Behavioural Research Statistical Methods

Project Report

The Influence of Comorbidity in Willingness to Expend Effort Among Individuals with Bipolar 1

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Abstract

The field of psychology has traditionally categorized individuals under specific disorders, resulting in a lack of recognition for comorbidities and hard boundaries for diagnosis. This report focuses on individuals with bipolar disorder and their higher reward sensitivity. The report discusses the shift towards a spectrum system that allows for comorbidities and focuses on a certain set of disorders instead of drilling down on one. The dataset used in the paper we will be analyzing has data on comorbidities, but the paper concentrates only on Bipolar I. Results show that individuals with bipolar disorder have a higher inclination towards financial rewards rather than fame-related rewards. In this report we will discusses and analyze if internalizing disorders show more avoidance to risky situations for reward, while externalizing disorders approach riskier situations for reward.

1 Introduction

1.1 Problem statement

We will be replicating and analyzing the results of the paper, *Willingness to Expend Effort Toward Reward and Extreme Ambitions in Bipolar I Disorder*[4]. We tackle the problem of categorizing individuals with mental health disorders on a spectrum and check if the result of the paper are consistent under this spectrum system. Our aim is to contribute to the shift towards a spectrum system that allows for comorbidities and focuses on sets of disorders instead of drilling down on one.

In particular, we are concerned that the results of the paper do not account for the internalizing and externalizing comorbidities plaguing the individuals under the banner of Bipolar I disorder. One may intuitively conclude that externalizing disorders such as drug abuse would make individuals more susceptible to being risk-taking whereas internalizing disorders have the opposite effect. We test our theories on the results of this paper and check if spectrum analysis (inclusive of comorbidities) would sway the results obtained by the paper.

1.2 Literature Review

1.2.1 Bipolar disorder

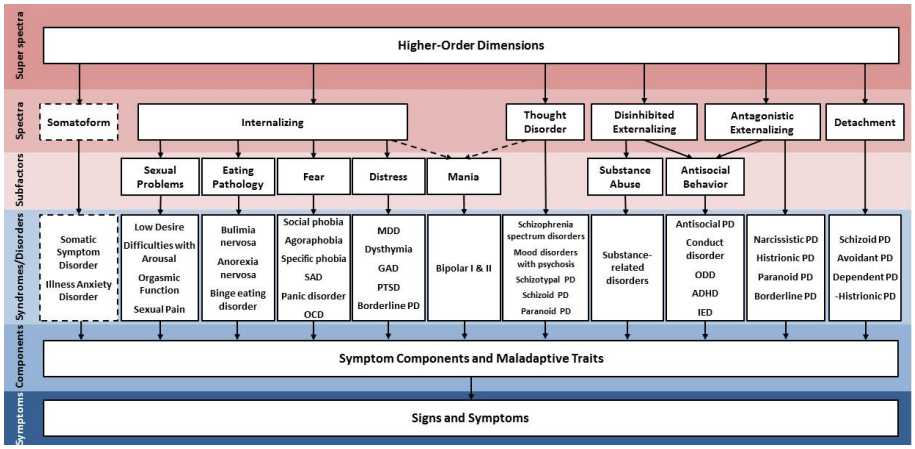
Bipolar disorder is a mental illness that is categorized by cycles of manic and depressive episodes which are periods of intense, elevated and irritable mood swings which are accompanied

by several other symptoms. [1]

1.2.2 The Hierarchical Taxonomy Of Psychopathology (HiTOP)

The field of psychology has been moving towards a spectrum system that allows for ***comorbidities****, which refers to the co-occurence among mental disorders* [3].

The Hierarchical Taxonomy Of Psychopathology **(HiTOP)** is a novel approach in mental health research that seeks to enhance our understanding of mental disorders by providing valuable insights into risk factors, treatment response, etc. The goal is to not resort to historic methods of categorizing individuals under any one disorder but to rather employ dimensional measures that assess the individual across various aspects of the disorder(s). With these developments, the HiTOP system offers great promise for increasing mental health research and improving care for people with mental diseases.



