Ova Snus: Identifying and Acting on Addictive Trends with Personal Informatics and Data Visualization

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1 ABSTRACT

This study aims at leveraging data collected from diverse user cohorts to elucidate the various consumption and urge patterns of users who consume snus. From the analysis, we attempted to derive insightful trends using intuitive visualizations. To conduct experiments and evaluations, a low-fidelity prototype was featured. These were conducted to understand what translates to the users the best. Our findings affirm that users adeptly engage with some visual representations when compared to others. From the experiments we performed, we observed that most users aligned with our hypothesis. The experiments' robust methodology reinforced our insights into the preferences of users. In summary, our study demonstrates the effectiveness of employing intuitive visualizations to uncover consumption and urge patterns within diverse snus users. Through the use of a low-fidelity prototype and meticulous experimentation, our research sheds light on user preferences, offering valuable insights for informing future strategies in snus consumption analysis and user engagement.

2 INTRODUCTION

In the past 10 years, nicotine consumption has risen for children and young people in Denmark. The amount of children and young people who regularly use nicotine products has risen from 2% in 2010 to 11.4% in 2021. They usually consume nicotine from nicotine pouches or vapes [12]. Hence nicotine pouches have a negative effect on the youth of today's world.

To help users of nicotine pouches be more aware of their usage and consumption triggers, a personal mobile data interaction device has been conceptualized in this report. Use and urge patterns have been shown in visualizations, and non-nicotine alternatives and motivators have been incorporated into the device to help the users take action to reduce or quit their snus use. The device has been developed to address the negative effect it has on people.

The article will look at existing research and tracking solutions for nicotine addiction. It will detail a data collection process on snus consumption and craving helping us visualize their data. The final solution is described including the user interface and chosen visualizations. Experiments and evaluations carried out will then be detailed. Lastly, a discussion section will discuss the project process and the main results of the solution, and a conclusion section will sum up the report.

Our project followed the path of the 5 stages of the stage based model.

(1) Preparation Phase: We reviewed existing research on nicotine addiction and tracking solutions, conceptualized a mobile device and identified the need for data collection on snus urge and consumption.
(2) Collection Phase: Gathered diverse user data on snus consumption and urge, conducted an analysis to derive trends using interactive visualizations. Finally, tested low-fidelity prototypes.
(3) Integration Phase: Integrated findings from user feedback to refine visualization methods. Then we developed a mobile app which incorporated the insights of the user. From this, we were able to align the visualization methods with the users requirements.
(4) Reflection Phase: Evaluated outcomes by analyzing the preferences of the user and considered the limitations faced during the development process to incorporate improvements in the future. This helps users understand their snus patterns through visualizations that we provided.
(5) Action Phase: It enabled users to act on these visualizations and patterns. Some features empowered users to take actions based on the insights gained from the visualizations which could either help them track their consumption or work towards quitting consumption.

2.1 Analysis

Current research on nicotine addiction, primarily focuses on smoking-related issues. Nicotine, whether in cigarettes or smoke-free alternatives causes health risks such as increased heart rate and blood pressure, mainly concerning individuals with underlying heart conditions. Exposure of nicotine to children can have a long lasting effect on the brain chemistry, especially as their brains are still developing [1]. Comparatively, nicotine pouches pose fewer health risks than cigarettes, accounting only for 5% of the health risks associated with smoking. Economically, snus users cost the Danish govt significantly less than snus users. While nicotine pouches offer a safer alternative for adults, they still pose greater risks for children and youth [4]

Several existing apps aid snus and cigarette users in quitting. Smoke-Free and Xhale focus on cold turkey cessation, tracking cravings and offering health and economic data. Smoke-Free provides online coaching, while Xhale offers advice through videos and is free with an age limit of 12 [3]. Quit snus helps users quit gradually or immediately with features like goal tracking and health data [10]. From this we learnt it was effective to incorporate tracking solutions that should assess the user experience, easy of use, integrating counselling services and cost to meet the requirements of the users.

Smartphone applications have demonstrated a positive influence increasing the cessation rate of using snus. The use of notifications and text messages are useful in these quitting apps [7]. However, there is still a need for more research on this topic [9]. Tobacco users are more likely to quit tobacco if they have better knowledge of specific health risks caused by tobacco.

Professional counselling is proven to be effective in quitting nicotine consumption. Users are 5 times more likely to stop using nicotine if they combine professional counselling with drugs for nicotine withdrawal. Mobile apps are an easily accessible and inexpensive form of behavioral support. [6]. Hence it would be efficient for us to include behavioural support and professional counselling in the snus tracking apps.

Four types of triggers can affect users: Emotional, Pattern, Social, and Withdrawal. Strategies for dealing with them that can lead to human behavior [5].

An emotional trigger reminds the user of how they felt when consuming nicotine such as to enhance a good mood or escape a bad one such as when they were stressed, anxious, or lonely. They can deal with this by being distracted such as talking to a friend or family member, listening to music, or exercising.

Pattern is an activity that the user likes to consume nicotine along with. These could partying and drinking, stress, finishing a meal, or driving. They can deal with this by changing their routine such as chewing gum, exercising, or going for a walk. Replace the activity with another activity.

Social triggers are occasions with other people consuming nicotine. This could be in bars, concerts, or being with friends who consume nicotine. They can deal with this by trying to avoid places that involve these circumstances or trying to distract themselves while others are consuming nicotine.

Withdrawal triggers are the feelings and associations from addiction. Withdrawal symptoms produce the craving for nicotine such as craving the taste or feeling restless. To deal with this it is advisable to make a quit plan, get a text message for support, distract themselves, and understand their smoking patterns by tracking their reduced consumption.

The data collected mainly focused on the consumption or urge at a particular time, location and context. By doing this social-, withdrawal-, and pattern triggers have been combined into the context trigger in the study. Emotional triggers have been avoided in the study due to the lack of knowledge about emotional triggers at the beginning of the project [36, 37, 38].

2.2 Prototype

The final solution is an app with a user interface that includes visualizations that provide information on snus use and craving patterns to increase users' awareness of their usage.

The user interface consists of five screens in a mobile app format: (1) Goal setting parts, figure 4, (2) Tracking page, figure 5, (3) Progress page, figure 6, (4) Community and support page, figure 7 and Notifications, figure 8.

When setting up their app, users first define their snus quitting method present in the goal-setting section of the UI. They can choose between quitting immediately or setting up a gradual reduction plan, by specifying a daily intake and pace of reduction. It allows users to enable a quitting mode. There is more evidence that users who pick a quitting date have higher chances of successfully quitting snus as written in section 2.1. Rewarding themselves while quitting could account for motivation. Having a purpose for reducing snus intake can become a driving factor. The tracking page is the part of the app where the users will report consumption and urges as seen in figure 5. The user can specify the time, location, and context in which they consumed or craved snus. Finally, a personal goal statement is displayed at the bottom of the page to remind them of their statement and to edit the quitting method.

The progress page displays visualizations displaying the users consumption patterns as seen in figure 6. The user is free to make notes about the insights. This button is included in the solution to allow the user to express and remember their reflections on the data directly in the app.

The community and progress pages consist of two parts as seen in figure 7. The first part is a supporting tool that gives counseling on how to resist snus. Counselling proves to be an effective tool when quitting as written in the section refAnalysis. Every day the user can read a new technique or be reminded of a previous one for educational purposes. The second part of the page is a community platform where the users can share progress and thoughts. This is part of the solution because sharing and following other's progress can for some be used as motivation.

Notifications are part of the solution and are shown in figure 8. The purpose is to remind the user to track. It has also been considered to send guiding techniques to help the user resist in certain situations. However, this has not been chosen due to the complications which follow the overuse of notifications.

During the design process, a default goal setting has been considered. The importance of the app is supporting and guiding the users in understanding their consumption patterns and how to resist urges with different processes to quit. Users who find it hard to keep up with the default setting can edit their goals. This would be a key feature of our app. In addition, many of the visualizations on the tracking page are also not included in the final design. They are seen in figure 12 due to not showing progress patterns in a period, but only on the specific day of tracking.

The users will have to track their data manually and there is no automated tracking in this solution. This is due to the feasibility of tracking the context triggers such as feelings of boredom etc.

Visualizations are very critical for delivering value to the users. Only a selected set of the multiple visualizations we had, are in our app. A key element of the product was to consider not only consumption but urges as well. The user can choose whether to show consumption, use, or both when interacting with the visualizations.

The first visualization is a heatmap that offers a versatile view allowing users to select different timescales via radio buttons as seen in figure 9. In "Daily" mode, hours intervals are displayed on the Y-axis, and days of the week on the X-axis, highlighting daily trends from time triggers. Hours without records are omitted.

The "Weekly" mode shifts to a broader timescale, with days of the week on the Y-axis and the count of weeks on the X-axis, helping to pinpoint problematic days such as Fridays, when social activities might increase nicotine usage.

In the "Monthly" view, weeks are on the Y-axis and months on the X-axis, ideal for long-term users to track their progress and

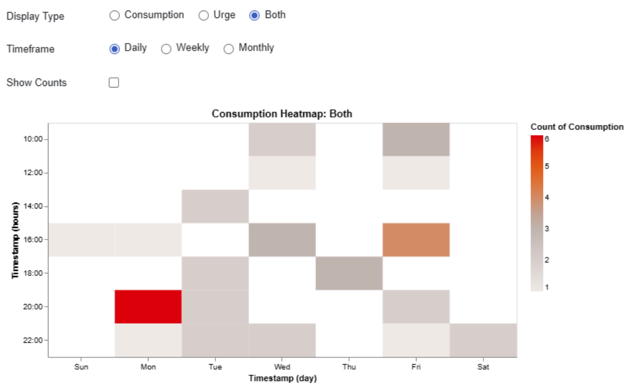

Figure 1: Heatmap with real user data

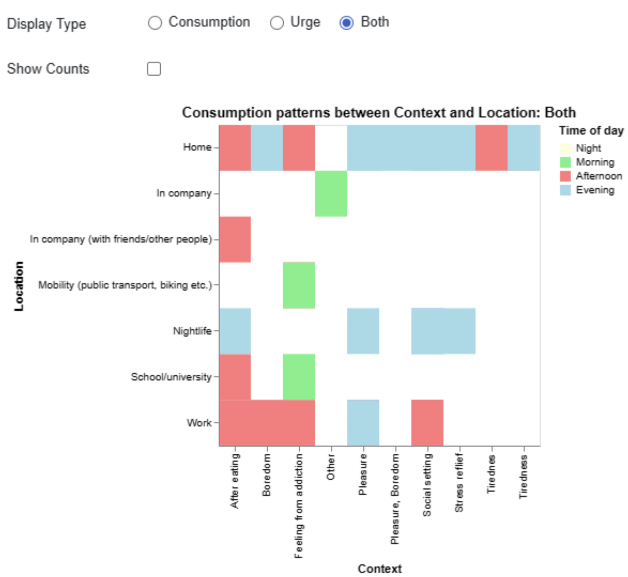

Figure 2: Location vs Context vs Time plot with real user data

observe trends over time. Additionally, users can opt to display exact counts on the heatmap for precise analysis, though this feature is off by default to avoid overcrowding. This is important for a mobile-based solution where hover functions are not feasible. Choosing an appropriate color scheme also posed challenges due to the need for app coherence, limitations of the Vega-lite framework, and the need for clear visualization (see previous attempts [22, 23).

