

Saha, K., Sugar, B., Torous, J., Abrahao, B., Kiciman, E., & De Choudhury, M. (2019, July). A Social Media Study on the Effects of Psychiatric Medication Use. In *Proceedings of the International AAAI Conference on Web and Social Media* (Vol. 13, No. 01, pp. 440-451)., <https://www.aaai.org/ojs/index.php/ICWSM/article/view/3242>

A SOCIAL MEDIA STUDY ON THE EFFECTS OF PSYCHIATRIC MEDICATION USE

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- *One in Six* Americans take **psychiatric medications**
- *Five of the top 50* drugs sold in the U.S. are **psychiatric medications**

EFFECTS OF PSYCHIATRIC MEDICATIONS

- Their mechanism of action poorly understood
- Selection of drug treatments is primarily on trial-and-error basis
- Understanding the effects of psychiatric medication is important
- Clinical trials and reports of adverse events
- Limitations with the existing methodologies

OUR WORK

...conducts a **large-scale social media study** of the effects of 49 FDA approved antidepressants across four major families (SSRIs, SNRIs, TCAs, and TeCAs)

...adopts a **patient-centered approach** to study the effects of these drugs as reflected and self-reported in **longitudinal social media data**

PATIENT-CENTERED APPROACH

- ❖ Historically, psychiatric care has adopted a “Disease-Centered Model”
 - Neglects the psychoactive effects of drugs
- ❖ Consequently, a “Drug-Centered Model” has been advocated
 - Care becomes more collaborative
- ❖ “Patient-Centered Model”

Twitter Data

Stream Data

Psy. Drug mentions in 2015-16

Self-reports of Intake

Account created before 2015?

Personal Drug Intake Classifier

Compile Treatment & Control Data

Control User Data

Treatment User Data

Construct *Before* and *After* samples data

Control Date

Treatment Date

- Covariates
- Suicide
- Psychosis
- Anxiety
- Stress
- Depression
- n-grams
- LIWC

Compute covariates on data before treatment dates

Control Covariates

Treatment Covariates

Stratify similar users on propensity scores



User strata

- Outcomes
- Suicide
- Psychosis
- Anxiety
- Depression
- Cognition
- N. Affect
- P. Affect