Adopting such an approach opens up promising avenues for research and development in psychology. Historically, psychiatrists have conducted extensive patient follow-up, often lasting many years, in order to exclude probable diagnoses and arrive at their final conclusive diagnosis. This diagnostic procedure is similar to that used by physicians to diagnose physical disorders. However, studies have shown that while physical diseases usually do not occur in tandem, the presence of an mental disorder only increases the chances of having another mental disorder. Or in other words, a comorbidity. [2]

1.2.3 Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication

According to Kessler et al. (2005)[2], mental health problems are relatively frequent, with about 50% of respondents reporting at least a single disorder. They also show that comorbidity, or having multiple disorders in the same person, is highly common in mental disorders. In fact, more than 80% of people with a single disorder also had another disorder. These findings indicate that mental health disorders are frequently accompanied by other disorders (comorbidities), emphasising the importance of improved diagnosis and treatment of these conditions.

1.2.4 Willingness to Expend Effort Toward Reward and Extreme Ambitions in Bipolar I Disorder

This is the paper that we will be replicating and analyzing over the remainder of this report. The study examines the association between bipolar I disorder and the propensity to put in a lot of effort in order to get rewards or to pursue extreme goals.

The study follows patients that have bipolar I disorder until they showed a decrease or a complete absence of symptoms. They then completed custom tests that are used to measure the patient's willingness to pursue difficult tasks (EEfRT) and other relevant tests (WASSUP) and statistical analysis is conducted on the results to check for any correlations. The findings indicated that those with bipolar I illness had greater levels of fierce ambition than those without the disease and were more eager to put in effort to get rewards. These results imply that bipolar I disorder may be accompanied with an increased desire for rewarding behaviour, which may help people acquire excessive aspirations. The study however does not take into account any effects that may be caused due to the internalizing and externalizing commodities experienced by the individuals. It further concludes that individuals with Bipolar I disorder are more susceptible to ambitions on the financial side than the popular side, owing to the stronger correlation with WASSUP_Fin scales compared to WASSUP_Pop.

1.3 Hypothesis development

During the course of this project, we have formulated three hypotheses that we intend to prove/disprove through statistical analysis of the provided data.

1. Individuals with comorbid anxiety disorder will show lower proportion of hard tasks se-

lected on the EEfRt compared to baseline and score lower on WASSUP Popular Fame and Financial success scales.

2. Individuals with a history of comorbid substance use disorder will show a higher proportion of hard tasks selected on the EEfRt compared to baseline and score higher on WASSUP Popular Fame and Financial success scales.

3. Individuals with both comorbidities will show the highest proportion of hard tasks selected on the EEfRT and WASSUP Popular Fame and Financial success scales

These hypotheses are based on our assumptions that internalizing comorbidities, such as anxiety, would negatively impact an individual and decrease their risk-taking behavior, while externalizing comorbidities, such as substance abuse, would have the opposite effect, potentially even overriding any internalizing comorbidities.

2 Method

2.1 Participants selection criteria

The final dataset analyzed (N = 40) excluded 10 participants due to missing data on key variables. The study recruited remitted Bipolar 1 participants from the San Francisco Bay Area through various means and had exclusion criteria such as substance abuse, primary psychotic disorder, brain injury/disease, and medical conditions impairing the central nervous system. Participants were between 18-60 years (M = 35), with 17 males and 23 females. Ethnicity included 76% Caucasian, 10% Asian American, 4% African American and 10% Other. Compensation was given through cash and rewards won during the task. The dataset was obtained from Dr. Sheri Johnson's page on Open Science Forum (OSF).

2.2 Data collection methods

2.2.1 Effort Expenditure of Rewards Task (EEfRT)

The EEfRT, developed by Treadway et al. (2009) [5], offers participants a choice between an easy task (30 key presses with index finger of the dominant hand in 7 seconds) and a difficult task (100 key presses with pinky finger of the nondominant hand in 21 seconds) to

earn monetary rewards. Participants had a 50% chance of earning the reward on each trial, with monetary rewards ranging from $1.24 to $4.30 for the difficult task and $1.00 for the easy task. Data from previous studies (N=800) using the task indicated that participants were more likely to choose the difficult task as reward level increased, indicating its advantage at least some of the time. The EEfRT was programmed in Matlab using the Psychtoolbox version 2.0 (Johnson et al., 2017).

