear, while 33.82% believed they were unclear and 17.65% expressed neither.

When asked how often they use the paper version of their protocols (as opposed to the mobile phone app, which provides access to a PDF version of the paper protocols), 9.09% of Johnson County paramedics ( $N=77$ ) claimed to use their paper protocols frequently, while 51.95% claimed to use them infrequently and 22.08% expressed neither. For Sedgwick County ( $N=67$ ), 16.42% of paramedics claimed to use paper protocols frequently,

while 64.18% claimed to use them infrequently and 19.40% expressed neither.

When asked about their overall satisfaction with the paper version of protocols, 76% of Johnson County paramedics ( $N=75$ ) claimed to be satisfied with paper protocols, while 6.67% claimed to be dissatisfied and 17.33% expressed neither. For Sedgwick County ( $N=65$ ), 40% of paramedics claimed to be satisfied with their paper protocols, while 30.77% claimed to be dissatisfied and 29.23% expressed neither.

**Thematic Analysis.** Before analyzing frequency data, a thematic analysis was conducted to categorize free text responses from all participants including EMT, AEMT, and paramedics. These free text questions were included in the survey in order to better understand when EMS professionals use their protocols, and how they perceive them in their own words.

The free-text response questions asked in the survey and performed a thematic analysis on were:

- When (*i.e.*, what situations) are you most likely to use your protocols?

- *What do you like about your protocols?*
- *What would you change about your protocols? (Table 1).*
- *Are there any particular protocols you find troublesome, confusing, ambiguous, difficult to learn, use/interpret, etc.? If so, why?*

## Discussion

The need for this research stemmed from observations of members in the Johnson County and Sedgwick County Emergency Medical Service administration, and the initial hypothesis was that EMS professionals would report a dissatisfaction with current medical protocols. This research indicates that EMS professionals, and paramedics in particular, in both counties are generally satisfied with their current medical protocols. Clear differences exist between the counties, however, in their level of satisfaction and perceived utility of their respective protocols. Sedgwick County reported lower positive percentages across the board in usability categories such as learnability, clarity, and ease-of-use. Sedgwick County also reported lower levels of satisfaction with both paper and electronic protocols. Also, though the majority of Sedgwick County claimed their protocols made their job easier (80%), this figure was almost 15% higher in Johnson County. A well-constructed protocol, which is designed with human factors principals in mind and approached from a user-centered perspective, should receive a positive response rate that is close to 100% on this particular question, as protocols are perhaps the most important tool in the arsenal of an EMS professional.

For this reason, it was also surprising to see how infrequently the surveyed paramedics referenced their paper protocols, and to some degree, the electronic ones. The only version of the protocols which over 50% of paramedics reported using always or most of the time were the Sedgwick County electronic protocols. It is also worth mentioning that fewer than 50% of paramedics in either county reported referencing their paper protocols even half of the time, with almost 40% of paramedics in Sedgwick County claiming to never use them.

This research also found that the most problematic aspect of the protocols, as identified by EMS professionals, is the formatting/sections. This was a particularly large concern in Sedgwick County, and the algorithm/decision tree flow was commonly referenced as the main point of contention.

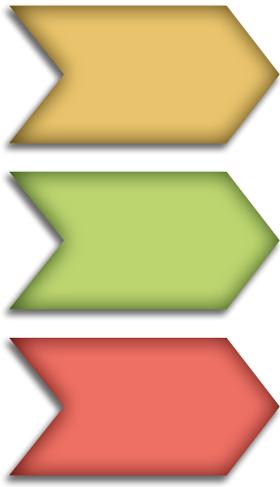
## Conclusion

This preliminary work suggests that the medical protocols in both counties are not being utilized to their full potential and may be, in part, a product of dissatisfaction within the EMS community due to poor formatting and design. A need exists for more effective and user friendly protocols that EMS professionals find useful and want to use. Adherence to these protocols is crucial, and any aversion within the medical community is something that may be alleviated through a redesign process that involves the participation of EMS professionals and administrators. This research has identified possible shortcomings present in the current medical protocols in both counties, and suggests that these issues be addressed so EMS professionals may better serve their communities.

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# Distracted Driving: Manipulation vs. Maintenance in Auditory and Visual Tasks

*Tony Hula*

Alex Chaparro, Ph.D.

Wichita State University

## Introduction

The majority of traffic accidents (41%) are a direct result of distracted driving (National Highway Traffic Safety Administration [NHTSA], 2008). As technology advances, there will be more distractions available to drivers. To limit the effects of distractions on drivers, car designers must know the type of distractions that lead to the greatest increased rate of accidents. Humans are inherently bad multitaskers (Sanbonmatsu et al., 2013). Sanbonmatsu et al. (2013) found that individuals who are more likely to multitask are also more likely to overestimate their abilities and be impulsive. The purpose of this study is to identify what types of distractions are most detrimental to driving performance.

Distractions affect attention in the form of different types of perceptual blindness. This can be troubling when driving, because driving decisions are based on the visual scene. One form of this perceptual disruption is called inattention blindness, or the looked-but-did-not-see phenomenon. Inattention blindness is an inability to see unexpected or irrelevant information in a visual scene (Moore & Egeth, 1997). This can pose a problem when drivers become too comfortable in their tasks, often “going through the motions” without specifically attending to what is being looked at. If a driver is only attending to other cars on the roadway and not expecting a pedestrian to walk in front of their car, the pedestrian may go completely unnoticed. Therefore, drivers are taught to always give the right of way to pedestrians, increasing their salience in the scene. However, a driver has to be actively searching for less common hazards, which could include pedestrians, animals, bicycles, or motorcycle.

Another common perceptual impairment caused by distractions is change blindness. Change blindness is a phenomenon where people are unable to see changes in a scene after an interruption (Rensink, O’Regan, & Clark, 1997). This is common in

distracted driving scenarios. When an individual looks away from the road, to attend to a cell phone or other activity, it provides an ideal interruption that would induce change blindness and cause a driver to be susceptible to new hazards in the driving scene. The best way to limit this from impacting driving performance is to pay constant attention and maintain eye contact with the roadway. By paying attention to the roadway the driver is able to not only see an object, but to classify that object before moving on to additional searches.

