Examining Patient Evaluations of Antidepressant Drug Use and Efficacy

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Introduction

According to the 2015 report "Depression and Other Common Mental Disorders: Global Health Estimates" by the World Health Organization, depression is the leading cause of disability and burden of disease worldwide. Evidence-based guidelines generally recommend that second-generation antidepressants (e.g. selective serotonin reuptake inhibitors and selective norepinephrine reuptake inhibitors)—in conjunction with psychotherapy—be taken as the first line of treatment for depression (Anderson et al., 2008; Qaseem, Barry, & Kansagara, 2016; Won et al., 2014). Given the considerably large array of existing pharmacological treatment options for depression and heterogeneity in risk/benefit trade-offs thereof, it is worth examining critical aspects of patients' subjective treatment experiences across a representative sample of the antidepressant drug landscape.

Research indicates that efforts to maximize treatment benefits for patients with psychiatric illnesses are hampered by poor adherence to prescribed medications (McDonald, Garg, & Haynes, 2002). Among the many different patient factors known to affect adherence to psychiatric treatment (e.g. patient beliefs, stigmas, cost, fears of addiction, etc.), adverse drug side effects are commonly reported as a reason for reluctance to accept or continue pharmacological treatment programs (Fortney et al., 2011; Sansone & Sansone, 2012).

Statement of goals.

1. What is the relationship between perceived effectiveness, perceived side effects and overall satisfaction?
2. What is the relation between perceived side effects and perceived effectiveness?

Why do you care?

This topic interests us because we believe that

Why should we care?

Description of your data.

For the current research, we utilized a publicly available data set obtained from the UCI Machine Learning Repository, which contains patient reviews for specific drugs being taken to treat various conditions (Gräßer, Kallumadi, Malberg, & Zaunseder, 2018). The authors of the data set obtained the patient drug review data by pooling across multiple online pharmaceutical review sites. Each patient review for a specific drug consisted of the following: The drug name (brand), overall satisfaction rating, perceived effectiveness rating, side effects rating, the condition being treated, benefits comment, side effects review, and overall comments. Overall Satisfaction was rated on a scale of 1 to 10, with 10 representing highest possible satisfaction. Perceived Effectiveness and Side Effects ratings were given on a 5-step Likert response scale (Table 1). The remaining review aspects (benefits comment, side effects comment, overall comments) were written responses and excluded from our analyses.

DrugName: the name of the drug
Satisfaction: Rating (10-point scale, 10 being highest satisfaction)

Effectiveness: 1 - Ineffective; 2 - Marginally Effective; 3 - Moderately Effective; 4 - Considerably Effective; 5 - Highly Effective

Side Effects: 1 - Extremely Severe Side Effects; 2 - Severe Side Effects; 3 - Moderate Side Effects; 4 - Mild Side Effects; 5 - No Side Effects

