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I, Kiely M Donnelly, hereby submit this original work as part of the requirements for the degree of:

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Optimism as a Potential Moderator of the Effects of Emotional Distress on Seizure Control in Adults with Temporal Lobe Epilepsy

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Committee Chair: Bruce Schefft, PhD

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Steven Howe, PhD

Steven Howe, PhD
Optimism as a Potential Moderator of the Effects of Emotional Distress on Seizure Control in Adults with Temporal Lobe Epilepsy

A thesis submitted to the Graduate School of the University of Cincinnati in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

in the Department of Psychology of the College of Arts and Sciences

January 2010

by

Kiely M. Donnelly

B.S., Fordham University, 2005

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Abstract

Stress is a commonly reported seizure precipitant among individuals with epilepsy. Yet, the relationship between stress and seizure susceptibility remains unclear. The purpose of this study was to examine the relationship between emotional distress and lifetime seizure load in individuals with temporal lobe epilepsy (TLE) as well as the potential moderating effect of explanatory style on this relationship. Analyses were performed on data collected from 148 individuals with TLE. Scales 2 (Depression) and 7 (Psychasthenia) of the Minnesota Multiphasic Personality Inventory (MMPI & MMPI-2) were used as a measure of emotional distress and explanatory style was measured using the Revised Optimism-Pessimism Scale (PSM-R).

Overall, the results do not support the strong relationship between emotional distress and lifetime seizure load that was expected, and an interaction between emotional distress and explanatory style was not observed. However, there appears to be a significant relationship between Scale 2 and seizure load for those individuals with higher levels of intelligence. Interestingly, neither Scale 2 nor 7 significantly predicted seizure load in those individuals in the low IQ group. The results suggest that individuals with higher levels of intelligence may be more aware of the negative impact depressive symptoms are having on their life, resulting in higher levels of emotional distress and ultimately an increase in seizure frequency.
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Chapter 1
Introduction

Background and Significance

Many patients with epilepsy report that psychological factors adversely affect their seizures. Indeed, stress is the most commonly reported seizure precipitant, and individuals with temporal lobe epilepsy (TLE) identify stress as a seizure precipitant at a higher rate than do patients with other epilepsy syndromes (Frucht, Quigg, Schwaner, & Fountain, 2000). However, evidence to support these reports is scarce. It is challenging to define and measure stress. Further, there is individual variability in reactions to seemingly stressful life events. How one reacts to stressors is largely dependent on one’s subjective interpretation of these negative events (Abramson, Seligman, & Teasdale, 1978). There is strong evidence that optimistic individuals show better psychological and physical adjustment to stressful life events, and more successful coping with health challenges than pessimistic individuals (Peterson & Bossio, 2002). Yet, no research to date has examined the potential moderating effect of optimism on the relationship between stress and seizure frequency in epilepsy patients.

Psychological Factors and Epilepsy

Epilepsy is a multifaceted neurological disorder that produces uncontrollable seizures and substantial, but often overlooked, psychological distress. The unpredictable nature of seizures is a major source of stress for people with epilepsy. In fact, many report that not knowing when the next seizure might occur is the worst thing about having the disorder (Fisher, et al., 2000). In addition, many individuals living with epilepsy are faced with lifestyle limitations, medication side effects, neuropsychological deficits, and social stigma. Thus, not surprisingly, people with epilepsy report higher levels of psychological distress than those without seizures (Strine, Kobau,
Chapman, Thurman, Price & Balluz, 2005). They also exhibit higher rates of psychiatric disorders compared to the general population, with depression and anxiety being the most predominant diagnoses in these patients (Beyenburg, Mitchell, Schmidt, Elger, & Reuber, 2005; Hermann, Seidenberg, & Bell, 2000; Kanner, 2003; Vasquez & Devinsky, 2003). Those individuals with TLE seem to be most at risk for comorbid psychopathology compared to other epilepsy syndromes (Kondziella, Alvestad, Vaaler, & Sonnewald, 2007; Perini & Mendius, 1984). The combination of unpredictable seizures and increased levels of psychological distress leads to significant burdens for individuals living with epilepsy. It has been shown that anxiety and depression are significant predictors of health-related quality of life in persons with epilepsy (Johnson, Jones, Seidenberg, & Hermann, 2004; Lehrner, et al. 1999; Szaflarski & Szaflarski, 2004; Testa, Schefft, Szaflarski, Yeh, & Privitera, 2007; Wiegartz, Seidenberg, Woodard, Gidal, & Hermann, 1999).

