Spring 2014

Thought derailment as a predictor of verbal memory performance in people with a serious mental illness

Shannon Leigh Kovach
James Madison University

Thought Derailment as a Predictor of Verbal Memory Performance in People with a Serious Mental Illness

---

A Project Presented to

The Faculty of the Undergraduate

College of Integrated Science and Technology

James Madison University

---

in Partial Fulfillment of the Requirements

for the Degree of Bachelor of Science

---

by Shannon Leigh Kovach

May 2014

Accepted by the faculty of the Department of Psychology, James Madison University, in partial fulfillment of the requirements for the Degree of Bachelor of Science.

FACULTY COMMITTEE:

____
Project Advisor: Bernice Marcopulos, Ph.D.
Associate Professor, Graduate Psychology

____
Reader: Kenn Barron, Ph.D.
Professor, Psychology

____
Reader: Jeff Dyche, Ph.D.
Associate Professor, Psychology

HONORS PROGRAM APPROVAL:

____
Barry Falk, Ph.D.,
Director, Honors Program

Table of Contents

List of Figures

Tables

Preface

Assessments in the neuropsychological setting can provide a wealth of information that is crucial to brain functioning research. Neuropsychological testing is typically used for either a general assessment of cognitive ability or to target a specific area of interest and test the level of cognitive functioning. In this study, I am looking to see if the presence of a certain symptom, thought derailment, can be used as a predictor of verbal episodic memory performance, which is measured using the California Verbal Learning Test. If the symptom is a predictor, it can give the treatment team an estimation of the baseline ability for verbal episodic memory prior to neuropsychological testing based on the presence of thought derailment.

Acknowledgments

I'd like to thank Dr. Bernice Marcopulos for serving as my project advisor and offering me guidance and support in creating my thesis. I'd also like to thank Dr. Kenn Barron and Dr. Jeff Dyche for serving on my honors thesis committee and offering their valuable feedback to help shape and improve my thesis. Thanks to Beth Caillouet and Julie Ann Kent at Western State Hospital for giving me much needed advice and help in addition to letting me access their database, without which my research project would not have been possible. I'd also like to thank Cathryn Richmond for her feedback and assistance on my project. Finally, thanks to my family and friends for their love and support during this process.

Abstract

Thought derailment, a subtype of formal thought disorder characterized by ideas in speech not following logically from previously expressed ideas (Andreasen, 1979), is most commonly seen in patients with schizophrenia or bipolar disorder. The current study examined how the presence of thought derailment might predict verbal episodic memory performance as measured by the California Verbal Learning Test– Second Edition (CVLT-II). Past research has found that people with severe thought disorder perform poorer on measures of recall and categorization, which are important components of the CVLT-II (Jamadar et al., 2012; Kerns & Berenbaum, 2002; Nestor et al., 1998; Stirling et al., 2006). My sample was taken from consecutive referrals to the neuropsychology lab of a state psychiatric hospital, 188 patients had ratings on a 5-point scale for thought derailment. Of those who were given the CVLT-II, 31 patients were judged not to have thought derailment (rating of 0) and 40 were given a rating between 1 and 4. Several variables of the CVLT-II (immediate free/cued recall, delayed free/cued recall, false positive recognition, and intrusions) were correlated with thought derailment and only false positive recognition showed a significant correlation (r =.28, p=.02). False positive recognition was also the only variable of interest to account for significant variance in thought derailment (R^2= 0.07, p= 0.03). The findings are discussed in terms of the literature hypothesizing an underlying deficit in lexical semantic memory access in thought disordered patients.

Introduction

Cognition in Schizophrenia

Serious Mental Illness (SMI) has been defined in federal legislation as a mental disorder that significantly interferes with one's ability to function (Wang, Demler, & Kessler, 2002). Disorders that are labeled as SMI include schizophrenia, bipolar disorder, major depression, and post-traumatic stress disorder. These disorders are labeled as being serious mental illnesses because they are characterized by impairments in many areas of functioning. One of the most common deficits in many types of SMI is cognitive ability, especially reasoning and memory (Wang et al., 2002).

Schizophrenia is considered to be one of the most debilitating forms of serious mental illnesses. Despite the vast amount of research conducted on schizophrenia, the exact etiology of the disorder is still unknown. Currently, schizophrenia is regarded as a brain disease that has social and environmental factors that can contribute to the expression of the illness (Marcopulos & Kurtz, 2012). Schizophrenia has a large genetic component with some studies reporting as much as 80% genetic liability for the disease (Tandon, Keshavan, & Nasrallah, 2008). The disorder has a higher prevalence in younger males and the course of illness is typically more severe in males. This relates to the finding that a younger age of onset of schizophrenia is correlated with more severe course of illness (McGrath, Saha, Chant, & Welham, 2008; Tandon et al., 2008).

Of the many types of functional impairments that can lead to an SMI classification, cognitive deficits, particularly memory impairments, are among the most disabling (Tandon et al., 2008). Cognitive deficiencies are present in people with schizophrenia, sometimes even prior to the onset of illness, and can also be found to a lesser degree in non-psychotic relatives (Tandon et al., 2008). The neurocognitive impairments in schizophrenia are vast with many types of memory moderately or severely impaired (Marcopulos & Kurtz, 2012). One type of memory that often shows severe impairment in schizophrenia, and can be very impaired in other types of SMI, is verbal episodic memory. This is typically tested by list learning with delayed recall and recognition measures (Lezak, Howieson, Bigler, & Tranel, 2012).

Thought Derailment

People with bipolar disorder or schizophrenia often experience some sort of thought disorder, a debilitating symptom characterized by bizarre or nonsensical discourse as a result of disturbed thought processes (Nestor, Shenton, Wible, Hokama, O'Donnell, Law, & McCarley, 1998). Due to the many ways thought disorder can be expressed, it can be further broken down by subtypes. One such subtype is known as thought derailment, which is when people are unable to maintain a single train of thought and will string together unconnected sentences (Oltmanns, Murphy, Berenbaum, & Dunlop, 1985). This symptom is noticeable in patients during their initial psychiatric assessment at a mental hospital and the assessor can rate the level of thought derailment on a scale from not present to severe.

