

BITTER DATA: AN EXPLORATION INTO DATA EDIBILIZATION OF NEGATIVE EMOTION

Abstract

“Bitter Data” transforms 100,000 distress postings from Chinese social media into a multi-sensory experience using data edibilization. We’ve mapped distress data quantity to the bitterness and color of tea through data analysis and experimentation. Participants taste, smell, and observe 11 cups of tea, each embodying a year’s distress data, in our workshop. Their facial expressions, recorded upon tasting, visually indicate emotional states. This project explores benefits and pragmatic solutions to challenges of data edibilization.

Keywords

data edibilization, data physicalization, data art, data tasting, emotion data, data representation

Introduction

“I lost my job/ I lost my love/ I failed an important exam, I feel bitter.” People often use bitterness to describe the negative emotions they feel. Research by Poggi and D’Errico explores the mental ingredient of bitterness:

people tend to use “bitter” to describe the negative emotion in between anger and sadness [1]. In our study, we gathered over 100,000 pieces distress postings on Chinese social media that chronicle dissatisfaction in their lives. This data is infused with negative emotions that associate with bitterness and led us to project title Bitter Data.

Several previous studies emphasize the pivotal role of emotional appeals in data visualization. For instance, Charles contends that emotional appeal forms an essential component of modern data visualization. Designs that explore emotional data in a multi-dimensional manner can enhance the attractiveness, humaneness, and usability of the presentation [2]. Yet, data visualizations relying solely on visuals can only evoke emotions through elements like color, innovative design, and aesthetics. In their research, Wang et al. suggest that focusing on eliciting emotional responses can further extend the value of data visualization. They posit that data physicalization, as compared to pure digital visualization, is

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more adept at bringing human emotion to the forefront [3]. When data is intrinsically tied to human emotion, data physicalization proves to be a more effective approach.

Therefore, in this study, we plan to deploy a broader range of materials and senses to present and allow to feel this distress data full of negative emotions. We aim at obtaining a rich and humanly presentation of bitter data. Through an artistic and participatory approach that involves the audience’s sight, taste and smell, we make the data humanly, to let the audience feel and perceive the bitter negative emotions such as anxious, uncertain, and hopeless of the responding people behind the plain data. Preliminary



Figure 1. “Tasting the bitter data”: 11 cups of bitter tea each corresponding to a year’s distress data.

of the responding people behind the plain data. Preliminary attempt is introduced in an earlier poster [4].

Data Edibilization

In this study, we use data edibilization [5] to present the trouble data to provide rich sensory modalities for the audience.

Data edibilization is a specific type of physicalization, using food to present data. Prominent examples include Carine and Maud inviting individuals in workshops [6] to map data provided by researchers on weekly tasks using the color, shape, and flavor of candies. The TastyBeats project [7] exemplified a valuable sample of experiencing personal data through food by printing an individual’s daily heart rate changes into a mixed sports drink. Other fields, such as art

research, offer captivating practices [8, 9] in data expression through food. For instance, Data Cuisine has held workshops across Europe using local food to express open data. Their most recent event in Paris in 2019 used local ingredients to represent climate change and the Yellow Vest Movement [8].

Wang et al.’s study [5] proposed the concept of data edibilization, listing preliminary potential benefits of this research method, including (a) attracting public participation, (b) the multi-sensory data of food being used for data coding, and (c) the inherent properties and characteristics of food serving to narrate data stories.

Bitter Data

Concept

In essence, traditional data or screen-based visualizations struggle to convey the genuine emotions behind the numbers. This inherent limitation inspired us to delve into the taste of the distress data. Therefore, we scrutinize the data, mapping trends of posting quantities onto the bitterness and color tone of bitter tea. People often sit down and have a cup of tea when explaining their problems to friends or family. As a famous saying goes: a worry shared is a worry halved. Hence, the idea behind using tea and tasting the amount of problems was connected to tea emphasising emotional load of data and aiming for understanding and sharing the worries that people had. There’s no doubt that when we encounter

troubles, the natural response is to feel distress and bitterness. But does tasting bitter food also provoke negative emotions? Many empirical studies investigating connections between taste and mood have affirmed that taste influences people's emotional states. A study illuminates that there are interconnections between taste, emotion, and cognition, and the experiments with over 250 participants show that bitter taste affects mood negatively [10]. Also, another study leverages the technology of 3D food printing as a medium to empirically substantiate the inherent correlation between gustatory perception and emotional response [11]. What's more, taste can be a powerful tool to express and communicate experience. Certain studies have begun to integrate taste as a novel design element to enhance the sensory richness in human interaction. For example, a study develops a taste experience analysis framework based on Temporality, Affective reactions, and Embodiment, to emphasize the potential design implications for taste [13].

Therefore, just as words encapsulate emotions, taste can elicit emotional responses. Distress postings are text data imbued with negative emotions, with bitterness serving as a metaphor for these negative sentiments. The bitter taste can thus be perceived as a bridge that links these elements, facilitating a symbolic mapping of the two.