Type: Chemical type of the drug

Here is a snapshot of our data

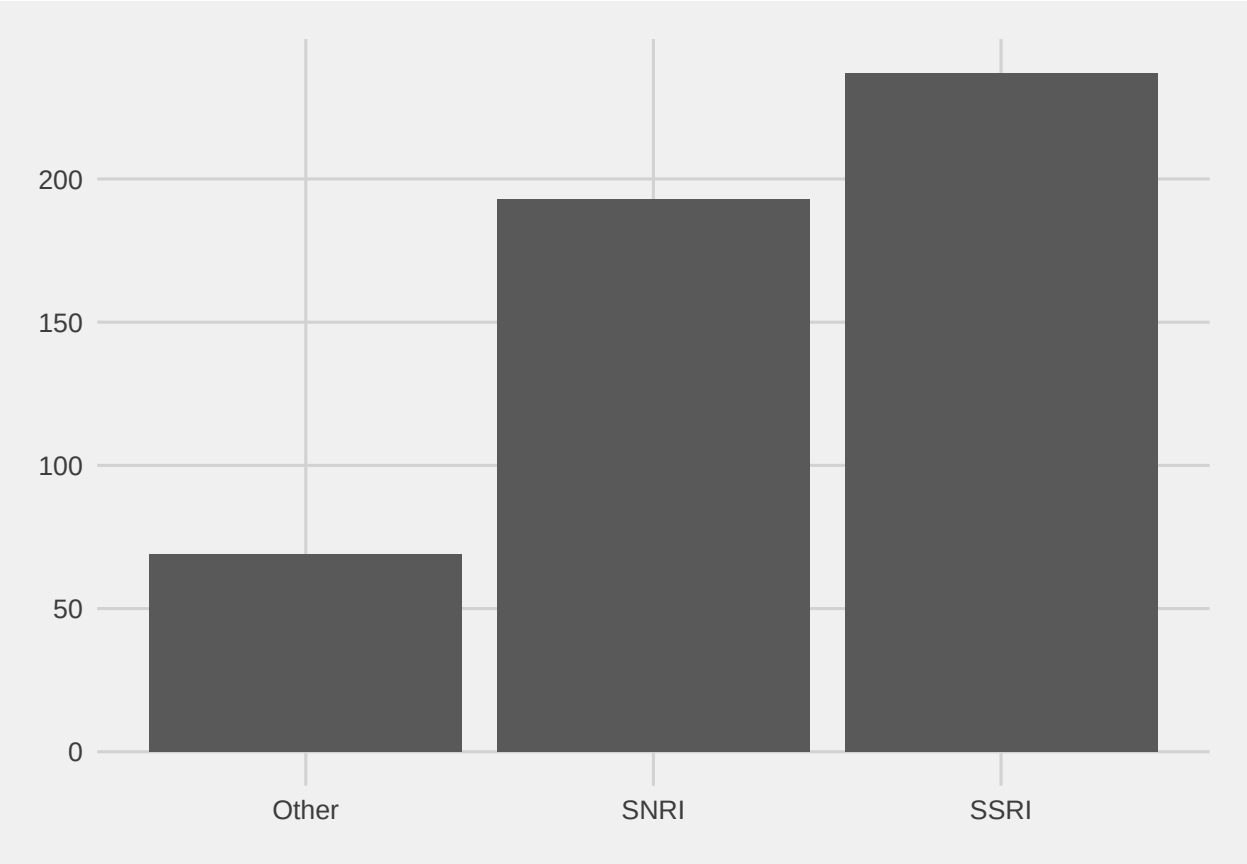
drug	rating	effectiveness	sideEffects	type
effexor	1	2	1	SNRI
effexor	9	5	4	SNRI
lexapro	3	2	2	SSRI
cymbalta	7	4	4	SNRI
effexor	10	5	5	SNRI
paxil	8	4	4	SSRI

The raw dataset included patient reviews on drugs taken for various non-psychiatric (depression-related) medical conditions/needs (e.g. common cold, acid reflux, high cholesterol, contraceptives, etc.). We filtered all cases where depression was at least one of the conditions listed by the patient as a reason for drug treatment. To simplify our analyses and to maximize sample size, we chose not to further subdivide filtered cases by presence or absence of comorbid conditions; cases with condition listed as "depression & anxiety" were not differentiated from those listing only "depression". This filtering resulted in a total of 499 cases. Next, we converted the perceived effectiveness and side effects ratings responses to be numerically represented on an ordinal scale ranging from 1 to 5, representing the lowest to best possible ratings respectively (Table 1). We also defined an additional categorical variable, "Drug Type", which was not included in the original data. This variable provides a higher order grouping of specific drug brands in terms of the primary mechanisms of action by which they achieve their pharmacological effects. For example, drugs such as Prozac and Citalopram belong to a family of drugs known as selective serotonin reuptake inhibitors (SSRIs).

Choice of Drug Brands and Type

Based on our filtering criteria, we identified 46 distinct drug brands across multiple drug types. One question we aimed to address was how different drug types were distributed across the patient sample, as indexed by the relative number of reviews associated with specific drugs.