Derailment in people in a manic state is a result of patients rapidly jumping between multiple coherent topics (McPherson & Harvey, 1996). Conversely, derailment in schizophrenia is postulated to be a failure in logically connecting thoughts, hence the abrupt changing of topic of conversation (McPherson & Harvey, 1996; Oltmanns et al., 1985). This indicates that there may be different mechanisms responsible for thought derailment in these two types of SMI. Persons with schizophrenia have difficulty using categories, or semantically sorting information, which may contribute to thought derailment (Nestor et al., 1998). Nestor and colleagues hypothesized that poor ability to semantically cluster information may be caused by an impairment in the temporal lobe. Improperly working semantic structures in the temporal lobe cause an overload in working memory, which in turn causes artificial connections to form among elements because information is not properly purged from working memory (Nestor et al., 1998). Perhaps some combination of these theories may explain the contextual processing deficiencies people with schizophrenia have. The amount of information available in the lexicon of people with schizophrenia is not affected by thought disorder, but their ability to organize and access this information is impaired (Goldberg & Weinberger, 2010).

Formal thought disorder has been linked to impairment in the inferior parietal lobule in a functional magnetic resonance imaging (fMRI) study; damage to this region triggers a loosening of associations. Both people with schizophrenia and bipolar disorder show deficits in this brain area as measured by a fMRI scan during a Semantic Object Retrieval Task (SORT), which could help explain their poor performance on semantic association tasks (Jamadar et al., 2012). A study by Sans-Sansa et al. (2013) used fMRI data to examine the brains of patients with schizophrenia who showed presence of thought disorder. They found reduced volumes in the left superior temporal gyrus, a region associated with Wernicke’s area, and the left inferior operculum, which overlaps with Broca’s area. The orbitofrontal and medial frontal cortex also showed reduced volume bilaterally. This indicates that impairment in the classic speech regions of the brain is associated with developing formal thought disorder in patients with schizophrenia (Sans-Sansa et al., 2013). Although there is not general consensus on which brain regions are related to thought disorder, this suggests that impaired connectivity between brain areas is an important component in the development of formal thought disorder. There may be no specific brain structure that causes thought disorder, but rather a disconnect between speech areas with other parts of the brain.

A study by Kerns and Berenbaum (2002) looked at the effects of semantic priming (pairing a target word with a categorically similar prime word, i.e. fruit is semantic priming for the target word banana) on formal thought disorder in patients with schizophrenia to see if it aided their ability to perform semantic tasks. However, they found that patients with formal thought disorder show semantic impairments in tasks with and without priming. A study by Weiss et al. (2003) showed that patients with schizophrenia were able to use semantic strategies to encode information and were almost as successful at recall as normal controls. However, in the PET scans that accompanied the encoding tasks, patients with schizophrenia showed less hippocampal activity than the normal controls. This indicates that there is an error in the neural circuitry in the brains of people with schizophrenia that prevents them from making deeper connections. Formal thought disorder has been associated with semantic network over activation; people with schizophrenia who have thought disorder are more likely to make an association between unrelated words than people with bipolar disorder who also have thought disorder (Jamadar et al., 2012).

Past research examining thought disorder in schizophrenia has found that higher levels of thought disorder is predicted by reduced executive functioning and limited semantic ability (Stirling, Hellewell, Blakey, & Deakin, 2006). Maeda et al. (2007) found that thought disorder has been shown to worsen over time in people with schizophrenia, although they did not specify which types of schizophrenia were represented in their sample. Severe thought disorder has been strongly correlated with poor test performance on measures of verbal memory and categorization, as well as executive functioning (Nestor et al., 1998). A study conducted by

Subotnik et al. (2006) found that having participants with schizophrenia take the Gorham Proverbs Test (Gorham, 1956) induced thought disorder, which allowed researchers to measure their level of bizarre-idiosyncratic and concrete thinking. The findings of the Subotnik et al. (2006) study support the theory that thought disorder in patients with schizophrenia is at least partially caused by dysfunction in both discrimination of relevant stimuli and encoding of pertinent information into memory. This means that people with schizophrenia who have a thought disorder have difficulty discerning stimuli that are necessary for the task at hand from distractor stimuli. This is related to an attentional deficiency; however, they also have trouble during encoding the target stimuli into memory. Both of these problems affect the patient's ability to recall information during a memory task, as the information they need to remember often was never encoded into memory in the first place.

California Verbal Learning Test

The California Verbal Learning Test (CVLT) is a neuropsychological test designed to identify memory disorders in a variety of patient populations (Delis et al., 1991). Patients with schizophrenia who are given the CVLT often show moderate to severe memory impairments. The CVLT has been associated with temporal lobe activation, specifically in the hippocampus (Johnson et al., 2001); and patients with schizophrenia have shown decreased levels of hippocampus activity on semantic encoding tasks, which could help explain why they demonstrate memory impairments on the CVLT. Areas showing the highest level of impairment include ability to freely recall items and being able to recognize previously heard items (Paulsen et al., 1995). People with schizophrenia also show inconsistency in recalling items across trials and frequently recall items that were not on the list, known as making an intrusion error, in both free and cued recall trials (Paulsen et al., 1995). Patients with schizophrenia might make more intrusion errors due to their tendency to encode items on a phonemic level thus recalling words with similar sounds as list items. In retention trials of the CVLT, patients with schizophrenia show a tendency to make false positive recalls (incorrectly remembering a word that was not on the list) for words phonemically related to items on the list (Paulsen et al., 1995). This could be related to clanging, a type of disorganized speech and thought common in schizophrenia characterized by combining words in a sentence based on sound rather than meaning (Lerner, Bentin, Shriki, 2012).

People with schizophrenia typically show much better improvement in recognition trials compared with free recall trials; this could be associated with their failure to use semantic sorting to aid free recall (Paulsen et al., 1995). These findings suggest that patients with schizophrenia fail to encode list items on a semantic level and instead process them superficially based on other factors such as similar phonetic characteristics (Paulsen et al., 1995). Damage to the prefrontal cortex has been found to affect episodic memory by impairing strategic contribution of memory encoding and retrieval (i.e. semantic strategies). Therefore, dorsolateral prefrontal cortex impairment in people with schizophrenia could explain why they do not typically employ a semantic clustering mechanism on the CVLT-II to aid in recall (Barch & Ceaser, 2012).

Although extensive research has been conducted on various aspects of the California Verbal Learning Test, to date there has been no research looking at how thought derailment in SMI is correlated with verbal episodic memory. This could be an important association because if patients with presence of thought derailment perform worse on the CVLT-II than patients without thought derailment, it could indicate an important verbal episodic memory component to derailment. While thought derailment could appear to be primarily an attention issue, this study could link derailment to underlying impairments in verbal memory and semantic clustering abilities. This could mean that derailment is a result of encoding words into verbal memory based on phonetic similarities rather than semantic categories. Thus, when a person with derailment is trying to complete a sentence, this failure to group words semantically causes them to select a word or phrase that is incorrectly encoded and stored to complete their thought.