Distractions also limit eye movements. Many studies show increased limitation as a result of additional cognitive load when comparing different amounts of load on visual scanning patterns (Briggs, Hole, & Land, 2011; Han & Kim, 2004; Lee, Lee, & Ng Boyle, 2007; Recarte & Nunes, 2000; Recarte & Nunes, 2003; Zhang, Kaber, Rogers, & Land, 2014). Cognitive tunneling and limited gaze points also resulted from increased distractions as well as limited safety instrument scanning. Fixation duration was increased as a result of distractions, meaning that individuals rely more on cues from the environment and are often limited by less processing. When a person has limited resources available they are more likely to make a mistake in judgement or decision making resulting in erroneous behavior.

Increasing cognitive load can force the brain to react to situations without processing them completely, which often leads to mistakes in performance. This is the difference between “bottom up” processing, which is a form of simple processing that takes in information directly from the senses without analyzing the information, and “top down” processing, where an individual recognizes and categorizes a stimulus as it is encoded to distinguish properties and expectations regarding it specifically. An example of “bottom up” processing could be the fear response associated with a person jumping out to scare you from a hidden location. “Top down” processing comes through associations, like seeing an apple, knowing it is juicy, but depending on the color for it to be sweet, tart or

a combination of the two. When drivers are distracted they rely more on “bottom up” processing than “top down,” which may result in more errors in judgement due to the lack of cognitive resources. These errors can be fatal when driving, so limiting attentional distractions is critical to maintaining driver and pedestrian safety.

## Methods

Qualifications for participation include minimum age of 18 years, 20/20 vision, and two years driving experience. Thirty-five participants were tested with a final data pool of 30 participants. Five participants’ results were dismissed due to failures in technology or participant misconduct, like looking away from the eye tracker. Many participants were WSU students completing the experiment for SONA credit, however some participants were unaffiliated with WSU.

This study was designed to distinguish between both modality and task difficulty to compare visual manipulation and maintenance conditions to auditory manipulation and maintenance conditions. This will allow researchers to determine which modality and load level could be tapped into with the least amount of detriment to driving performance.

Auditory tasks included a word bank of either four or five words, depending on the level of cognition required. The maintenance task contained five words and consisted of simply remembering them. The manipulation task consisted of four words, but the words had to be reorganized alphabetically to complete the task successfully. The number of words were different for each condition to equate the task difficulty. This would show that the effects were due to the manipulation of information rather than the difficulty of the task. For the visual maintenance tasks, participants were asked to remember the form of a shape as it was described over time. For example, a dot moved up one space, to the left one space, down one space, and to the left one space. The image would resemble a question mark rotated 90 degrees to the right without

the point at the bottom. Imagining what a question mark would look like 90 degrees to the right is an example of a manipulation of information task. For the manipulation condition in this experiment, we used the same set of directions as the maintenance task, however, participants were asked to report the mirror image of the shape.

## Results

The initial data showed a consistency with prior research, in that, the maintenance condition was shown to cause little or no detriment in both visual and auditory modalities, meaning a person can maintain information (up to about 7 digits or items, for about 30 seconds) without any impairment to performance on a primary task. The manipulation tasks were shown to cause more cognitive tunneling, which restricted visual gaze and impaired hazard detection. This means that the difficult tasks used up additional resources, which left less attention for driving so the scene was scanned less often and hazards were not processed. The data also revealed that the mirrors and gauge cluster, or the safety instrument panel, was looked at less often in the manipulation conditions than in maintenance conditions. The number of looks were determined by numerically representing the average horizontal gaze points and comparing them for intensities. Smaller gaze point average indicates a restricted visual search, which extended to the edge of the scene less often. When the smaller average is combined with a

larger standard of deviation it means that the gaze points were held longer, indicated by the increased standard of deviation. Interestingly, the maintenance condition resulted in more visual searches than the control condition. This would imply that maintenance does not require all of the additional resources, therefore, the resources that were in reserve were available for allocation toward visual searching during the experiment. Thus, this is considered an experimental effect that would not generally translate to the general public.

## Discussion

The preliminary findings imply that receiving auditory information has no effect on driving performance. This could indicate that it may be beneficial to incorporate audio voice command centers in automobiles. For example, if it is getting chilly a driver could simply tell the car, just like interacting with intelligent personal assistants Siri or Alexa to turn down the air conditioning five degrees. This would allow certain simple controls like changing the radio or other features to be automated without requiring glances away from the road. This type of technology can be incorporated and utilized in a way that is conducive to the primary task. Many recent advances, like backing cameras or automatic collision avoidance systems are a step in the right direction, but they have been marketed as a failsafe for distracted driving. There is no failsafe for distracted driving aside from omitting distractions whenever possible.

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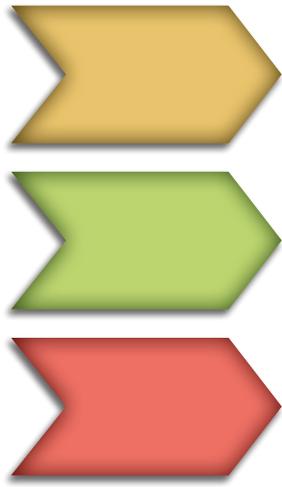
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# Mechanism of Anthrax Protective Antigen Pre-Pore Formation

*Jasmine Mayorga*

James Bann, Ph.D.

Wichita State University

## Introduction

Anthrax is a gram positive rod-shaped bacteria. The toxicity of anthrax is caused by bacterium *Bacillus anthracis*, which serves as carrier for enzymes into the cytosolic compartment. This pathogenic bacterium has two components to its toxicity known as the AB toxin system. The A component is the enzymic activity and the B component is the binding moiety. This bacterium consists of three nontoxic protein components: Protective antigen (PA), lethal factor (LF), and edema factor (EF). The interaction of PA with either enzymic moiety LF or EF allow for the binded PA to enter the endosome. Under acidic conditions, either enzymic moiety is allowed to translocate its toxins into the host (Kintzer, Tang, Schawel, Brown, & Krantz, 2012).