The second visualization is also a heatmap that aims to offer causes of consuming nicotine, combining Context, Location, and Time into one plot as seen in figure 10. Location can be found on the Y axis and Context on the X axis. This essentially creates Location-Context pairs that reveal recurring combinations, such as being at home and bored. To provide these observations with a time cue the day is split up into four 6-hour segments (night, morning, afternoon, and evening) and assigned a color for each. Each field of the heatmap

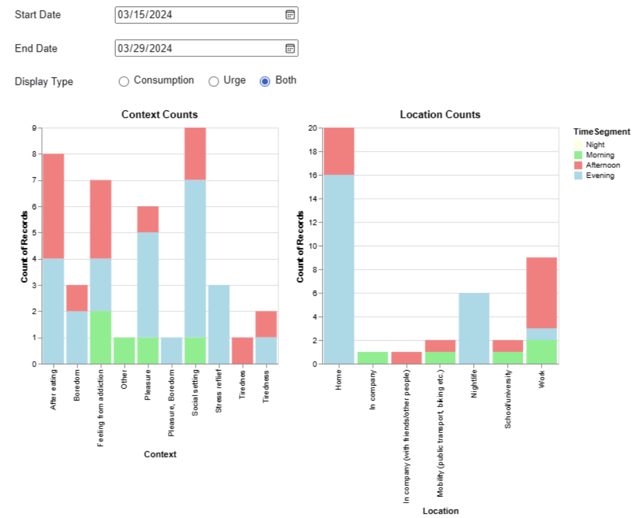

Figure 3: Barcharts showcasing Context and Location with real user data

was colored by the time of the day in which they most commonly occurred.The functionality displaying the time is also present here. Due to the complexity of combining context, location, and time into one plot, many iterations passed until this solution emerged. At first, the idea of showcasing counts over pairs of context-locations16 was born. This was followed by an iteration15 where a green color scheme was used to differentiate times of the day.

The next iterations would experiment with different color schemes (13, 14]. These were undergoing an experiment. These iterations also showcase the feature where only counts surpassing a certain threshold would be displayed. This was not chosen for aesthetic reasons as one heatmap would display only high numbers and another heatmap would display all numbers. A test was needed to determine the value of this feature. Another attempt at showcasing the amount of consumption was to differentiate fields by opacity 21, this was a theory that yielded sub-optimal results as the plot became hard to read.

In the visualization shown in figure 11, the context and location were split into two different plots. A simple stacked barchart the counts of which gives a visual indication of the times of the day, employing the same colors to ensure consistency.The records that are displayed depend on the time interval chosen.

Just like the other visualizations, this plot went through multiple rounds of prototyping. The first iterations[19, 20] did not have the possibility of choosing a time window or indicating time.

2.3 Related work

A study [2] published in the Frontiers of Psychiatry journal aimed to assess the impact of addiction treatment, with routine monitoring of test participants. This study has a massive scope involving multiple universities and organizations, across countries, nonetheless some key similarities have been found to our study. This study focuses on developing a person-centered application for individuals dealing with addiction recovery. This point of view aligns with our aim of providing a tailor made solution to users, by enabling them to record their consumption. From the recorded data, users can gain intricate knowledge of their usage patterns and most often encountered situations that prompted use. Thus enabling them to take action if desired (aligning with the principles defined by Sharon [11]).

3 METHOD

The Method section delineates the design and execution of our experiment aimed at evaluating the efficacy of various visualizations in conveying information to users. The main objective of this study was to investigate the quality of the visualizations to understand if the desired patterns from the visualization are understood by the user.

To achieve this, we employed a think-aloud evaluation methodology which is shown in the evaluation guide in figure 26 wherein participants were instructed to perform a series of predefined tasks while verbalizing their thought processes. These tasks covered a spectrum of information visualization scenarios, resulting in a comprehensive assessment of user interaction and understanding. By conducting the evaluation, we wanted to understand what type of visualizations are helping our users understand their data better. We provided them with a contrast of various visualizations to perform a particular task and deduced what the users found the easiest to interpret and use 29 We noted down the input of different participants and implemented changes in our prototype, to meet the necessities of the user.

We also conducted a within-subjects experiments by formulating two hypotheses which is shown in the experiment guide in figure 32. Hypothesis 1 stated that implementing a high contrast color scheme along with an increase in font size in visualizations would enhance readability for users. Hypothesis 2 suggested that simpler and basic visualizations, utilizing clear and simpler shapes, would be more universally understandable compared to complex visualizations. The independent variables we focused on were the font-size, 2D visualizations and the color-scheme as in 34 and 35 The dependent variable we used was the time of interpretation. The dependent variable varied when we varied the independent variables. This was evident to attain insights regarding the proposed hypotheses. The survey aimed to validate our hypotheses and elucidate any variations between user perceptions and experimental findings. The interpretations of various users was analyzed and noted down. Upon collecting these insights from various users, we were able to come to a common ground on the hypothesis that we proposed.

Quantitative and qualitative data collected during both the experiment and survey phases were analyzed to assess the validity of the hypotheses and draw conclusions regarding the effectiveness of various visualization techniques. Throughout the study, ethical considerations, including informed consent and participant confidentiality, were upheld to safeguard privacy of all participants [8].

4 RESULTS

The analysis of the data that we collected from the participants yielded insightful findings regarding consumption and urge patters among snus users. In this section, we will walk through the key findings of our study, focusing on the visualizations of the trends and the engagement of users with different representations. We also elucidate the identification of breakdown situations during the evaluation. These results offer valuable insights to user preferences and comprehension challenges, shaping our understanding of effective strategies for identifying patterns in consumption and urge.

4.1 Evaluation methods

During the evaluation process, our objective was to pinpoint the different instances where users encountered challenges in interpreting their patters. Through careful observation, we identified situations where the user experienced breakdowns in completing some tasks since some visualizations were not as easy to interpret as we imagined. This offered valuable insights into the aspects of interpretation that proved challenging or straightforward for them. We also considered it important to document the cognitive process of the participants, enriching an understanding on their behaviour for different pattern identification tasks. After performing the evaluation, we observed that various users exhibited a notable ability to discern consumption pattern, particularly favoring the simplicity and intuitiveness of bar graphs and heatmaps which can be seen in 28 and 29. Tasks involving identification of location and moods (context) associations were efficiently accomplished with interactive bar charts, highlighting their effectiveness in recognition of pattern. Conversely, for pinpointing specific times of consumption on particular days, users preferred the clarity and precision offered by heatmaps over more complex visualization formats such as layered plots. These observations underscore the importance of tailoring visualization methods to align with users' cognitive processes and task requirements for optimal comprehension and engagement.

4.2 Experiment results

In the survey that we conducted for our experiment with a group of carefully selected participants, we were able to obtain significant insights on the independent variables, font-size and color-scheme. Interestingly, our findings revealed unanimous agreement with our hypothesis regarding font size, suggesting a clear preference or ease of comprehension across all participants seen in 34. Conversely, the exploration of color-scheme as an independent variable exhibited a varied landscape, where participants depicted varied cognitive responses 35. Notable, one participant, familiar with platforms like GitHub, displayed an inclination towards a single color spectrum for pattern identification. This contrasted the preferences of other participants who favored distinct and contrasting color-schemes as their thought process stated that they were able to associate certain colors with certain cases.(such as red for high consumption and green for low consumption).Consequently, while our hypothesis regarding font-size stood validated, the hypothesis surrounding the color-scheme exhibited considerable variation among participants, highlighting the intricacies of individual cognitive processes and preferences in visualization interpretation. On conducting this survey, on a selected group of subjects, we inferred that all the participants aligned with our hypothesis with respect to the independent variable, font size. Whereas when it came to the color-scheme as an independent variable, we were able to see a variation in the thought process of various users. We had a test participant who was used to using GitHub and hence preferred the different shades of a single color to identify patters whereas other users preferred using a contrasting color-scheme for pattern identification. Hence our hypothesis with respect to the font-size proved to be valid whereas with respect to color-scheme it proved to be varied. Our investigation into the second hypothesis yielded confirming results, as users consistently demonstrated greater comprehension and ease of pattern recognition when presented with simpler graph structures, as opposed to a singular complex graph with multiple fields. Across all participants, a clear preference emerged for graphs featuring simpler shapes and fewer visual elements, indicating a universal inclination towards straightforward visual representations for interpretation. These findings underscore the importance of employing simplicity and clarity in data visualization design to enhance user understanding and enable efficient pattern identification.

5 DISCUSSION

In the evaluation tests performed, we observed that users preferred simplicity and intuitiveness in visualization formats to answer the tasks. The experiment results showed a preference for a larger font-size for the ease of comprehension, while color-scheme preferences varied among users. Overall, the findings outline the importance of simplicity and clarity in the data visualization design, aligning with the users' cognitive processes and preferences for efficient pattern identification.

Our app focuses on education and equipping users with tools to monitor and understand their addiction, while also incorporating common features of nicotine cessation apps. These include using cost savings and health benefits as motivation to quit, and allowing users to share their progress with a supportive community. We emphasize customizable goals to enhance adherence, respecting that the decision to quit or reduce nicotine use is a personal one. Recognizing the complexities of addiction, we empower users to set their own pace and goals for recovery.

One of the biggest challenges faced when developing a prototype was balancing the desire to provide as much data as possible inside the visualizations, while also keeping them easily understandable to the users. We think that the most data can be learned from the relation between Context and Location.

Several limitations affecting our solution were pinpointed. The first and biggest limitation is the amount of data at hand. Although there are many studies and datasets focusing on nicotine consumption and addiction, they are focused on health effects and groups of people rather then individuals. This prompted us into recruiting test participants, who were not always consistent with tracking (although this can be expected from real users as well). This initial data collecting was done with the help of questionnaires, which also added to the inconvenience of tracking. In order to combat this lack of data we proceeded to generate data programatically, this of course meant that no meaningful pattern could be observed, but helped with developing and testing our prototypes.

One limitation we faced was time constraints, which limited the number of evaluations we could conduct. Additionally, while the Observable and Vega-lite framework we used have a low entry barrier and offer basic visualization options, we encountered a steep learning curve and limited customizability when trying to tailor the visualizations to our specific needs.