Our bitter taste experiments led us to choose bitter tea as our edible medium. The bitterness and color tone of the tea serve as encodings for the quantity of distress postings. By adjusting

brewing times and the amount of tea leaves, we brewed 11 cups of tea, each with a unique level of bitterness and tone correlating to the annual data, as depicted in Figure 1. A darker, more bitter tea signifies a year filled with more troubles, translating to heightened bitterness experienced by individuals that year.

Subsequently, we organized a workshop to validate our edible data representation. Six participants tasted the 'bitter data' and shared their experiences. We captured their facial expressions during the tasting session, which served as a secondary data mapping approach.

This progression from numerical distress data to bitter tea, and finally to facial expressions of bitterness, transformed our approach to data representation. The taste, color, facial expressions, tea leaves, and all other materials present in the workshop collectively physicalized the 11 years of distress experienced by young Chinese people.

The Distress Data

Nowadays, people tend to complain about their troubles on social media. It is like going to a temple or church to tell the troubles or setbacks they suffer, with a sense of prayer or pouring out. A study has suggested that social media eliminates time delays and physical distances, increasing the possibility that individual negative emotions escalate into collective negative emotions, which generates an emotional emergent whole that cannot be traced back to the individual [12]. On a Chinese social networking site called

DouBan, there is a post that had existed from 2011 to 2021 dedicated to telling troubles. A considerable number of Douban users replied below telling their troubles, accumulating more than 130,000 replies in that post. This is an emotional emergent whole on social media about people's distress. These ordinary distress postings cover problems about relationships, study, careers, growth, health, and other shared concerns. They are trivial and real.

With a period of 11 years, these distress postings as a whole reflect the troubled history of young Chinese people during that time (according to Douban's official statistics, as of the end of 2019, Douban had more than 200 million registered users and more than 400 million monthly active users. It is aimed at smartphone-based people aged 13-45, mainly young people in China). To some extent, this can be counted as the emergence of collective negative emotions among young people in Chinese society in a decade. Those postings were removed as a whole in November 2021, but luckily, we happened to crawl all the replies before it was removed.

We are going to analyze and present this distress data for four reasons:

1. This data spans 11 years from 2011 to 2021, and through its analysis and display, we can macro see the changing trend of troubles and negative emotions among young Chinese people.
2. Can major social events such as national development and epidemic outbreaks be reflected in the vast amount of

trouble data posted by individuals on social media? The correlation between trouble data on social media and societal conditions is worth exploring.

3. The original post has been deleted, and this data is the only backup of the people's troubles in the past 11 years. It is worth commemorating the troubles and negative emotions of ordinary people in these 11 years by analyzing and presenting their fluctuation.

4. These massive troubles form a text dataset containing negative emotions, and we can try to use the presentation to connect it with human feelings and emotions and explore how to let people experience the deep meaning and emotions behind the data.

Data scraping and processing

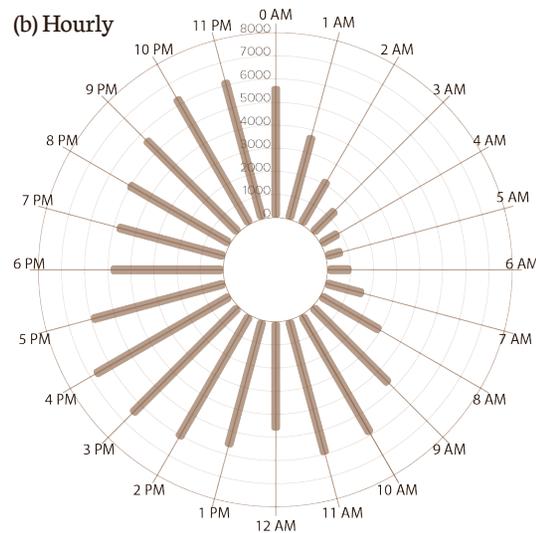
Using Python's crawler tool, we crawled these distress postings from the site and cleaned the data. More than 130,000 replies were crawled from February 2011 to July 2021. We wrote a program to automatically remove replies containing garbled or non-distress words. After this, three people manually cleaned up the data separately, keeping only text related to personal distress. In the end, 105752 pieces of distress text in the past 11 years remained. A sample data is shown in Figure 2 (a) (the original text is Chinese, which is shown after the translation).