Compare the outcomes of similar users

Relative Treatment Effect (RTE) per drug

DATA



List of
psychiatric
medications

49 medications



Twitter posts
mentioning
psychiatric
medications

601,134 posts
by **230,573**
unique users



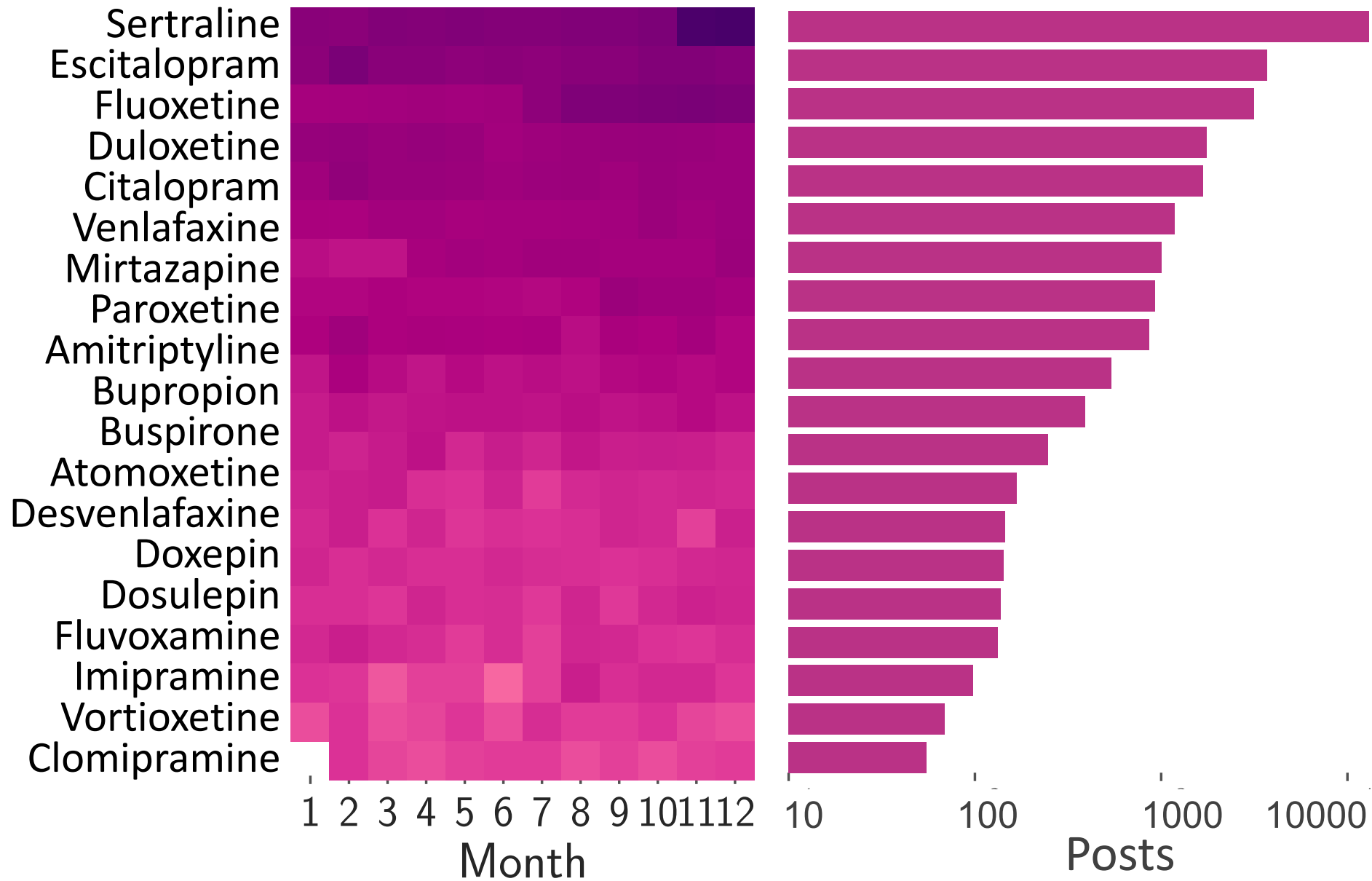
Medication Self-
intake classifier
(Klein et al.
2017)

93,275 self-
intake posts

*I'm taking my first dose of **X** tonight.*

*First day on **X**. Dose 1 taken, and I
already feel weird from it.*

*My no-med experiment went
horribly awry, so I'm starting **X**
today.*



TREATMENT AND CONTROL DATASET

- Twitter timelines of 23,191 users who self-reported psychiatric medication intake (2015-2016) [Treatment]
- Random Twitter user timelines (283,374 users) [Control]

STUDY DESIGN

- Conduct **Observational Study**
- Adopt a **Causal Inference Framework** based on **Matching**
- Compare the outcomes of **similar (matched) individuals**, those exposed to a **treatment** (psychiatric drug intake), and those who were not.
- Use **stratified propensity score** analysis

BEFORE AND AFTER SAMPLES

- For **Treatment** users, the before and after the date of the first intake of medications
- For **Control** users, we simulate **placebo** dates by non-parametrically assigning dates from the distribution of **Treatment dates**.

MEASURING SYMPTOMATIC OUTCOMES

- Affect and Cognition
- Depression, Anxiety, Stress, Psychosis, and Suicidal Ideation

AFFECT, COGNITION

LIWC categories of

- *positive and negative affect* for **affect**,
- *cognitive mechanics, causation, certainty, inhibition, discrepancies, negation, and tentativeness* for **cognition**

DEPRESSION, ANXIETY, STRESS, PSYCHOSIS, SUICIDAL IDEATION

- Supervised learning classifiers trained on Reddit domain-specific datasets
- Positive class from r/depression, r/anxiety, r/stress, r/psychosis, r/SuicideWatch
- Negative class from 20M Reddit posts gathered from 20 subreddits (eg. r/AskReddit, r/aww, r/movies).