During the extensive prototyping process, we gained valuable insights, though the journey was marked by setbacks. If we were to start over, we would streamline our technology choices to avoid constant switching. Delaying prototyping until we reached a consensus was a mistake that likely extended our development time unnecessarily. More frequent evaluations and iterations could have prevented wasted efforts on discarded elements. We often debated various options, when seeking external feedback might have been more efficient. Additionally, choosing nicotine addiction as our focus, despite its relevance, posed challenges due to limited data and our lack of personal experience, leading to time-consuming workarounds.

6 FUTURE WORK

The method of tracking on a physical device has been discussed in the project to help users track at a higher speed and to include semi-automated tracking. However, we saw limitations in creating a device that would not collect too much noisy data when carried around every day and all day and decided it was not suitable for this project. However, it could be interesting to look further due to the possibility of collecting more time-related data.

There could also be an idea to look into creating semi-automated sentences on the most likely location, context, and time slots users use and resist snus the most. This could be a feature that could make it easier for the users to interpret the visualizations and take action on how to quit consumption.

Throughout the project, we utilized several tools and frameworks to create both low and high-fidelity prototypes, including Figma, Flutter [24 25], Observable 13, and Flutter Flow. These experiences helped us refine our vision for the final product. Due to time constraints and limited mobile development expertise, we focused on meeting course requirements, resulting in an executable Figma prototype and an Observable notebook for our data visualizations. A natural extension of our work would involve developing a comprehensive mobile application that integrates all our efforts.

7 CONCLUSIONS

In this project, we identified the intricate landscape of the engagement of users and comprehending the data visualizations for design elements such as font-size, color-scheme and complexity of the visualizations. Through rigorous experimentation and analysis, we unraveled valuable insights into user preferences and cognitive processes, implying the importance of simplicity and clarity in visualization design. Our findings aimed at aligning the visualization methods with the user's cognitive tendencies and task requirements to optimize the engagement and comprehension of patterns by the user. Our study underscores the importance of design in communicating insights to users and highlight the importance of a personal informatics system for users to understand their current consumption patterns. By leveraging these insights, we accomplish the task of enabling users to be aware of their current trends and in some cases the health outcomes of these trends.

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A APPENDICES

This appendix contains additional figures which complement the analysis presented in the main sections of this paper.

A.1 Links

Process of visualizations for snus project
Final Data Visualiztion
Figma Prototype

A.2 Final user interface (Solution)

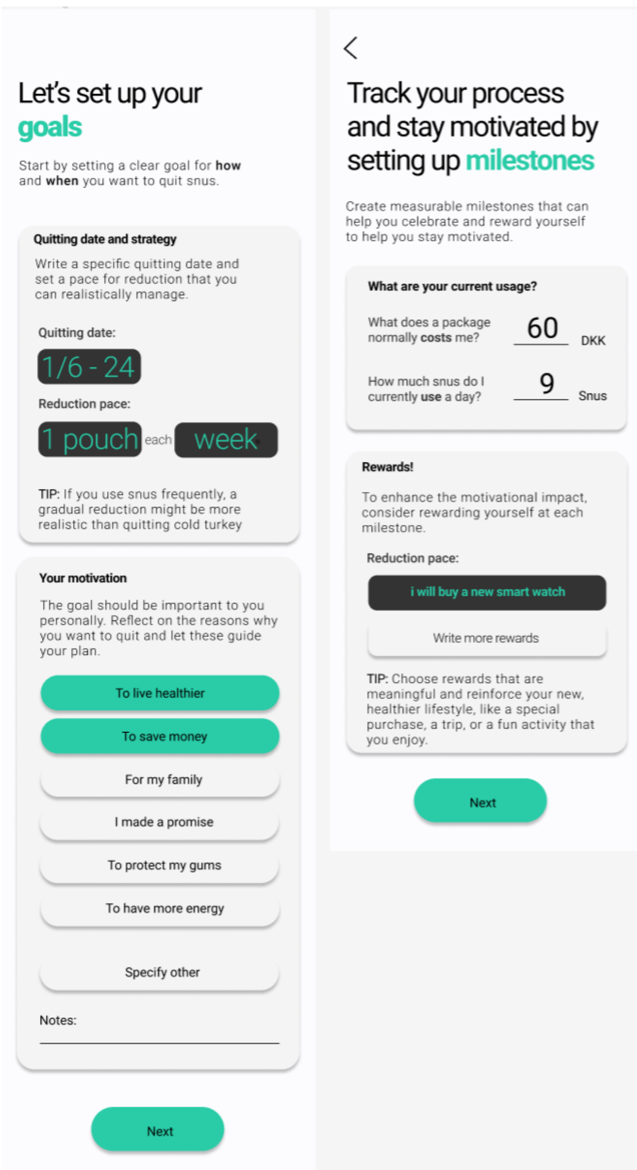


Figure 4: Goal setting parts in the UI

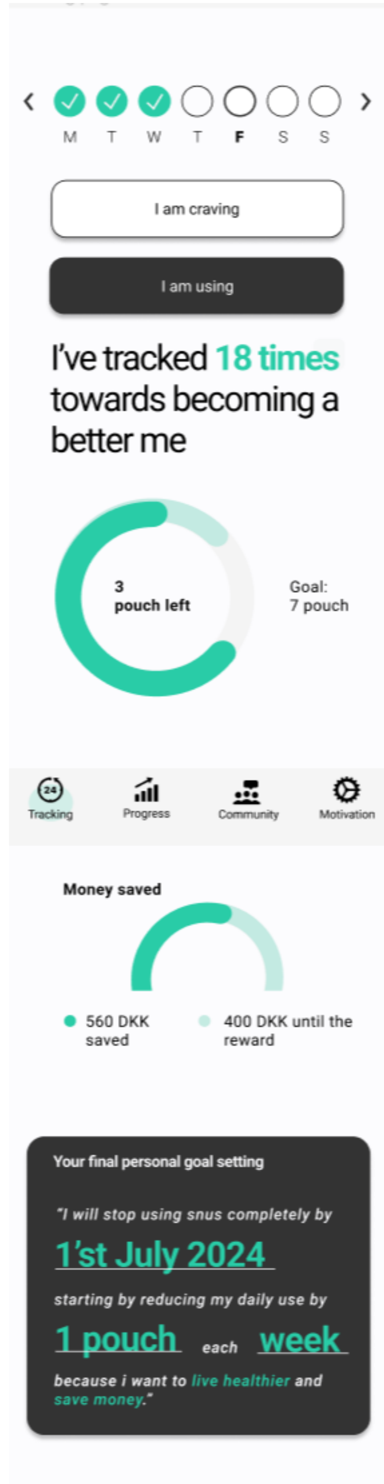


Figure 5: Tracking page in the UI

Figure 6: Progress page in the UI

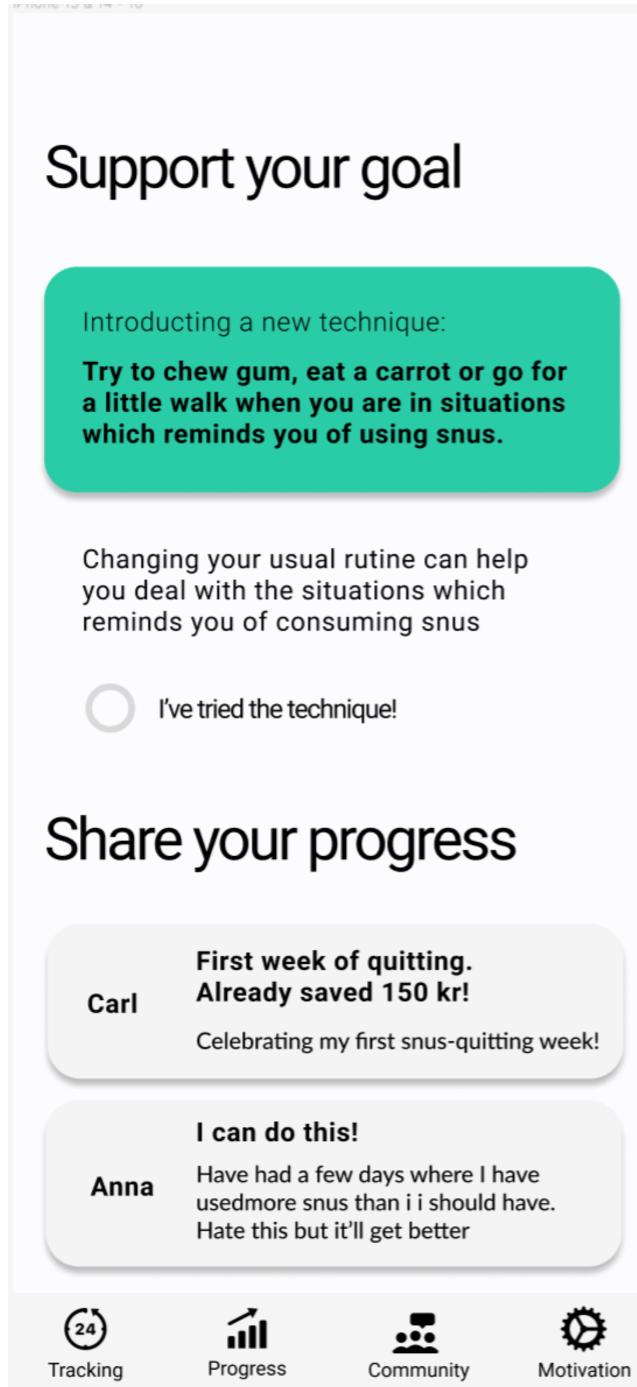


Figure 7: Community and support page in the UI

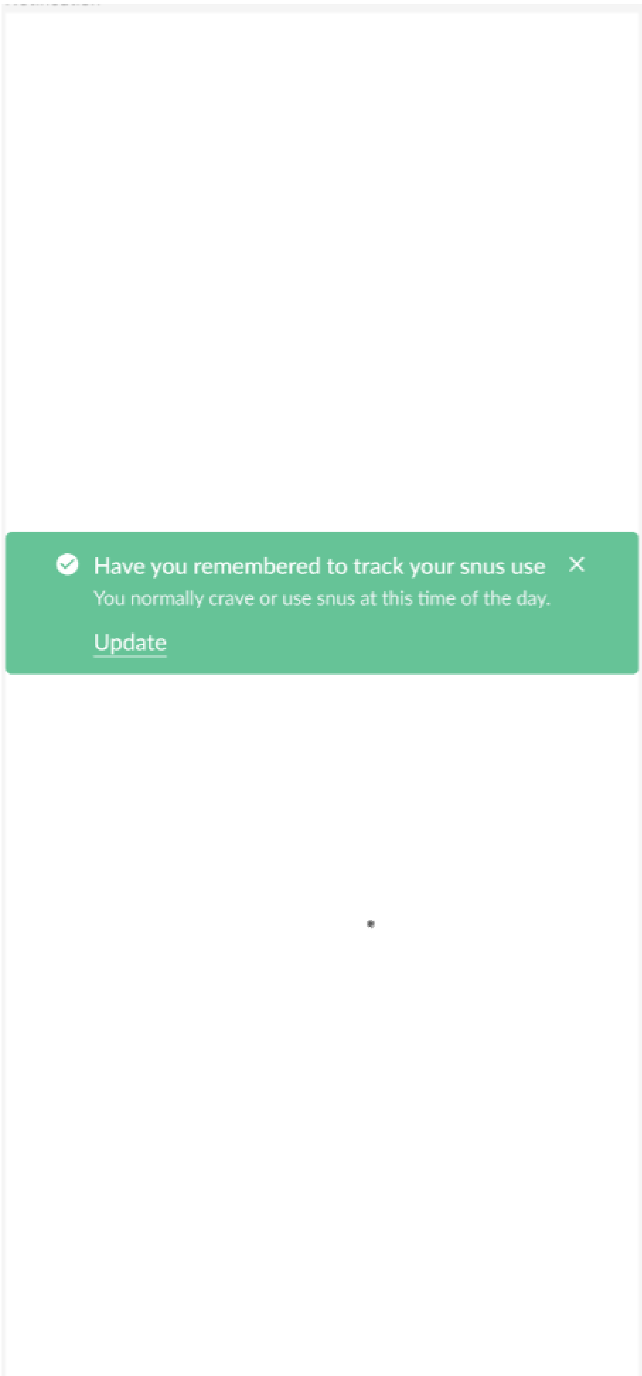


Figure 8: Notifications by the app

A.3 Final visualisations (Solution)