The emotional tone of this distress data is singular: negative feelings of bitterness. The goal of our work is to convey this bitter emotion to the audience through data edibilization. Therefore, we need to

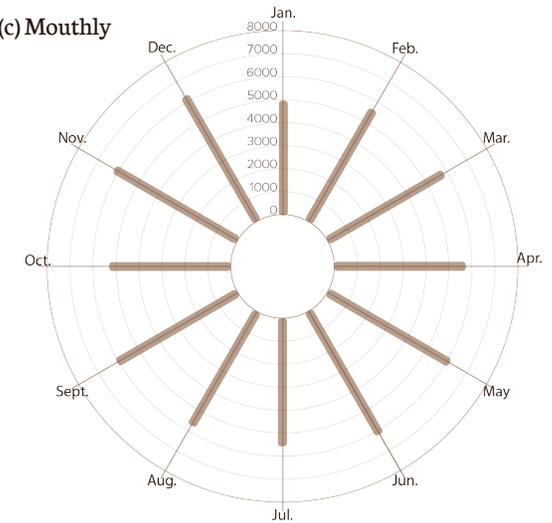
(a) Original Data Sample

ID	Posting Time	Distress Posting	Link
The lazy cat in the shade	2016-10-31 15:34:45	I am very confused about whether to change jobs, what should I do?	https://www.douban.com/people/97587886/
Mr. Nanyin	2016-10-31 16:47:59	I don't want to contact him anymore.	https://www.douban.com/people/93352612/
Feng-FUNG	2016-10-31 17:07:26	Can I have a chance in this life?	https://www.douban.com/people/64296623/
Onion Fairy	2016-10-31 20:13:29	Should I completely give up on him?	https://www.douban.com/people/haniluya/
Medusa	2016-10-31 22:56:27	Does he really like me?	https://www.douban.com/people/47481971/
jiaxuan629	2016-11-03 09:48:14	Will there be a turnaround in work?	https://www.douban.com/people/152905003/
Nicotine	2016-11-04 03:57:25	When can I get the money?	https://www.douban.com/people/139149468/
o Peng Peng o	2016-11-04 11:37:58	Can the I pass the test at the end of December?	https://www.douban.com/people/41530515/
Evil Granny	2016-11-14 13:41:12	I feel uncomfortable.	https://www.douban.com/people/65586549/
Js	2016-11-15 17:33:59	He is not worthy of my love again, he has failed me again and again.	https://www.douban.com/people/45159422/
crow	2016-11-30 12:43:39	I should give up my illusions and face the reality.	https://www.douban.com/people/chexiaochan/

(b) Hourly



(c) Monthly



(d) Yearly Trends

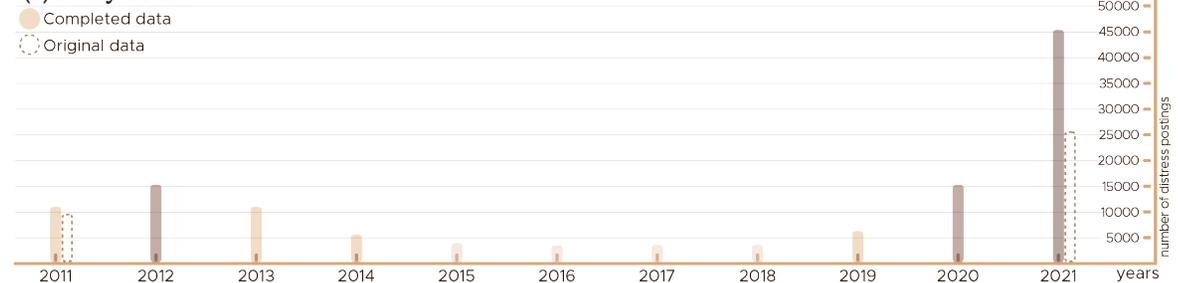


Figure 2. The distress data: (a) Data samples of the original distress postings, complete with ID, posting time, text, and link. (b) The hourly trends in distress data quantity. (c) Monthly trends in distress data quantity. (d) Yearly trends in distress data quantity.

quantify the degree of bitterness in the data. We analyze the quantity of distress data at three time scales: year, month, and hour. The analysis results are shown in Figure 2.

On the scale of hours, shown in Figure 2 (b), the biological clock is evidently the most significant factor. During the sleeping period from 1 a.m. to 7 a.m., the number of distress postings is very low, reaching its lowest point at 5 a.m. As people gradually wake up, the number of distresses starts to increase, but overall, there are fewer distresses from 7 a.m. to 9 a.m. There are also potential influencing factors such as work stress and cultural habit, because after a lunch break, the number of distresses peaks at 4 p.m., reflecting the peak of daily stress at this moment. Subsequently, the number of distresses decreases during dinner and evening rest, but it reaches a new peak from 10 p.m. to midnight.