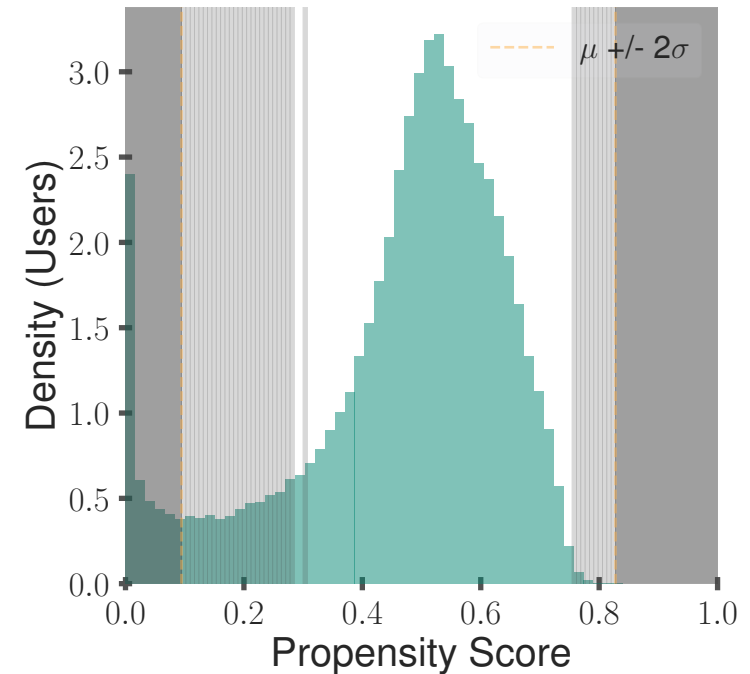
MATCHING FOR CAUSAL INFERENCE

Covariates:

- Social Attributes (#tweets, #followers, #followees, duration on platform, frequency of posting)
- Top 2,000 unigrams
- Normalized psycholinguistic occurrence of LIWC categories
- Baseline mental health status (aggregated use of depression, anxiety, stress, psychosis, and suicidal ideation)

PROPENSITY SCORE ANALYSIS

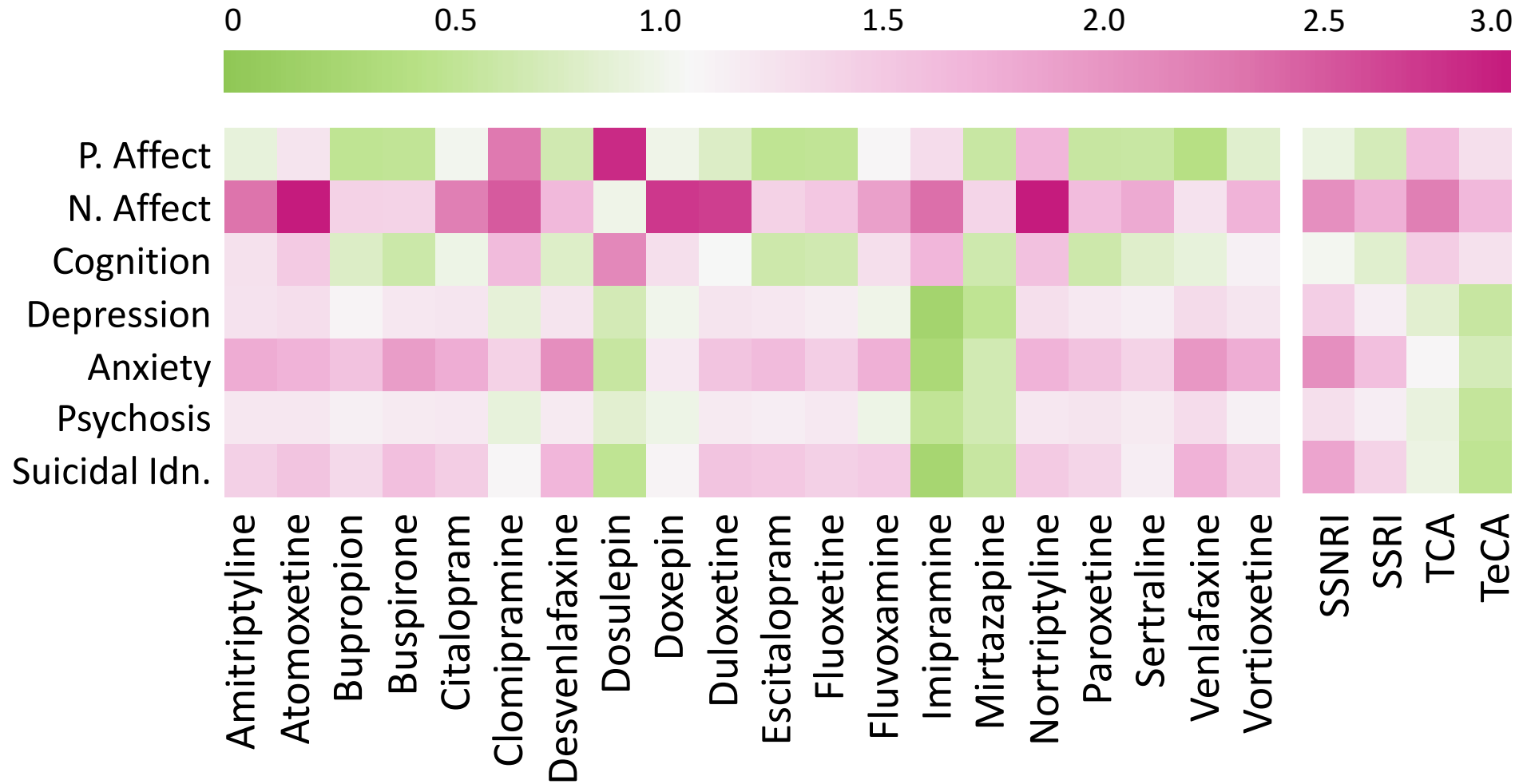
- Use logistic regression classifier to estimate propensity scores on covariates
- 100 strata of equal width of propensity scores
- Standardized differences to measure balance of covariates