Research suggests that people with epilepsy experience higher rates of depression and anxiety. Although the severity of these symptoms has proven to be a strong predictor of quality of life, it is unclear whether these psychological symptoms are related to more frequent seizure activity. Some studies show a clear relationship between seizure frequency and levels of depression and anxiety (Jacoby, Baker, Steen, Potts, & Chadwick, 1996; Mensah, Beavis, Thapar, & Kerr, 2007). Conversely, Attarian, Vahle, Carter, Hykes, and Gilliam (2003) found no relationship between seizure frequency and the severity of depression as measured by the Beck Depression Inventory. Similarly, Choi-Kwon, et al. (2003) after dividing patients into three groups according to their seizure frequency found no difference in the number of patients with either depression or anxiety among the groups using the Hospital Anxiety and Depression Scale.

*Stress and Epilepsy*
Unfortunately, a diagnosis of epilepsy is often coupled with additional stressors such as employment difficulties, dependence on others, and fear of injury during a seizure. Many of these stressors are chronic in nature, and it is well known that chronic stress can lead to immunosuppression (Segerstrom & Miller, 2004) and hypertension (Pickering, 2001). Interestingly, there is also evidence that stress may increase one’s seizure susceptibility (Rhodes, Harney, & Frye, 2004). Even though epilepsy is characterized by unprovoked seizures, there are many seizure-precipitating factors (e.g., sleep deprivation, alcohol consumption, menstruation) that place one at greater risk for seizure occurrence. Self-report studies reveal that stress is by far the most commonly reported seizure precipitant, with 21% to 64% of subjects reporting stress as a seizure-precipitating factor (Fisher, et al., 2000; Haut, Vouyiouklis, & Shinnar, 2003; Nakken, Solaas, Kjeldsen, Friis, Pellock, & Corey, 2005; Spector, Cull, & Goldstein, 2000). Therefore, not only are people with epilepsy reporting higher levels of stress than the general population, but this stress appears to precipitate seizures. Recent interest in this topic has stimulated further exploration of the relationship between stress and epilepsy, which until recently has been overlooked.

There is some evidence that a severe stressful life event puts individuals at greater risk for developing epilepsy (Christensen, Li, Vestergaard, & Olsen, 2007). Yet, it is unclear to what extent stress increases seizures in persons with a diagnosis of epilepsy. Early research supports a positive association between perceived stress and seizure frequency with a higher seizure frequency found on self-perceived high-stress days as well as the day following a high-stress rating (Temkin & Davis, 1984). Conversely, Neufeld, Sadeh, Cohn, and Korczyn (1994) failed to find an increase in seizure frequency in Israeli epilepsy patients under the threat of missile attacks during the Persian Gulf War. More recently, in a prospective seizure-diary study of 71
subjects with localization related epilepsy, Haut, Hall, Masur, and Lipton (2007) found that higher self-reported stress levels were associated with an increased risk of seizures the next day. Further, research shows that progressive relaxation training is an effective intervention for seizure reduction, leading to a mean decrease in seizure frequency of 29%, which suggests that maintaining low stress levels may significantly reduce one’s seizure frequency (Puskarich, Whitman, Dell, Hughes, Rosen, & Hermann, 1992). This is further supported by limited data showing that yoga has the ability to improve seizure control (Panjwani, Selvamurthy, Singh, Gupta, Thakur, & Rai, 1996; Rajesh, Jayachandran, Mohandas, & Radhakrishnan, 2006). However, there is no clear evidence that practicing yoga can reliably lead to a reduction in seizure frequency (Ramaratnam & Sridharan, 2000).

Optimism, Pessimism, and Physical Well Being

While there are no widely accepted definitions of optimism and pessimism, two theoretical views predominate. Scheier and Carver (1987) define optimism and pessimism as generalized positive and negative outcome expectancies. Others conceptualize optimism and pessimism as an explanatory style, or the way in which people habitually explain the causes of bad events in their lives (Peterson & Seligman, 1984). This view emerged from the attributional reformulation of the learned helplessness model as a way of explaining individual differences in responses to uncontrollable and aversive events. According to this model, one’s causal explanations vary along three dimensions: (1) internal versus external, (2) stable versus unstable, and (3) global versus specific (Abramson, Seligman, & Teasdale, 1978). An individual with a pessimistic explanatory style views the cause of negative events as internal to one’s self, permanent, and pervasive across multiple situations, whereas, optimistic explanations for
negative events are attributed to external causes that only temporarily affect specific domains of one’s life.

This diathesis-stress model posits that a pessimistic explanatory style is a weakness that puts one at greater risk of negative outcomes when faced with environmental stressors (Abramson, Seligman, & Teasdale, 1978). Therefore, pessimistic individuals are more negatively affected by bad events than optimistic individuals. Further, these individuals begin to expect bad events in the future, leading to motivational deficits when faced with challenges. Explanatory style has been studied most frequently with regard to depression and a pessimistic explanatory style is correlated with depressive symptoms in a variety of populations, including TLE patients (Hermann, Trenerry, & Colligan, 1996; Peterson & Seligman, 1984). However, there is evidence that explanatory style influences one’s physical well being as well (Peterson & Bossio, 1991). Research shows that a pessimistic explanatory style is correlated with poor health measured in a variety of ways including self-reported symptoms, number of doctor visits made over a one-year span, lowered immune functioning, health status over a 20-year span, and premature death (Kamen & Seligman, 1987; Kamen-Siegel, Rodin, Seligman, & Dwyer, 1991; Peterson, 1988; Peterson, Seligman, & Vaillant, 1988; Peterson, Seligman, Yurko, Martin, & Friedman, 1998).