On a monthly scale, shown in Figure 2 (c), the number of distress postings doesn't appear to fluctuate significantly. We've excluded the data for the years 2021 and 2011 from our analysis due to incompleteness—the 2021 data is only available up to July, and the 2011 data lacks January. Generally, the data suggests people experience fewer distress at the start of the year, possibly reflecting optimism for the future. Conversely, distress peaks at the year's end. Besides January and February, distress levels also seem lighter in April, July, and October. These months correspond to the start of spring, summer, and fall, suggesting that people may be more active

and positive at the onset of these seasons. Yearly, noticeable fluctuations occur in the number of distress postings, and the influencing factors are more complex. Note that due to missing data for certain months in 2011 and 2021, we have adjusted and completed the data for these two years based on the proportion of monthly data. Figure 2 (d) shows the results before and after the adjustment, but our analysis focuses on the adjusted data. As can be observed, distress postings began to decline year by year after reaching a

small peak in 2012, suggesting that this year marked the highest level of distress among individuals in the first half of the 2010s. A period of stability and decrease was seen from 2015 to 2018, possibly indicating a smoother and more stable phase for young Chinese people. In 2019, however, distress postings surged and continued to increase rapidly in the subsequent years. The total count of distress postings in 2021 was nearly three times that of 2020. This sharp rise is likely associated with the COVID outbreak. The pandemic, confining people to their homes,



Figure 3. Experiment 1: Researchers looking for bitterness materials.

led to an increased reliance on social media for expressing their distress and bitterness. As hope seemed elusive during the long-drawn epidemic, the accumulation of negative emotions appeared to grow exponentially.

Comparatively, the annual variation in the distress data proves to be the most intriguing, with significant shifts in people's bitterness. Hence, we will employ bitter foods as an illustrative tool to represent this yearly trend. The original data is large and complex, and there are almost twenty times the difference between the lowest and highest points. Therefore in the following section we introduce our precise experiments and calculations to explore how to reflect such quantitative differences with bitterness. More importantly, we wish to establish a reliable approach that connects negative emotions and bitter foods, and provide a reference for those who may wish to explore similar data edibilization approaches.

Bitter Experiments and Mapping Approach

Experiment 1: Bitter Foods

Initially, we ought to determine which bitter edible material could best represent our distress data. Various foods and beverages such as coffee, beer, tea, medicine, and bitter melon all bear bitter tastes. We chose to use Chinese tea and bitter melon for our first bitter taste experiments (Figure 3). This is because the context of our distressed data is Chinese, and it is more appropriate to use

edible materials characteristic of Chinese culture. In the experiment, we tried to make beverages with three ingredients: green tea, bitter tea (Kuding tea), and bitter melon, as depicted in Figure 4. Both bitter tea and bitter melon juice presented a pronounced bitterness. Ultimately, we selected bitter tea as our medium for subsequent data edibilization. Kuding tea has been used as a tea beverage in China for more than 2,000 years, is known for its bitter taste, and has many health benefits

[14]. We reached this decision as, during the experiment, we found that the degree of bitter taste and color tone of the bitter tea can be modulated via the brewing process, which is beneficial for us to map the data later. In contrast, the color and bitterness of bitter melon juice proved challenging to manipulate. Additionally, and perhaps more crucially, China's tea-tasting culture carries metaphors symbolizing the tasting of troubles and distress. For instance, the Tang Dynasty



Figure 4. Experiment 1: Testing bitter edible materials. (pictures above) The process of making bitter melon juice, green tea, and bitter tea. (pictures below) Researchers tasting the bitter juices and teas.



Figure 5. Experiment 2: Quantifying the bitterness of the tea. (a) Gradual color change when using bitter tea bags. (b) Bitterness matrix of using bitter tea leaves with variable brewing times and quantities of tea leaves.

poet Jiao Ran eloquently praised the transcendental nature of tea drinking in his verse, “Attain enlightenment with just three sips, why torment oneself over worldly distress?” This line captures a spiritual elevation achieved through tea tasting that enables one to rise above life’s hardships. Furthermore, tea is also a medium of cross-cultural communication, with tea drinking customs prevalent worldwide.

Consequently, although the source text of our data is in Chinese, the taste of tea can effectively communicate the underlying distress to an extensive non-Chinese speaking audience. This universality of tea consumption could facilitate a broader understanding and empathy towards the distress data we aim to convey.

Experiment 2: Bitter Quantification

Before we can accurately correlate the bitterness of bitter tea with the quantity of distress data, we must understand how to manipulate the tea’s bitterness through its brewing process. Numerical studies in the

field of food chemistry have attempted to quantify tea’s bitterness, such as measuring the bitterness of black tea [15], green tea [16], and oolong tea [17]. These studies focus on identifying the specific chemical constituents in tea that contribute to its bitterness, exploring how varying concentrations of these components affect the overall taste. Generally, catechins in tea are the chief contributors to its bitterness. A higher concentration of catechins results in increased bitterness.

As a result, by controlling the total concentration of tea, we can in turn control its bitterness. Traditional Chinese tea brewing techniques identify three key factors influencing this process: the quantity of tea used, the temperature of the water, and the brewing duration. These factors have been validated by research which, despite acknowledging the influence of the tea leaves’ machining process, highlights how rehydration capacity is affected by product composition, water temperature, and rehydration time [18].

