Towards Understanding the Life of Neurodiverse College Students Through Visualization

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ABSTRACT

We investigate challenges and opportunities in visualizing time-series data to better understand the unique challenges experienced by neurodiverse college students in everyday life. We present visualizations based on 2,372,838 units of sensor data and 1,146.63 hours of sleep data collected from a mixed-method study with 20 college students. Our visualizations highlight unique patterns of stress, navigation, and sleep quality experienced by neurodiverse college students. The proposed visualizations are a first step in investigating how to visualize such data to better represent the lived experiences of neurodiverse students which can facilitate technology design and policy making.

Keywords: Neurodiverse Students, Data Visualization, Fitbit

Index Terms: H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

1. INTRODUCTION

In the USA, over half a million children with Autism Spectrum Disorder (ASD) will be in their adulthood over the next decade [1, 2] and 45% of them will pursue post-secondary degrees [1, 3]. Unfortunately, it is estimated that only 38.8% of these students will complete their degrees [3]. To prevent or reduce this large dropout, it is critical to understand the experience of college students with ASD. In this paper, we use the term "Neurodiverse" to refer to individuals with ASD and neurotypical to refer to individuals who don't identify as individuals with autism.

We propose a set of visualizations that can serve as a starting point in understanding how to display large, diverse, and complex data in ways that can assist sense-making of the challenges faced by neurodiverse college students. For example, by visualizing these data we learned about between- and within-group variability related to experienced physiological distress, navigation patterns, and sleep quality. Such visualizations together can paint a rich picture of the daily lifestyle of neurodiverse students and how that compares with neurotypical students.

In summary, our work makes two key contributions. First, we identify challenges associated with effectively representing physiological and contextual data collected from neurodiverse students to facilitate sense-making of their everyday lives. Second, we present visualizations based on 2,372,838 units of sensor data and 1,146.63 hours of sleep data collected from 20 participants. To the best of our knowledge, this is the first attempt to visualize a large set of objective data collected from neurodiverse users that can assist them to reflect on their everyday living experience.

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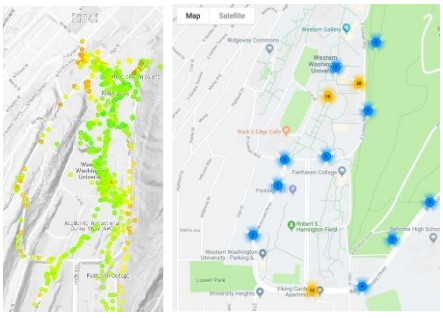
2. DATA COLLECTION AND PROCESSING

We conducted a mixed-method study with 20 college students (10 neurotypical and 10 neurodiverse) from two post-secondary institutions located in the Pacific Northwest of USA. For each participant, the study consisted of a pre-interview, followed by a weeklong field study, and a post-interview. From the field studies, we collected large amounts of physiological data (1,738,645 units of heart rate, 315,345 units of step count, and 1,146.63 hours of sleep) and contextual data (318,848 units of geographical location) using Fitbit and mobile phone.

3. VISUALIZATION

3.1 Understanding Physiological Distress

Stress is an expected aspect of life for students which can negatively impact the quality of life if not addressed properly. This is especially critical for neurodiverse students who experience higher levels of stress and have a higher rate of drop out [1,3]. To help students de-stress, the first step is understanding factors that induce stress. One of the factors that we examined is "physical location" and its influence on stress. Our choice is informed by research on stress management and which identified physical location as one of the major factors that contribute to stress [4]. We visualized variations of heart rate in different locations, which is a well-established measure used to calculate stress.



1(a) 1(b)

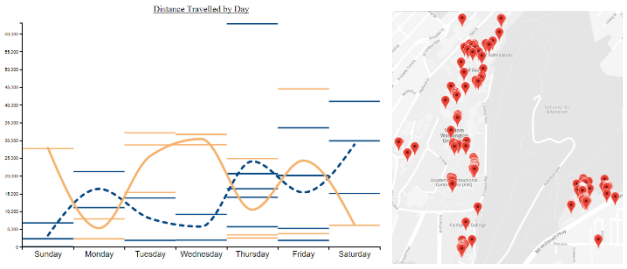
Figure 1: Relationship between location and physiological stress experienced by participants. Figure 1(a). Stress experienced by an individual user and 1(b) Locations where participants spent time.