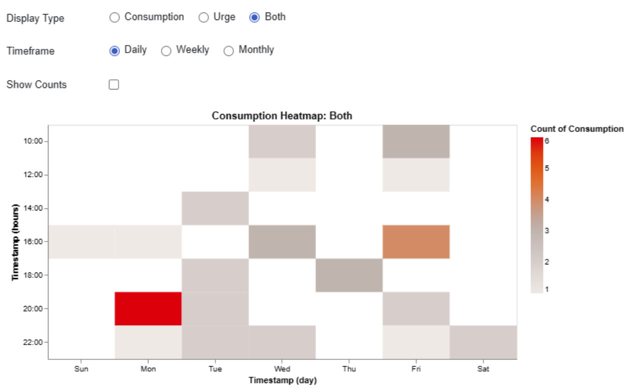


Figure 9: Heatmap with real user data

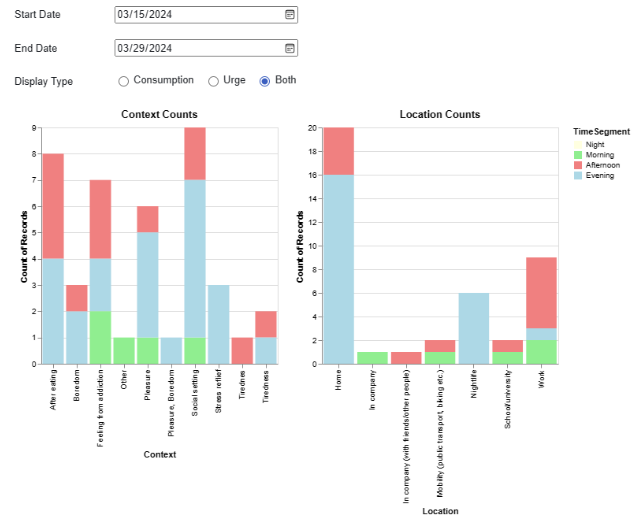


Figure 11: Barcharts showcasing Context and Location with real user data

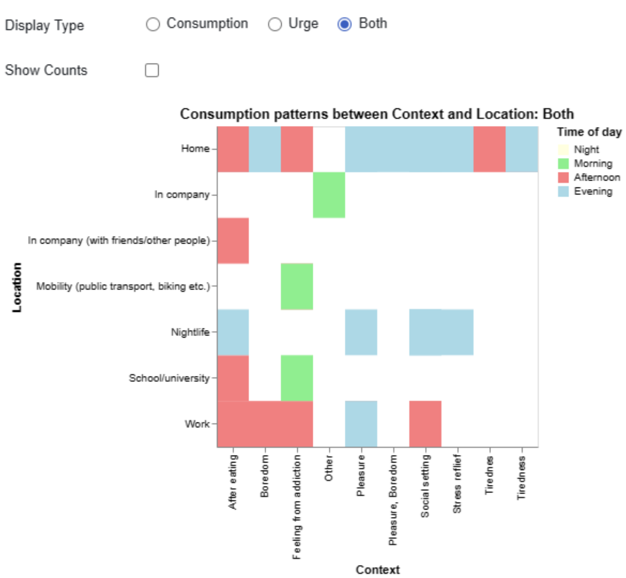


Figure 10: Location vs Context vs Time plot with real user data

A.4 Other Visualisation iterations and UI

Figure 12: First UI

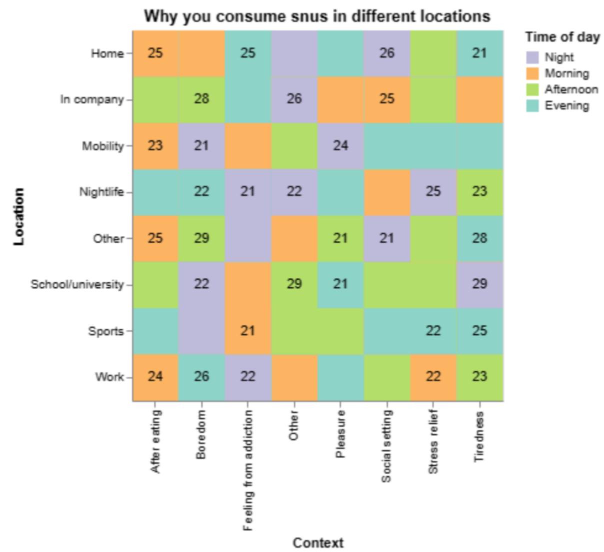


Figure 13: Heatmap showing high consumption over pairs of Context-Location, differentiated by time

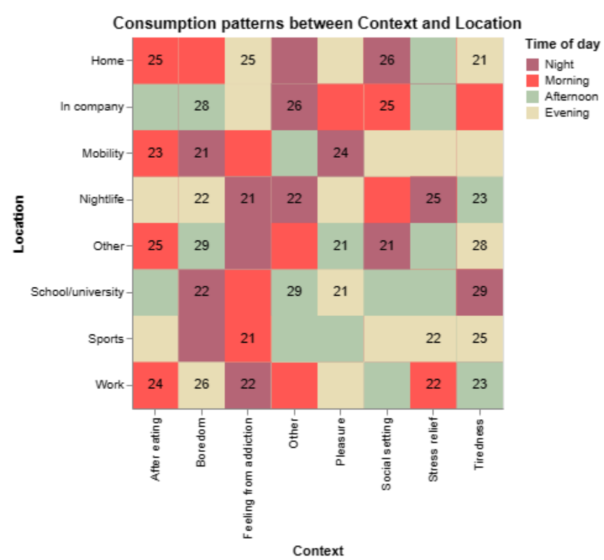


Figure 14: Heatmap showing high consumption over pairs of Context-Location, differentiated by time (Different color scheme)

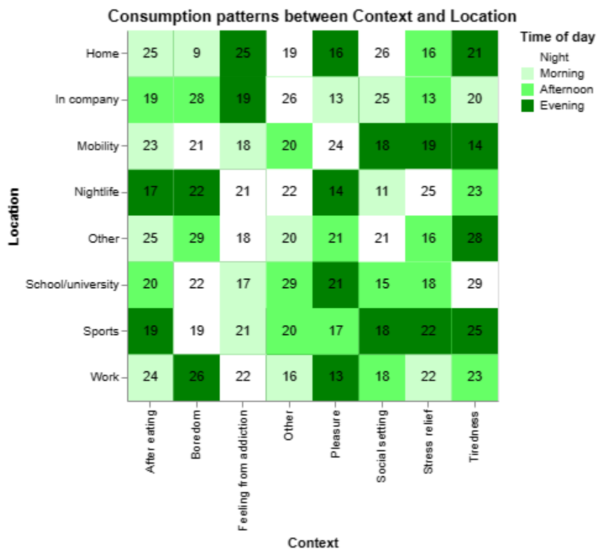


Figure 15: Heatmap showing high consumption over pairs of Context-Location, differentiated by time (Green color scheme)