So, with these findings in mind, we aim to adeptly manipulate these parameters to represent distress data accurately through the bitterness of our tea. We embarked on our second experiment with the aim to discern how to brew tea at varying degrees of bitterness. As demonstrated in Figure 5, we attempted brewing a bitter tea matrix with diverse quantities of tea leaves and durations of brewing. The results were clear - a higher quantity of tea leaves or a longer brewing duration resulted in a darker tea color, stronger concentration, and a heightened bitterness in taste. We explored bitter tea bags, which showcased a more distinct color profile compared to loose tea leaves, highlighting their potential as a valuable color design tool. The specific correlation between brewing time and tea color depth is presented in Figure 5. This experiment affirmed that we can manipulate the bitterness and color of tea by controlling the brewing time and the quantity of tea leaves used. Consequently, we resolved to use tea leaves as our primary brewing material, complemented by tea bags to enhance and control the color. Additionally, we identified

the quantity range of tea leaves and the brewing time range that can alter the taste of the tea from lightly bitter to extremely bitter.

Experiment 3, Mapping Approach

Our objective is to map the number of distresses and the factors affecting bitterness each year. Firstly, we organize the distress data in ascending order. After experimenting with various modeling techniques including linear fitting, polynomial fitting, and power fitting, we determined that the quadratic polynomial fitting was the most suitable for the distress data trends.

Even though a quantitative relationship between the concentration of brewed tea, brewing time, and quantity of tea leaves isn't explicitly provided, based on our previous experiment, we believe they are likely interrelated multiplicatively. Thus, these two influential factors can be integrated into a quadratic equation to calculate the most suitable tea brewing method for each year. By incorporating the annual number of distresses into the equation, we map the results to the brewing time and tea quantity range obtained from Experiment 2, thereby determining the annual tea brewing method as depicted in Figure 6. Using 100 degrees Celsius hot water, the least distressful year, 2015, required 8 grams of tea leaves brewed for 13 minutes, whereas the most distressful year, 2021, required 62 grams of tea leaves brewed for 83 minutes, supplemented by 5 tea bags. The quantity of tea leaves can be intuitively discerned from Figures 6

and 8, while the color of the tea provides a visual clue about its concentration. By tasting these teas, we can comprehend the amount of distress data corresponding to each year from the bitter taste of the tea. However, perceptions of bitterness can vary significantly among individuals, and cultural background may further influence one's experience with bitter tea. To address this, we plan to conduct workshops to gather a broader range of responses to the bitter tea's

representation of negative emotions. These workshops will also record participants' facial expressions—an instinctive reaction to bitterness—which offer another layer of data mapping to the original negative emotional data. By observing and documenting these reactions, we hope to refine our understanding of how bitterness can effectively communicate distress across diverse audiences.

