

# Measuring Mood Instability Using a Generative Model of Affect

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## Background

- Mood instability is characteristic of bipolar (BD) and borderline personality (BPD) disorders.
- It is not clear how to conceptualise and measure mood instability.
- One approach is to develop a generative model describing why mood changes over time and estimate the states of the model using an ideal Bayesian observer.
- We describe such a model here and use it to infer distinct types of mood instability in BD and BPD patients as well as characterising the effect of lithium on mood instability.

## Methods

- A recursive, grid-based Bayesian filter estimated two causes of mood instability: change in the mean of the mood generative process (volatility) and variation in the expressed mood (noise).
- Daily mood ratings from the AMoSS (up to 3 years of data from 51 BD, 35 BPD and 51 control participants) and Oxlith (35 BD patients randomised to 4 weeks of lithium or placebo) studies were analysed.

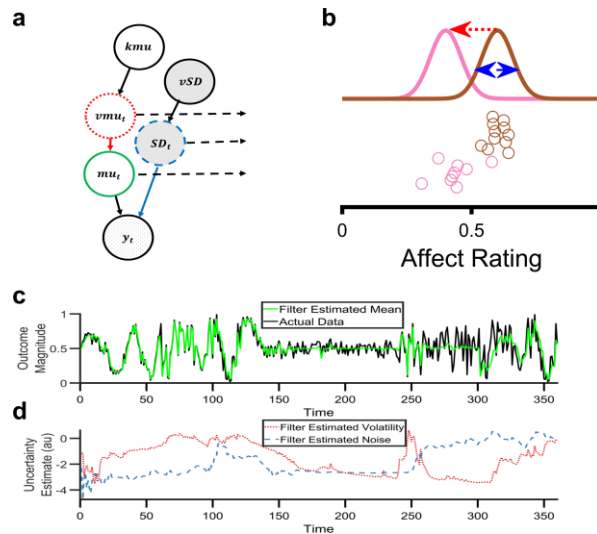
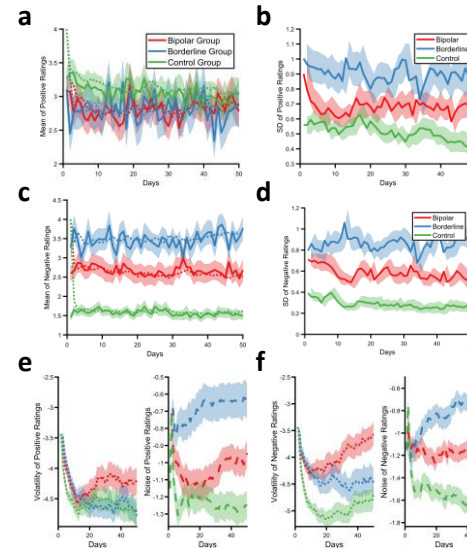


Figure 1: The Model

**a**, the generative process: Mood ratings ( $y_i$ ) are drawn from a gaussian distribution with a mean ( $\mu_{t_i}$ ) and standard deviation (noise,  $SD_i$ ). The mean can change between draws (volatility,  $vmu_i$ ). The noise and the volatility can also change between draws ( $vSD$ ,  $k\mu$ ). **b**, causes of variability: The model describes two immediate cause of variability in the ratings: volatility, red arrow (the mean of the gaussian has changed) and noise, blue arrow (the SD of the gaussian). **c** and **d**, the Bayesian filter. Inverting the generative model from **a** allows estimation of the state of the model given observed mood ratings. **c** black line synthetic data with high/low volatility and noise, green line model estimated mean ( $\mu_{t_i}$ ). **d** model estimated volatility ( $vmu_i$ ) and noise ( $SD_i$ ) from same data

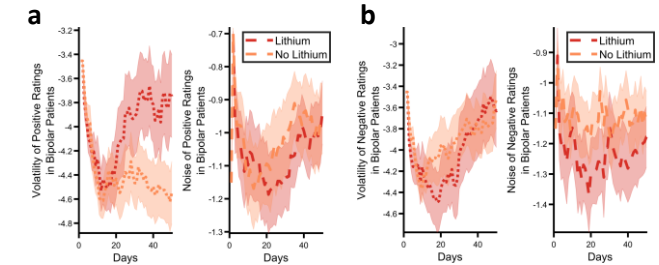
## Bipolar Disorder and Borderline Personality Disorder are associated with specific types of mood instability



**a-d** mean and standard deviation of raw positive (**a,b**) and negative (**c,d**) mood ratings across 50 days. Variability in both positive and negative ratings (here measured as standard deviation) is greatest in borderline group, then bipolar group, then controls for both (effect of group  $p < 0.001$ ). Previous work (Tsanas et al. 2016) describes the same ordering for other measures of variability (RMMSD, entropy, TKEO). **e-f** model derived estimates of variability across the same 50 days indicate a specific association between type of variability and diagnosis (type of variability x group  $p < 0.001$ )—bipolar group show higher volatility, borderline group show higher noise.

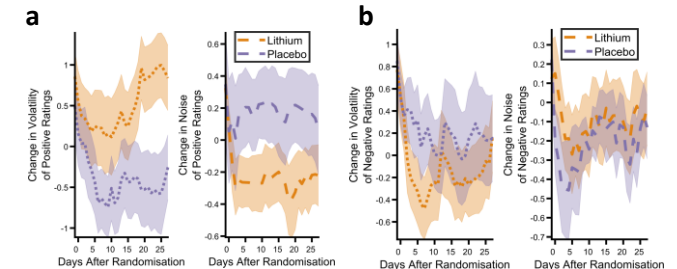
## Results

### Ongoing lithium treatment is associated with a specific increase in positive volatility in the cohort study



Bipolar patients treated with lithium ( $n=22$ ) showed greater positive affective volatility than those not treated with lithium ( $n=29$ ) (main effect of treatment  $p=0.02$ , **a, left panel**), with no effect on other measures of mood variability (all  $p > 0.8$ )

### Lithium leads to increased positive volatility in a randomised trial



Lithium treatment, relative to placebo, caused a specific increase in positive volatility (time x group x type of variability x valence  $p=0.008$ ), time x group for positive volatility  $p=0.02$  (**a, left panel**), other types  $p > 0.19$ . Lithium treatment did not influence the mean or SD of ratings.

## Conclusion

A generative model of affect identified distinct types of mood instability in BD and BPD patients and characterised a targeted effect of a known mood stabiliser. By elucidating mechanistic processes computational approaches may be able to identify novel treatment targets in psychiatric disorders.