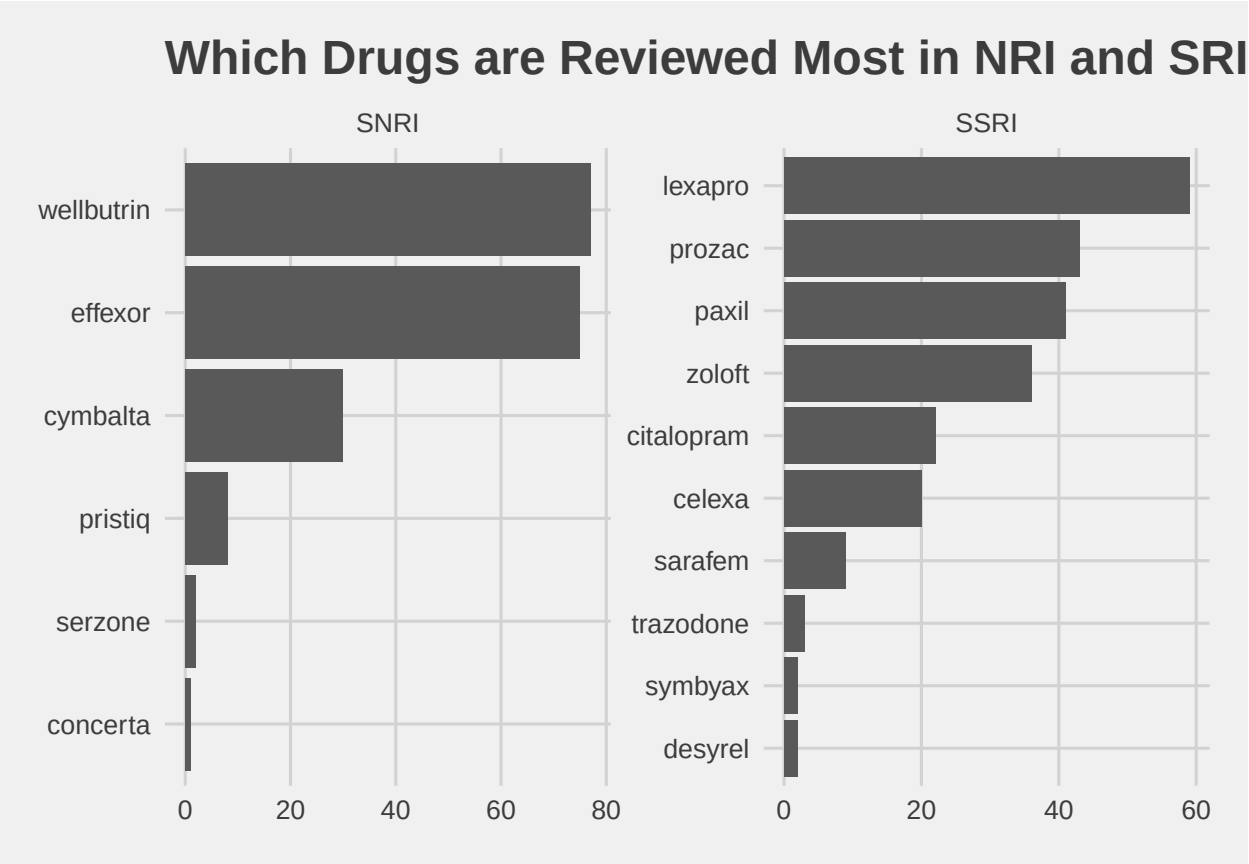
SSRIs and SNRIs accounted for a vast majority of the reviews in the data (Figure 1). Out of the 499 patient reviews, 193 (39%) were for drugs classified as SNRIs, and 237 (47%) for drugs falling under the SSRI category. The "Other" category encompassed drugs spanning several unique types including, but not limited to, monoamine oxidase inhibitors (MOAIs), amphetamines, benzodiazepines, atypical antipsychotics, and tricyclic antidepressants. Although each of the aforementioned drug types are like SSRIs and SNRIs, insofar as they each represent distinct biochemical mechanisms of action, we chose to group all other drugs into a single category due to the relatively small number of reviews available for drugs not accounted for by the two dominant categories. That SSRIs are the most popular choice of antidepressant drug is consistent with existing literature.



Answering Our Questions.

Simple EDA

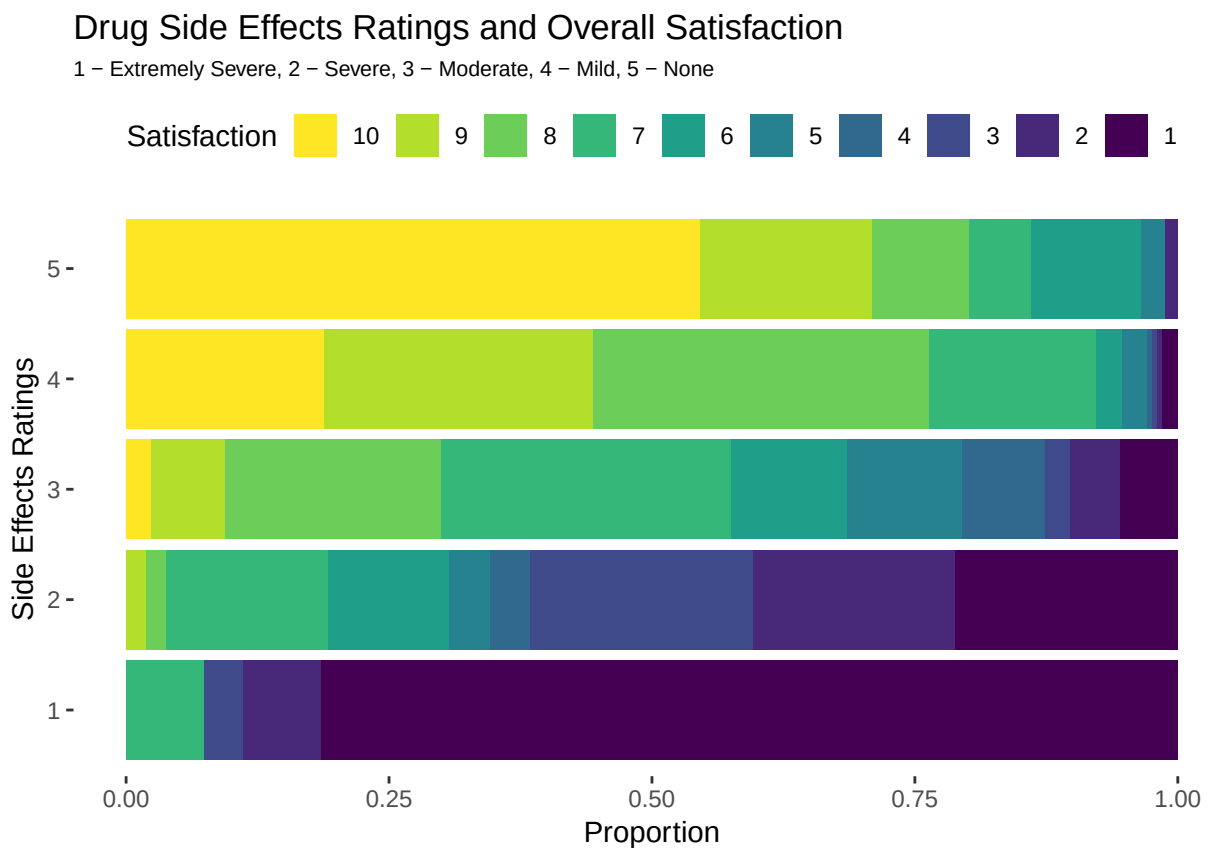
We wanted to familiarize ourselves with our data by getting a general sense of the relationships between our variables.