The study of the mutant protein's mechanism is of interest in understanding the pathogenesis in the anthrax toxin. Recently, D425A has been of particular interest. LF<sub>f</sub>-DTA studies determined the ability of D425A hetero heptamer to transport effector proteins to the cytosol. However, the critical role of mutant D425A in pore formation is its ability to inhibit PA activity almost completely (Janowiak, Finkelstein, & Collier, 2009). For example, when the mutant protein is allowed to co-oligomerize with WT PA 63, the pre-pores formed are non-functional. For these reasons, this study will examine D425A's role in pore formation. It was hypothesized that the D425A mutant would be stuck in an intermediate state, not allowing it to fully mature to pore. Using a fluorospectrometer, the pH stability of the mutant and compared it to the wildtype protein was examined.

Repeated studies on the D425A mutant protein and the wildtype protein in different conditions are needed to give certainty as to the intermediate structure seen in previous studies. To measure this, we studied the fluorescence quenching of both the wildtype PA and D425A mutant without the 350 Alexa Fluoro fluorescent label. This study aims to confirm if previous studies were label dependent.

## Methods

In order to study this mutant this study focused on the kinetics of pore formation. The experimental rate of formation was determined by using an Applied Photophysics SX.18MV-R Stopped Flow Spectrofluorimeter. Experiment rates were determined at 5°C, 10°C, 15°C, and 20°C. Proteins were incubated at the pH 5 buffer (50 mM sodium phosphate buffer, 150 mM NaCl, 2.5 mM MgCl<sub>2</sub>). Excitation was set at 350 nm, and the rates were collected in split time base mode at 2 seconds and 20 seconds. All data points collected represent an average of at least two shots acquired.

## Results

Kinetic studies on protein's conformational transitions showed similarities in both the Wildtype and D425A mutant protein. There was a drop in the slope of the rate of formation for both proteins, which indicates both proteins experience an initial kinetic change in the protein's conformation. This indicated the D425A mutant experienced a signal for pore formation similar to that of the Wildtype protein. The only difference in the rate of formation occurred after two seconds. For the kinetics on the mutant protein there is no kinetic movement after approximately two seconds; however, for the wildtype protein, a downward slope continued. The downward slope is the kinetic movement of the protein maturing to a full-pore state. It makes sense for the D425A mutant to not experience a stop in kinetic movement since this mutant has been shown in literature to be incapable of pore formation. In both proteins, an increase in the rate of formation with higher temperature occurred.

To closer examine the initial kinetic change in both proteins, a plot of activation energy was calculated proteins. The rate constant,  $\ln k$ , of D425A was 2.98

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**Table 1: Protein Rate Constants at Various Temperatures**

Protein	5°C	10°C	15°C
WT	1.68	4.23:53*	11.8:2.387
D425A	2.42	5.8	15.74

kcal/mol. This is similar to that of  $\ln k$  WT of 3.10 kcal/mol. A closer look at the rate constants at various temperatures. Table 1 shows similar results as the plot. At all the temperatures, the rate constants of both the WT and mutant protein D435A resemble although not the same.

## Conclusion

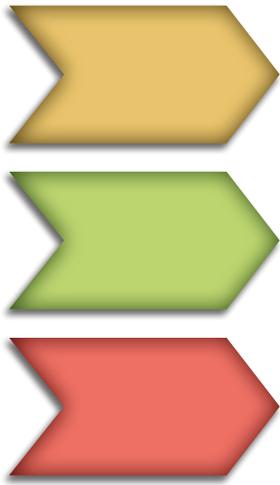
The kinetics of the transition of the pre-pore to the pore are complex, with at least two separate phases, depending on the temperature. Clearly, as the temperature rises, the rate of the transition to the pore becomes faster. Interestingly, in both studies, for the D425A mutant, the transition stops and there is no further kinetic change after 1 s (from 5 C - 20 C). For the WT protein, the kinetics at all temperatures show a slow phase after ~2s, that continues to decrease. Results indicate that this latter phase is due to the formation of a pore. Thus, the D425A mutant is likely to be halted at an intermediate step in pore formation. Arrhenius analysis of first phase transition indicates the kinetic pathway utilized is the same for the D425A and Wildtype protein.

The information gleaned from this study is crucial for understanding the mechanism of pore formation and suggests that the earliest step in pore formation involves movement in or around Trp 346 (Pilpa et al., 2011). Therefore, targeting this region with small molecule therapeutics is likely to be effective at halting the process of pore formation.

antigen integrates poly- $\gamma$ -d-glutamate and pH signals to sense the optimal environment for channel formation. *Proceedings of the National Academy of Sciences of the United States of America*, 109(45), 18378–18383. doi:10.1073/pnas.1208280109

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# University Students' Perceptions of Cell Phone Interruptions During Face-to-Face Interactions: Gender Differences in Communication

*Aja Molinar*

Greg Meissen, Ph.D.

Wichita State University

## Introduction

Many studies have discovered negative effects associated with cell phone use. The studies support the idea that society should be moving away from excessive cell phone use—not gravitating toward it. Recently, cell phone use has been found to adversely affect romantic relationships when one partner interrupts intimate time to direct attention to a cell phone. Of course, cell phone interruptions do not just interfere with romantic relationships. Lee Humphreys conducted an observational study in 2005 to examine the effects of cell phone interruptions. When two individuals, together in public, were monitored, Humphreys noticed that if one of them accepted a phone call, the other individual would exhibit anxiety-type symptoms.

