

Identification of Stratified Social-Behavioral Markers in Neuropsychiatric Disorders by using smartphone technology

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Facts & Figures










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Introduction:

The concept of passive behavioral monitoring (digital phenotyping[1]) data is characterized by the unobtrusive, and continuous collection of social and behavioral data. This data is collected in real-time and within the natural environment of individuals. The social and behavioral data is collected by utilizing the rich temporal trace of social and behavioral data that is generated as a by-product of smartphone sensors.

We have developed a passive behavioral monitoring application, called BeHapp (<https://behapp.org/>). This application collects the temporal trace of behavioral data by using the large extent of smartphone sensors available (Figure 1).

Figure 1: BeHapp data modalities

	Call History		Accelerometer
	SMS Messaging History		Ambient noise
	Interval based WiFi Scans		Ambient light
	Interval based Bluetooth Device Scans		
	Location Data		
	App Usage		

Aim:

Our aim is to identify objective and quantitative measures for aberrant social behavior in neuropsychiatric disorders by using smartphone data.

Methodology:

A total of 82 age- and gender-matched participants collected BeHapp data. These participants installed BeHapp on their own Android smartphone. In total we included:

- 16 Alzheimer's Disease (AD)
- 15 AD Controls
- 28 Schizophrenia (SZ)
- 23 SZ Controls

These participants are included over three different ongoing studies. For the preliminary results we used three smartphone modalities to generate features that relate to social behavior. These modalities include application usage, communication logs and location data. Features are based on previous literature [2,3,4] and log transformed for normality when needed.

Results:

Figure 1: AD and SZ patients spent more time at home.

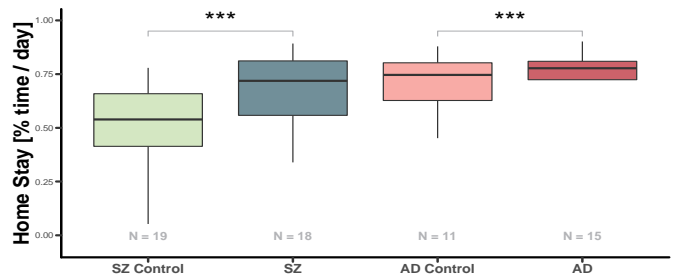


Figure 1: Relative to their controls, AD and SZ patients spent more time at home during the day. These results suggest that AD and SZ patients are more socially withdrawn than their sex and age-matched controls.

Figure 2: SZ patients call more frequently with the same persons

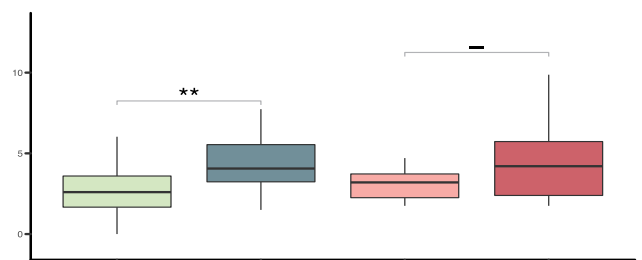


Figure 2: Average repetition for a single contact id per group. These results suggest that outgoing and incoming calls for SZ patients are more focused on a smaller group of individuals in comparison to their controls.

Figure 3: SZ patients call significant more

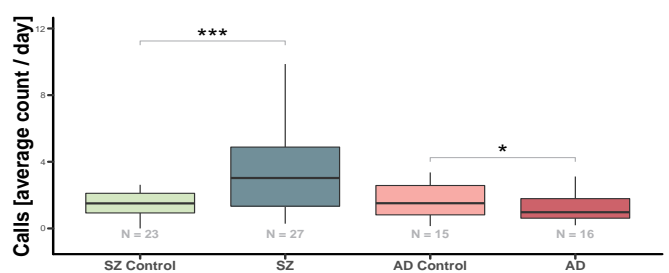


Figure 3: Average number of calls per day per group. Here the results suggest that SZ patients call significant more than their controls. In combination with the Figure 2 it suggest that the call more but more often with the same person. Results also showed that AD patients call significant less than their controls.

Value of IMI collaboration:

As a results of the networking opportunities in IMI we were able to create awareness of our application in IMI associated institutes. As a consequence we collected data from variety of patients populations what allowed us to obtain relevant and unique behavioral insights for these populations.

Impact & take home message:

Visual inspection of the individual features suggest disease specific changes in the social behavioral patterns of neuropsychiatric patients. In addition, we also conclude that passive behavioral monitoring is a new and capable method for measuring specific changes in human behavior.

BIBLIOGRAPHY

1. Onnela, J., Rauch, S.L. (2016). Harnessing Smartphone-Based Digital Phenotyping to Enhance Behavioral and Mental Health. *Neuropsychopharmacology*, 41, 1-12.
2. Palmius, N., Tsanas, A., Saunders, K.E.A., Bilderbeck, A.C., Geddes, J.R., Goodwin, G.M., de Vos, M. (2017). Detecting Bipolar Depression from geographic location data. *IEEE Transactions on Biomedical Engineering*, 64(8), 1761-1771.
3. Saeb, S., Zhang, M., Kar, C. et al. (2015). Mobile phone sensor correlates of depressive symptoms severity in daily-life behavior: An exploratory study. *Journal of Medical Internet Research*, 17(6), 1-11
4. Wang, R., Aung M., Abdullh, S., et al. (2016). CrossCheck: Towards passive sensing and detection of mental health changes in people with schizophrenia. *Conference on ubiquitous computing*, 1-12