TREATMENT EFFECT

- Relative Treatment Effect (RTE)
 - Ratio of change in outcome of Tr. And Ct. users per stratum
- Individual Treatment Effect (ITE)
 - Regress on psycholinguistic attributes and outcome in Ct. users
 - Predict on attributes of matched Tr. users
 - Ratio of actual (counterfactual) and predicted outcome

RELATIVE TREATMENT EFFECT



INDIVIDUAL TREATMENT EFFECT

Attribute	Coefficient	Attribute	Coefficient
Sertraline		Fluoxetine	
<i>Past Tense</i>	 0.52	<i>Cognitive Mech.</i>	 0.35
<i>Tentativeness</i>	 0.35	<i>Present Tense</i>	 0.34
<i>1st P. Singular</i>	 -0.18	<i>Relative</i>	 0.31
<i>Aux. Verbs</i>	 -0.23	<i>Percept</i>	 0.30
<i>Cognitive Mech.</i>	 -0.25	<i>Conjunction</i>	 -0.10
Escitalopram		Duloxetine	
<i>Article</i>	 0.22	<i>Cognitive Mech.</i>	 0.46
<i>1st P. Singular</i>	 0.10	<i>Relative</i>	 0.44
<i>Social</i>	 -0.07	<i>1st P. Singular</i>	 0.41
<i>Bio</i>	 -0.13	<i>Social</i>	 -0.20
<i>2nd Person</i>	 -0.18	<i>Work</i>	 -0.26

- **Blues** indicate greater likelihood of improvement
- **Reds** indicate greater likelihood of worsening

DISCUSSION

TAKEAWAYS

- Social media is an effective sensor to scalably detect behavioral changes in those who initiate treatment via (self-reported) use of psychiatric medications
- Observe that people's online behaviors change in some unexpected ways following drug intake

POLICY AND ETHICS

- Potential negative consequences of this work
- Ethical complexities
- Self-treatment

CLINICAL IMPLICATIONS

- Patient-Centered Approach to Pharmacological Care
 - Complementary insights into the effects of drugs
 - Pre-treatment signals seem to be predictive of individual drug success
- Drug Repurposing
 - Low cost and high volume assessments of people's own reports and perceptions related to antidepressants' use

TECHNOLOGICAL IMPLICATIONS

- Technologies for Regulatory Bodies
- Technologies for Drug Safety Surveillance
- Technologies to support Digital Therapeutics

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Thank You

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