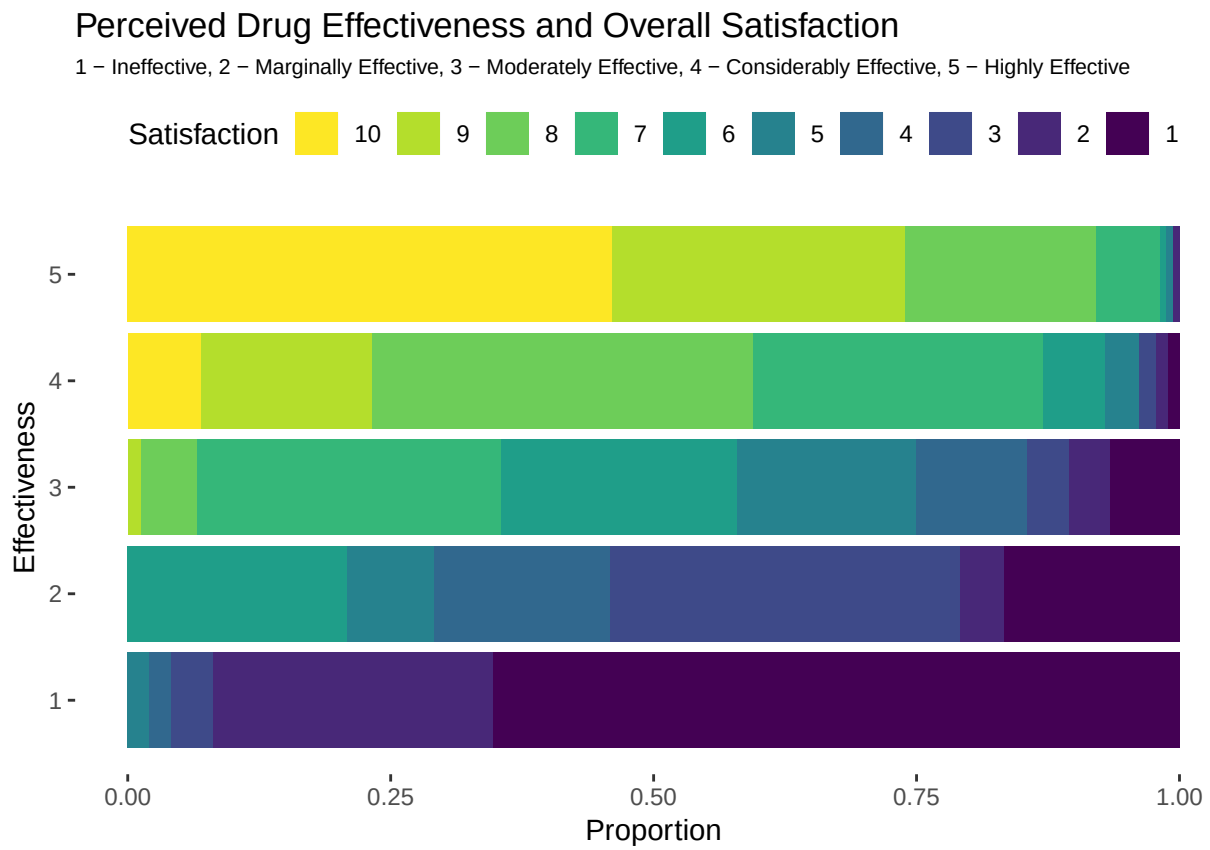
Here we see counts for each drug in their respective drug family type. We didn't include the other column because it has a large amount of different drugs that make up such a small proprotion of the overall data. The SRI group has a few more drugs than NRI, NRI has two drugs that are more frequent than the most frequent SRI drug.