The proposed study seeks to extend research done on thought derailment by investigating archival neuropsychological test data for correlations between performance on variables of interest in the CVLT-II and thought derailment in a sample of patients with SMI using a correlational study design. The broad category of SMI was used because it was an archival study and I could only rely on pre-collected data. In order to make the sample size as large as possible, I included any patient with a SMI who was rated by the psychologist or psychiatrist as having thought derailment on a patient symptom checklist. I looked at thought derailment as a phenomenon that can be used to predict verbal episodic memory performance; therefore I was not as concerned with the diagnosis of the patients who show presence of thought derailment. I ran post-hoc tests to see which disorders more frequently report thought derailment as a symptom; however, diagnosis was not a main factor in the current study.

Hypotheses

My first hypothesis is that there will be a significant correlation between thought derailment and the semantic clustering (recall based on categories), intrusion error (recalling items not on the list), false positive recognition (incorrectly identifying a word not on the list) and free and cued immediate and delayed recall (unprimed recall and categorically primed recall assessed immediately following learning and after a short period of time) variables of the CVLT-II. A hierarchical multiple regression will be calculated to determine how much variance is attributed to semantic clustering. The outcome variable is thought derailment and various component scores of the CVLT-II will be the predictor variables. Semantic clustering will be entered into the model first, after controlling for significantly different demographic variables. By entering this variable first, we're able to determine the amount of variance attributed to semantic clustering (some of this variance is attributed to non-significantly different factors that weren't controlled for) before analyzing how much is due to the presence of other significant predictors in the model. A significance threshold of $p < 0.05$ using a two tailed test will be used as well as R^2 for effect size of the regression to determine how much variation the model explains.

Previous research has shown that severe thought disorder has been linked with poor test performance on the Wechsler Memory Scale-Revised (WMS-R), which scores immediate and delayed recall of orally presented stories as well as a word pair list, and the Wechsler Adult Intelligence Scale-Revised (WAIS-R), which tests verbal categorization and abstraction by asking participants to determine which words are alike (Nestor et al., 1998). The constructs tested by the WMS-R relate to the immediate and delayed recall variables in the CVLT and the construct tested by the WAIS-R relates to the ability to semantically sort items. Research on the CVLT conducted by Paulsen et al. (1995) has shown that patients with schizophrenia make more false positive recalls on the measure of recognition and have more intrusion errors than the normal population. Therefore, it is hypothesized that patients who have presence of thought disorder will have lower semantic clustering scores and higher levels of intrusion errors and false positive recognition.

My second hypothesis is that the semantic clustering and serial clustering variable of the CVLT-II will be significantly lower in patients with thought derailment. This will be determined by conducting an independent samples t-test with thought derailment (present vs. absent) as the grouping variable and serial clustering and semantic clustering as the outcome variables. A significance level of $p < 0.05$ using a two-tailed test will be used to see if the *p*-values indicate significant correlations as well as Cohen's d to determine the effect size if significant results are found. Past research has found that patients with schizophrenia have difficulty semantically sorting information and they typically fail to use semantic sorting to assist with free recall on the CVLT (Nestor et al., 1998; Paulsen et al., 1995; Stirling et al., 2006). To date, no research has found that people with schizophrenia have serial clustering scores that differ significantly from the normal population. Based on the general consensus that people with schizophrenia fail to order information semantically, it is hypothesized that the SMI sample at Western State Hospital will have lower semantic clustering scores than serial clustering scores.

Out last hypothesis is that duration of illness will be significantly correlated with false positive recognition and intrusion errors on the CVLT-II and higher thought derailment scores. I predict that a longer duration of illness in patients with thought derailment will be a moderator for poorer CVLT-II performance. Pearson correlations will be calculated to determine the level of correlation between duration of illness and thought derailment and both false positive recognition and intrusion errors, with a significance threshold of $p < 0.05$ using a two-tailed test. R^2 will be calculated to determine the effect size for this correlation. Previous research has shown that thought disorder worsens over time in schizophrenia (Maeda et al., 2007). Earlier age of onset has previously been to be correlated with poorer performance on the CVLT (Paulsen et al., 1995). In addition, people with schizophrenia tend to make more intrusion errors when recalling items and are more likely to falsely recall items on the recognition task (Paulsen et al., 1998) Therefore, it is hypothesized that a longer duration of illness will be significantly correlated with more false positive recognition and intrusion errors on the CVLT-II and presence of more severe thought disorder.

Methods

Participants

My sample came from a database of consecutive referrals made between 2003 and 2012 to a neuropsychology service at an adult state psychiatric hospital (Western State Hospital) affiliated with an academic medical center (University of Virginia). Patients were referred for neuropsychological assessment by their treatment team, typically their clinical psychologist, in order to characterize their cognitive impairment. The patient population of Western State Hospital is primarily made up of forensic cases and severe cases of mental illness. This archival data study proposal was reviewed and approved by my university and the hospital's Institutional Review Board. There were a total of 188 patients who had been rated on a 0 to 4 scale (0 corresponding to the lowest or absent rating and 4 with the most severe presence) for presence of thought derailment.

Measures

The California Verbal Learning Test is designed to test verbal episodic memory through list learning and measures of cued (using categories to help participants recall list words) and free (not having any memory cues to help recall) long and short-term delays (Delis et al., 1991). Verbal episodic memory tests measure a patient's ability to learn new information over time. Episodic memory pertains to memory for details of one's own life and experiences, sometimes referred to as autobiographical memory. Testing of verbal episodic memory is accomplished by giving patients material to learn to test their encoding ability and then later having a recall and/or a recognition trial to examine their ability to retrieve the information (Beck, Gagneux-Zurbriggen, Berres, Taylor, & Monsch, 2012).

