

Codex Endogenous: Visualizing the Self

By

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Abstract

The Quantified Self is best described by Gary Wolf as “self-knowledge through numbers.” William James’ theory of the consciousness of the self and the study of coping inspires drawings that retell personal narratives at the same time reveal traces of the subtle emotion associated with *intentional forgetting*. *Codex Endogenous* is a project that reveals and visualizes the beauty and morphology of a “self” and its environment. Here, “codex” refers to a collection of pages stitched together, and “endogenous” is a term in cognitive neuroscience used to describe phenomena that is spontaneously generated from an individual’s internal state. Every day, quantifiable information about the self is produced; left unrevealed would leave the spirit of a self undiscovered. In this project, the self information is transformed into self-knowledge. Data is tracked throughout a day, categorized into implicit and explicit information, visualized as daily data drawings. Analogous to the practice of keeping a daily journal, *Codex Endogenous* is a digital journal in a screen-based format. It is composed of drawings that embody data representation of the quantified self in the context of environmental habituation including the intentional redaction of information rather forgotten.

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Codex Endogenous aims to construct a narrative about the self by examining drawings produced from a series of streaming data sources relating to the self. A daily representation of data is translated into patterns that make up a visual language mapped on a canvas. This thesis has been developed by conducting a series of experiments on the self, to develop a framework and visual language on how to attain, process, and grow the understanding of a self concept amongst one's environment and own consciousness.

There is simply too much information to keep track of the complex narrative that makes up your own self-hood. When you look in the mirror and see yourself, you can point out the physical appearance, but it is often a much harder task to recall accurate self knowledge. Self knowledge can be difficult to unravel and recall because of the complexity of themes within our psyche. There is not a mapped out visualization with a detailed legend for navigating, but rather a novel with sequences of interconnecting events that have themes and story lines (Wilson and Dunn). All data is retrieved by the use of memory. The way in which we are able to retell stories involves inevitable forgetting and reforming narratives. Jenny Holzer, who took government documents recounting the War on Terror and turned them into redaction paintings integrated the destructive memories into ethereal retold stories (Bailey). In this work, "redaction" as a form of an interaction with self data is speculated upon throughout the iteration process a month long study.

Much like suppression of memory, outputted patterns and glyphs can be redacted to visualize an intentional forgetting of information. Wilson describes the term suppression as a conscious decision to banish a thought from awareness, but is not completely removed from memory and can be recovered under some circumstances. Codex Endogenous uses a combination of input methods to collect data on the daily to reconstruct and use integration to form new stories. Information is stored in a personal database to be retrieved at the creation of a drawing. Redaction in drawings symbolizes a conscious decision to forget. Rather than attempting the inevitably hard action of "letting go" of impressionable memories, artistic data visualizations of personal integrates personal understanding of ourselves into further in hopes of helping with moving forward from a current struggle.



FIGURE 1.1: Without tools for "seeing" all of oneself in a mirror, personal data that trails all of our behavior is unrevealed.

2.1 The Concept of the Self

Codex Endogenous takes into account the extensive research on psychology of the self and how accurate self knowledge effects self esteem, motivation and belief systems. An accurate self concept can be warped when viewing digitized data doubles take forms. The organic and abstract forms in data drawings leave enough interpretation to integrate both negative and positive data into a fully realized form.

2.1.1 The Quantified Self

Dating back to the first cave paintings, humanity has been compelled to record themselves for thousands of years. When this complex human tendency to preserve themselves combines with the power of computation, the conversion of human bodies and minds into data flows are figuratively reassembled for the purpose of self-reflection and interaction (Ruckenstein). The quantified self movement formed in 2008 by developers working in the technology sector around Silicon Valley formed a community and held conferences to meet up and share their projects and tools (Swan, b). The quantified self is defined by using "invisible technology" in order to collect data that reflects the daily lives of people. Motivation to collect such data comes from a desire to change or improve. By recording physical activity, psychological and emotional "states" the ideals of the quantified self come from "lifelogging" in the mid-'90s. The emergence of the quantified self movement has opened up a portal to multiple dimensions of data doubles.