Satisfaction Measured Against Side Effects and Effectiveness

Next we examined how the users' overall satisfaction are related to the users' reported side effects and effectiveness levels.

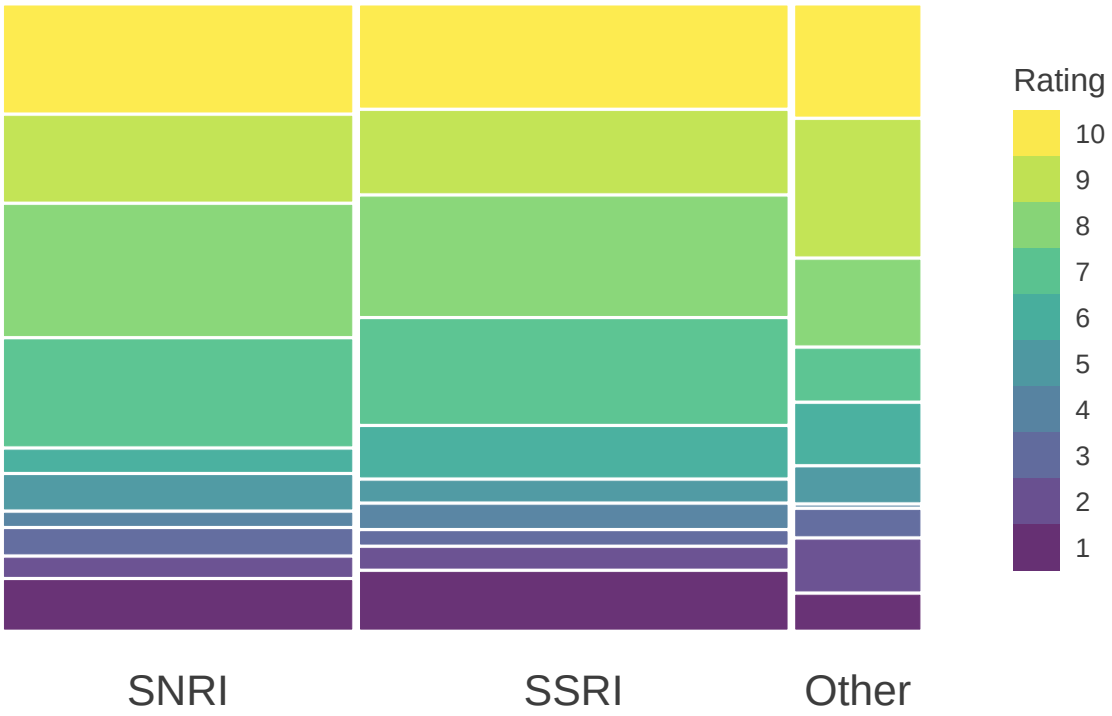


The plot revelas that the worse the side effects are, the least satisfied the subjects were. This generally makes a lot of sense because people who are already feeling bad and are taking medications to mitigate their ailments most likely don't like feeling additionally worse. It's interesting to see how over half of the users reporting no side efects rate the drug 10/10, while almost 80% of users with extremely severe side effects have a satisfaction level of 1.