The CVLT consists of List A, which is a 16 item list of words that fall into four different categories, and List B, which contains 16 new items that fall into four categories; two categories are the same as List A and two are new (Delis, Kramer, Kaplan, & Ober, 1987). The examiner reads List A five times and asks the patient to recall items they remember after each trial. List B is then read and patients are again asked to recall which items they remember; List B serves as a distracter list for delayed recall trials of List A (Delis et al., 1987). The CVLT also consists of short and long term delayed recall trials for List A, a yes or no recognition list. A second version of the California Verbal Learning Test (CVLT-II) was created in 2000 (Delis, Kramer, Kaplan, & Ober, 2000). The CVLT-II contains a forced choice recognition test not present in the first edition, which can screen for malingering (Delis et al., 1987; Delis et al., 2000). Concurrent validity between the first and second edition is high; sample groups administered both tests receive similar mean scores and standard deviations with satisfactory correlations between tests (Delis, Kramer, Kaplan, & Ober, 2002).

The CVLT quantifies and provides normative data for various other categories including rate of attainment across trials (items that people remember across trials), semantic clustering (recall based on categories) and serial clustering (recall based on list position), primacy-recency effects (remembering list items presented first vs items presented last), and retention across long and short delays (ability to remember items across periods of delay) among other variables (Delis et al., 1991). A construct validation study of the CVLT found that using a semantic learning strategy to recall list items (grouping items based on categories) is more effective than using a serial learning strategy (organizing items based on list position) (Delis, Freeland, Kramer, & Kaplan, 1988). Hence, people who group items into semantic categories tend to score better on the CVLT.

Research Design

I used a correlational method, which allowed us to determine the strength of relationship between variables I compared. I also conducted several Pearson's chi squared tests for analysis of the data to look at which diagnoses reported more thought derailment and if patients with a forensic status, secondary gain, or those who failed TOMM trial 2 were more likely to show presence of thought derailment. This will inform us of differences in the effect of thought derailment on test performance based on patient diagnosis. A benefit of using archival data is having a much broader pool of participant data to draw from than I could have collected during the time period of this study. Another advantage of using an archival database is having many variables for each participant so I can run post-hoc analyses on any variables I may not have considered collecting from participants.

Results

My sample had a mean age of 40.0 (*SD*= 14.44), an average of 11.24 years of education (*SD* = 2.98), a mean age of onset of illness at 25.72 years of age (*SD*= 13.86) and a 14.35 year mean duration of illness (*SD*= 12.57). The total sample was 59% male, 67.6% Caucasian, 26.1% African-American/African and 6.4% identified as another race. Schizophrenia spectrum was the most common Axis 1 diagnosis with 52.7% of the sample falling under that diagnostic category, 25.0% were diagnosed with a mood disorder, 4.8% with a cognitive disorder (i.e. amnesia and dementia), and 17.5% with another disorder. The sample was 50.5% civilly committed to the hospital, 48.9% of those who had forensic status showed presence of secondary gain (having external motivation to perform well or poorly on a test, i.e. financial or legal benefits). In addition, 76.1% of the sample passed the Test of Memory Malingering (TOMM) Trial 2, which is designed to screen for malingering (purposely performing poorly on a measure).

Compared to patients who were rated as not having thought derailment (a rating of zero; n=72), those who showed a presence of thought derailment (a rating greater than zero; n=116) did not show significant differences in sex ($\chi^2 = 0.02$, $p = 0.88$), race ($\chi^2 = 2.72$, $p = 0.606$), civil or forensic status ($\chi^2 = 1.73$, $p = 0.19$), secondary gain ($\chi^2 = 0.86$, $p = 0.35$) or failure rate of the Test of Memory Malingering (TOMM) trial 2 ($\chi^2 = 0.07$, $p = 0.79$). However, there was a significant difference in Axis 1 diagnosis, with Cramer's V finding a moderate effect size ($\chi^2 = 38.65$, $p < 0.01$, $V = 0.45$). Significantly more patients with a schizophrenia spectrum disorder had a presence of thought derailment (67.2%). There was also a significant effect for age (t (185)= -2.11, $p = 0.04$, $d = 0.32$) with a small effect size using Cohen's *d*. Patients with derailment were significantly older ($M = 41.72$, $SD = 14.16$) than patients without ($M = 37.18$, $SD = 14.54$). When looking at demographics of patients with thought derailment who were also given the CVLT, I did not find many significant differences in demographics. The only significant difference between groups was axis 1 diagnosis, which has a moderate effect size ($\chi^2 = 14.71$, $p < 0.01$, $V = 0.46$) (Table 1).

A 2 x 9 factorial analysis of variance tested the effects of the CVLT variables on presence of thought derailment. The variables included in the analysis were CVLT total raw score, immediate cued and free recall, delayed cued and free recall, semantic and serial clustering, false positive recognition and intrusions. None of the variables produced significant main effects at the $p = 0.05$ level, although false positive recognition approached significance, $F(1,61) = 2.98$, $p = 0.09$. Those with presence of thought derailment ($M = 1.28$, $SD = 1.80$) had higher rates of false positive recognition than those without derailment ($M = 0.90$, $SD = 1.71$).

A Pearson matrix correlating CVLT variables of interest with demographic variables revealed some significant relationships. Thought derailment was significantly correlated with diagnosis ($r = -0.33$, $p < 0.01$) and the false positive recognition variable of the CVLT ($r = 0.28$, $p = 0.02$) (Table 2). Many of the CVLT variables were significantly correlated with education, which makes sense when considering that those with more education are likely to have better memorization and recall skills and are also more likely to use a semantic learning strategy. The correlation matrix of just the CVLT variables revealed many more significant relationships. While most of the variables were highly correlated with each other, serial clustering and intrusions did not have many significant correlations with other variables (Table 3). The correlation matrix of the demographic variables also found many of the variables to be correlated with each other. Particularly age, sex, duration of illness, secondary gain and civil or forensic status were highly correlated with many other variables (Table 4).

A hierarchical multiple regression was calculated to determine if semantic clustering would account for a significant amount of variance in predicting the presence of thought derailment. CVLT total raw score and false positive recognition were included as alternate predictors in the model. Evaluating the assumptions helped us choose variables that demonstrated a linear relationship, although the linearity of the predictor variables with the outcome variables was very weak. I first accounted for any variance due to diagnosis, a factor that was highly correlated with thought derailment, by only selecting cases of patients with schizophrenia, thus limiting the sample to only 36 participants but removing diagnosis variance.

There were no outliers in the dataset as determined by our value for Mahalanobis distance (2.92) being less than the critical level at 3 degrees of freedom (*MD*(3)= 16.27). Our model passed the independence of observations assumption; our Durbin-Watson value of 2.41 indicates no autocorrelation. Our probability plot shows homoscedasticity, the variances do not greatly deviate along the line of best fit. The dataset did not show multicollinearity, as tested by the variance inflation factor (VIF) values all being less than 10 and the tolerance values being greater than 0.10. Finally, the residuals were approximately normally distributed.