Figure 17: Barchart of Locations showing Time

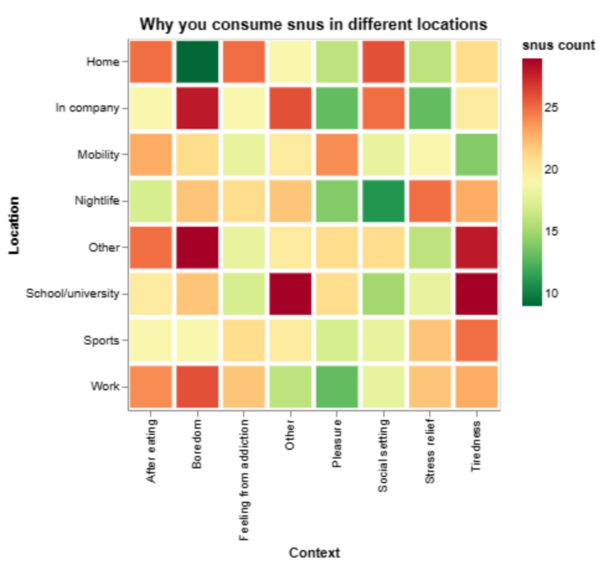


Figure 16: Heatmap showing high consumption over pairs of Context-Location

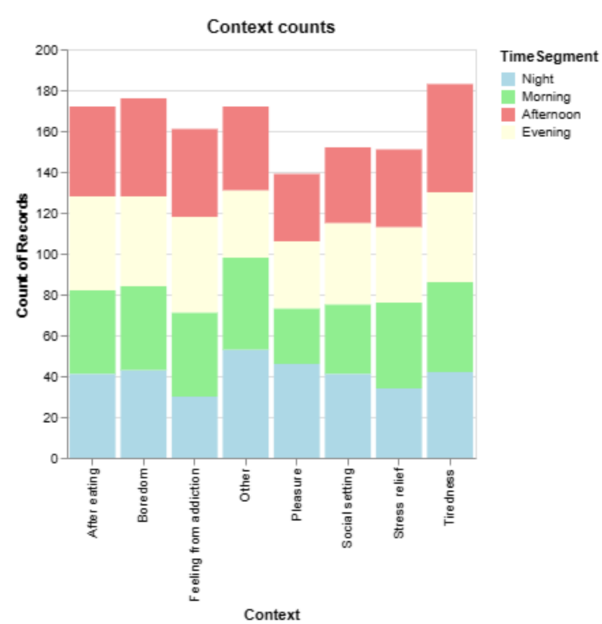


Figure 18: Barchart of Contexts showing Time

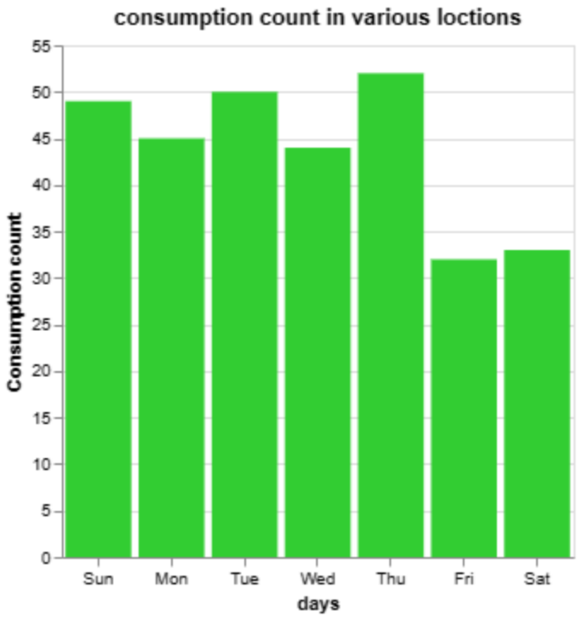


Figure 19: Barchart showing counts over Location

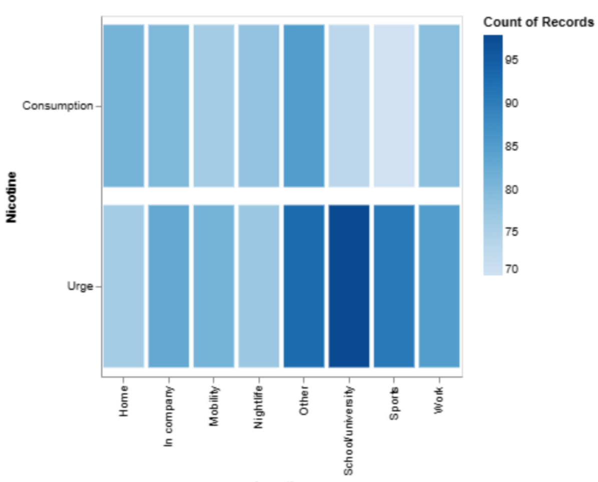


Figure 20: Consumption and Urge over Locations

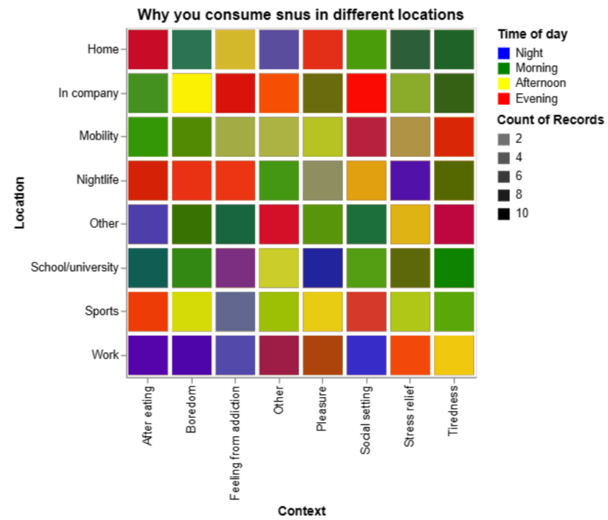


Figure 21: Heatmap showing consumption over pairs of Context-Location, differentiated by time (Using opacity)

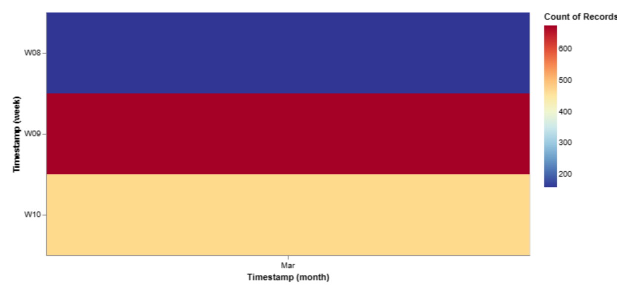


Figure 22: Heatmap Months and Weeks

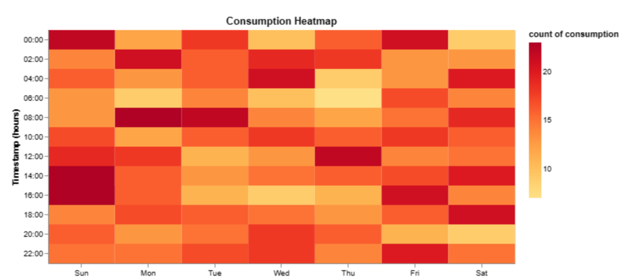


Figure 23: Heatmap showing hourly data over weekdays

A.5 Flutter demo

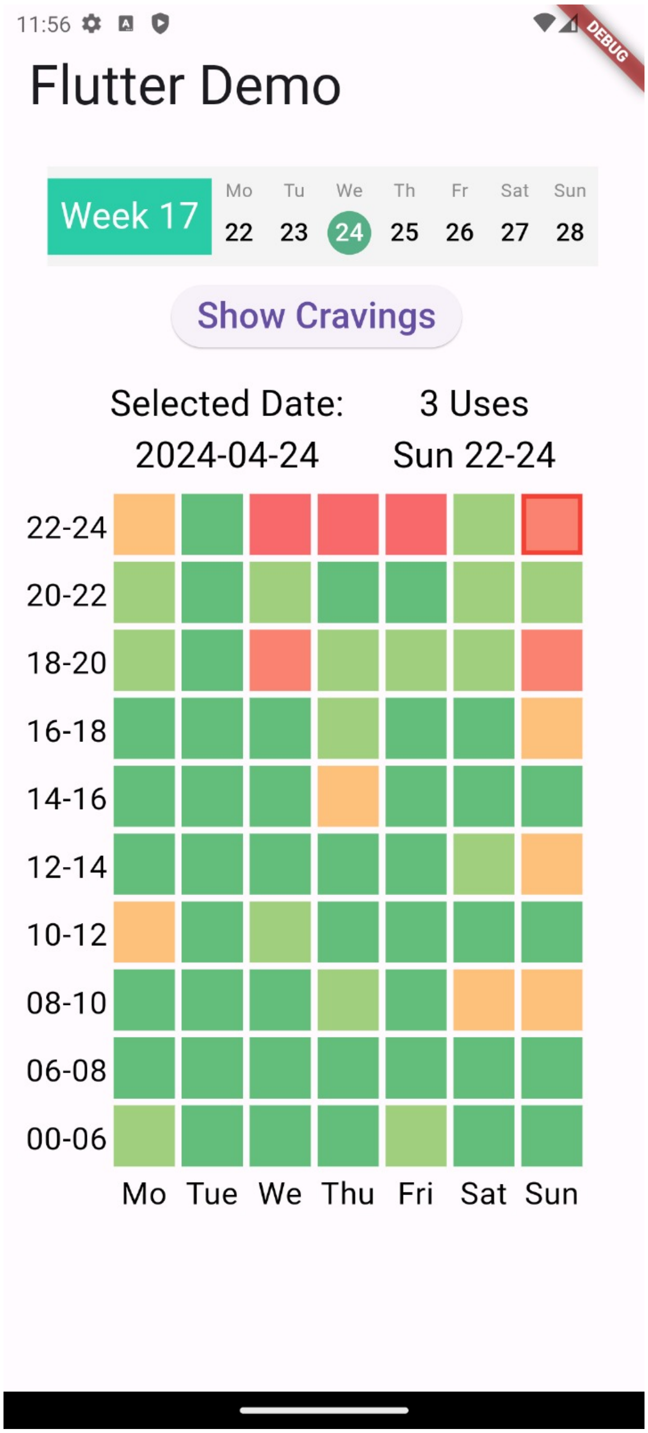


Figure 24: Flutter Heatmap

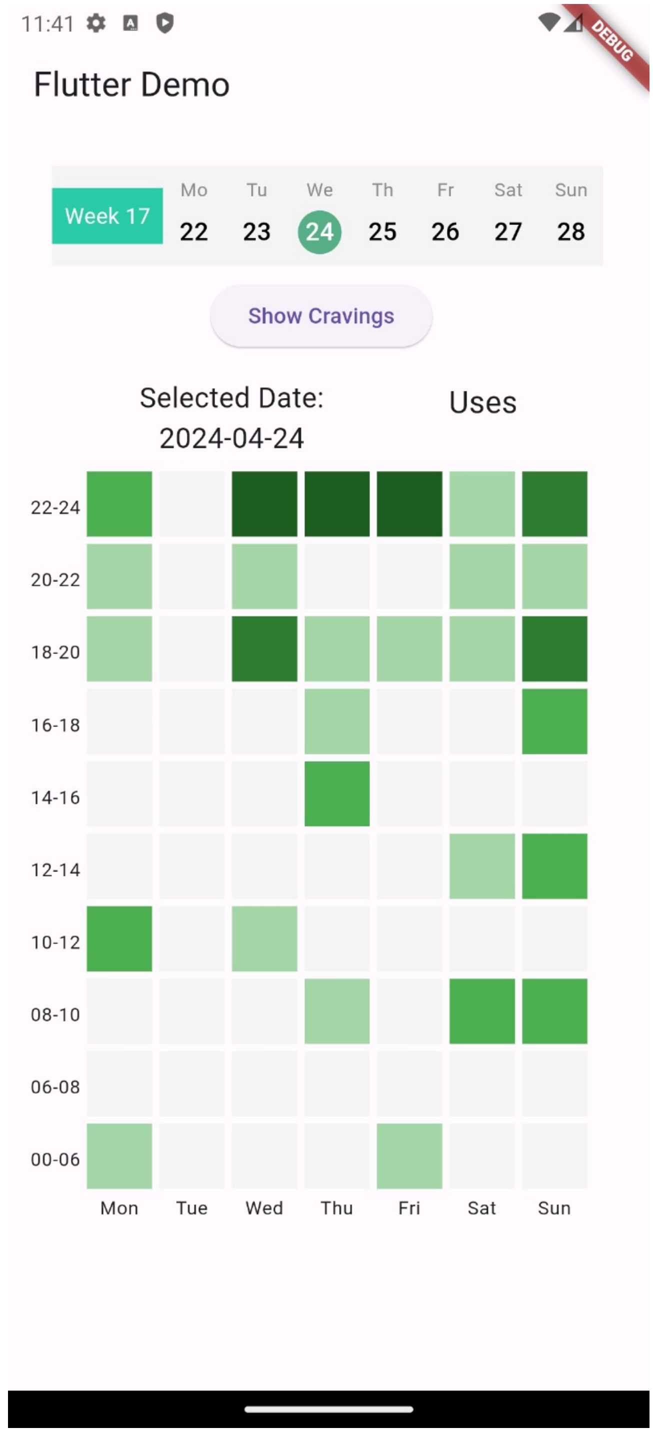


Figure 25: Flutter Heatmap with Green Color Scheme

A.6 Evaluation

Evaluation

Purpose: Understand if desired patterns from the visualizations are understood by a user.