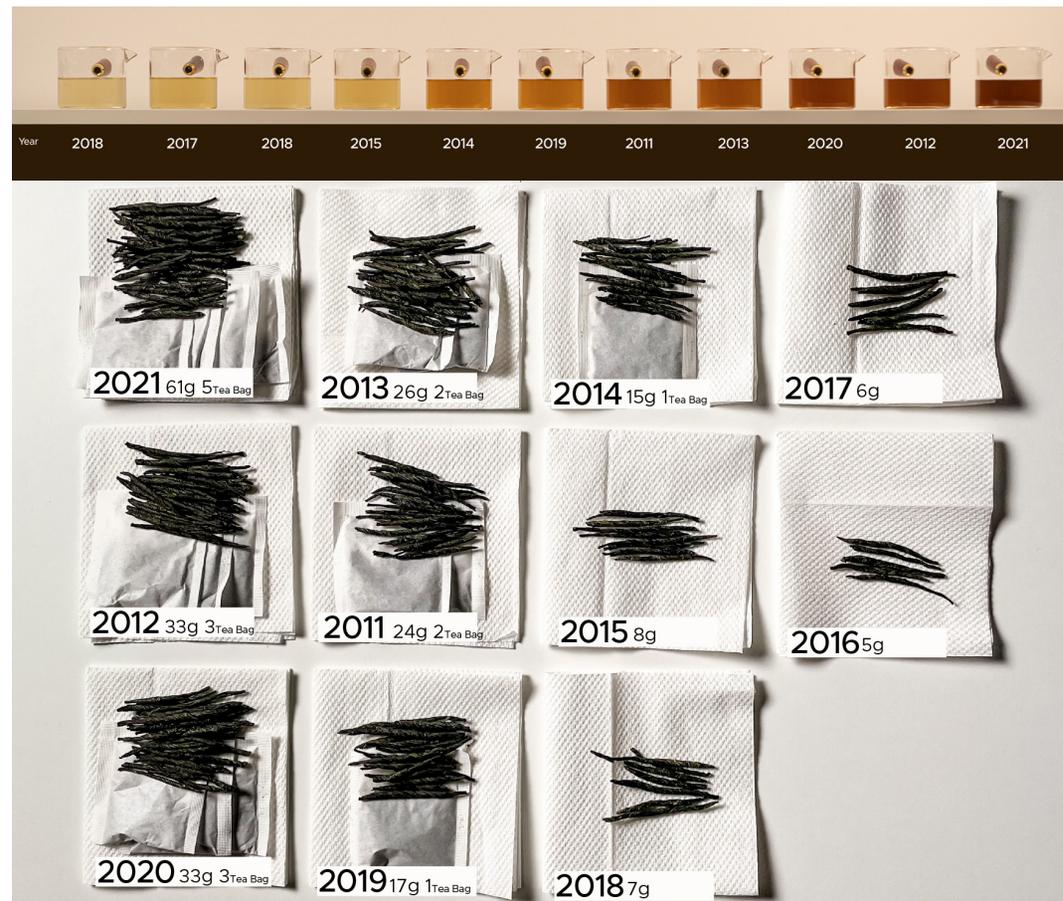


Figure 6. Experiment 3: Determining the required quantity of tea.

Tasting the bitterness of data

Workshop Design

We recruited six volunteers from the university campus, aged 26 to 35 ($M=28.3$, $SD=3.32$; 3 males, 3 females), for a workshop on data edibilization using bitter tea (Figure 9 and Figure 11). Volunteers came from diverse backgrounds including computer science, traditional engineering, arts, and design. All had prior tea consumption experience and no tea allergies.

In advance, we brewed eleven pots of tea at a consistent temperature, each representing negative emotions from social media posts between 2011 and 2021, left to right. To prevent participant influence, tastings were conducted individually, progressing after each completed tasting.

Before each participant began tasting, we provided a brief overview of the data source, informing them that the tea symbolized 11 years of social media data. Additionally, participants rinsed their mouths with water between tastings to minimize interference.

Participants sequentially tasted bitter teas for 2011-2021, experiencing yearly bitterness changes. We advised leaving the tea in their mouths for 2-3 seconds to standardize and enhance flavor perception. This ensured consistency among participants and allowed thorough flavor perception. After flavors diminished, participants evaluated the taste. At the experience's end, participants described



Figure 7. The setup of the bitter data tasting workshop .



Figure 8. Illustrating the quantity of tea leaves, tea bags, and brewing time allocated to each cup of tea.

the gustatory journey trend based on recall, enhancing data tasting and understanding data edibilization characteristics through evaluation and imaginative recall.

Mapping Bitter Data With Facial Expression

Departing from many studies in the data edification field that typically employ interviews to validate the efficacy of data mapping [5,6,7], we introduced a unconventional approach in our study. Given that reactions to bitterness are often instinctively expressed through facial expressions during experiments, we referred to images of participants' facial reactions to the bitter tea as an alternative representative method of the bitter data. We value human emotional responses more than objective measurements, which is the purpose of this

work, to turn data into rich feel and experience, rather than being abstracted into measurement data again. It is interesting to compare human and machine measurements in the future, but this study merely focuses on the reaction itself.

Facial expressions, emotions, and taste are intricately intertwined. Facial expressions serve as a key indicator of emotional states, providing important clues for understanding an individual's feelings. Emotion recognition through facial expressions has been proven to be a method for identifying emotional information without requiring specific training [19]. Different tastes of food elicit distinct patterns of facial reactions [20]. Bitterness and sourness evoke more prominent facial responses, with clear expressions of disgust and surprise, and

these reactions intensify with increasing concentrations [19, 21]. This aligns with our personal experiences during the experiment of tasting teas of varying intensities. While this approach is unconventional in the field of data edibilization, we hypothesize that it could provide an intriguing and direct means of measuring the subjective experience of bitterness.

During the workshop, we use a camera to record their facial expressions (Figure 7). The collection of facial images was carried out with the participants' consent.

Results

Intriguingly, upon tasting each variant of the bitter tea, participants often spontaneously shared their associations with the corresponding years or reflected

upon their personal experiences during those years. Informed by observed facial expressions, all participants (6/6, 100%) were able to perceive a general trend in the data over the span of 11 years (Figure 10). That is, participants sensed the bitterness corresponding to the years 2011-2015 starting at a high level and gradually decreasing, while the bitterness of the tea corresponding to 2015-2018 maintained a consistent and relatively bland level. From 2018 to 2021, there was a trend of increasing bitterness, culminating in extreme bitterness by 2021.

However, three participants (3/6, 50%) did not perceive the tea corresponding to 2012 as more bitter than that corresponding to 2011. The results suggest that the intense bitterness of the first cup may have excessively stimulated their taste buds, thereby inhibiting their ability to perceive an increase in bitterness in the second cup. This observation seems to align with the research findings by Mura et al. [22], where the ability to perceive bitterness was noted to be influenced by the initial intensity of bitterness and may recover over time.

All participants (6/6, 100%) found the four cups of tea corresponding to the years 2015-2018 remarkably bland. Participants linked this observation with a period of minimal complaints and pain on Chinese social media, hypothesizing that this phase might represent a relatively calm period in society. Some spontaneously reflected, 'It seems that life was worry-free back then,' and 'It appears that the online environment

had not yet become so deteriorated.' This stimulated them to reflect on their personal experiences during these four years, which, in retrospect, seemed to be characterized by a state of relative tranquility. Despite minor variations in bitterness across the four cups of tea, the participants found it challenging to discern the changes in bitterness.