While research has shown that a pessimistic explanatory style has negative effects on one’s health, the mechanism by which explanatory style affects physical well being remains unclear. The link may be the difference in how optimists and pessimists react to stressful life circumstances. However, little research has explored how explanatory style interacts with stress to make illness more or less likely. Dykema, Bergbower, and Peterson (1995) found that the occurrence of bad life events did not interact with explanatory style to predispose one to illness. Unfortunately, using life events as a measure of stress is complicated due to individual
differences in the perception of these events. Bad events become stressful only when one feels unable to cope successfully with their effects. Thus, measuring perceived stress seems like a stronger alternative. Jackson, Sellers, and Peterson (2002) examined whether perceived stress interacts with explanatory style to predict subsequent illness in college students, and they found that a pessimistic explanatory style appears to exacerbate the impact of stress on illness. Interestingly, there was no relationship between stress and illness for those with an optimistic explanatory style. The findings support the diathesis-stress relationship and suggest that an optimistic explanatory style may act as a buffer against the effects of stress, preventing physical illness.

Few studies have explored the potential benefits of optimism on mental and physical health in persons with epilepsy. In 2007, Pais-Ribeiro, Martins da Silva, Meneses, and Falco created a 7-item epilepsy-specific optimistic orientation scale and found that optimism is associated with better perception of physical and mental health as well as improved quality of life. However, it was not associated with perception of seizure control or seizure frequency. This suggests that optimism has some beneficial effects on health status perception, but little therapeutic effect on seizure control. Further, it does not explore the interaction between stress and explanatory style. Given that many individuals with epilepsy report that stress exacerbates their seizures, an optimistic explanatory style could be protective against the deleterious effects that stress may have on seizure severity.

The purpose of the present study was to examine the relationship between emotional distress and seizure frequency in patients with TLE as well as the potential moderating effects of explanatory style on this relationship. If emotional distress is found to have a role in increasing seizure frequency, promoting optimism in patients with TLE may prove to be a therapeutic target
for achieving better seizure control. The following hypotheses were tested: (1) individuals with high levels of emotional distress as measured by the Minnesota Multiphasic Personality Inventory (MMPI) will experience more seizures than individuals with lower levels of emotional distress, and; (2) the relationship between emotional distress and seizure frequency will be stronger for individuals with a pessimistic explanatory style than for those with an optimistic explanatory style suggesting that explanatory style moderates the relationship between emotional distress and seizure frequency.
Chapter 2

Method

Participants

Analyses were performed on neuropsychological data collected from 148 individuals with TLE (76 left TLE, 62 right TLE, 10 bilateral TLE) who had undergone pre-surgical evaluation of medically intractable seizures on the Epilepsy Monitoring Unit at University Hospital in Cincinnati, Ohio. Patients were included in the study if they met the following criteria: (a) confirmed TLE based on continuous video/EEG monitoring, (b) age 18 or older, (c) valid MMPI or MMPI-2, (d) Full-Scale IQ score of 70 or above on the Wechsler Adult Intelligence Scale—Third Edition (WAIS-III) or WAIS-R, (e) absence of a comorbid neurological disorder or serious psychiatric disorder.

Measures

All patients completed an abbreviated version of the MMPI (first 399 items) or MMPI-2 (first 370 items) as part of a larger routine neuropsychological examination. Profile validity was determined by the staff neuropsychologist (BKS). Scales 2 (Depression) and 7 (Psychasthenia) were used as a measure of emotional distress. The items included on Scale 2 deal with various aspects of depression such as general dissatisfaction with life, little hope of overcoming problems in the future, psychomotor retardation, and lack of interest in one’s surroundings. Scale 7 is another measure of psychological discomfort, but the items deal with feelings of anxiety, fear, agitation, obsessive thoughts, and doubts about one’s own abilities (Graham, 2006). While both of these scales are reliable measures of emotional distress, they measure different constructs.
and were both used in an attempt to specify the symptoms individuals with epilepsy are referring to when they report that emotional stress exacerbates their seizures.