Table 5 displays the unstandardized regression coefficients (*B*) and the standard of error (*SE B)* the standardized regression coefficients (β), R^2 and the *F* statistic for change in R^2. After step 3, with all predictors in the equation, R= 0.39, $F(3, 35) = 1.93$, $p = 0.15$. The only variable to account for significant variance in thought derailment was false positive recognition, which accounts for 7% of the total variance in thought derailment. Model 3, which contained false positive recognition as a predictor, differed significantly from the first two models (p= 0.03).

Independent samples *t*-tests were conducted to determine if those with presence of thought derailment had different semantic and serial clustering scores from those without derailment. The tests showed that serial clustering did not differ significantly between those with (M = -0.40, SD = 0.75) or without thought derailment (M = -0.36, SD = 0.75); (t (69)= 0.25, p = 0.80). Semantic clustering scores did not show significant differences between presence (M = 0.16, SD = 0.93) and absence of derailment (M= -0.11, SD= 0.65); (t (69)= -1.40, p= 0.17).

A series of Pearson correlations were run to determine the relationship between duration of illness with thought derailment and CVLT variables of interest. There was not a significant relationship between duration of illness and number of intrusions (r = -0.06, R^2 <0.01), false positive recognition (r = 0.08, R^2 <0.01), or presence of thought derailment (r = 0.13, R^2 = 0.02). Pearson correlations were also run to see if there was a significant relationship between semantic and serial clustering based on presence of derailment. There was a significant relationship between serial and semantic clustering in the absence of thought derailment condition (r = -0.59, R^2= 0.35). However, the correlation was not significant in the presence of derailment condition (r= -0.30, R^2= 0.09).

Discussion

In my study, I hypothesized that semantic categorization would be worse in patients with thought derailment and would account for a significant amount of variance in predicting the presence of derailment. My second hypothesis was that semantic and serial clustering scores on the CVLT would be significantly worse for patients with presence of derailment than those without. I also predicted that a longer duration of illness would result in more intrusions and false positive recognition on the CVLT as well as a more severe rating for presence of thought derailment.

There were some limitations in evaluating my first hypothesis, the statistical power of the regression was limited due to the small sample size; this could be corrected in a future study by having a large enough sample to control for diagnosis while maintaining power. In addition, the linear relationship between the predictor and outcome variables were weak, this could be a result of limitations in the data; the semantic clustering and false positive recognition variables are both standardized scores, which is more limiting than their raw score range. The standardized data also corrects for several differences, including age, already, so this could be another limiting factor to using z-scores instead of raw scores for the variables. The thought derailment scale only ranges from 0 to 4 with most of the sample falling in the 1 to 2 range, so this is very limiting in creating a linear relationship between variables. While the third model in the regression differed significantly from the first two models, overall the predictor in the third model, false positive recognition, accounted for little variance of thought derailment (adjusted $R^2 = 0.07$).

The hierarchical regression did not support the first hypothesis, which was that semantic clustering would account for a significant amount of variance in thought derailment. My first hypothesis also predicted significant correlations between thought derailment and various components of the CVLT; however, only false positive recognition showed a significant correlation. This finding supports a previous study, which found that patients with schizophrenia tend to make more false positive recognitions; however, that same study also found that higher rates of intrusions and lower semantic scores among people with schizophrenia (Paulsen et al, 1995), which my study did not support. Using the correlation matrix, I found that semantic clustering did significantly correlate with recall (delayed and immediate, cued and free), so that higher semantic clustering scores were associated with better recall. This indicates that less semantic clustering is associated with poorer recall and overall test performance, although it does not serve as an effective predictor for presence of thought derailment. One study found that out of several formal thought disorder subtypes, only derailment significantly predicted both impaired lexical access and poor semantic storage (Leeson, Laws, & McKenna, 2006). Future research could build upon this past research and use total amount of recall as a dependent variables to see if semantic clustering accounts for a greater amount of variance than in my study.

My second hypothesis about semantic and serial clustering variables having significantly different scores between groups was not supported by the independent samples t-test. Neither of the t-tests reported significant differences in serial or semantic clustering between those with thought derailment and those without. This does not support past research, which has found that patients with thought disorder typically have trouble semantically processing information and using semantic categories to assist in sorting information (Kerns & Berenbaum, 2002; Nestor et al., 1998; Paulsen et al., 1995; Stirling et al., 2006). To date, no research has looked at serial clustering in thought derailment, but it is typically not as impaired in patients with schizophrenia as semantic sorting is. For this reason, my nonsignificant results for the serial clustering t-test are not surprising.

I did not find significant evidence to support my third hypothesis, which was that longer duration of illness would result in more intrusions and higher rates of false positive recognition on the CVLT-II. I also failed to find a significant correlation between duration of illness and thought derailment ratings. This is in contrast to prior research, which has shown that thought disorder worsens over time in patients with schizophrenia (Maeda et al., 2007). The results of a study by Andreasen & Grove (1986) suggest that the degree of thought derailment could be a useful tool to predicting severity of disorder, particularly for schizophrenia spectrum illnesses. Future research could look at derailment as a predictor for severity of illness to support the findings of past research (Andreasen & Grove, 1986).

The patients who showed presence of thought derailment did not differ significantly from those without derailment across many demographic categories. However, one demographic variable that did have a significant difference between groups was age; patients with thought derailment were older than patients without. The other variable that showed a significant difference was Axis 1 diagnosis, which was significant in both the overall sample as well as the subset who was given the CVLT. Of the patients showing presence of thought derailment, significantly more were diagnosed with a schizophrenia spectrum disorder than those without derailment. This supports prior research on thought derailment, which has mostly been found in patients with schizophrenia (McPherson & Harvey, 1996; Nestor et al., 1998; Oltmanns et al., 1985).

I referred to the manual for the California Verbal Learning Test, Second Edition to see what was already investigated regarding correlation between variables. Although the manual reports interdependence among variables, it did not give specific data on the degree of correlation between variables. Thus, the correlation matrices I ran were helpful in determining strength of correlation among CVLT variables. Finding many significant correlations between the variables serves to strengthen the construct validity of the CVLT-II by showing strong relationships between variables. The matrix showing the relationship between CVLT variables and demographic variables only showed a significant correlation for thought derailment with false positive recognition. Patients with presence of derailment had a higher rate of false positive recognition than those without. This could be related to difficulty discerning relevant stimuli and encoding the appropriate information, which has been found to be a symptom of thought disorder (Subotnik et al., 2006).