After tasting the tea corresponding to 2019, 5 participants (5/6, 83.3%) perceived a significant increase in bitterness compared to the prior year, evoking intense discomfort reflected in their facial expressions. Some of the participants (4/6, 66%) made a connection to the onset of the COVID-19 pandemic in China in 2019, a period marked by elevated societal tension. Interestingly, three participants (3/6, 50%) spontaneously stated that the tea for 2020 was perceived to be more bitter than that of 2012, even though the color and intensity were similar. This observation could possibly be linked to our prior discussion about the influence of the initial intensity of bitterness on the subsequent tolerance and perception of bitterness. As the intensity was notably low from 2015 to 2018, their ability to perceive bitterness remained largely unaffected. Furthermore, the bitterness intensity from 2018 to 2020 displayed a gradual upward trend, with significant increments each year, allowing participants to discern a marked increase in bitterness and perceive 2020 to be noticeably more bitter than 2012.



Figure 9. Workshop participants engaging with the bitter data.

Discussion

Advantages

The research of Wang et al. proposed six significant benefits of utilizing data edibilization: Attractiveness, Sensory Richness, Intangible Richness, Memorability, Affectiveness, and Sociability, all of which are detailed comprehensively in their study [5]. These benefits are well-reflected in our project. For instance, the attendees of our workshop expressed high levels of interest in the tea tasting activities, as well as the underlying data they represented. By engaging multiple senses such as taste, smell and sight, they could experience the fluctuations of distress data across the 11-year span in a unique and tangible way. Such a participatory experience is likely to leave a more lasting, nuanced impression of data shifts compared to conventional visualizations. In addition, based on these advantages, our workshop attempts to further explore the potential benefits of edibilization.

· Facial Expressions as an Assessment Tool for Data Edibilization

Facial expressions can be especially useful in situations where respondents are unable to articulate their experiences verbally [23]. In our study, the use of facial expressions as a means to evaluate the effectiveness of data edibilization showed potential. Despite the individual differences in the degree of reaction and manifestation, this did not prevent us from capturing the overall response changes to different degrees of bitterness. Particularly

in expressing reactions to strong bitterness, facial expressions provided an intuitive and expressive feedback mechanism, allowing us a deeper understanding of participants' perception of data mapping. However, this approach also has its limitations. For instance, with more subtle changes in bitterness, facial expressions might not provide sufficient sensitivity. Secondly, related research indicates that bitterness, sourness, and saltiness elicit more pronounced facial responses, while sweetness and umami tend to yield less distinct expressions [24].

Moreover, displaying the facial expressions of all participants could accompany data edibilization as an alternative form of visualization. In a sense, the facial expressions exhibited by participants consuming the bitter tea corresponding to the data are a reenactment of negative emotions.

· Spontaneous Associations and Recollections Triggered by Bitter Tea Tasting

An intriguing observation during the experiment was the spontaneous reminiscences that tasting bitter tea, representing negative emotions data, triggered in some participants. Without any specific prompts, the tasting sessions occasionally stimulated the participants to articulate personal experiences and societal impressions associated with the corresponding years of the data. This spontaneous recall of memories appeared to occur naturally and intermittently, providing further insight into the complex relationship between sensory experiences

and memory. This highlights the potential of using bitter tea as a unique tool that can, at times, induce a deeper personal connection with the negative emotions data, facilitating not only an understanding of overarching trends but also a reflection on personal narratives intertwined with these data points.

Challenges

In line with Wang's characterization of data edibilization as an emerging research trajectory [4], our investigation acknowledges the strong potential of this novel approach for fostering a sensuous understanding of complex data landscapes. Wang and his colleagues have emphasized several potential challenges associated with this methodological direction, including, but not limited to, food literacy and sensory capabilities. Our aspiration in this study is not to propose an all-encompassing solution to these latent obstacles. Rather, through our project as a case study, we aim to illustrate how these challenges can be pragmatically addressed in specific circumstances.

· Food literacy

The challenge of food literacy refers to the possibility that the audience, due to unfamiliarity with the encoded food item, may misinterpret or miss the significance of the expressed data [5]. Bitter Data successfully employs the intense bitterness, cultural attributes, and the correlation with negative emotion data of Bitter tea to address the challenge of food literacy. To begin with, given the significant role that tea culture plays in



VISAP'22, Pictorials and annotated portfolios.

Figure 10. Mapping facial expressions in correlation with the bitterness of each year.

Chinese gastronomy, along with its wide global recognition, participants are likely to readily assimilate the cultural attributes of the food medium. Moreover, within the context of this project, the bitterness inherent to the tea, which carries the flavor, may assume greater significance than its cultural attributes.