The Revised Optimism-Pessimism (PSM-R) scale was used to measure optimism and pessimism (Malinchoc, Offord, & Colligan, 1995). The scale was developed using a technique known as Content Analysis of Verbatim Explanations (CAVE), which allows researchers to measure explanatory style by analyzing the causal explanations used in spoken or written material (Peterson, Luborsky, & Seligman, 1983; Schulman, Castellon, & Seligman, 1989). The PSM-R consists of 263 items found on both the MMPI and the MMPI-2. Of the 263 items, 85 describe “good” or positive events and the remaining 178 describe “bad” or adverse events. In order to quantify the degree of causal explanation in each item, three independent judges rated the items on each of the three dimensions of explanatory style—internality, stability, and globality—using a scale ranging from 1 to 7. The sum of the average ratings across the three dimensions was used as a composite weight for each item and can range from 3 to 21. Items with low composite weights represent causal explanations that are external to the respondent, brief in duration, and circumscribed in effect for both good and bad events. Conversely, high composite weights are associated with causal explanations that are internal to the respondent, stable, and wide ranging in effect for either good or bad events.

Based on the pattern of item endorsement, each subject receives optimism and pessimism composite raw scores (CoPos, CoNeg). The sum of composite weights for the 85 items that represent good events is referred to as the CoPos raw score and ranges from 0 to 1,324.33 depending on how many of the items were answered true. A high CoPos score indicates that the subject explains the cause of good events as relatively internal, stable, and global (i.e. an optimistic explanatory style). A low CoPos score suggests that the subject explains the cause of
good events as external, unstable, and specific, indicating a pessimistic explanatory style for
good events. The CoNeg raw score is calculated by summing the composite weights of the items
answered true out of the 178 items that represent bad events. CoNeg raw scores range from 0 to
2,601.64. A high CoNeg score indicates that the subject explained the cause of bad events as
internal, stable, and global—a pessimistic explanatory style. Conversely, a low CoNeg score
indicates the subject explains the cause of bad events as external, brief, and specific—an
optimistic explanatory style. Therefore, a high CoPos score and a low CoNeg score represents an
optimistic explanatory style and a pessimistic explanatory style is indicated by a high CoNeg
score and a low CoPos score. CoPos and CoNeg raw scores are then used to determine a sex-
specific $T$ score representing one’s position on a bipolar optimism-pessimism continuum (higher
scores indicate a pessimistic explanatory style).

In this study, CoPos and CoNeg scores were computed based on an abbreviated version
of the MMPI and MMPI-2. The abbreviated versions of the MMPI and MMPI-2 contain 70 of
the 85 items referred to as good events and 138 (MMPI) or 137 (MMPI-2) of the 178 items
referred to as bad events. Using the abbreviated versions, CoPos scores range from 0 to 1095.99
(MMPI) and 0 to 1092.33 (MMPI-2); CoNeg scores range from 0 to 2006.30 (MMPI) and 0 to
1992.28 (MMPI-2). Earlier work revealed good agreement between full and abbreviated PSM-R
$T$ scores (Griffith, Smith, Schefft, & Privitera, 2008).

Seizure frequency was obtained from patient self-report. Patient charts were reviewed to
determine an estimate of seizure frequency over the course of one year. This number was then
multiplied by one’s epilepsy duration to calculate an estimate of lifetime seizure load for each
patient. Demographic characteristics and neuropsychological variables of the subjects enrolled in
the study are presented in Table 1. This research was approved by the University of Cincinnati Institutional Review Board.

<table>
<thead>
<tr>
<th>Demographic and Seizure Related Characteristics</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>37.56</td>
<td>11.02</td>
</tr>
<tr>
<td>Seizure duration (years)</td>
<td>18.04</td>
<td>13.81</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>93.75</td>
<td>13.23</td>
</tr>
<tr>
<td>PSM-R</td>
<td>60.14</td>
<td>8.07</td>
</tr>
<tr>
<td>MMPI Scale 2</td>
<td>64.91</td>
<td>13.13</td>
</tr>
<tr>
<td>MMPI Scale 7</td>
<td>62.39</td>
<td>13.93</td>
</tr>
<tr>
<td>Average number of seizures per year</td>
<td>219.47</td>
<td>795.16</td>
</tr>
<tr>
<td>Sex</td>
<td>60.8% female</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>91.2% white</td>
<td></td>
</tr>
</tbody>
</table>

**Data Analysis**

There were no missing data. Frequency distributions and P-P plots were used to assess the normality of each variable. Seizure load scores were positively skewed and were transformed by taking the natural log of each raw score. Multiple regression analyses were carried out on transformed data to test the hypotheses of this study. First, the relationship between emotional distress (Scales 2 and 7 of the MMPI) and seizure load was assessed. A model was then constructed to assess the relationship between explanatory style (as measured by PSM-R *T* scores) and seizure load. The explanatory style by emotional distress interaction was then entered in the regression equation to test the potential moderating effects of explanatory style on the relationship between emotional distress and seizure load. Full Scale IQ scores were then used to divide the sample because previous research indicates that the utility of many neuropsychological predictors varies with the intelligence of the individual (Schefft, Testa, Dulay, Privitera, & Yeh, 2003; Testa, Schefft, Privitera, & Yeh, 2004). Dividing FSIQ scores
into two groups based on a median FSIQ split resulted in a high IQ group (IQ ≥ 92) and a low IQ group (IQ < 92). Regression analyses were run separately in these two groups to assess the relationship between seizure load and the following predictors: emotional distress, explanatory style, and the interaction between these two variables. Finally, given the high frequency of simple partial seizures (SPSs) for some patients, the above analyses were run with and without SPSs included in each patient’s calculated seizure load score. Patients with only SPSs (N = 15) were removed from these analyses.
Chapter 3