Figure 1 (a) presents a visualization where we chose to plot variations of heart rate data as colored markers placed on a map and Figure 1(b) where data points are grouped by location. These visualizations highlight physical regions of experienced stress as well as average stress experienced by a participant at that specific location using marker clusters (Figure 1(b)). The color of these markers correspond to the participant's variation of heart rate where red represents high stress, green represents the participant's lowest stress, and a gradient of yellow in-between represent the distance between these two extremes. The benefits of such visualizations are

twofold. First, participants can become better aware of their stress, which could lead to better stress management (e.g., avoiding stressful locations when possible). Second, policymakers can use such visualization to identify high-stress locations on campus and strategically create stress reduction facilities (quiet rooms, counselling centers) near such areas to provide better access to stress management opportunities.

3.2 Examining Navigation Pattern and Lifestyle

By examining participants' navigation patterns, we hope to answer a specific question: Do navigation patterns differ between neurotypical and neurodiverse college students and if yes, how? For many students, attending college is a dramatic change in their lives and it can be difficult to adapt to their new independence. Students navigation patterns reflect their freedom through the choices of where they travel and the locations where they spend time and closer examination of navigation may reveal how students have adapted to their newfound independence.



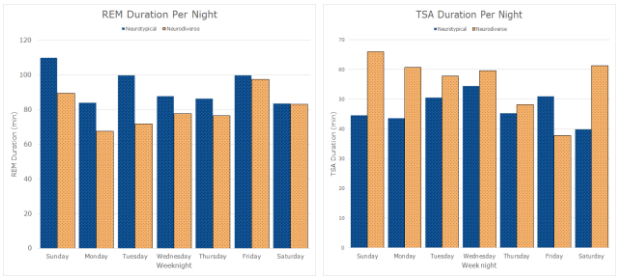
2(a) 2(b)

Figure 2(a). Distance travelled by individual users by days-of-week and 2(b) Locations where students spent time, left and right clusters indicate academic buildings and residents near campus.

We explored various techniques to visualize participants' navigation patterns. Figure 2(a) uses colors to differentiate the distance travelled by neurotypical and neurodiverse students on each day of the week. We observe that while both groups have similar navigation patterns on weekdays, it significantly varied on weekends. While neurotypical participants (dotted blue) showed an incline on distance travelled, for neurodiverse participants (solid brown), we observed a sharp decline. However, Figure 2(a) lacked access to context (where they spent time) and flexibility to examine more details. Figure 2(b) uses colored pins to mark locations where participants have spent more than 30 minutes at a time. This interactive visualization enabled filtering of the participants or groups of participants to display, the ability to toggle each overlay, as well as the ability to zoom and scroll around the map to examine details. Figure 2(b) shows two main clusters belonging to academic buildings and campus residences, revealing a highly structured lifestyle for neurodiverse students.

3.3 Examining Sleep Pattern

Sleep, and the quality thereof, is important to sustain various brain and bodily functions. To understand differences in sleep quality, we investigated two markers: rapid eye movement (REM) sleep-phase duration, and time spent awake (TSA) during the full sleep period. REM was chosen because this phase of sleep has been demonstrated to correlate with crucial brain functions such as memory consolidation, which facilitates learning. TSA was chosen because restlessness in the full sleep period demonstrates that less time was spent in the more crucial sleep stages. We utilized bar charts to visualize the group differences and used days-of-week instead of raw dates as they also indicate how sleep patterns differ depending on the time of the week. Figure 3 highlights that neurodiverse students have less REM sleep and have more awake times irrespective of days of the week.



3(a) 3(b)

Figure 3: REM sleep duration (3(a)) and Time Spent Awake (3(b)) by neurotypical (dark blue) and neurodiverse (brown) groups by days-of-week.

3.4 Challenges and Limitations

Visualizing large dataset collected using sensors and mobile phone presented many challenges. For example, we collected heart rate data from Fitbit and location data from mobile phones, which were not synced. While Fitbit collects heart rate every second, location data was collected every ~20 seconds, which required pre-processing. Another challenge resulted from scalability issues as we needed to plot a hundred thousand heart rate data points at once in the google map, which Google API had difficulty handling. To address scalability issues, we used data reduction techniques to create clusters of data instead of plotting individual data points, which may not reflect the accurate stress data at a given time. The visualizations proposed here are first steps in exploring how to represent such data that enables sense-making, pattern finding, and reflection. We are investigating other techniques to improve visualization efficacy and designing new representations that can shed light on different aspects of the lives of neurodiverse college students. In addition, we are examining intuitive visualization techniques that can be utilized as just-in-time interventions for assisting users in stress management.

4. Conclusion

We investigated how to visualize physiological and contextual data to better understand the everyday experiences of neurodiverse college students. Findings from our current research will yield valuable insights into design considerations for the visualization of everyday living. In addition, we hope effective visualizations of such data will help neurodiverse users better understand factors contributing to their stress and lead to the design of effective stress management techniques.

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