Formative evaluation (after the design has been developed) to gain insights into the quality of the visualizations.

Method: Think aloud (ask users to perform tasks)

Questions:

- *Progress based on indicators.*
    - Can you tell us in which location you consumed the most snus?
    - How much snus do you usually consume at home?
    - In which context are you usually using snus?
    - At what time of the day do you normally use snus?

- *Weekly progress*
    - On which day of the week do you consume snus the most?
    - On which day of the week do you consume snus the less?
    - At what time of the week do you consume snus the most?

- *Combined indicator*
    - In which context are you most likely to consume snus the most?
    - At what time do you normally consume snus when you are home?
    - In which location will you most likely consume snus?

Test-persons: Random choice of people of all genders between 18-30 years old. 2-3 test persons needed.

Figure 26: Evaluation guide

1	User background			Daily progress				Weekly progress			Combined indicator		
2	Test person	Gender	Age	Can you tell us in which location you consumed the most snus?	How much snus do you usually consume at home?	In which context are you usually using snus?	At what time of the day do you normally use snus?	On which day of the week do you consume snus the most?	On which day of the week do you consume snus the less?	At what time of the week do you consume snus the most?	In which context are you most likely to consume snus the most?	At what time do you normally consume snus when you are home?	In which location will you most likely consume snus?
3	1	F	25	bar success: uni, home, work	3 per day	addiction	heatmap:6-9 night. Based on the colors	heatmap-saturday	heatmap- sunday or tuesady (with least the first plot was hard to identify cuz of the colors)		absitinence on the right plot , first plot wasnt clear to identify	both the plots were readable left-evening right -eveining night morning	left- work uni right-home
4	2	F	24	bar success: uni, home, work	4 per day, (which is wrong)	addiction	22-24 18-20 on the heatmap. step plot-evening after 12 . Based on the colors	left(layer chart)-sunday heatmap-friday or saturday	left-tuesady heatmap- tuesday	heatmap- evening. left- evening	left- abstinence and tiredness. right(collective bar)- abstinence	left(layered chart)-evening. right- 10pm	right- home left- work or uni
5	3	M		bar success: uni, home, work	3 times a day	addiction	left-20-22 right 20-24(color blends so might need outlines, some colors are similar)	left- (difficult to answer, not able to read the graph) right- he can see red but cant tell if its the most used cuz the user is unable to sum up (friday or saturday)	right- tuesday (cuz it has the lightest colors or darkest greens) left- hard to read cuz the colors blend	right- 22 left- 15 to 24 on a sunday	left-first plot is very confusing, because the context is aligning with the hours right- abstinence and home but not very clear difference between the location and context	left-less of colors overlaping so easier to interpret (22-24) right-21-24 (slightly confusing why some are grey and the others are colored)	left- work uni right-look like linear stairs so slightly unclear
6													
7													
8													
9													
10	Results:												
11	Progress based indicators:												
12	The first 3 of the graphs was easy to understand but the time wise graphs was did correctly interpredted by any of the test partcitipants.												
13	The bar charts and the heat map was easiest to understand in term of count												

Figure 27: Evaluation test

feedback	First graphs	Second graphs	Third graphs
charts were good!step chart - was a little confusing to interpret(try and remove the bars behind it). the colors could be checked	For the first graphs (process based on indicators) there was some critique. The bar chart was simple and exact to look at, did not contain time. The pie chart does not display an extact number. The heat map is fine, but it does not contain numbers so it is not clear how much snus you consume at a time which can help indicate when you most likly are consuming most snus. The time chart did they not understand and it migth be because of the bar lines in the background.	For the second graphs it was difficult to understand the left one because of the color sceme was quite same. They did not really want to answer the questions based on this graph and this could indicate that they found the heatmap more interpretabl. The heatmap did not contain numbers again. Same argumentation as the first graphs.	
the layered chart for avg use in a day using context, was not that clear to understand. the bar was slightly better. maybe have a key instead of text. left-prettiest, right-easier to interpret			
video editor graph for the last one. it has segments based on the time and color based on the region. where we have colors for reason, timeframe and length. to know which day we consumed the most snus, we could implement just a bar graph. assigning different colors for the different locations on the bar graph for locations.	Heat map: He was not sure that the colors meant in terms of the count. The key does not specify the exact count. He prefered the green and white and it reminded him of github. He missed a number on the graphs so that you are able to see exact consumption. Bar chart: The bar chart could have been difficiated in different colors based on location. The Pie chart: colors blend too much and there is no outlines. Time: He did not interpret it correctly.	The left: Difficulties in understanding it because of the many similar colors and graphs laying untop of each other. He did not interpret it correctly. The rigth: The heatmap did not indicate the eact number of taken snus in the different days (summing it up underneeds or in a bar chart). The colorsceme was understandable but he prefored the green one better.	Both of the last two graphs was not easy to understand. He did not interpret any of the graphs correctly, but he did understand the bars on the last graph.