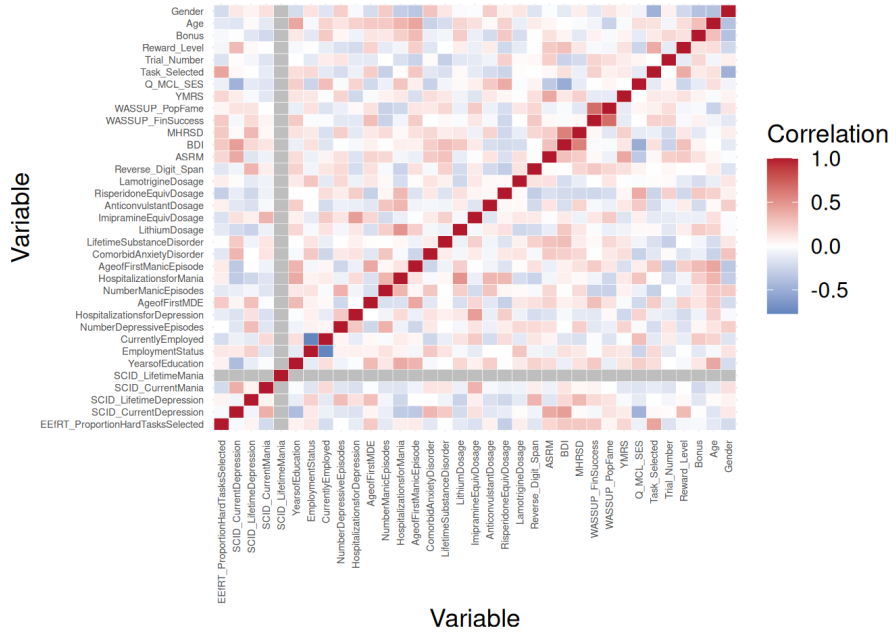
2.2.2 Willingly Approached Set of Statistically Unlikely Pursuits (WASSUP), Popular Fame and Financial Success subscales

The WASSUP (Johnson & Carver, 2006) measures high life ambitions with two subscales: Popular Fame (7 items) and Financial Success (4 items). Persons with bipolar disorder typically score higher on these subscales (Johnson, Carver, et al., 2012). Participants rate their likelihood of setting specific life goals on a 5-point scale. Internal consistency alpha coefficients for the two subscales in this sample were $\dot{8}5$ and $\dot{7}1$, respectively, with a high correlation of $\dot{6}6$ between them (Johnson et al; 2017).

3 Statistical analyses

3.1 Analysis Done by Praneetha

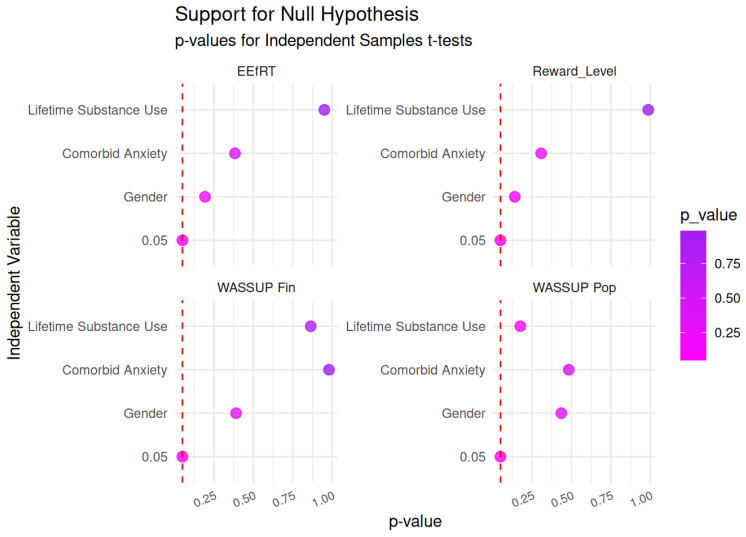
We begin by first exploring the data through exploratory visualizations and tests for normality. Finding the data, pre-processing (including handling categorical and non-categorical variables), normality tests, applying appropriate transformations on non-normal data and performing correlation tests on the data was majorly handled by my teammate Praneetha Gokul.



3.2 Analysis Done by Me

My analysis primarily consisted of performing the pairwise t-tests to test hypothesis 1 and 2 and performing the ANOVA and a posthoc TukeyHSD to test hypothesis 3. It should be noted that the PopFame and FinSuccess data were *not* normally distributed, and as such, the Welsch t-test was used to test the alternative hypothesis. (Post some transformations to help make it more normal).