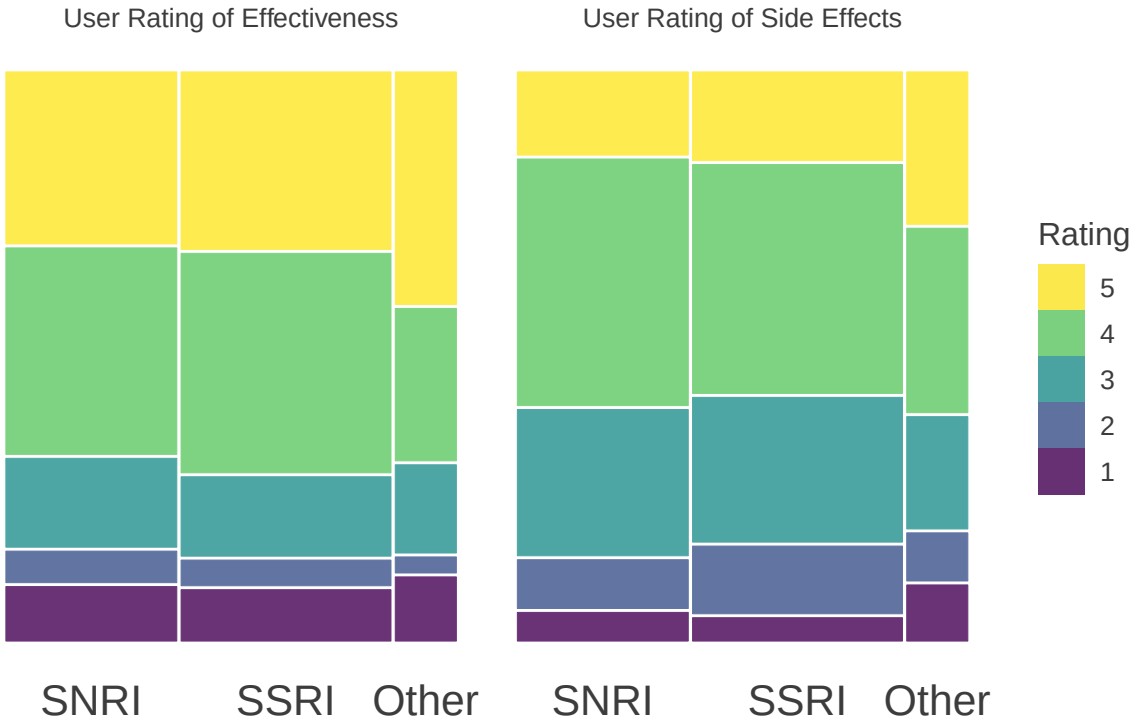
The above plot shows that the more effective the drug was, the more satisfied the users were. The response proportions are not as extreme as side effects although. It is worth mentioning that it is a possibility that users have a tendency to select the most extreme values, and it calls into account how accurate a Likert variable can truly be due to its subjective nature.

Overall Satsifaction By Drug Type

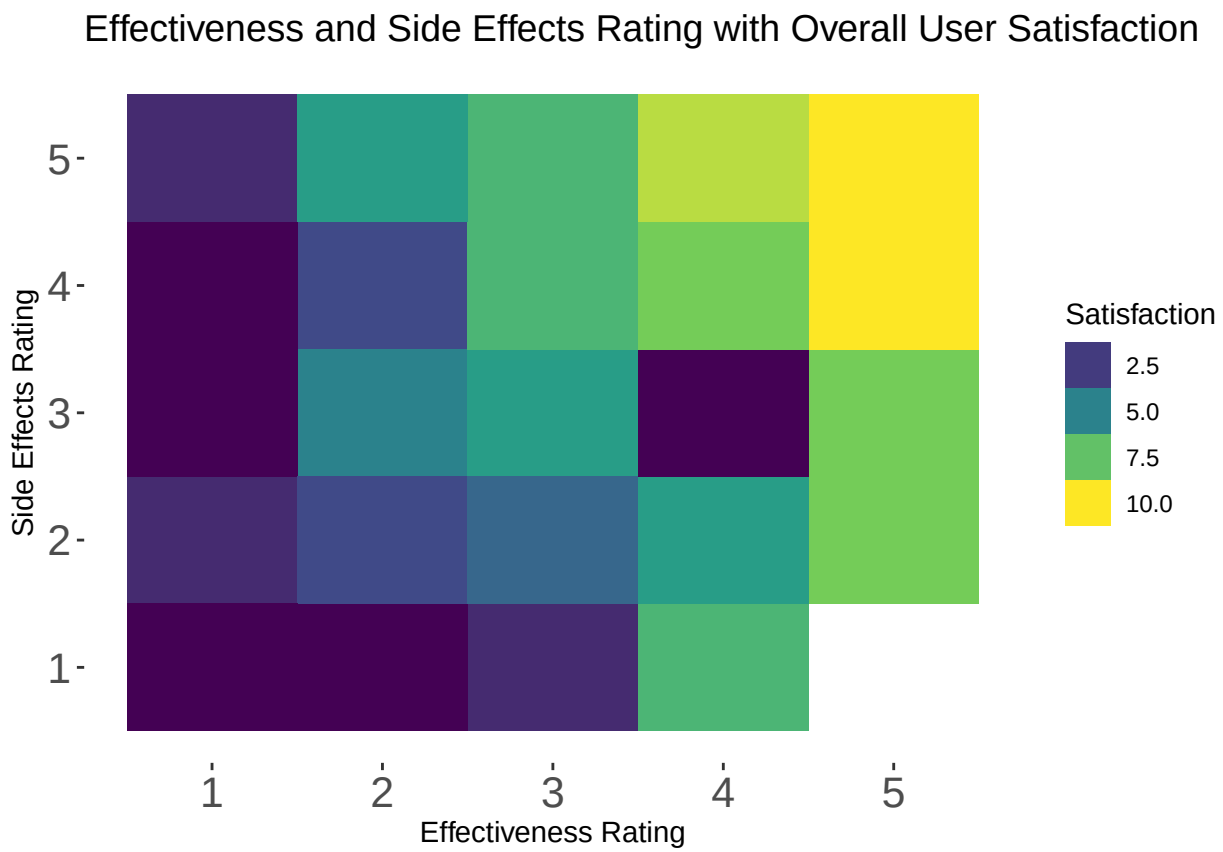


This mosaic plot shows that for the most part the three groups are fairly similar in terms of rating. The differences might be attributed to just random chance.