The purpose of this study was to examine university students' perceptions of cell phone interruptions, phone calls and text messages that interfere with daily face-to-face interactions. Although information had been gathered on the effects of cell phone use and interruption, limited information was available to describe participants' perceptions toward these effects. It was hypothesized that female students were more likely to have negative perceptions regarding cell phone interruptions due to male students being less likely to indulge in cell phone or technology use (Ericson, 2012). It was also hypothesized that students who exhibited mild to severe anxiety would have negative perceptions concerning cell phone interruptions, since anxiety-type symptoms are exhibited in some individuals exposed to cell phone interruptions. Sufficient evidence did not exist to form a hypothesis regarding race or age and reaction to cell phone

interruptions. However, as cultural variations between different demographic groups play a role in communication, the perceptual differences between demographic groups (race and age) were also compared.

## Methods

Participants' ages ranged from 18-64 years. All participants were enrolled at Wichita State University and volunteered to participate through SONA, the experiment participation system for the Psychology Department at Wichita State University. A 23-item survey was generated and included basic demographic questions, items used to detect anxiety, and items used to detect perception of cell phone interruption and use. Participants rated statements such as, "I avoid talking to people who spend too much time texting." Items used to detect anxiety were borrowed from the commonly used Generalized Anxiety Disorder 7-Item Scale (GAD-7) created by Spitzer, Kroenke, Williams, and Lowe (2006). The survey was completed by 339 volunteer participants. Responses were collected during an approximate four-month time span.

An independent sample t-test was conducted to compare the perceptions of cell phone interruptions between males and females. Results were not significant,  $t(335) = .168, p > .05$ . Female students ( $M = 3.79, SD = .422$ ) did not hold significantly different perceptions toward cell phone interruptions compared to male students ( $M = 3.78, SD = .418$ ). A one-way between subjects ANOVA was used to test for differences in perceptions of cell phone interruptions among four anxiety levels (no anxiety, mild, moderate, and severe). There were no significant differences in perceptions at the  $p < .05$  level across the four anxiety levels, [ $F(3, 335) = 1.495, p = .216$ ]. A Pearson correlation coefficient was calculated to assess the linear relationship between perception and anxiety level. No correlation was indicated between the two variables ( $r = .057, n = 339, p = .146$ ).

## Discussion

In the sample of 339 participants, one participant was mildly aversive to cell phone interruptions, which was equivalent to 0.3% of the sample population. Approximately 20.9% of the sample population was moderately aversive toward cell phone interruptions. The majority of participants, 78.8%, were highly aversive toward cell phone interruptions. Nonaversive perceptions toward cell phone interruptions were not reported. As for the measurements of anxiety, approximately 42.8% of participants showed no anxiety ( $n = 145$ ). Of the same sample, 31.9% of participants suffered from mild anxiety ( $n = 108$ ). The percentages of participants who suffered from moderate and severe anxiety were 13.0% and 12.4%, respectively.

Both hypotheses were rejected. No relationship was found between anxiety levels and perception toward cell phone interruptions, or any other demographic variable (age or ethnicity). Remarkably, there was a complete absence of nonaversive perceptions toward cell phone interruptions, with nearly 80% of student participants holding highly aversive perceptions toward cell phone interruptions.

The study results coincided with the idea that there is less difference between males and females than is perceived in mainstream media. Contrary to the hypothesis, the results also supported the idea that individual characteristics and demographics likely do not affect perception toward cell phone interruptions. Negative perceptions toward cell phone interruptions are likely generalizable throughout the population, which may be explained by a confounding variable. This may also account for the lack of difference in perceptions between anxious and non-anxious individuals. Another aspect that may account for the lack of difference between anxious and non-anxious individuals is, again, that negative perceptions toward cell phone interruptions are very generalizable. Perhaps anxious individuals' *responses* to cell phone interruptions may differ from non-anxious individuals, but their perception of the interruptions mirror the perception of the general population.

## Limitations

A possible limitation to this study may be that participants were pooled using SONA, a system used by Wichita State University's Psychology Department. Many participants seek to earn credit within their psychology courses, and there is an increased likelihood that participants were psychology majors. Results may have differed if more student participants of differing majors of study were included in the analysis. The survey might have been improved with the addition of a question addressing students' major of study, in order to analyze the comparisons between these students.

## Conclusions and Future Study

Future research may involve conducting interviews to assess what students dislike most about cell phone interruptions and discover any confounding variables. An effort should be made

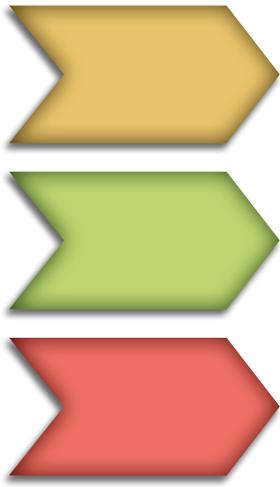
to conduct focus groups to quantify salient issues that may be difficult to obtain from surveys alone. Replicating the study with non-student participants may be considered for the purpose of increasing the generalizability of results. Different perspectives should also be the focus of qualitative and quantitative methods, such as analyzing how participants believe others perceive their *own* cell phone use. On a larger scale, the study should be replicated with participants internationally, to study whether cultural aspects affect perceptions toward cell phone interruptions.

Although several studies have been published relating to cell phones and face-to-face communication, this study is the first to analyze perceptions of the combination of these influences on a university campus. Analyzing the perceptions of technology use should be considered when incorporating technology into daily life. Results of this study provide support of a new attitude forming in society that transcends gender, ethnicity, and age.

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# Homeless Voices: Narratives of the Homeless in Wichita

*Valerie Noseng*

Natalie Grant, Ph.D.

Wichita State University

## Introduction

In 2016, there were 571 homeless individuals counted in Wichita, Kansas during the Homeless Point in Time Count. The definition of “homeless” by the U.S. Department of Health and Human Services is an individual with no permanent housing. According to Elzbieta Krajewska-Kulak, et al. (2016), public perception of the homeless population has been negative. Homeless individuals are viewed as alcoholics, lazy, and potentially dangerous. Stereotypes of this or any population are inaccurate and damaging.