Figure 28: Evaluation test feedback and results

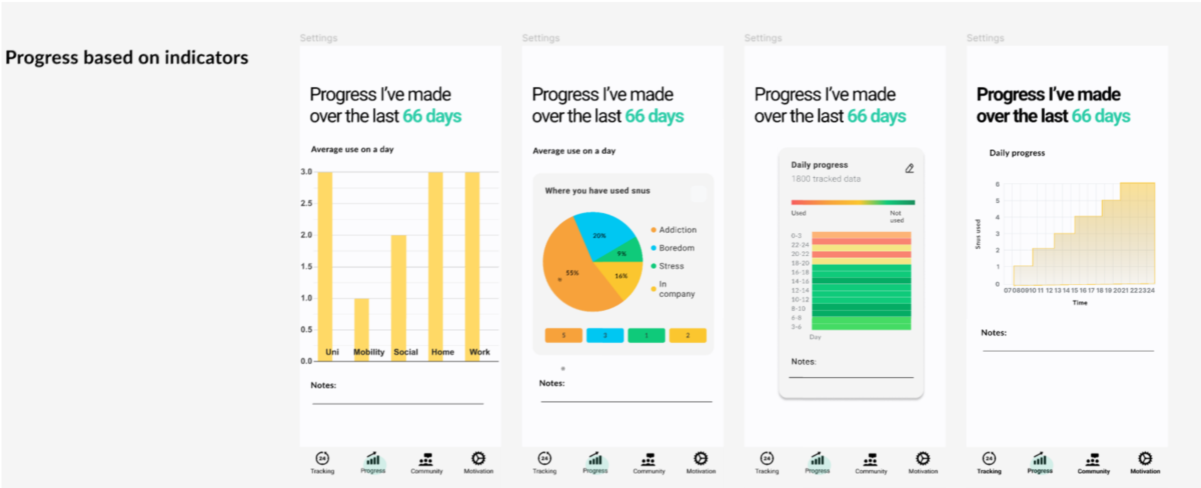


Figure 29: First Evaluation

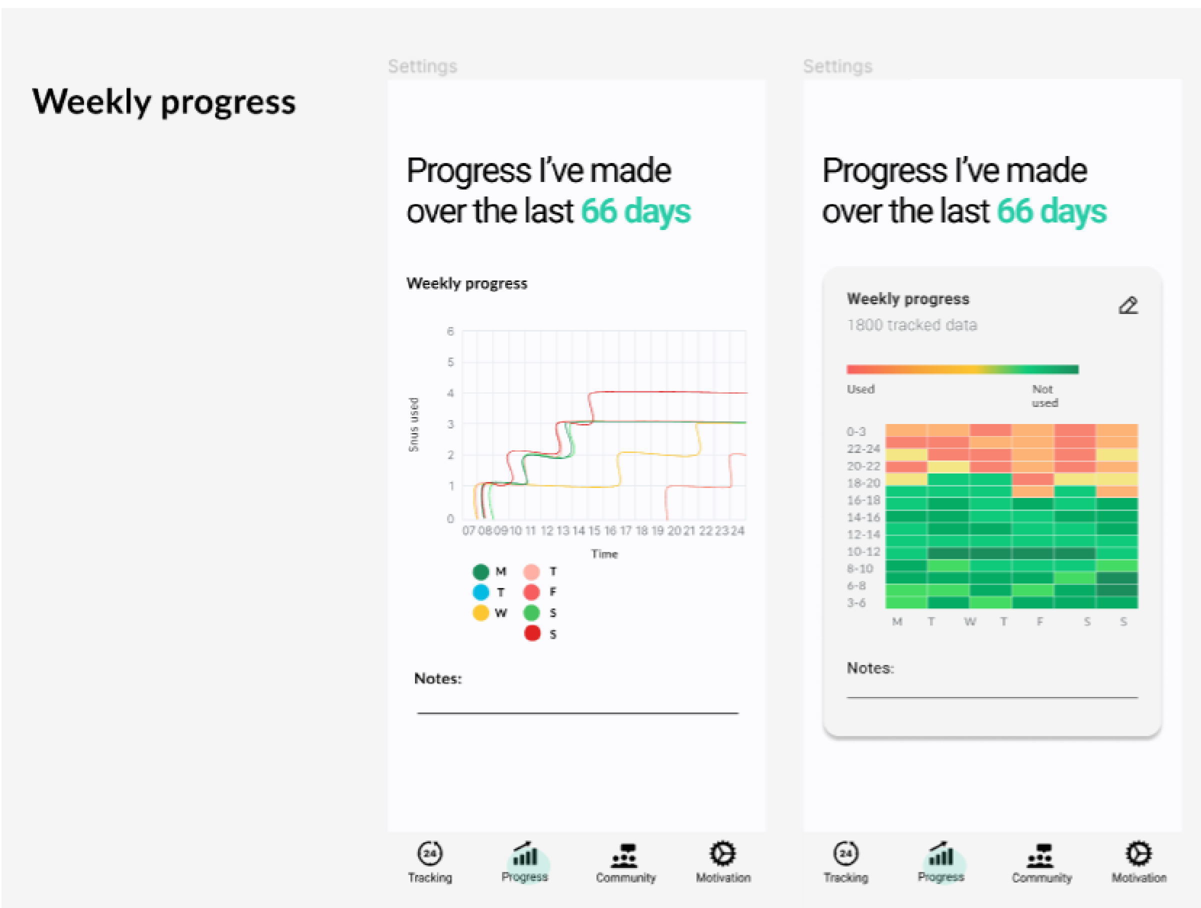


Figure 30: Second evaluation

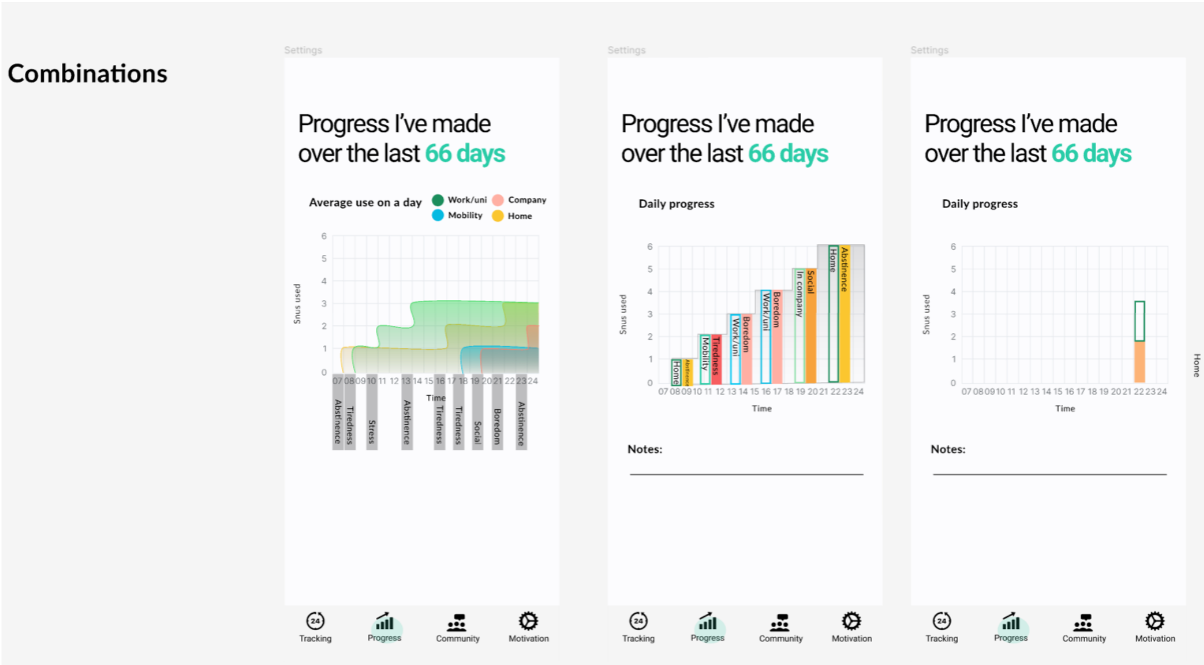


Figure 31: Third evaluation

A.7 Experiment

Experiment

Purpose: Are the visualizations readable for the user? (Fond size, color scheme). (to make sure that the user can reflect and react to the information)

Method: Within-subject

Hypothesis- implementing a high-contrast color scheme with an increase in the font size in the visualizations will improve readability for the users.

Hypothesis- simple and basic visualizations using clear and simpler shapes can be used by people of any age category. They are easier to read and understand when compared to complex visualizations.

Independent variable-

Dependent var- speed of interpretation

Questions (we would like to know):

1. Is the font size readable?
2. Does a high contrast scheme improve readability for the user?
3. Does simplifying the visualizations make it easier (faster) for people?
4. Does simplifying the visualizations easily motivate a user to track/reduce their consumption of snus?

Font size:

1. Are you able to read both font sizes?

Color:

2. Which color helps you identify the most consumption of snus?
3. Which color helps you identify the least consumption of snus?
4. Do you associate the color with high consumption?

Simplifying visualization:

5. At what time of the day do you consume snus the most?
6. Can you identify the maximum consumption in all the plots?

Figure 32: Experiment guide

USER BACKGROUND		FONT-SIZE	COLOR CHOICE	VISUALIZATIONS		RESULTS
AGE	GENDER	are you able to read both the fonts?	Do you associate the color with high and low consumption?	At what time in a day do you consume snus the ?	Can you identify the maximum consumption in all the plots?	
25	F	Hard to read on the first one. Have eyesigth problems. A combination between the sizes as the second is too big.	She prefers the contrasting plots. Do not understand the emtpy plots.	Around midnigth 10-12 in the evning	More time on the last one. Simple in the first one. Pie chart there is no exact number.	
24	F	Fond type makes it difficult it read. Size she agrees with the orther person.	Red and the dark green. Colorblind be aware	Between 19-20. The interval is higher and the step is the	Bar: successfull. Pie: agree. last one: Work/uni	
	M	Week 17 looks blury. The first is blury and the second is fine. The other fonds are fine. Only the weekday.	Left: Clear beacuse the comsumptions is higher it is darker. The rigth: Cannot tell if there is different types of data.	Left: 22-24 Rigth: evening Less clear, because it is the same color. Would you like the same color sceme: The key is good and makes it more understandable.	Bar: Right Pie: rigth Heatmap: Rigth. Time: Not rigth.	
RESULTS		We can conclude that the font size in the picture to the left was a little hard to interpret. The one on the right was slightly bigger and hence to set the size with a value between the 2. Our hypothesis with respect to the font size proved to be right.	Considering the results of the experiment, due to the variation in reults with regards to the colors being used, we can say that the hypothesis to have contrasting colors can be considered true with the addition of a clear indicator (in the form of a key or interaction) to help the user easily identify the peaks and dips in consumption.	the heatmap was easier to read to identify the time at which maximum snus was consumed. the step graph was slightly had to interpret. Most of the users were able to derive the results from the simpler graphs as it was easier to deduce results from multiple simpler graphs when compared to one visualization that had many fields in it		Both the hypothesis proved to be true in the case of the independent variables of font-size, colors and visualizations.

Figure 33: Experiment results

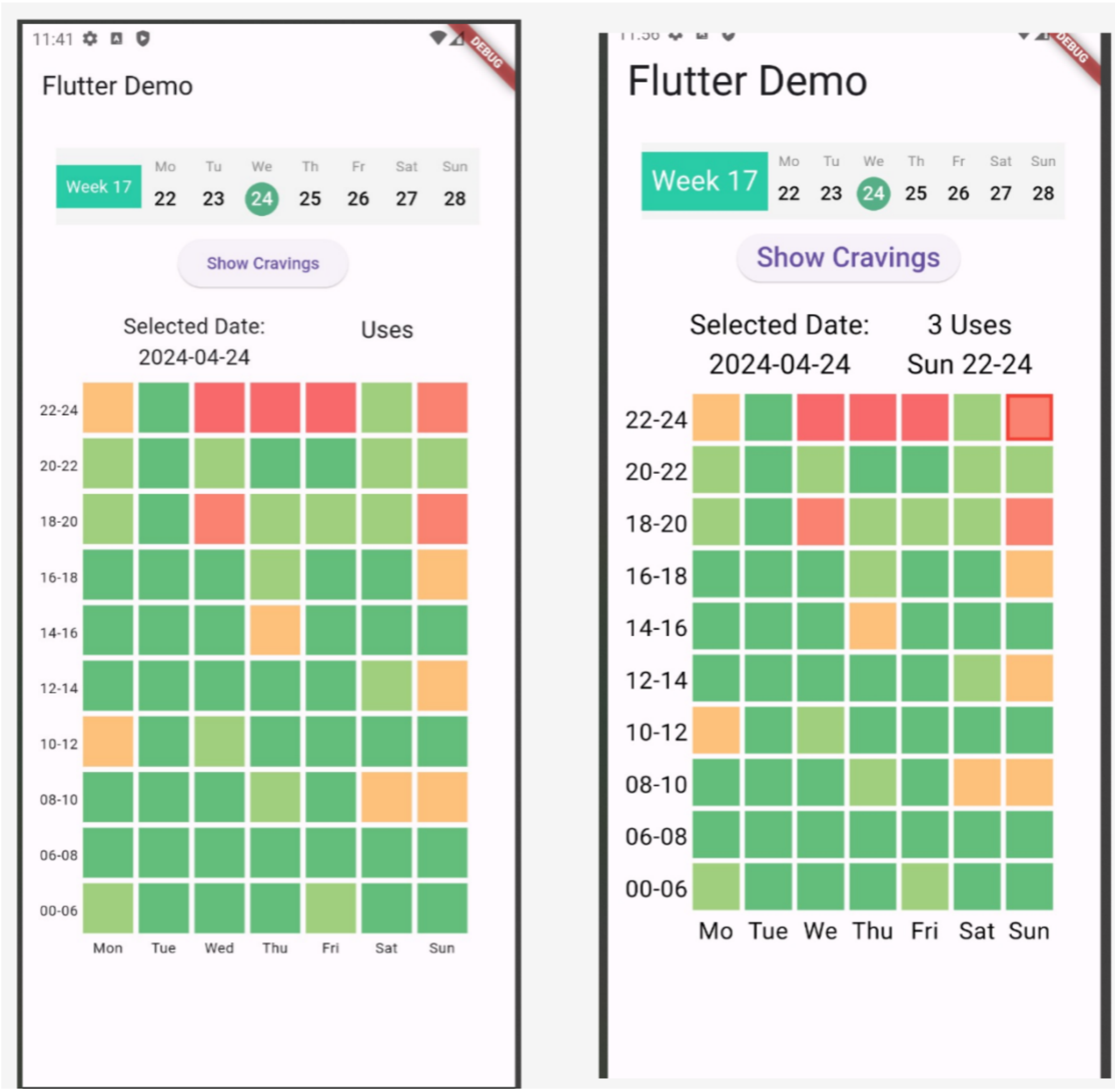
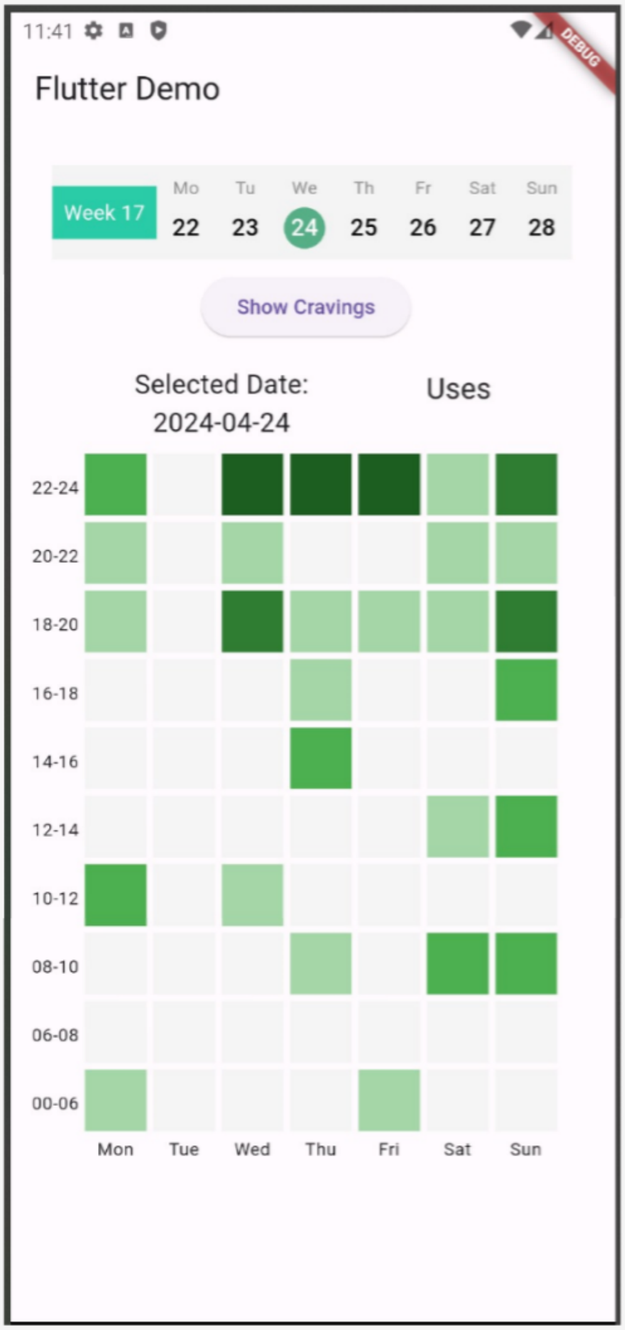