Results

The descriptive data presented in Table 1 reveal that the patients included in this study reported relatively high levels of emotional distress. The mean for both Scale 2 and Scale 7 are over one standard deviation higher than test taker’s in the MMPI normative sample. One-way ANOVA’s revealed that there was no significant main effect of laterality of seizure focus on age, duration of seizures, seizure load, PSM-R scores, or MMPI Scales 2 and 7, as shown in Table 2. Therefore, all subjects were grouped together for further analyses. Correlations for the independent and dependent variables are presented in Appendix A.

Table 2
Study Variables Across Seizure Groups

<table>
<thead>
<tr>
<th>Diagnostic Group</th>
<th>Left TLE</th>
<th>Right TLE</th>
<th>Bilateral TLE</th>
<th>$F$ (2, 145)</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>38.17(10.74)</td>
<td>36.63(11.03)</td>
<td>38.70(13.78)</td>
<td>.39</td>
<td>.68</td>
<td>.01</td>
</tr>
<tr>
<td>Duration</td>
<td>18.94(14.92)</td>
<td>17.13(11.99)</td>
<td>16.80(16.52)</td>
<td>.33</td>
<td>.72</td>
<td>.00</td>
</tr>
<tr>
<td>Seizure Load (lg)</td>
<td>6.79(1.85)</td>
<td>6.44(1.73)</td>
<td>6.75(1.68)</td>
<td>.66</td>
<td>.52</td>
<td>.00</td>
</tr>
<tr>
<td>PSM-R</td>
<td>60.24(7.47)</td>
<td>60.04(8.97)</td>
<td>60.00(7.22)</td>
<td>.01</td>
<td>.99</td>
<td>.00</td>
</tr>
<tr>
<td>MMPI Scale 2</td>
<td>65.09(11.97)</td>
<td>64.90(14.79)</td>
<td>63.50(11.72)</td>
<td>.06</td>
<td>.94</td>
<td>.00</td>
</tr>
<tr>
<td>MMPI Scale 7</td>
<td>63.29(13.09)</td>
<td>61.79(15.61)</td>
<td>59.20(8.42)</td>
<td>.47</td>
<td>.62</td>
<td>.00</td>
</tr>
</tbody>
</table>

Multiple regression was used to investigate whether individuals reporting high levels of emotional distress experience a greater number of seizures over their lifetime. Surprisingly, the model including Scales 2 and 7 as predictors of seizure load was not significant, $F(2, 145) = 2.14, p = .12, R^2 = .03$ and neither of the variables (Scale 2, Std b = .22, $p = .07$; Scale 7, Std b =
individually were significant predictors. Next, PSM-R T scores were used to predict seizure load, and the results suggested that bipolar optimism-pessimism sores have little effect on the frequency of their seizures, $F(1, 146) = 1.95, p = .17, R^2 = .01$. The interaction between emotional distress and explanatory style was then included in the regression model to determine whether explanatory style moderates the relationship between emotional distress and seizure load as was hypothesized. Before computing the interaction terms, scores on Scales 2 and 7 as well as the PSM-R were centered by subtracting the mean of each variable from the scores. Once again, the model was not significant, $F(5, 142) = 1.04, p = .39, R^2 = .04$. Neither the interaction of explanatory style and Scale 2 (Std b = -.12, $p = .36$) nor the interaction of explanatory style and Scale 7 (Std b = .09, $p = .53$) significantly predicted seizure load. Overall, the results indicate that emotional distress and explanatory style are unable to account for a clinically meaningful portion of the variance in predicting seizure load as shown in Table 3.

Table 3
Results of Regression Analyses for Predicting Seizure Load

<table>
<thead>
<tr>
<th></th>
<th>Emotional Distress Only</th>
<th>Explanatory Style Only</th>
<th>Emotional Distress, Explanatory Style, and Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2 (p)$</td>
<td>$R^2 (p)$</td>
<td>$R^2 (p)$</td>
</tr>
<tr>
<td>All subjects</td>
<td>.03 (.12)</td>
<td>.01 (.17)</td>
<td>.04 (.39)</td>
</tr>
</tbody>
</table>