Ratings of Effectiveness & Side Effects Across Drug



In the same vein, the three drug types perform fairly, with some slight variations that are difficult to distinguish whether the differences can be attributed to randomness or not.s

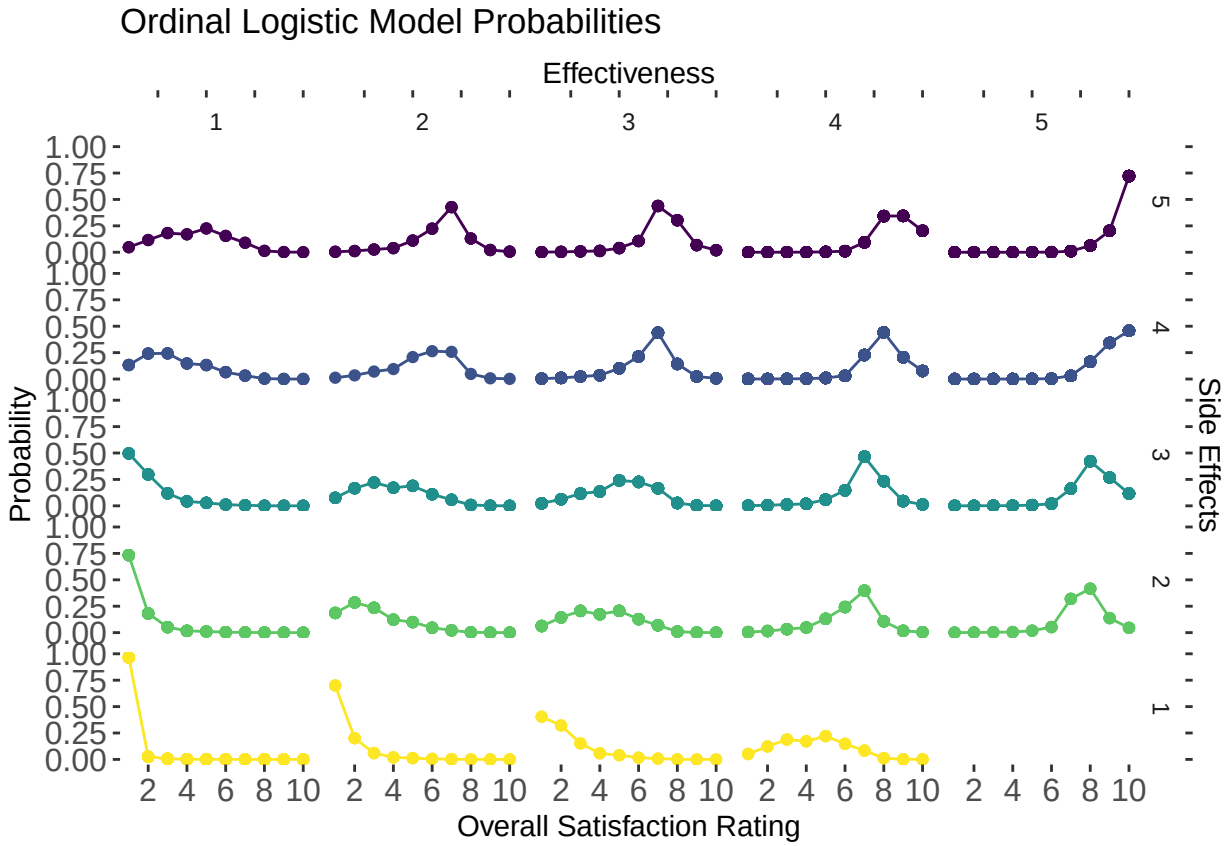


This heatmap shows how side effects and effectiveness are related to how satisfied the user is with their medication. There appears to be a trend that as effectiveness increases and side effects get less severe that satisfaction increases, however it is far from perffect. When effectiveness is four and side effects is three, the heatmap value is extremely low.