Now because this included 3×4 t-tests (3 because I decided to try out Gender too), this was a lot of data to process. I needed a way to visualize this in a simple graph. Bar graphs were less than ideal. In the end I settled with this dot plot visualization which quickly summarizes the results of my analysis.



Next, I performed the ANOVA and posthoc TukeyHSD tests to further test hypothesis 3. After running the ANOVA, we observed a significant effect.

```
##                                                    Df Sum Sq Mean Sq F value
## ComorbidAnxietyDisorder:LifetimeSubstanceDisorder  1 0.5727  0.5727  11.954
##                                                     Pr(>F)
## ComorbidAnxietyDisorder:LifetimeSubstanceDisorder 0.00142 **
```

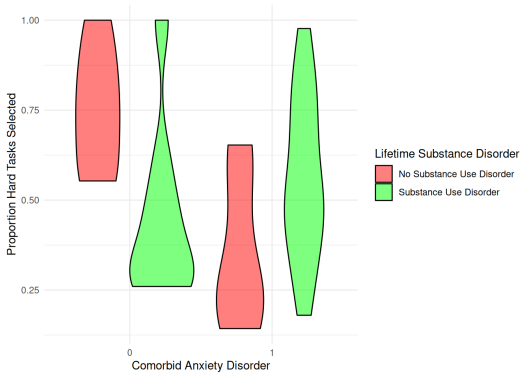
Performing followup TukeyHSD on the model provided the following interesting results.

```
aov(formula = EEfRT_ProportionHardTasksSelected ~ ComorbidAnxietyDisorder * LifetimeSubstanceDisorder,
data = data_update)
## $ComorbidAnxietyDisorder
##            diff        lwr        upr     p adj
## 1-0 -0.07305227 -0.2180372 0.07193269 0.3136571
## $LifetimeSubstanceDisorder
##             diff        lwr       upr     p adj
## 1-0 0.0005056264 -0.1466537 0.147665 0.9944786
## $`ComorbidAnxietyDisorder:LifetimeSubstanceDisorder`
##                diff         lwr          upr     p adj
## 1:0-0:0 -0.3979742 -0.71634764 -0.079600688 0.0094274
```

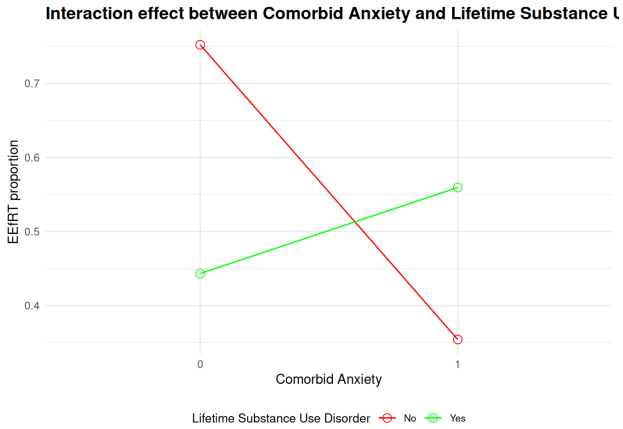
The post hoc Tukey HSD analysis on EEfRT indicated a significant interaction effect, with individuals having only comorbid anxiety disorder showing a significant difference ($p < 0.01$) compared to those with no comorbidity. In contrast to previous findings, the comorbid anxiety group exhibited a negative difference (-0.3979742) in the proportion of hard tasks selected on the EEfRT, when compared to the only bipolar group.

However, there was no significant effects found when testing on the WASSUP_Pop or WASSUP_Fin success scales.

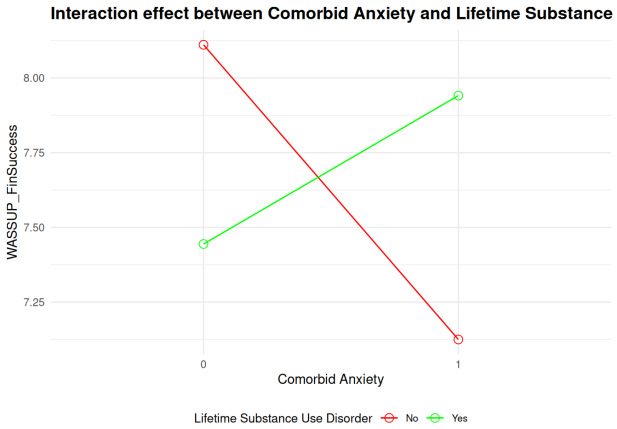
These visualizations **generated by my teammates** are in line with my findings and hint that hypothesis 1 is (at least partially) true.