The finding that high scores on Scales 2 and 7 of the MMPI did not negatively affect seizure frequency is counterintuitive. Thus, further exploration of potential moderating variables was conducted. Contrary to the hypothesis, the regression model including the interaction between explanatory style and emotional distress did not support the prediction that explanatory style plays a moderating role in this relationship. However, there is evidence that only pessimistic individuals are vulnerable to physical harm when faced with stress, and that for those
with an optimistic explanatory style there is no relationship (Jackson, Sellers, & Peterson, 2002). In order to test this possibility, the relationship between emotional distress and seizure load was examined separately in highly pessimistic subjects and highly optimistic subjects. According to the developers of the PSM-R, a pessimistic explanatory style is suggested by a PSM-R $T$ score greater than 50 (Malinchoc, Offord, & Colligan, 1995). In order to compare highly optimistic and pessimistic individuals, it was decided to use a more stringent cutoff and the sample was divided into three equal groups. Those individuals with scores greater than or equal to 64 were included in the high pessimism group and those individuals falling in the bottom third of this scale with $T$ scores less than or equal to 56 were included in the high optimism group. Not only did I fail to find support for a relationship between emotional distress and seizure load in the highly pessimistic individuals, if anything, the relationship between emotional distress and seizure load is stronger for highly optimistic individuals ($R^2 = .04, p = .47$) than highly pessimistic individuals ($R^2 = .01, p = .87$). However, emotional distress accounted for a small percent of the variance of seizure load in both optimistic and pessimistic individuals.

Next, the potential moderating role of intelligence was examined since previous work has shown that intellectual level affects the utility of many neuropsychological predictors (Schefft, Testa, Dulay, Privitera, & Yeh, 2003; Testa, Schefft, Privitera, & Yeh, 2004). The sample was divided based on a median Full Scale IQ split (median FSIQ = 92). The mean FSIQ was 103 (average range) for the high IQ group and 82 (low end of low average range) for the low IQ group. The results of the regression analyses are presented in Table 4.
Table 4
*Multiple Regression Predicting Seizure Load from Emotional Distress*

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df</th>
<th>$R^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>All subjects</td>
<td>2.14</td>
<td>2,145</td>
<td>.03</td>
<td>.12</td>
</tr>
<tr>
<td>High IQ</td>
<td>3.34</td>
<td>2,76</td>
<td>.08</td>
<td>.04</td>
</tr>
<tr>
<td>Low IQ</td>
<td>0.14</td>
<td>2,66</td>
<td>.00</td>
<td>.87</td>
</tr>
</tbody>
</table>

For those individuals with FSIQ scores of 92 or above, Scales 2 and 7 accounted for a small but statistically significant portion of the variance in predicting seizure load. However, only Scale 2 was an individually significant predictor (Std $b = .35$, $p = .03$). Interestingly, emotional distress did not significantly predict seizure load in those individuals with FSIQ scores below 92, and Scale 2 was unable to individually predict seizure load in this group of subjects (Std $b = .01$, $p = .95$) as shown in Figure 1. While there appears to be no relationship between emotional distress and seizure frequency in the low IQ group, those individuals reported higher levels of emotional distress compared to the high IQ group. For the low IQ group, the mean $T$ scores for both Scales 2 ($T = 67$) and 7 ($T = 65$) are considered clinically diagnostic (high scores) in MMPI profile interpretation (Graham, 2006). Whereas, the mean $T$ scores are several points lower for both Scales 2 ($T = 63$) and 7 ($T = 59$) in the high IQ group. The difference in mean scores on Scales 2 and 7 between the high and low IQ groups did not reach statistical significance.
Several patients in this study had a high number of simple partial seizures (SPSs). It was thought that removing SPSs from each patient’s seizure load would result in a more consistent measure of seizure frequency. For example, 10 complex partial seizures per month are likely more debilitating and stressful than experiencing 10 SPSs per month. There were 15 individuals in the sample that only experienced SPSs. They were removed from the analyses, reducing the number of patients in the sample to 133. As shown in Table 5, the results are similar to those found above. However, emotional distress gains slight predictive accuracy for seizure load with SPSs removed from the sample, and Scale 2 was again an individually significant predictor (Std
Neither PSM-R scores nor the interaction between emotional distress and explanatory style were able to account for a large portion of the variance in predicting seizure load. Once again, the relationship between emotional distress and seizure load was highest in those individuals with FSIQ scores of 92 or above and Scale 2 was an individually significant predictor of seizure load (Std b = .41, p = .02) in this group.