According to Ksenia Fedorova, technologies that utilize biosensing to gain an accurate "picture" of one's mental and bodily state would help create balance with more "informed" behavior (Fedorova). This project attempts a snapshot for a person to distinguish and identify their mental and bodily state, while grounding themselves in the environment. Data is taken from streams of data that is left by the self during the span of 24 hours. Later the data is recalled in a one time journal-like task.

When Gary Wolf, the pioneer published his article in The New York Times titled *The Data Driven Life*, many expressed feelings of negativity toward the idea and questioned whether a life always under quantifying is a life worth living (Wolf). It is important to realize that there is substance to this argument, as some instances of obsessive behavior can be manifested into an over interest in self tracking and evaluation. For instance, the prominent habit of the pro-anorexia community uses tactics of obsessive self-tracking and bypass the benefits of transforming oneself (Ruckenstein). One of the ways to combat over analyzing

within viewing self data is to design a visual language that strays away from conventional graphs, plots and bar charts. *Codex Endogenous* takes relational forms and color to create and display affect within personal data.

Gestalt psychology is briefly considered in the context of the creation of data visualization. The purpose of visualization is so that our eyes can distinguish good information and our brain can understand it. Fedorova also mentions the aspect of the "body schema" as viewing the self in a series of connections and associations(Fedorova). The psychology of attention and memory plays a large role in studying data visualization due to its interaction with the story that is being told. On the other hand, the behavioral psychology behind QS has been scrutinized on whether it provides a clear path for change or improvement. Gary Wolf explains that when we track ourselves, something changes when we digitize our information. When we use sensors to automatically track ourselves, we are reminded that our ordinary behavior carries more obscure signals that can be used to inform our behavior. (Swan, a).

The use of storytelling for the quantified self poses benefits in psychological processes regarding memory. Hilviu et al. discuss the way narration can "produce insights related to the data collected." Declarative memory, or memory that can be consciously recalled, can be broken into semantic memory and episodic memory. Semantic memory refers to general facts, while episodic memory is when sequences of detailed events are recalled. Representing data as a story like and episodic memory can make the information more memorable. Theory of Mind or the ability to perceive emotions of themselves and others can be linked to the use of fabula, or "a sequence of events causally connected" in storytelling. The paper discusses the creation of empathy by linking the role of mirror neurons. QS data can allude to a plot by defining connections between events (Hilviu and Rapp, 2015).

This work is considers gestalt psychology, cognitive load and story telling in the formation of it's visual language. Not only is the legend designed to be learned over time through scaffolding at the entry stage, but the way data is drawn out in a sequence makes the drawing form in a narrative based structure.

2.1.2 The Empirical Self

William James theorized the Self as a sum total of all that they can call theirs:

[...] not only their body and his psychic powers, but their clothes and their house, their loved ones and children, their ancestors and friends, their reputation and works, their lands and horses, and yacht and bank-account. All these things give them the same emotions. If they wax and prosper, he feels triumphant; if they dwindle and die away, he feels cast down (Green, 1997).

James divided the history of self into three parts – its constituents, the feelings and emotions they arouse, the actions to which they prompt. When we use sensors to automatically track ourselves, we are reminded that our ordinary behavior carries more obscure signals that can be used to inform our behavior (Whitson). The collection of the data for this work aims to seek information that makes up the empirical self. William James grouped all of the components of the empirical self into three subcategories: (1) the material self, (2) the social self, and (3) the spiritual self. In this work, items of data like bio-metric data, geospatial data (current location), weather data, time spent working, etc. can be classified as the material self as it pertains to the tangible objects, people or places that carry the designation *my* or *mine*. Data collected about who people interact with each day is classified as the social self. In effort to support the spiritual self, emotional data through daily survey is collected.

