

# VISUALIZING EXPERIENCE SAMPLING DATA TO ENHANCE CLINICAL INSIGHTS INTO MENTAL RESILIENCE

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## Definitions:

ESM - Experience Sampling Method is a technique that collects real-time data about individuals' thoughts, feelings, and behaviors through repeated surveys.  
Mental Resilience - The ability to return to emotional stability after stressful events

## 01 INTRODUCTION

Mental resilience as a process is a key indicator of psychological well-being. When this recovery process is impaired, it may signal underlying or future mental health issues. Hence, mental health professionals seek ways of understanding the resilience capabilities of their patients. New technologies, like ESM, offer rich, real-time data on individuals' emotions. However, these data are often complex and hard to interpret. Consequently, visualization techniques are required, in order to transform data collected through ESM into visualizations that offer clear and actionable insights to mental health practitioners. The research question explored in this project is the following: *How can we present meaningful insights from ESM data on an individual's mental resilience after stressful events?*  
To answer the research question, firstly a review of relevant literature was carried out to understand the key concepts of mental resilience and effective visualization methods. Based on these insights, four visualizations were developed. Finally, these visualizations were evaluated through feedback from mental health practitioners to assess their usefulness in therapeutic settings.

## 02 LITERATURE ON MENTAL RESILIENCE

A literature review was first conducted to identify the key factors that define mental resilience. These insights directly informed the design and focus of the visualizations developed in this study. Firstly, Zietse et al. (2025) pointed out that the total time it takes to emotionally recover from a stressor is a central measure of resilience. Also, recovery is often non-linear, with ups and downs, not a straight path back to baseline. Additionally, Velozo et al.(2023) indicated that people whose emotions take longer to return to baseline may be more vulnerable to mental health conditions, like depression. Moreover, Almeida (2005) showed that different types of stressors have different emotional impacts and that clinicians should pay closer attention to the ones that are consistently more emotionally disruptive for the individual. Finally, Sherman et al. (2024) emphasized the effect of post-stressor activities, as engaging in meaningful activities can help speed up recovery and boost resilience.

## 03 VISUALISATION TECHNIQUES

A review of existing research was carried out in order to understand the benefits of various visualization techniques for presenting ESM data.

- Line graphs are widely preferred for visualizing temporal data. Also, they are intuitive, helping users easily spot trends and patterns - Okan et al. (2016).
- Error bars and hover-enabled details enhance the precision and interpretability of line graphs. Literature suggests that incorporating uncertainty values into visualizations is crucial for informed decision making - Karagappa et al. (2024).
- Box plots effectively summarize data distributions and allow easy comparison across different groups of data - Williamson et al. (1989).
- Heatmaps are considered a suitable tool to convey the correlation between two variables. Additionally, this format enables quick identification of patterns and interactions among the parameters through color gradients - Gadiparthi et al. (2024).

## 04 DEVELOPED VISUALIZATIONS

**Line Graph Visualizing Average Mood Rating Around Stressors:** A line graph showing how an individual's mood rating, on average, changes before and after stressful events. The x-axis represents time relative to the stressor, while the y-axis shows mood ratings. A dotted line marks the baseline mood, which is the average mood before the appearance of stressors. This graph is also enhanced by including error bars and hover-enabled details to reveal variability and precision, helping clinicians understand not just the recovery trend, but also its consistency across events.  
**Line Graphs Visualizing Average Intensity of Specific Emotions Around Stressors:** A set of line graphs illustrating how different negative emotions, such as sadness or stress, vary on average before and after stressful events. By visualizing each emotion separately, clinicians can identify which emotional responses are most intense or long-lasting. The x-axis shows time relative to the stressor and the y-axis reflects average emotion intensity on a 1–10 scale.  
**Box Plots Showing the Variation of Recovery Time By Type of Stressor:** A set of box plots comparing how long it takes for individuals to emotionally recover from different types of stressors, such as psychological or financial stressors. Each plot represents the distribution of recovery times for a given stressor type, showing the median, variability, and outliers. This helps identify which stressors have the most prolonged emotional impact.  
**Heatmap Visualizing How Recovery Time is Affected by Stressor Type and Post-Stressor Activities:** Heatmap showing the average change in recovery time (in hours) for each combination of stressor type and coping activity, compared to the average recovery time of the individual. Negative values indicate faster recovery (more effective coping), while positive values indicate slower recovery (less effective coping). Also, the color gradient enhances readability, as greener shades imply improved recovery and redder shades imply worsened recovery.