In our design, we ensured that the participants tasted only the infusion of bitter tea, which corresponded to variations in the bitterness intensity that mirrored the purely quantitative changes in the selected dataset. This approach streamlined the cognitive load in the perception and communication of data. Crucially, as previously stated, there exists an intertwined relationship between negative emotions and bitterness. Participants were able to associate the bitterness of the bitter tea with the hardships represented in the data of the corresponding years. Bitter tea allowed participants to not merely perceive the data but also to experience it. This was evident in the results, as participants could perceive and express, via their facial reactions, the overall trend of bitterness that corresponded with the data mapped over an 11-year span.

In this experiment, we underscore the importance of a strong connection between the specific food used in data edibilization and the data itself. If the bitterness were not so closely linked to negative emotions, significant issues would arise in data communication.

· Sensory capabilities

The challenge of sensory capabilities, as



Figure 11. Workshop participants engaging with the bitter data.

outlined by Wang and colleagues, posits that variations in taste sensitivity and tolerance among individuals may affect the experience of data edibilization [4]. Indeed, one participant (1/6, 16%) who had a habit of consuming espresso coffee, which is notoriously bitter, reported having developed a certain tolerance to bitterness. Despite this, he could still perceive fluctuations in the bitterness corresponding to different data points, and even experienced extreme bitterness for certain data. Thus, it is apparent that within the scope of our project, this personal variance did not detract significantly from the overall data edibilization experience in any of the conducted experiments and workshops.

Interestingly, we noticed that bitterness tolerance correlated with the intensity of bitter intake and the duration of tasting. This is in line with findings from Mura et al. [23] which show that the sensitivity to bitterness can be influenced by the initial bitterness intensity and recover over time. This may introduce bias in data comparison, for instance, when some participants reported that the 2020 tea tasted more bitter than that of 2012. Additionally, our study participants generally demonstrated less sensitivity to minor fluctuations in bitterness intensity, as evidenced by the collective tasting experience of tea representing the years 2015 to 2018.

In light of these observations, we propose

expanding the concept of sensory capabilities to include: 1) an understanding that an individual's taste tolerance can evolve over time, influenced by the progression of food consumption, and 2) an acknowledgment that the food medium serving as the data representation might cause participants to overlook subtle variations, an effect likely influenced by the method employed for data mapping.

However, we do not believe this detracts from the potential of data edibilization. On the contrary, these sensory capabilities can be cleverly leveraged as an advantage. In this project, the tolerance to bitterness can mirror our daily adaptation to negative emotions. When participants continuously experience low strength bitter teas, perceiving variations in bitterness becomes challenging. The sensed bitterness morphs into a constant, flat backdrop, leading to a form of sensory adaptation. This observation aligns with experiences in daily life. Some participants spontaneously commented that the years corresponding to the moderately bitter teas (2015-2018) were "times when society was generally in a positive mood." When living in a relatively stable and tranquil environment, a sudden increase in bitterness (akin to significant life stress) elicits a pronounced response, contrasting sharply with the prior status. Additionally, when bitterness intensity maintains a high level, participants seem less sensitive to gradual changes, reflecting a certain degree of sensory adaptation. During the tasting

of the teas corresponding to 2011-2015, phrases like "bitter to the point of numbness" were frequently expressed, suggesting life's bitterness to the point of numbness. This finding echoes resilience observed in real life, where individuals accustomed to enduring difficulties may become less sensitive to additional hardship. This could help explain why our study effectively allows participants to experience the overarching trend rather than focusing on specific data points representing individual years. Therefore, this suggests that sensory capabilities can serve as a dimension that can be leveraged, enhancing participants' experiential understanding of the rich variation in the data, especially when aligned with emotional related data.

Conclusion

In conclusion, this study presents an empirical exemplification of data edibilization, showcasing its potential in representing negative emotion data. In our research, bitter tea was utilized as an edible medium for data representation, with its bitterness and color intensity serving as encodings for the quantity of distressing posts. By modulating brewing time and the quantity of tea leaves, we prepared 11 distinct cups of tea, each bearing a unique bitterness and hue. This corresponds to the annual negative emotion data extracted from social media over an 11-year period. As part of this workshop, facial expressions were harnessed as a potent validation tool for assessing the success of our data edibilization process, serving as an immediate mirror to participants'

reactions to differing bitterness levels. Simultaneously, we observed that sensory capabilities undergo continuous transformations as tasting progresses over time, adding complexity to data perception. While we acknowledge this as a limitation, it can also be judiciously exploited as a tool for data experience. In this project, the tolerance to bitterness mirrors our daily adaptation patterns to negative emotions, thereby strengthening the connection between the food medium and the data.

Our research underscores the potential of data edibilization as a tool to deepen participant engagement in data representation. It encourages a segment of data representation research to delve into more nuanced, sensory-driven data comprehension techniques, illuminating promising pathways for making complex data landscapes more accessible, interpretable, and humane.

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