Other research points to an overload in working memory as a symptom of thought derailment, which could also explain the differences in false positive recognition scores (Nestor et al., 1998). Jamadar et al., 2012 found that patients with schizophrenia who have thought disorder were more likely to make associations between unrelated words than patients with bipolar disorder who also had derailment. This could explain why patients with derailment were more likely to falsely identify words that were not on the list. However, the difference could also be due to patients in the sample suspected of malingering evidenced by failing TOMM trial 2 (17.2% of this subset of the sample did not pass the TOMM) or presence of secondary gain. These patients may have been performing poorly on purpose in order to make their cognitive abilities seem worse than they actually are.

In the literature review of my study, I looked for research specifically on thought derailment, a subtype of formal thought disorder. Past research on derailment has found that semantic processes are often impaired compared to non-thought derailed patients (Nestor et al., 1998). Thus, a main part of my hypothesis came from the belief that semantic clustering would show impairment. However, the use of the term thought derailment on the patients intake interview, might be used in a broader sense to rate patients for presence of formal thought disorder. If this is the case, it would be better in future research to adjust my hypotheses to more accurately reflect the research on formal thought disorder with less of a focus on thought derailment.

One limitation to my study was that the thought derailment variable was assessed during the patient's psychological intake interview. There could be a significant period of time (several weeks or longer) between this entrance assessment and when the patient was given the CVLT-II. During this time, medication or other factors could have treated the thought derailment, and this type of thought disorder may not have been in affect while the patient was taking the CVLT-II. I have no indication of whether the patient was currently experiencing thought derailment while taking the CVLT-II. Another limitation is that I only used archival data, thus my pool of data was limited to patients who have been previously rated for thought derailment, were referred for a neuropsychological evaluation and who were given the CVLT-II. I could not manipulate treatment conditions and make sure any extraneous variables were controlled for. The results of the study are only correlational, it is not a true experiment and no causality can be established between variables. Because many participants were on medication during testing, this was a possible confound in the study as their performance on the CVLT-II may be a result of medication effects rather than thought derailment.

In my study, I used the broad category of SMI for the sample in order to ensure a large enough sample size. Most of the past research has looked at thought derailment or formal thought disorder in schizophrenia (Goldberg & Weinberger, 2010; Jamadar et al., 2012; Kerns & Berenbaum, 2002; Maeda et al., 2007; McPherson & Harvey, 1996; Nestor et al., 1998; Oltmanns et al., 1985; Paulsen et al., 1995; Sans-Sansa et al., 2013; Subotnik et al., 2006). While schizophrenia spectrum was the primary axis 1 diagnosis of those rated as having thought derailment, other diagnoses were included in the sample. This could have limited potentially significant results by including such a broad range of diagnoses, many of which may have had a low thought derailment rating.

A study by Harvey and Brault (1986) found that mania and schizophrenia have different predictors for incompetent references, with pressure of speech being more common in mania and derailment being the best predictor in patients with schizophrenia. Although both disorders showed presence of derailment, it was hypothesized they were influenced by differing etiologies, which contributed to their difference in being effective predictors for reference failures. Since thought derailment in schizophrenia and mania have been theorized to have different underlying causes (Harvey & Brault, 1986; McPherson & Harvey, 1996; Oltmanns et al., 1985), this might have affected my study by having the two disorders rated on the same scale for a differently expressed symptom. Future research might improve upon my study by having a large enough sample to focus exclusively on thought derailment in patients with a schizophrenia spectrum disorder.

References

Andreasen, N. C. (1979). Thought, language and communication disorders: 1. Clinical assessment, definition of terms, and evaluation of their reliability. *Archives of General Psychiatry*. 36(12), 1315-1321.

Andreasen, N. C. & Grove, W. M. (1986). Thought, language and communication in schizophrenia: Diagnosis and prognosis. *Schizophrenia Bulletin*. 12(3), 348-359.

Barch, D. &, Ceaser, A. (2012). Cognition in schizophrenia: Core psychological and neural mechanisms. *Trends in Cognitive Sciences*. 16(1), 27-34. doi: 10.1016/j.tics.2011.11.015

Beck, I. R., Gagneux-Zurbriggen, A., Berres, M., Taylo, K. I., & Monsch, A.U. (2012). Comparison of verbal episodic memory measures: Consortium to establish a registry for Alzheimer's disease- neuropsychological assessment battery (CERAD-NAB) versus California verbal learning test (CVLT). *Archives of Clinical Neuropsychology. 27*, 510-519.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd Ed.). Hillsdale, NJ: Erlbaum.

Delis, D., Freeland, J., Kramer, J., & Kaplan, E. (1988). Integrating clinical assessment with cognitive neuroscience: Construct validation of the California Verbal Learning Test. *Journal of Clinical and Counseling Psychology*. 56(1), 123-130.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (1987). *The California Verbal Learning*

Test. New York: Psychological Corporation.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (2000). *The California Verbal Learning Test: Second Edition*. San Antonio, TX: Psychological Corporation.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (2002). Book review: California verbal learning test- second edition.. *Archives of Clinical Neuropsychology*. *17*, 509-512.

Delis, D. C., Massman, P. J., Butters, N., Salmon, D. P., Cermak, L. S., & Kramer, J. H. (1991). Profiles of demented and amnesic patients on the california verbal learning test: Implications for the assessment of memory disorders. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*. 3(1), 19-26.

Goldberg, T., & Weinberger, D. (2010). Thought disorder in schizophrenia: A reappraisal of older formulations and an overview of some recent studies. *Cognitive Neuropsychiatry*. 5(1), 1-19. doi: 10.1080/135468000395790

Gorham, D. R. (1956). *Clinical manual for the Proverbs Test*. Missoula, MT. Psychological Test Specialists.

Harvey, P.D., & Brault, J. (1986). Speech performance in mania and schizophrenia: The association of positive and negative thought disorders and reference failures. *Journal of Communication Disorders*. 19, 161-173.

Jamadar, S., O'Neil, K. M., Pearlson, G. D., Ansari, M., Gill, A., Jagannathan, K., & Assaf, M.

(2012). Impairment in semantic retrieval is associated with symptoms in schizophrenia but not bipolar disorder. *Biological Psychiatry*. 73, 555-564.