Figure 34: First experiment - font size



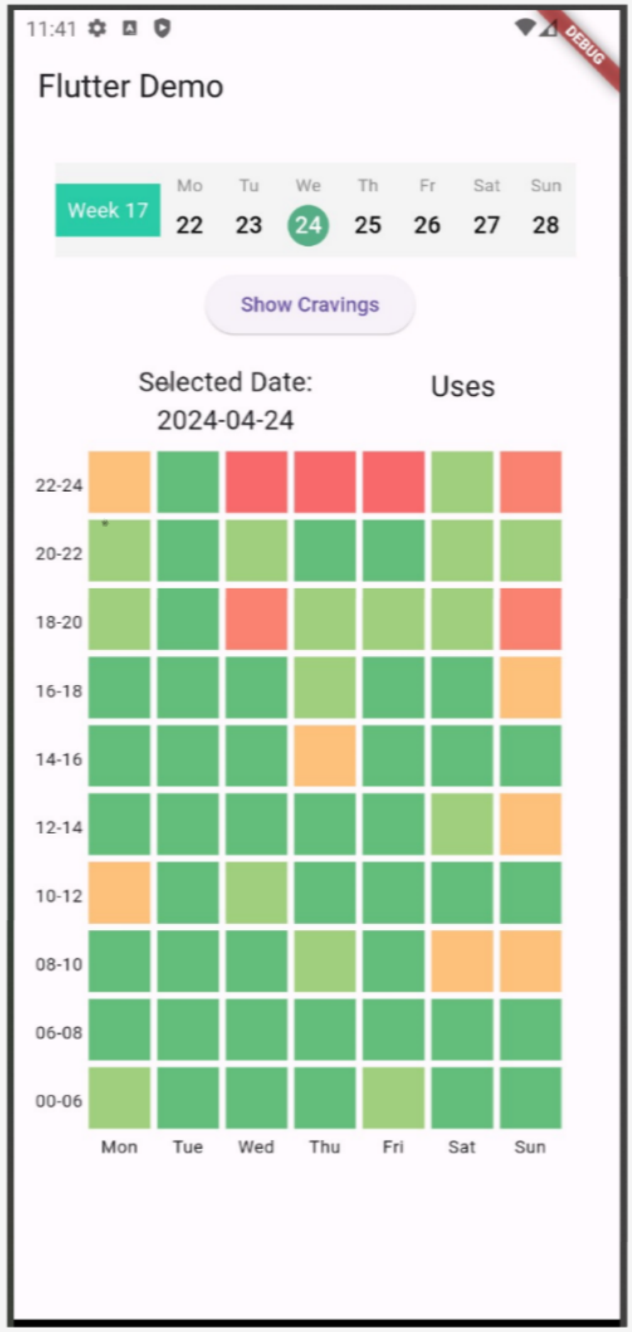
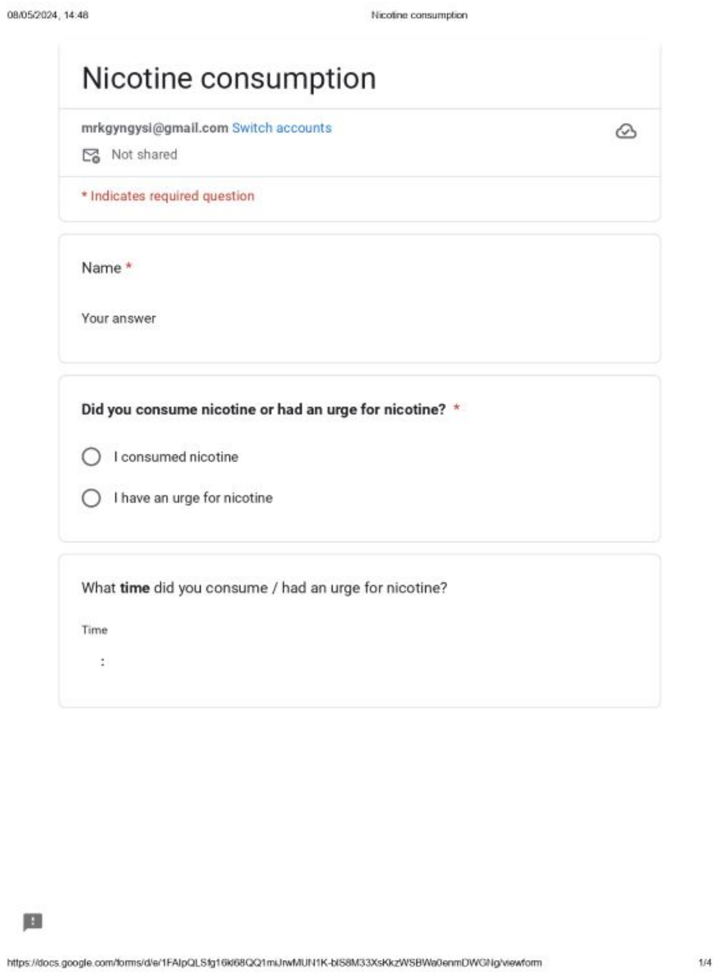


Figure 35: Second experiment - color scheme in heat maps

A.8 Data collection - Google forms



08/05/2024, 14:48 Nicotine consumption

Nicotine consumption

mrkgyngysi@gmail.com Switch accounts

Not shared

* Indicates required question

Name *

Your answer

Did you consume nicotine or had an urge for nicotine? *

- I consumed nicotine
- I have an urge for nicotine

What **time** did you consume / had an urge for nicotine?

Time

:

https://docs.google.com/forms/d/e/1FAIpQLSfg16kl68QQ1miJrwMUN1K-bIS8M33XsKkzWSBWa0enmDWGNg/viewform 1/4

Figure 36: Google form

08/05/2024, 14:48 Nicotine consumption

Where did you consume / had an urge for nicotine?

- [ ] Home
- [ ] Work
- [ ] School/university
- [ ] In company (with friends/other people)
- [ ] Nightlife
- [ ] Sports
- [ ] Mobility (public transport, biking etc.)
- [ ] Other

If other, please specify

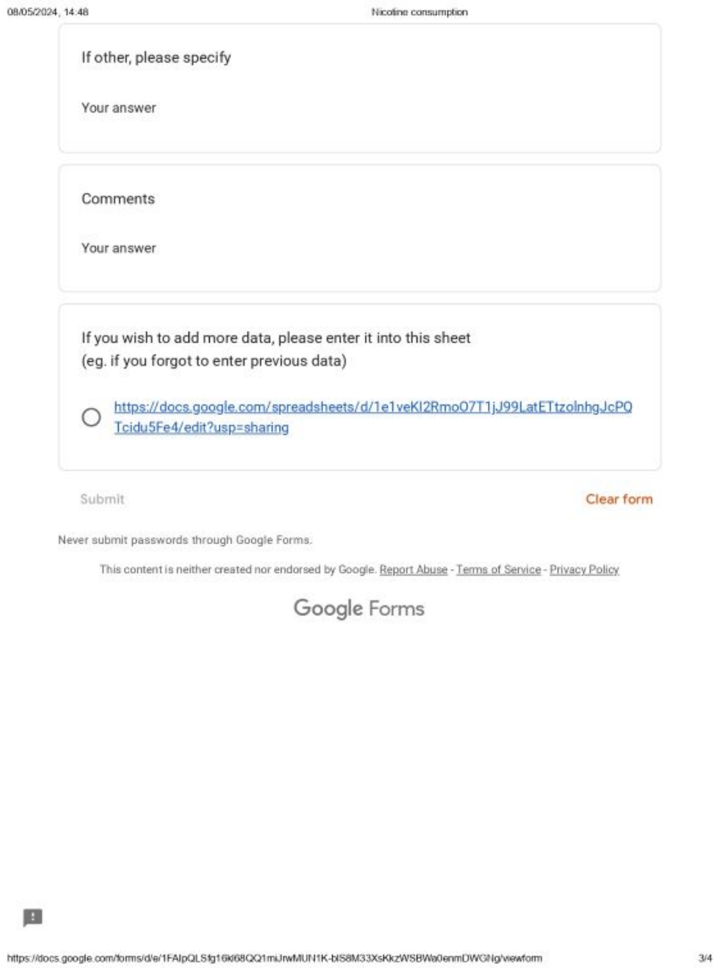
Your answer

In which **context** did you consume / had an urge for nicotine ?

- [ ] Stress reflief
- [ ] Social setting
- [ ] Pleasure
- [ ] Boredom
- [ ] Tiredness
- [ ] Feeling from addiction
- [ ] After eating
- [ ] Other

https://docs.google.com/forms/d/e/1FAIpQLSfg16kl68QQ1miJrwMUN1K-bIS8M33XsKkzWSBWa0enmDWGNg/viewform 2/4

Figure 37: Google form



08/05/2024, 14:48 Nicotine consumption

If other, please specify

Your answer

Comments

Your answer

If you wish to add more data, please enter it into this sheet
(eg. if you forgot to enter previous data)

- [ ] https://docs.google.com/spreadsheets/d/1e1veKI2RmoO7T1jJ99LatETtzolnhgJcPQTcidu5Fe4/edit?usp=sharing

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Google Forms

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Figure 38: Google form

A.9 Contribution list

Parts of the report and other work	Amalie	Aarabhi	Márk
Abstract		X	
Introduction	X	X	
Analysis	X	X	
Prototype	X		X
Related work			X
Method		X	
Results		X	
Discussion			X
Future Work	X		X
Conclusion		X	
Figma prototype	X		
Observable	X	X	X
Evaluations & Experiments	X	X	
Research and exploration	X	X	X
Video	X	X	X

Table 1: Contributions List