Previous research revealed three important themes: lack of resources available for mental health, negative effects of stigma, and the criminalization of the homeless. In *Can I Get Some Remedy? Criminalization of Homelessness and the Obligation to Provide an Effective Remedy*, Eric Tar references the case of *Pottinger v. City of Miami* where homeless individuals were receiving citations for sleeping on the streets even though there were nearly 10 times more homeless individuals than shelter beds. Due to there not being enough shelter beds, the rest of the homeless population had to do life sustaining activities outside. The court concluded that the ordinances were criminalizing homelessness itself. According to previous studies, homeless individuals also experience harassment and victimization (Shipley & Tempelmeyer, 2012; Williams & Stickley, 2011).

This study aims to share stories of homeless individuals living in Wichita, Kansas in order to reduce stigma and create a dialogue between community members and the homeless population.

## Methodology

### Participants

Individuals who self identified as homeless and were utilizing Open Door Ministries, a nonprofit organization that provides services to homeless individuals, volunteered to participate in a focus group. This study includes three participants, two males and one female.

### Procedures

Interview questions were designed to collect stories of homelessness and identify the effects of stigma on the homeless population. A semi structured interview included open ended questions that allowed participants to go into further detail if they wanted to and took place at Open Door Ministries in Wichita, Kansas. The study was approved by the Institutional Review Board at Wichita State University.

## Results

Three main themes emerged from the results of this study: adequacy of available resources, increased access to services, and the homeless community as family.

### Adequacy of Available Resources

All three participants mentioned that resources available for the homeless community in Wichita are adequate. Open Door provides services for the homeless, such as facilities for showering and doing laundry. They can also get mail, eat, and connect with other resources. Resources mentioned by participants were Open Door Ministries, The Lord's Diner, Interfaith Ministries, the Workforce Center, and the Homeless Outreach Team.

### Increased Access to Services

Participants were also asked if they thought there were any resources missing for the homeless community. All three participants indicated a need for a homeless shelter for women and access to resources on the weekends so they can utilize ser-

vices/facilities like showers, laundry, and a place to interact with others.

### Homeless Community as Family

The final theme that emerged was family. The participants referred to other homeless individuals as family. Participants described receiving help from other homeless individuals and a willingness to help others. Notably, when one participant was asked about his biological family, he stated he had not seen his family for eight or nine years, while another participant stated most of her biological family did not know she was homeless and she has been homeless for three years.

## Discussion

In this study, findings regarding stereotypes and their effects support information found in the literature. However, this study did not find evidence of harassment of homeless individuals in the Wichita community. In previous research, participants reported experiencing some form of harassment from the public. While all three participants mentioned stigma and that stereotypes affected how the homeless are viewed by others, none of the participants mentioned being harassed because they were homeless. Previous research also suggests that homeless individuals are more likely to be victims of crime than the general public (Shipley, 2012). All three participants said that they felt the community was very helpful and one participant spoke about how many people like to bring food and clothes to them. One participant indicated that she believes that she lost her job because her employer found out she was homeless.

Participants' perceptions of stereotypes and their effects were consistent with the literature. One participant described stereotypes of homeless people as lazy, dirty, and hopeless. He also said that although there are some homeless people that are lazy, not all of them are. Another participant said that most of the homeless people she knows work hard to try to get back on their feet.

New themes included adequate resources. Par-

participants reported that they felt satisfied with the amount of resources available. They also said that it was a matter of utilizing the available services. There may be some individuals who need services but are unaware of available resources or who do not utilize them. Wichita may be used as a possible example for other communities looking to support and help their homeless population. Wichita has a police task force called the Homeless Outreach Team, which is made up of officers that try to help homeless individuals find resources rather than give them citations or arrest them. Again, all three participants utilized Open Door services, but if individuals who did not utilize Open Door services were interviewed, the outcome may have been different and they may have felt there were not enough resources in the community.

While previous research found a lack of resources and shelters, the findings in this study regarding the Wichita area indicated a need specifically for women's shelters and increased access to services during the weekend.

The final theme that emerged from this study was the homeless community as a family. Access to space where these individuals can interact may help foster this sense of family within the homeless community. Participants who were interviewed utilized services from Open Door Ministries, which may have contributed to their response referencing a familial atmosphere. Results may have varied if there

were interviews from homeless individuals who did not utilize services from Open Door Ministries.

## Limitations

The study did have limitations regarding generalizability since there were only three participants interviewed. Another limitation is that all interviews were conducted with homeless individuals who utilized Open Door. Ministries participants said they felt supported and the community provides various resources for the homeless. Had homeless individuals who did not utilize services from Open Door Ministries been included, the results may have been different.

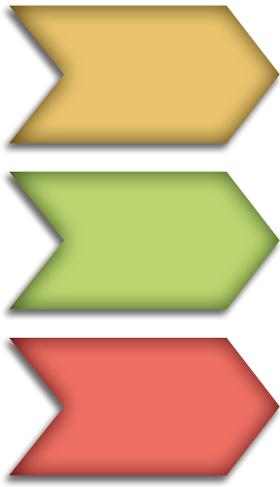
## Future Research

For further research on this topic, more interviews should be conducted in order to make the study more generalizable. Interviews should be conducted from various facilities that provide services to the homeless community, in an effort to determine if the familial feel is unique to those persons who frequent Open Door Ministries or is that the consensus of people who utilize all services in the Wichita community. Lastly, future interviews should focus on stigmas and the effects experienced by the homeless rather than focus on their individual stories.

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# The Impact of Childhood Abuse on Senior Citizens and their Coping Techniques

*Carrie Van Dusen*

Kyoung Lee, Ph.D.

Wichita State University

## Introduction

Childhood abuse can create lifelong changes in a person's psyche. Even one experience of abuse may have lifelong effects. Childhood maltreatment can lead to unfavorable psychiatric conditions, including depression and other diagnosable disorders (Nanni, Uher, Danese 2012; Chen, Maud, Paras, Colbenson, Sattler, et al 2010; Silverman, Reinherz, and Giaconia 1996). It is important to consider this when developing treatment. When trauma is experienced at an early age, it can alter the way the brain responds to fear and stress. These can be long-term effects that the person faces. The experiences that a child has in regards to trauma may cause that child to display symptoms of depression later in life. The brain is transformed by trauma, it might be structurally damaged, and hormones may be altered due to the abuse. It changes the development of the brain. It can alter the way the neural circuitry is formed and cause brain structures to physically change (Kendall-Tackett, 2016).