Table 5

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df</th>
<th>R²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>All subjects</td>
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<td>2,130</td>
<td>.04</td>
<td>.06</td>
</tr>
<tr>
<td>High IQ</td>
<td>3.14</td>
<td>2,66</td>
<td>.09</td>
<td>.05</td>
</tr>
<tr>
<td>Low IQ</td>
<td>0.47</td>
<td>2,61</td>
<td>.02</td>
<td>.63</td>
</tr>
</tbody>
</table>
It is well known that factors such as sleep deprivation and alcohol use can induce seizures in susceptible individuals. Yet, it remains unclear whether emotional factors can act as seizure precipitants. The goal of the present study was to examine the effect of emotional distress on lifetime seizure load and determine whether explanatory style moderates this relationship. Overall, the results do not support the strong relationship between emotional distress and lifetime seizure load that was expected. Interestingly, those individuals with higher levels of intelligence appear to be more negatively affected by emotional distress than those with lower levels of intelligence. Given that many individuals with epilepsy report that stress increases the frequency of their seizures (Fisher, et al. 2000; Haut, Vouyiouklis, and Shinnar, 2003; Nakken, Solaas, Kjeldsen, Friis, Pellock, & Corey, 2005; Spector, Cull, & Goldstein, 2000), it was surprising that the relationship between stress and seizure load was not stronger in our sample.

While this study failed to find a clinically meaningful relationship between stress and seizure frequency, it provides a useful step in a relatively understudied area. The results help to specify which psychological symptoms place individuals with epilepsy at greater risk for seizures. Scores on Scale 2 of the MMPI were able to individually predict seizure load in several models, but Scale 7 had little predictive utility. This suggests that as one scores higher on Scale 7, becoming more anxious, tense, and agitated, they are not at greater risk for having an increase in seizures. Whereas, those individuals with high scores on Scale 2 who feel sad, dissatisfied with their lives, and hopeless about overcoming their problems, may experience an increase in seizures.
The results are in line with a recent study showing that depression mediates the relationship between perceived stress and seizure frequency (Thapar, Kerr, & Harold, 2009). Thus, depression seems to be an important pathway in linking emotional distress to poor seizure control. This may help to explain why some studies have failed to find a clear relationship between depression and increased seizure activity (Attarian, Vahle, Carter, Hykes, & Gilliam, 2003; Choi-Kwon, et al., 2003). It appears that depressive symptoms alone do not place one at greater risk for seizures, but these symptoms do render one vulnerable to the effects of subsequent stress. Interestingly, in this study, only those individuals with a higher IQ score appear to experience an increase in lifetime seizure load due to an elevated Scale 2 \( T \) score. This finding suggests that individuals with greater intellectual resources are more affected by depressive symptoms. Perhaps they are more aware of the negative impact these symptoms are having on the quality of their lives, resulting in higher levels of emotional stress and ultimately an increase in seizure frequency.

Distinguishing between symptoms related to depression, anxiety, and stress is difficult, and as a result, an understanding of how these factors act together to influence seizures remains unclear. In order to truly understand this relationship, prospective studies are needed. Two studies have prospectively assessed the relationship between stress and seizure frequency and the results from both studies show that higher self-reported stress levels are associated with an increased risk of seizures the next day (Haut, Hall, Masur, and Lipton, 2007; Temkin & Davis, 1984). These studies suggest that there is temporal contiguity between stress and seizure activity, and it is likely that the use of lifetime seizure load in this study was unable to capture the acute effects of stress. Haut, Hall, Masur, and Lipton (2007) measured stress by asking subjects to rate their level of stress on 10-point scale, providing a rating of one’s emotional discomfort for a
given day. Conversely, the MMPI is a more global and stable measure of general emotional distress, clinical symptomatology and psychopathology (Golden, 1991). Thus, scores reflect not only emotional distress, but also how an individual likely perceives, reacts and responds to daily stressors. Taken together, it is reasonable to speculate that daily stress levels place one at greater risk for having a seizure the next day and perhaps those individuals with high scores on Scale 2 of the MMPI may be at greatest risk of these acute stress effects.

Although the relationship between stress and epilepsy remains complex, if not elusive, it is well known that stress can have negative effects on both mental and physical health. On the other hand, thinking positively has been linked to higher academic achievement, increased job productivity, enhanced athletic performance, and improved physical health (Gillham, Shatté, Reivich, & Seligman, 2002). In this study, we focused on explanatory style or how one habitually explains the cause of bad events (Peterson & Seligman, 1984). Optimistic individuals attribute bad events in their lives to external, unstable, and specific causes; whereas, pessimistic individuals prefer internal, stable, and global explanations. Research has shown that an optimistic explanatory style is associated with improved physical health while pessimistic individuals are at greater risk for depression, demoralization, and poor physical health (Peterson & Bossio, 1991; Peterson & Bossio, 2002; Peterson & Seligman, 1984). It was predicted that explanatory style would moderate the relationship between emotional distress and seizure frequency, with pessimistic individuals in the sample being more negatively affected by stress and, thus, experiencing more frequent seizures. However, I was unable to find evidence to support this hypothesis. Pais-Ribeiro, Martins da Silva, Meneses, and Falco (2007) failed to find an association between optimism and improved seizure control using their own 7-item epilepsy-specific optimistic orientation scale. Similarly, Kent (2008) found optimism to be a strong
predictor of quality of life in individuals with TLE, but an association between optimism and objective health, as measured by the objective physical disability rating scale (OPDR), was not observed. It is possible that optimism is not associated with increased physical well-being in persons with TLE. Alternatively, using a different measure of explanatory style may change the results. For example, Peterson (1988) found that subjects who favored stable and global explanations for bad events were at increased risk for illness. Whereas, whether one used internal or external explanations had no effect on subsequent illness. This suggests that using a measure such as Peterson et al.’s (1982) Attributional Style Questionnaire, which differentiates between the three dimensions of explanatory style may have allowed for better prediction of seizure frequency.