## 05 EVALUATION PROCEDURE

To evaluate the clarity and therapeutic relevance of the developed visualizations, a qualitative survey was conducted using the Qualtrics platform. Participants included two mental health practitioners and three university students from related fields, each with varying familiarity with ESM data. They were asked open-ended questions focused on two main aspects: (1) whether the visualizations were understandable, and (2) whether they could be useful in therapy. Responses were analyzed using thematic analysis, a qualitative method for identifying, organizing, and interpreting patterns of meaning within open-ended data. This approach allowed to systematically group participant feedback into themes that reflected shared views on interpretability and clinical usefulness. To ensure reliability of the analysis, two independent coders reviewed the data, achieving a Cohen's Kappa of 0.85, indicating strong agreement between them. This process made it possible to pinpoint which features were most valued in therapeutic settings and why.

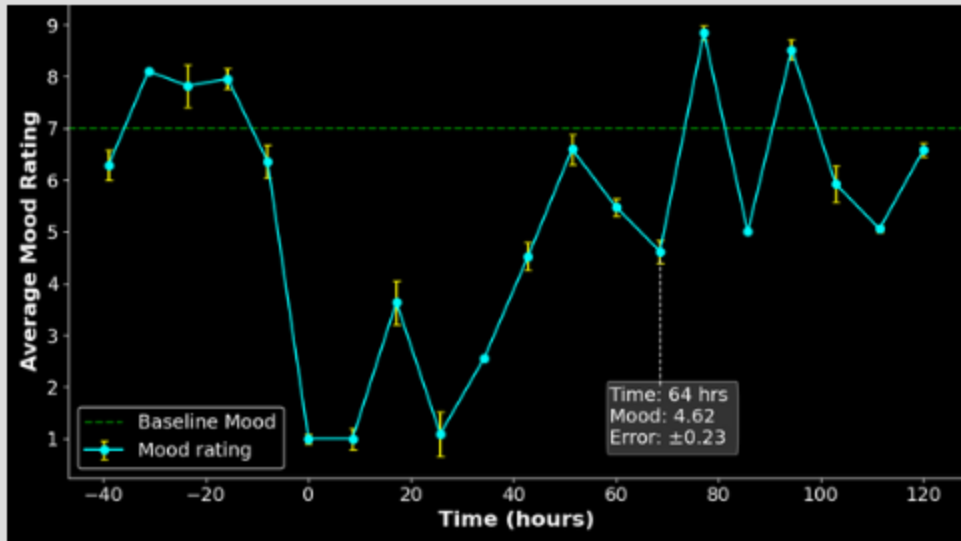
## 06 RESULTS AND DISCUSSION

Thematic analysis of participant feedback revealed that visualizations that combined intuitiveness and actionable information were more likely to be understood and valued in therapy. More specifically:

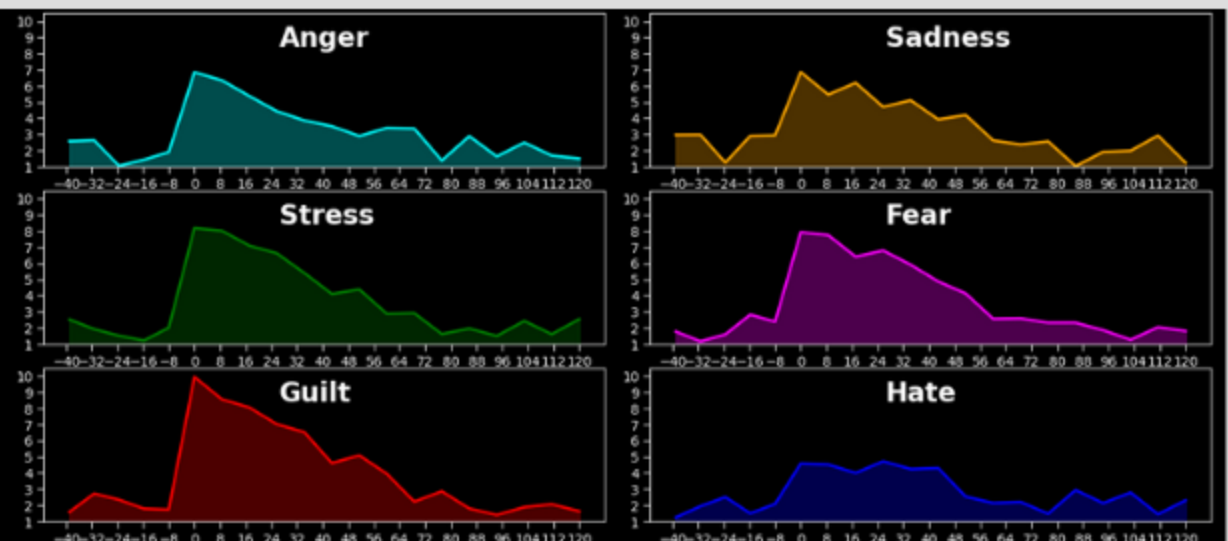
- The line graph depicting average mood score was praised for showing a general overview of how an individual recovers from stressful events, but lacked contextual depth to foster therapeutic interventions.
- Emotion-specific graphs were seen as highly useful for promoting emotional awareness and guiding tailored therapeutic discussions.
- Box plots helped in understanding which stressor types were most difficult to recover from, but some respondents found them less intuitive or questioned the feasibility of gathering enough data to produce a meaningful plot.
- The heatmap was widely viewed as the most practical tool, offering quick, visual insight into the effectiveness of different coping activities, which allows targeted interventions.

Participants also suggested enhancements, such as tracking resilience over time, filtering by stressor intensity, and visualizing individual recoveries. The collected insights highlight the importance of context-rich, clinically relevant and user-friendly visual tools for supporting mental resilience.

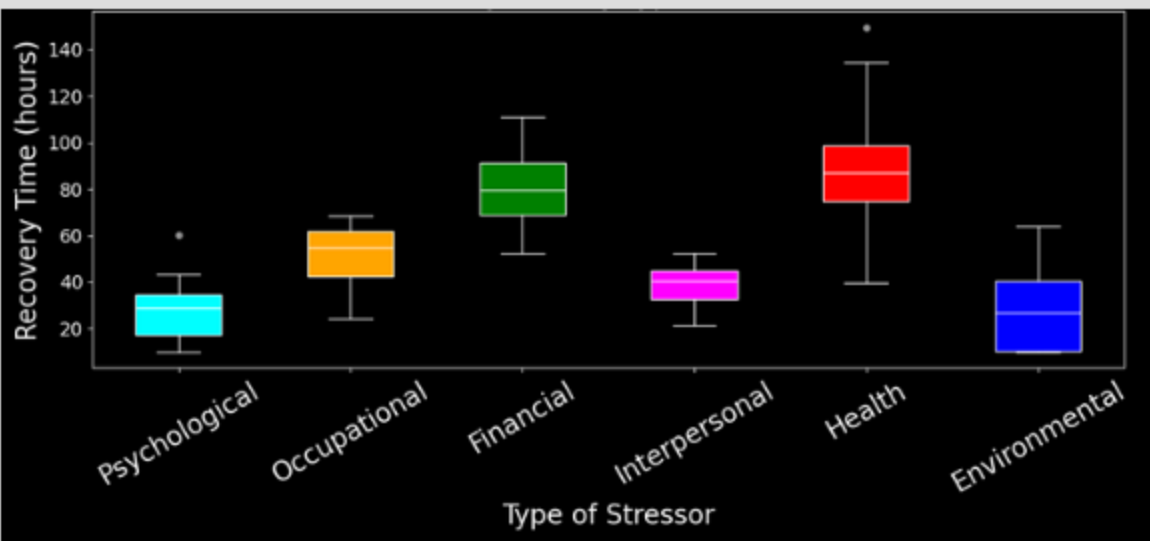
I: LINE GRAPH VISUALIZING AVERAGE MOOD RATING AROUND STRESSORS



II: LINE GRAPHS VISUALIZING AVERAGE INTENSITY OF SPECIFIC EMOTIONS AROUND STRESSORS



III: BOX PLOTS SHOWING THE VARIATION OF RECOVERY TIME BY TYPE OF STRESSOR



IV: HEATMAP VISUALISING IMPROVEMENT IN RECOVERY TIME BY STRESSOR TYPE AND POST-STRESSOR ACTIVITIES