Previous research has indicated that excessive substance abuse has been used as a way to self-medicate to keep away bad memories (O'Leary & Gould, 2010). People with mental illness tend to avoid thinking about their illness, which will affect the practitioner's ability to treat the disorder (Craşovan, 2013). It is important to study the ways an individual learns to cope with childhood trauma. The current system for addressing the issue of child maltreatment and teaching healthy coping skills to these individuals is limited. Coping strategies may affect the severity of depression. Examining the effects of different coping strategies may help inform treatment options for individuals who have suffered from childhood abuse.

## Methods

This study was designed to determine if childhood trauma and coping variables have a relationship with depressive symptoms in adults over the age of 65. Survey data sets were used from the Midlife Development in the United States (MIDUS) series combining MIDUS II biomarker project 2004-2009 and MIDUS II cognitive project 2004-2006 data. This study utilized three instruments, the Center for Epidemiologic Studies Depression Scale, the Childhood Trauma Questionnaire (CTQ) and the COPE inventory. The sample consisted of 265 older adults. Nineteen percent were employed and 67% were married with an income less than \$40,000.

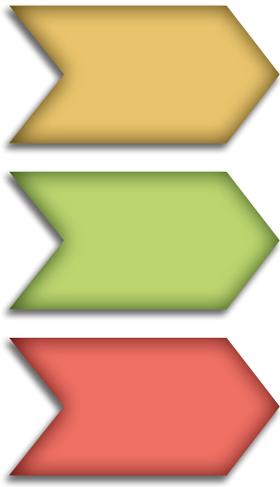
## Results/Conclusion

A correlation test revealed that depressive symptoms in older adults were significantly associated with coping variables and childhood trauma. Higher depressive symptoms were significantly associated with higher emotional neglect as a child. Nearly ten percent of participants expressed depressive symptoms. Results showed that people with higher perceived health scores had significantly lower depressive symptoms.

The findings provide insights for counselors and aid them in treating childhood abuse cases and teaching healthy coping skills that lower the risk of depression as people age.

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# Validating an Open Circuit Resonant Patch as an Ergonomic Proximity Biosensor

*Carol Vihuethpad,*

Kim Cluff, Ph.D.

Reece Burns, and Bernardo Villafaña<sup>1</sup>

Wichita State University

## **Author Note**

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Correspondence concerning this article should be addressed to Dr. Kim Cluff, Department of Biomedical Engineering, Wichita State University, Wichita, KS 67260-0066.

Contact: kim.cluff@wichita.edu

## **Introduction**

The extravehicular mobility unit (EMU) was first developed in 1974, and since then space suit design has essentially remained the same: modular limbs attached to the hard upper torso (HUT). The EMU's primary purpose is to support human life in space during Extravehicular Activity (EVA) by protecting astronauts from harsh environmental conditions. The EMU is a crucial component in safe space exploration, but since the HUT is a rigid body that rests on the shoulders, astronauts are forced to work around the suit's biomechanical restraints during EVA. In fact, shoulder pain ranks as the second most reported injury during training in the Neutral Buoyancy Lab (NBL) (Johnson, B. W., D., 2003). As a result of the additional stress on the rotator cuff, many suffer pain symptoms due to contact with the HUT. NASA relies principally on qualitative feedback from astronaut candidates (ASCAN) to self-report any discomfort from training.

The purpose of this study is to explore the use of an ergonomic biosensor to produce quantitative feedback.

## Materials and Methods

A small open circuit resonant sensor patch was adapted from SansEC technology, which may demonstrate capabilities to quantify ergonomic boundaries across suit designs with a high resolution in real time.

The relative permittivity, relative permeability, and electric conductivity of the copper trace determine the behavior of the open circuit sensor, governed by Maxwell's equations for electric and magnetic fields, which utilizes the material's physical properties. The result is an open-circuit resonant sensor that can provide measurements without electrical connection for power. The biosensor consisted of a self-resonating square planar spiral pattern (10.1 cm x 10.1 cm) of 20 turns constructed with a 2 mm trace of copper conductive material, and 0.5 mm gap width on a flexible polyimide substrate. A copper loop antenna was aligned around the sensor to generate radio frequency (RF) waves to induce a current, producing a magnetic field to interrogate the sensor for the frequency return loss from the environment,  $S_{11}$  response. A SubMiniature version A (SMA) connector was soldered to the antenna and connected to a vector network analyzer (VNA) with a 50 ohm coaxial cable. The VNA inductively energizes the patch with RF waves and then the VNA records the  $S_{11}$  response (specifically, changes in gain (dB) and frequency (GHz), which may be proportional to changes in proximity in the environment).

The sensor's capabilities as a proximity sensor were tested using a model to isolate and analyze the relationship between frequency shifts and distance. A gel-like phantom substrate was developed to mimic the dielectric properties of the skin and placed 50.8 mm (2 inches) from the sensor. The substrate was moved toward the sensor on a stage controlled via a micrometer to gauge specific displacement at increments of 8 mm.

A one-way analysis of variance (ANOVA) paired with a multiple comparison of means test was used to investigate the statistical significance of each resonant frequency shift at each incremental distance. A Bonferroni correction was performed on the multiple comparison of means test with

a desired alpha of 0.05 and 18 trials resulting in final correction of 0.0027 ( $\alpha = 0.05/18$ ). Additionally, these statistics account for noise by assessing the mean and standard deviation of 10 sweeps at each increment.

## Results

There were distinct frequency shifts and an increase in amplitude in the  $S_{11}$  response as the phantom substrate was moved toward the sensor. At 50.8 mm (2 inches) from the sensor, the baseline response is a peak at 1.3 GHz and approximately -5 dB. When the sensor and substrate make contact, the amplitudes of the peaks increase to -30 dB while the frequency response simultaneously decreases to produce the principle resonant peak at 1.295 GHz.