Model Creation

Ordinal Logistic Regression Model

We wanted to fit some models using our data to try and see if we could gain any more insight into how user satsifaction can be predicted using our drug data. The first model we looked at was an ordered logistic regression since our response variable in on a scale from 1 to 10. I created three models, which each model using side effects and effectiveness as predictors. The first model only uses those two, the second model takes into consideration drug type, and the third model takes into consideration the drug itself. The first model has the lowest AIC, which is a statistic produced from the model output used to compare against models. So even though it doesnt have the lowest residual deviance out of three models, it is the most interpretable model and lowest AIC, so we'll use that.



This plot shows the probabilites from the ordinal model. We can see that the model generally predicts high satisfaction as effectiveness and side effects increase. The probabilites are all generally low though, which suggests that it's pretty hard to accurately make a prediction based on this data alone.

Multinomial Logistic Regression Model

We also created multinomial models to see how well it would do treating the response as unordered. We made a few models all containing side effects and effectiveness as predictors. We also exmained drug type, the drug itself, and interactions between drug type and effectiveness and side effects. Once again we went with the simplest model since it had the best AIC and not a significantly worse deviance.

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## [1] 1218.239
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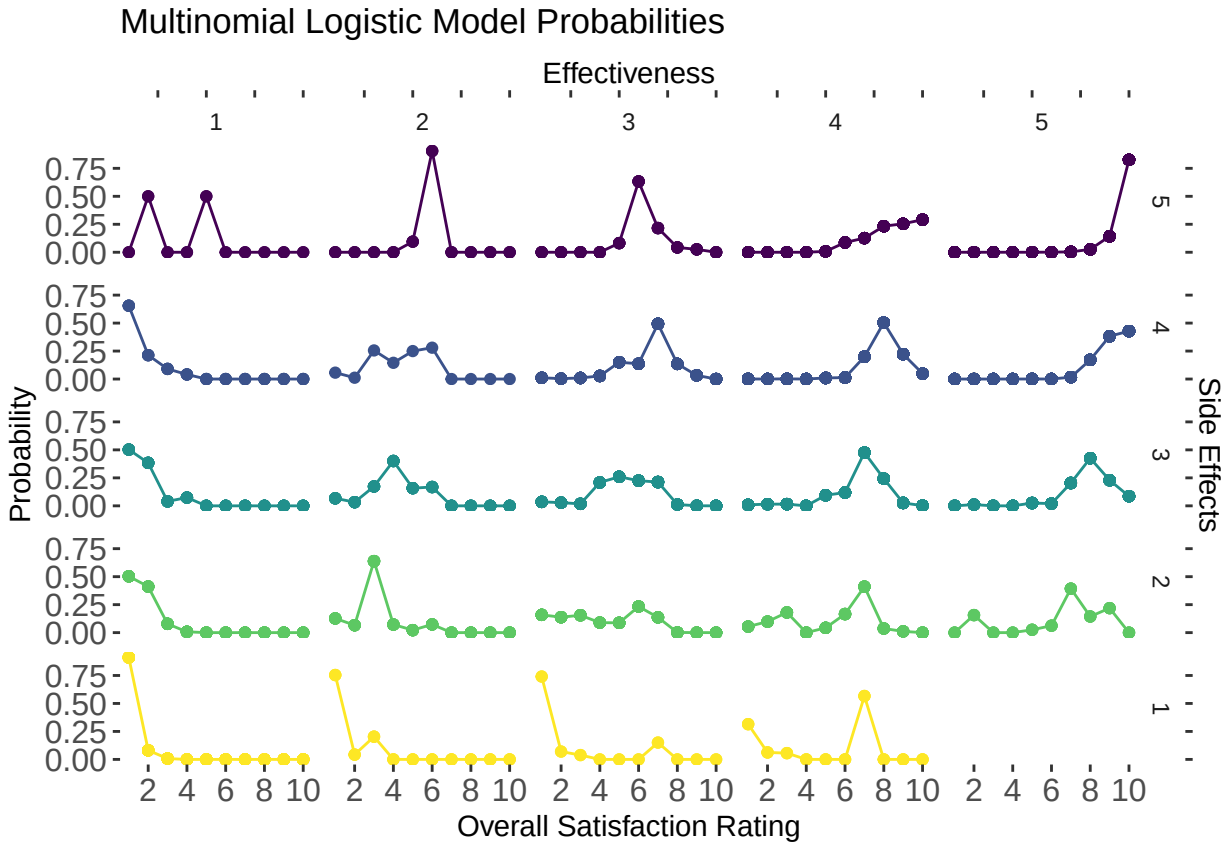

The mulitnomial model appears to be a little more decisive than the ordinal models, with most of the facets having a clear peak probability for one of the ratings. The deviance of this model is 1218.239, which is still extremely high, so this model probably isn't great for prediction.

State answers to your questions;

Describe how you came to these answers;

Explore the implications to your answers. For example, if your answer is a non-trivial model, plot the fit and describe what's going on in words.

Identification of work left to do/limitations.

References

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