Johnson, S.C., Saykin, A.J., Flashman, L.A., McAllister, T.W., & Sparling, M.B. (2001). Brain activation on fMRI and verbal memory ability: Functional neuroanatomic correlates of CVLT-II performance. *Journal of the International Neuropsychology Society.* 7, 55-62.

Leeson, V. C., Laws, K. R., & McKenna, P. J. (2006). Formal thought disorder is characterized by impaired lexical access. *Schizophrenia Research*. 88, 161-168.

Lerner, I., Bentin, S., & Shriki, O. (2012). Excessive attractor instability accounts for semantic priming in schizophrenia. *PLoS ONE*. 7(7), 1-14. doi: 10.1371/journal.pone.0040663

Lezak, M.D., Howieson, D.B., Bigler, E.D., & Tranel, D. (2012). Neuropsychological Assessment, 5th Edition. Oxford University Press.

Maeda, K., Kasai. K., Uetsuki, M., Hata, A., Araki, T., Rogers, M., Yamasue, H., & Iwanami, A. (2007). Increased positive thought disorder with illness duration in patients with schizophrenia. *Psychiatry and Clinical Neurosciences.* 67, 687-690. doi: 10.1111/j.1440-1819.2007.01730.x

Marcopulos, B. A., & Kurtz, M. M. (2012). *Clinical neuropsychological foundations of schizophrenia.* New York, NY: Routledge.

McGrath, J., Saha, S., Chant, D., & Welham, J. (2008). Schizophrenia: A concise overview of incidence, prevalence and mortality. *Epidemiological Reviews*. 30, 67-76. doi: 10.1093/epirev/mxn001

McPherson, L., & Harvey, P. (1996). Discourse connectedness in manic and schizophrenic patients: Associations with derailment and other clinical thought disorder. *Cognitive Neuropsychiatry*. 1(1), 41-53.

Nestor, P. G., Shenton, M. E., Wible, C., Hokama, H., O'Donnell, B. F., Law, S., & McCarley, R. W. (1998). A neuropsychological analysis of schizophrenic thought disorder. *Schizophrenia Research*. 29(3), 217-225. doi: 10.1016/S0920-9964(97)00101-1.

Oltmanns, T. F., Murphy, R., Berenbaum, H., & Dunlop, S. R. (1985). Rating verbal communication impairment in schizophrenia and affective disorders. *Schizophrenia Bulletin*. 11(12), 292-299.

Paulsen, J. S., Heaton, R. K., Sadek, J. R., Perry, W., Delis, D. C., Braff, D., Kuck, J., Zisook, S., & Jeste, D. V. (1995). The nature of learning and memory impairments in schizophrenia. *Journal of the International Neuropsychological Society.* 1, 88-99.

Sans-Sansa, B., McKenna, P. J., Canales-Rodríguez, E.J., Ortiz-Gil, J., López-Araquistain, L., Sarró, S., Dueñas, R.M., Blanch, J., Salvador, R., & Pomarol-Clotet, E. (2013). Association of formal thought disorder in schizophrenia with structural brain abnormalities in language-related cortical regions. *Schizophrenia Research*. *146*, 308-314.

Stirling, J., Hellewell, N., Blakey, A., & Deakin, W. (2006). Thought disorder in schizophrenia is associated with both executive dysfunction and circumscribed impairments in semantic function. *Psychological Medicine*. 36(4) : 475-484. doi: 10.1017/S0033291705006884.

Subotnik, K. L., Nuechterlein, K. H., Green, M. F., Horan, W. P., Nienow, T. M., Ventura, J., & Nguyen, A. T. (2006) Neurocognitive and social cognitive correlates of formal thought disorder in schizophrenic patients. *Schizophrenia Research*. 85 : 84-95.

Tandon, R., Keshavan, M. S., & Nasrallah, H. A. (2008). Schizophrenia, "just the facts": What we know in 2008. *Schizophrenia Research.* 100 : 4-19. doi:10.1016/j.schres.2008.01.022

Wang, P. S., Demler, O., Kessler, R. C. (2002). Adequacy of treatment for serious mental illness in the United States. *American Journal of Public Health*. 92(1) : 92-98.

Weiss, A.P., Schacter, D.L., Goff, D.C., Rauch, S.L., Alpert, N.M., Fischman, A.J., & Heckers, S. (2003). Impaired hippocampal recruitment during normal modulation of memory performance in Schizophrenia. *Biological Psychiatry, 53*, 48-55.

Tables

Table 1

Differences in Demographics by TD Rating and Sample with CVLT-II Scores

Demographics	Full Sample TD Present (*n* = 116)	Full Sample TD Absent (*n* = 72)	t / χ^2	CVLT TD Present (*n* = 40	CVLT TD Absent (*n* = 31)	t / χ^2	Total Sample (*n* = 188)
Age	41.72 (14.16)	37.18 (14.54)	-2.11*	37.90 (13.63)	39.94 (15.13)	0.60	40.00 (14.44)
Sex							
Male	58.6	59.7	0.02	55.0	58.1	0.07	59.0
Female	41.4	40.3		45.0	41.9		41.0
Race							
Caucasian	64.7	72.2	2.72	80.0	83.9	0.18	67.6
African-American/ African	29.3	20.8		-	-		26.1
Other	6.0	7.0		20.0	16.1		6.4
Education	11.23 (3.00)	11.26 (2.97)	0.08	12.35 (2.46)	12.90 (2.69)	0.90	11.24 (2.98)
Onset of Illness	26.37 (13.74)	24.61 (14.10)	-0.78	24.43 (13.04)	28.00 (16.03)	0.98	25.72 (13.86)
Duration of Illness	15.22 (12.72)	12.88 (12.27)	-1.13	12.01 (9.00)	12.48 (10.64)	0.19	14.35 (12.57)
Axis 1 Diagnosis							
Schizophrenia-Spectrum	67.2	29.2	38.62*	65.0	32.3	7.50*	52.7

Mood	19.8	33.3		-	-		25.0
Cognitive	5.2	4.2		-	-		4.8
Other	7.8	33.4		35.0	67.8		17.5
Forensic Status							
Civil	54.3	44.4	1.73	60.0	58.1	0.03	50.5
Forensic	55.6	45.7		40.0	41.9		49.5
Secondary Gain							
Yes	50.0	56.9	0.86	57.5	51.6	0.24	48.9
No	50.0	43.1		42.5	48.4		51.1
TOMM Trial 2							
Pass	76.7	75.0	0.07	92.5	90.3	0.11	76.1
Fail	23.3	25.0		7.5	9.7		23.9

Note. TD = Thought Derailment; CVLT= California Verbal Learning Test; TOMM = Test of Memory Malingering. Data for age, education, onset of illness and duration of illness are listed as mean and (standard deviation) and the test statistic is *t*. Valid percentages are listed for sex, race, axis 1 diagnosis, forensic status, forensic status, secondary gain, and fail TOMM trial 2 and the test statistic is χ^2, TOMM Trial 2 in the CVLT condition where the Fisher's Exact was used for probability. Some race and diagnosis categories omitted and considered as other to create cell counts greater than 5 for χ^2. *p < 0.05 for overall analysis.