Statistical analysis revealed that frequency shifts between each increment of displacement were significant and discrete within the test range, indicating there is evidence of a relationship between the two variables. The  $S_{11}$  frequency response was then plotted against displacement to determine the relationship between the two variables. The plot does not indicate a linear relationship over the entire displacement range. Due to the lack of linearity from this preliminary study, a linear regression test was not used to further analyze the data.

## Discussion

This study has demonstrated the biosensor's capabilities as an electromagnetic proximity sensor, which can be applied to examine the biomechanical restraints of the HUT due to scapulothoracic activity. Hence, the more a particular resonant peak appears in the  $S_{11}$  response due to contact with the scye bearing joint, the higher the potential of shoulder pain and/or injury. Ergo quantification of fit and comfort is fundamental in determining better placement of the scye bearing joint (where the modular arms attach to the HUT), allowing for more potential mobility.

Although a seemingly proportional relationship between phase shifts and displacement exists, this

study holds several limitations, including, but not limited to, the gel-like phantom model's simplification, the direction of measurement, and the lack of testing on additional sensor geometries. The gel phantom simplifies the study by simulating the dielectric properties of skin; however, the dielectric responses of each layer of biological tissue below the skin (adipose tissue, muscle, bone, and biological fluids) may affect sensor performance relative to the response to the phantom. To remedy this, development of a specific coupling gel alongside the application of the sensor patch, similar to ultrasound, may be desirable for better impedance matching to isolate and detect a specific substrate. This minimizes the potential for noise in response frequencies due to the non-homogeneous texture of the outer layer of the epidermis.

Additionally, a decreased testing range for displacement should be explored, from 50.8 mm to 15 mm, since the general measured clearance, free space between the shoulder and the EMU, is approximately 10 mm (Extravehicular Mobility Unit, 2012). Further exploration in the sensor application and reversing the experimental design, where the sensor moves while the substrate remains fixed, would allow the sensor to be more universally applicable and ultimately eliminate the need to shield the sen-

sor. Eventually, human biomechanics studies with similar movements in the EMU should be tested to further validate sensor design and performance.

## Conclusion

In short, this study provides a basis for further expansion to develop an ergonomic biosensor demonstrating strong potential capabilities to determine distance within  $\pm 1$  mm. Changes in permittivity and permeability can correlate to displacement via the open circuit sensor. Due to the sensor's simple design and ease of application, the sensor may be successfully used within a confined environment such as the EMU. The EMU design will retire alongside the International Space Station in 2024 (Extravehicular Mobility Unit, 2012). Regardless of the final space suit design, as the date fast approaches, the resonant patch can be adapted to measure ergonomic boundaries and even perhaps minimize the cost for pain and/or injury care following EVA training. As mission needs evolve in preparation for deeper space exploration, critical examinations of comfort within the space suit is essential in developing more mobile space suits to ensure the success of future manned missions.

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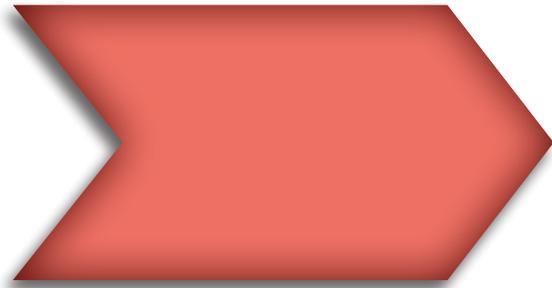
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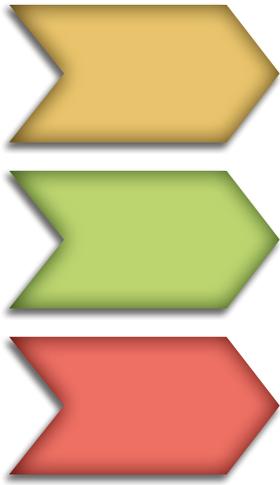
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# LITERATURE REVIEWS





# Demoralization and Social Isolation Among the Older Population

*Elizabeth Ramirez*

C. Brendan Clarke, Ph.D.  
Wichita State University

**S**ocial isolation is common among the elderly. Literature often highlights depression as the determining factor when identifying social isolation. However, identifying depression as the reason for isolation is unlikely considering statistics shows it declines with age (Fiske, Wetherell & Gatz 2009). Demoralization may actually be the best way to identify this behavior. Since it is a fairly new approach there is not a sufficient amount of studies regarding demoralization to grasp its full significance. A valid measuring instrument that would be ideal to use is the demoralization scale (RCd), which originated from the Minnesota Multiphasic Personality Inventory—II (MMPI-2). A benefit to applying the RCd to a research study is its ability to examine personality traits rather than the diagnosis (Tellegen, et al., 2006). The purpose of this literature analysis is to review demoralization with the older community, and bring attention to the lack of knowledge available regarding social isolation.

The restructured clinical scales (RC) were generated to refine the validity of the MMPI-2 (Tellegen et al., 2006). There are a total of 10 RC scales, demoralization (RCd) being one of them. Demoralization is a mesh of symptoms that is not specific to a single psychological disorder (Frank, 1974). Demoralization is illustrated by feelings of loneliness and helplessness (Tellegen et al., 2006). Depression and demoralization tend to be comorbid (Clark & Kissane, 2002), and can be mistakenly interchanged if overlooked. This is possible because demoralization is a newer concepts and the definition is not widely known (Jacobsen, Maytal & Stern, 2007). The RCd can be convenient to psychologists because it's capable of dissociating demoralization from depression. To help identify the difference, depressed individuals are incapable of feeling happiness, while demoralized individuals can but do not feel the desire to do so (Clarke & Kissane, 2002). This can enhance the chances of falling off the social ladder, especially among the older community.