We can see the interaction effects better plotted by me here.



(a) Interaction effect on EEfRT



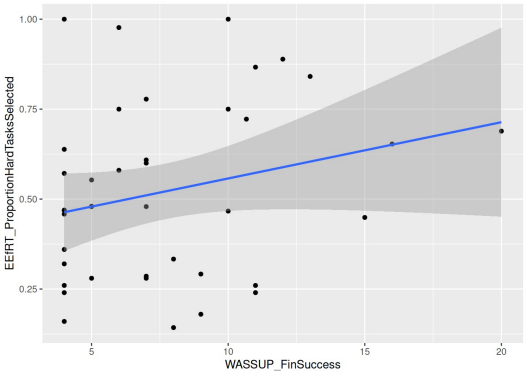
(b) Interaction effect on WASSUP_Fin

Figure 1: Interaction between Comorbid Anxiety and Lifetime Substance Disorders

3.3 Analysis Done by Prerak

Subsequently, my teammate Prerak worked to reproduce the regression models outlined in the paper and subsequently proceeded to construct his own novel linear regression models which established a relationship between EEfRT and Comorbid Anxiety and Lifetime Substance Use

disorders, following which he conducted a comparative analysis of the coefficients, and provided partial support for our hypotheses.



4 Discussion

4.1 Summary of findings

Although a significant effect was observed on the EEfRT task when comparing only bipolar group and comorbid anxiety disorder group, none of the hypotheses were consistently supported. However, certain trends were observed in graphs which can provide partial support to the hypotheses when certain factors are added to the model. For instance, while evaluating hypothesis 1, no significant effect was observed on the EEfRT task, but when evaluating hypothesis 3, the expected effect was observed. This may be due to the differentiation among the comorbid and non-comorbid groups, as well as the use of non-normal data and Welsch t-tests. Additionally, the study relies on DSM classification, which is highly categorical. HiTop classification system may provide a clearer understanding of the relationship between bipolar disorder and comorbidities. Those with Bipolar 1 and comorbid anxiety were less likely to select hard tasks in the EEfRT compared to those with only Bipolar 1, aligning with HiTop's classification of anxiety as an internalizing disorder characterized by avoidance motivation.

4.2 Limitations of the study

1. Small size of dataset

2. DSM classification of data

4.3 Implications of findings

Although we were unable to provide conclusive evidence that considering comorbidities along a spectrum would've changed the results of the paper we're analyzing, our findings suggest underlying trends and partial support, which cast doubt on the accuracy of the test results. We are of the opinion that the same tests, conducted with data obtained more in line with the HiTop classification scheme, would provide more conclusive evidence in support of our hypothesis.

5 Code

All the code used in our project can be found in my repository here: https://github.com/akcube/BRSM-Project.

References

[1] "From Anxiety to Schizophrenia: Mental Health Conditions Explained". In: (). URL: https://www.ourbetterworld.org/series/mental-health/support-toolkit/anxiety-schizophrenia-mental-health-conditions-explained?gclid=Cj0KCQjw0tKiBhC6ARIsAAOXutlXcYfytteNpeLLnxPdtMf28O2X-tJF5sgWfYVUKEfegOn0k6FIdUaAo6SEALw_wcB.

[2] "Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication". In: (). URL: https://pubmed.ncbi.nlm.nih.gov/15939839/.

[3] "The Hierarchical Taxonomy of Psychopathology (HiTOP): A Dimensional Alternative to Traditional Nosologies". In: (). URL: https://www.apa.org/pubs/journals/features/abn-abn0000258.pdf.

[4] "Willingness to Expend Effort Toward Reward and Extreme Ambitions in Bipolar I Disorder". In: (). URL: https://journals.sagepub.com/doi/abs/10.1177/2167702617718181.

[5] "Willingness to Expend Effort Toward Reward and Extreme Ambitions in Bipolar I Disorder". In: (). URL: https://www.researchgate.net/publication/319071386_Willingness_to_Expend_Effort_Toward_Reward_and_Extreme_Ambitions_in_Bipolar_I_Disorder.