Table 2

Correlation Matrix Demographics x CVLT Variables

	Thought Derail-ment	Age	Sex	Race	Edu-cation	Diag-nosis	Onset of Illness	Duration of Illness	Secondary Gain	Civil or Forensic	Fail TOMM Trial 2
Thought Derailment	1	0.08	0.00	0.11	-0.01	-0.33**	-0.01	0.13	0.08	0.02	0.13
Total	-0.07	0.14	0.03	0.00	0.34**	-0.23	0.28*	-0.16	-0.16	-0.20	-0.15
Immediate Recall – Free	-0.08	0.04	-0.20	0.12	0.41**	-0.24*	0.16	-0.13	-0.15	-0.11	-0.21
Immediate Recall-Cued	-0.05	0.04	-0.08	0.03	0.28*	-0.09	0.15	-0.14	0.01	0.03	-0.03
Delayed Recall- Free	-0.02	0.13	-0.10	0.10	0.32**	-0.10	0.23	-0.16	-0.15	-0.13	-0.11
Delayed Recall-Cued	-0.02	0.10	-0.09	0.05	0.29*	-0.17	0.19	-0.12	-0.15	-0.16	-0.17
Semantic Clustering	-0.05	-0.13	0.49	0.11	0.30*	-0.13	0.16	-0.23	-0.11	-0.15	-0.05
Serial Clustering	0.08	0.27*	-0.05	-0.10	0.10	-0.07	0.09	0.20	0.06	0.10	-0.08
False Positive Recognition	0.28*	0.90	0.22	0.04	-0.16	0.19	0.05	0.08	-0.07	0.01	0.04
Intrusions	0.01	0.17	0.01	0.05	-0.10	0.26*	0.04	0.06	0.06	0.14	0.02

Note. CVLT= California Verbal Learning Test; TOMM= Test of Memory Malingering. Data is given as Pearson correlations. *p < 0.05 for overall analysis, **p <0.01.

Table 3

Correlation Matrix CVLT Variables x CVLT Variables

	Total	Immediate Recall-Free	Immediate Recall-Cued	Delayed Recall-Free	Delayed Recall-Cued	Semantic Clustering	Serial Clustering	False Positive Recognition	Intrusions
Total	1	0.76**	0.78**	0.73**	0.77**	0.62**	0.17	-0.55**	-0.27*
Immediate Recall – Free	0.76**	1	0.78**	0.83**	0.79**	0.60	0.08	-0.51**	-0.22
Immediate Recall-Cued	0.78**	0.78**	1	0.80**	0.87**	0.61**	0.10	-0.50**	-0.22
Delayed Recall-Free	0.73**	0.83**	0.80**	1	0.89**	0.60**	0.03	-0.46**	-0.22
Delayed Recall-Cued	0.77**	0.79**	0.87**	0.89**	1	0.60**	0.04	-0.53**	-0.22
Semantic Clustering	0.62**	0.60**	0.61**	0.60**	0.60**	1	-0.40**	-0.40**	-0.23
Serial Clustering	0.17	0.08	0.10	0.03	0.04	-0.40**	1	-0.11	-0.17
False Positive Recog-nition	-0.55**	-0.51**	-0.50**	-0.46**	-0.53**	-0.40**	-0.11	1	0.56**
Intrusions	-0.27*	-0.22**	-0.22	-0.22	-0.22	-0.23	-0.17	0.56**	1

Note. CVLT= California Verbal Learning Test. Data is given as Pearson correlations. *p < 0.05 for overall analysis, **p <0.01.

Table 4

Correlation Matrix Demographics x Demographics

	Age	Sex	Race	Educ-ation	Diagnosis	Onset of Illness	Duration of Illness	Secondary Gain	Civil or Forensic	Fail TOMM Trial 2
Age	1	0.15*	-0.14	0.03	-0.14	0.60**	0.45*	-0.18*	-0.20**	0.03
Sex	0.15*	1	-0.02	0.22**	-0.02	0.13	-0.02	-0.25**	-0.35**	-0.03
Race	-0.14	-0.02	1	-0.14	-0.02	0.06	-0.21**	0.20**	0.25**	0.07
Education	0.03	0.22**	-0.14	1	-0.18*	0.08	-0.4	-0.09	-0.16*	-0.19*
Diagnosis	-0.14	-0.02	-0.02	-0.18*	1	-0.05	-0.12	0.10	0.10	0.11
Onset of Illness	0.60*	0.13	0.06	0.08	-0.05	1	-0.41**	-0.05	-0.05	0.12
Duration of Illness	0.49*	-0.02	-0.21**	-0.04	-0.12	-0.41**	1	-0.16*	-0.19*	-0.08
Secondary Gain	-0.18*	-0.25**	0.20**	-0.09	0.10	-0.05	-0.19*	1	0.85**	0.16*
Civil or Forensic	-0.20**	-0.35**	0.25**	-0.16*	0.10	-0.06	-0.16*	0.85**	1	0.17*
Fail TOMM Trial 2	0.03	-0.03	0.07	-0.19*	0.11	0.12	-0.08	0.16*	0.17*	1

Note. CVLT= California Verbal Learning Test; TOMM= Test of Memory Malingering. Data is given as Pearson correlations. *p < 0.05 for overall analysis, **p <0.01.

Table 5

Hierarchical Regression for Semantic Clustering as a Predictor of Thought Derailment

	Model 1			Model 2			Model 3		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Semantic Clustering	-0.14	0.16	-0.14	-0.15	0.25	-0.16	-0.10	0.24	-0.11
CVLT Total				0.00	0.02	0.02	0.02	0.02	0.22
False Positive Recognition							0.23	0.10	0.44*
R^2	0.14			0.14			0.39*		
F for Change in R^2	0.67			0.01			5.05*		

Note. CVLT= California Verbal Learning Test. *p < 0.05