2.2 Personal Data and Algorithm-Based Design

Biosensing and screen-based user interaction reveals data trails that propel the data drawings with *Codex endogenous*. Although the data recorded can be considered an organic process, the algorithmic processing of information mixes cybernetic qualities to the work.

2.2.1 Generative Design Using Personal Data

The availability of open source code has initiated a new genre of art making through the medium of code. Foundations such as The Processing Foundation and various platforms for sharing work like CodePen or Open Processing have made sharing art through programming easier for digital artists. The basis for using code to make art relies on the foundation that drawing with code as a form of looping actions that are attached to parameters.

Lev Manovich defines visualization as, “the situations when quantified data which by itself is not visual – the output of meteorological sensors, stock market behaviors, the set of addresses describing the trajectory of a message through a computer network, and so on – is transformed into a visual representation. (Manovich, 2002)” He also defines mapping as a similar concept to visualization, but it is separate in nature due to the representation to all data as numerical code, making it possible for computers to map a representation into another such as to view a grayscale image into a 3D surface, a sound wave into an image, and so on (Manovich, 2002).

These unconventional ways to view data hold characteristics of experiencing a phenomenon of synesthesia. Crétien van Campen Ph.D., a perceptual psychologist writes about the phenomenon of using concepts of synesthesia to create cross-modal association. He writes, “Kandinsky’s explorations of the consonance and dissonance of simultaneous auditory and visual stimuli offers alternatives for Gestalt experiments to the current experiments with elementary stimuli (letters, tones) (van Campen).”

With the availability to sensors available as data input all around us, attaching data from an input to algorithmic art can generate a new form of art embedded with data and information translated from the real world. For example, in today’s pop culture, the use of sound visualization is a powerful tool in enhancing one’s experience to listening to music at a concert or in a music video. Visualizing sound dates back to animators like Len Lye and Oskar Fischinger who used direct animation in his work to sync abstract shapes to beats of music to create a synesthetic connection between what sounds look like.

2.3 Parallels of Generative Art and Meditation

It was the work of Georg Nees who pioneered generative art during the first exhibition of “Generative Art” opened on 4 February 1965 in the seminar rooms of the Institute of Philosophy and Theory of Science at the University of Stuttgart in Germany (Nake). Margaret A. Boden and Ernest A. Edmonds defines as art that has been produced by the activation of a set of rules and where the artist lets a computer system take over at least some of the decision-making (Boden and Edmonds). An intrinsic quality to generative art relies on the step-by-step rules from which creates graphics from. The looping nature of an algorithm can automatically generate patterns based on these rules. For instance, a simple pattern one can generate using code may be a program to create a vertical line from one point to another. The pattern would follow a rule to add an integer to the x-coordinate of the two points from which the line segment is drawn from. Then a function of looping through this rule for a corresponding number of times would generate a row of vertical lines.

Fedorova compares the discourse between the inner and outer to what looks organic and what is a result of algorithmic processing (Fedorova). The first sketches of data drawings concepts to the resulting output from data requires an understanding of the streams of self data.

Mindfulness meditation is proven to improve neurological functions in the parts of the brain responsible for cognitive regulation of emotions like stress and anxiety. In a research study, meditation-related anxiety relief was associated with activation in the anterior cingulate cortex and ventromedial prefrontal cortex which is responsible for cognitive reappraisal processes (Zeidan et al.).

The impetus of this thesis comes from a long standing art practice of meditational drawings as a practicing artist who keeps a sketchbook. The drawings consist of patterns that are drawn in meditation over and over for a long period of time. Each pattern symbolized a new path of thinking or a new subject.