The limited literature available in reference to the elderly seems to show a correlation with demoralization. The factors that fabricate demoralization are related with poor

functional ability and dissatisfaction with relationship quality among friends or family (Jacobsen et al., 2007). Mobility is likely to decline with age and there is little that can be done to prolong it, which make the elderly vulnerable to being isolated from the community. It may not be intentional, but with younger generations staying busy and contributing to society through working, etc., it can be difficult to stay connected to elders. Emotions of helplessness with the older population can develop because of this as well. While they are encouraged to retire, these individuals are left feeling incompetent. Leaving the elderly with feelings of loneliness and helplessness can evolve into demoralization.

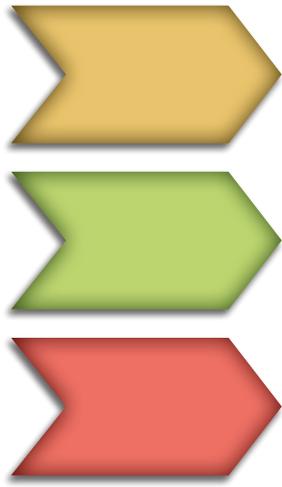
Social isolation can severely affect the quality of life among the elderly. It has been tied to higher rates of coronary artery disease, chronic heart failure, congestive heart failure, and frequent admissions to the hospital (Courtin & Knapp, 2015). Suffering from diseases like these can discourage one from being social because of the fear of being a burden to others. Deterioration in physical ability has a negative impact

on social behavior as well as generating feelings of loneliness (Shankar, et al., 2011). Social isolation and loneliness have a strong relationship as well; elderly who experience isolation seem to have an immense amount of loneliness (Shankar, et al., 2017). Chances of recovering from an illness are substantially weakened (Jacobsen et al., 2007).

Additional research involving the elderly population and the use of the RCd may help psychologists better treat demoralization and improve their quality of life. Identification of social isolation would also advance, allowing psychologists to aid the elderly in retrieving a social lifestyle. Entering old age increases the risk for a number of health implications making one susceptible to disconnecting from the community. Preventing terminal illness among elderly may be attainable by eliminating social isolation. Incorporating the RCd would help researchers achieve this goal. Emotions of demoralization are common across all disorders, but making sure they are not camouflaged by depression can make a huge difference in identifying the elderly at risk for social isolation.

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# Tissue Engineering of Vascular Grafts: Multi-layer Electrospun Scaffold Constructs

*Martina Salerno*

Anil Mahapatro, Ph.D.

Wichita State University

Organ Shortage and cardiovascular diseases (CVD) remain a problem in the medical environment. Tissue engineering is a potential solution but is limited by the lack of a successful avenue for nutrient supply and waste removal. Blood vessels are essential for the supply of nutrients and removal of waste within these systems (Smith & Gerecht, 2014). Since vascularization is needed for the successful integration of engineered systems with the human body, the creation of blood vessels, angiogenesis/vasculogenesis, is a necessary step for tissue engineering of all systems and organ modeling and remodeling (Nemeno-Guanzon et al., 2012). Engineered blood vessels could be used to treat cardiovascular diseases (CVD) like peripheral artery diseases (PAD) and coronary artery disease (CAD) or atherosclerosis (Xie et al., 2016). Both, in extreme cases, lead to a need for vessel grafting and even heart transplant (Hendry, Farley, & McLafferty, 2012).

Currently, blood vessel transplantation from synthetic sources and autografts are used to treat cardiovascular disease. Synthetic vascular sources are limited because of poor mechanical properties and consequences like thrombosis, rejection, and chronic inflammation (Nicolas et al., 2006). Autograft treatment of cardiovascular disease is limited due to a lack of suitable tissues that could effectively restore injured cardiac muscles or serve as vascular substitutes (Nemeno-Guanzon et al., 2012). Vessels can be negatively affected by aging, vascular disease, vein stripping, and prior graft procedures, which often makes them ineligible for autologous grafting (Konig et al., 2009; Nemeno-Guanzon et al., 2012; X. Wang, Lin, Yao, & Chen, 2007). The tissue engineering of blood vessels (TEBV) is an approach that can potentially relieve the shortcomings of autologous grafting (Nemeno-Guanzon et al., 2012). TEBV allows for patient-derived cell use and is a better approach since it allows the synthesization of tissue or

organ features that are specific to patient requirements (Nemeno-Guanzon et al., 2012). Constructed tissue engineered vascular grafts (TEVG) can be seeded with patient host cells, which can fill in the template scaffold created and theoretically produce a working vascular graft. The concept of using the patient's own cells is also advantageous because it has the potential for patient-specific tailoring.

This review primarily focuses on various sequential multi-layering approaches via electrospinning to create scaffolds for tissue engineered vasculature. Electrospinning is a method commonly used to create TE scaffolds. Using combinations of materials to create multiple layered systems has the potential to accurately mimic natural anatomy & create a successful base for implementation of TEVG. Multi-layer constructs can be customized and modified to better imitate natural vasculature and are being explored for an optimal set of materials and layering order to create a functional and adaptable blood vasculature system.

Many combinations of materials and methods have been used to attempt a successful vessel via electrospinning. Biomaterial categories used for vascular engineering include synthetic non-degradable polymers, synthetic biodegradable polymers, and biopolymers. These materials are

currently being used in an attempt to create vascular grafts with a large focus on creating grafts less than 6mm in diameter.

Electrospinning involves using a polymer solution and a DC power supply to create an electric field to charge the polymer solution, then extrusion through a controlled jet stream size onto a collector surface. Depending on the chosen variables for each of these components, different kinds and sizes of electrospun constructs can be created (Sell, McClure, Garg, Wolfe, & Bowlin, 2009). Variables for the creation of an electrospun construct include voltage applied, flow rate of the polymer, type and size of the extrusion needle, and working distance between the syringe tip and the collector surface (Al Rez et al., 2017). The electrospinning method is also versatile and variables such as substrate, structure, thickness, and arrangement can all be adjusted specific to the desired application.

This review provides a discussion of different approaches to multi-layer scaffold designs via electrospinning used for the creation of vessels. The studies discussed reveal the capabilities of electrospinning to create a working and anatomically correct scaffold and the potential material combinations, additives, and drug incorporations possible to further improve upcoming vascular grafts.

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