It is unclear whether an optimistic explanatory style is protective against the negative effects of stress in persons with epilepsy. However, it has been shown that optimistic individuals are less vulnerable to depression and treatment programs devoted to improving one’s optimistic explanatory style help prevent depressive symptoms in both adults and children (Gillham, Reivich, Jaycox, & Seligman, 1995; Seligman, Schulman, DeRubeis, & Hollon, 1999). Therefore, if depression is found to mediate the relationship between stress and seizure frequency, preventing depressive symptoms through enhancing optimism may lead to better seizure control, and would seem to warrant future investigation.

The current study had several limitations. Given the cross-sectional design, I was unable to assess whether there is a causal relationship between emotional distress and seizure frequency. There appears to be temporal contiguity between stress and seizure activity and the retrospective analysis of lifetime seizure load did not allow for examining this relationship. Further, scores on the MMPI have relatively high temporal stability (Graham, 2006). Thus, employing a measure of
emotional distress that is more sensitive to short-term fluctuations would allow for the assessment of the causal effects of emotional distress on seizure frequency. It is also possible that I was unable to find a strong relationship between emotional distress and seizure frequency because of the restricted range of $T$ scores on Scales 2 and 7. Given that the sample of patients used in this study reported relatively high levels of emotional distress, it is possible that I was unable to detect the effect of this distress on seizure frequency. Perhaps if the range of Scale 2 and 7 $T$ scores included lower scores the relationship between distress and seizure frequency would be stronger. In addition, stress is a difficult construct to define, and perhaps the items appearing on these scales are an inaccurate representation of the symptoms associated with stress. Future studies in this area would benefit from using an objective measure of stress. For example, there is evidence that adrenal steroids released in response to stress may contribute to seizure susceptibility particularly in the hippocampus (Joëls, Karten, Hesen, & de Kloet, 1997; Uno, Tarara, Else, Suleman, & Sapolsky, 1989). Therefore, determining whether fluctuations in corticosteroids, such as cortisol, are related to seizure activity may aid in a better understanding of the effect stress may have on seizure frequency.

The retrospective record of seizure frequency was another limitation of the current study. It is well known that self-reports of seizure frequency are imperfect. It is possible that seizures occur and are not reported. For example, many people lose awareness during seizures or they occur when the individual is asleep. The use of prospective designs in future research may minimize this problem and result in more accurate reports of seizure frequency. Asking participants to record seizures immediately after they occur will likely be more reliable than asking them to report how many seizures they have had in the last month. It is interesting that some argue that measuring seizure severity is equally as important as measuring seizure
frequency. Given that seizure severity significantly predicts anxiety, self-esteem, locus of control, and quality of life, it may be important to measure when studying psychological variables (Bautista, & Glen, 2009; Smith, Baker, Dewey, Jacoby, & Chadwick, 1991).

The results of this study emphasize the need to further evaluate the relationship between stress and epilepsy. Overall, a strong relationship between emotional distress and seizure frequency was not supported. However, the results give some support to the finding that depression mediates the relationship between stress and seizure frequency (Thapar, Kerr, & Harold, 2009), particularly for those individuals with higher levels of intelligence. More prospective studies are needed to evaluate the relationship between stress and seizure occurrence. Studies that measure stress (both subjectively and objectively) and seizure occurrence over time are needed in order to fully understand this relationship.
References


disorder population. Poster presented at the 36th annual meeting of the International Neuropsychological Society, Waikoloa, HI.


Appendix A

Correlations of Independent and Dependent Variables

<table>
<thead>
<tr>
<th></th>
<th>Sz Duration</th>
<th>Sz Load (lg)</th>
<th>FSIQ</th>
<th>Scale 2</th>
<th>Scale 7</th>
<th>PSM-R</th>
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<tbody>
<tr>
<td>Sz Duration</td>
<td>.580</td>
<td>-.309</td>
<td>.087</td>
<td>-.010</td>
<td>.082</td>
<td></td>
</tr>
<tr>
<td>Sz Load (lg)</td>
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<td>.076</td>
<td>.115</td>
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<tr>
<td>FSIQ</td>
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<td>.309</td>
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<td></td>
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<td>.718</td>
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<tr>
<td>Scale 7</td>
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<td></td>
<td></td>
<td>.735</td>
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<td>PSM-R</td>
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