FIGURE 3.1: Meditation drawing journal entries

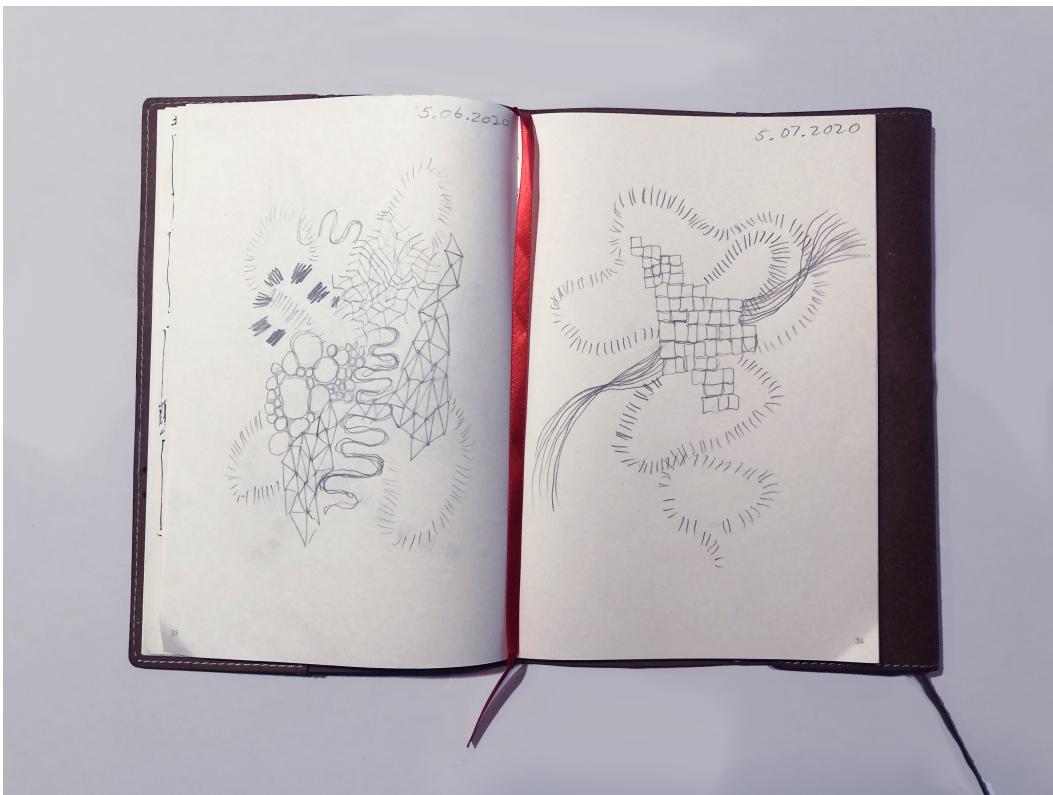


FIGURE 3.2: Meditation drawing journal entries

The visual desisions of *Codex Endogenous* is informed by modernist paintings, early computer art dating back to the late 70's and current research in information visualization. Starting with the name of the project, *Codex Endogenous* is a direct reference to *Codex Seraphinianus*. A mysterious 360 page book written with an asemic language by Italian architect Luigi Serafini and published in 1981 blanketed with surrealist imagery and diagrams. The book has been analysed by linguists and computer scientists which in turn has created many interpretations. Serafini wanted to trigger our sense of childhood by emulating the sense of mystery and illiteracy we were accustomed to as children when we didn't know how to read a book. Seraphini prompts a reader to make sense out of hallucinatory imagery. By revealing information that is then being abstracted, there is opportunity for new pathways of thinking of the Self when viewing personal data.

In a survey of early computer art in the book *Arist and Computer* multiple artists recount their approach to using code. In their work *Graphic Music*, Franke describes artworks as offers of perception. He describes a chart that outlines modalities of perception from the eye and ear both separately and together functioning in synchronism. He considered syntactic weight and semantic weight. He then compares the static image to a time based image. *The Appeal of Computer Graphics* Databases of imagery external to a computer program, where a computer uses the same data over and over again and applies slight variations over time. The manual effort is creating such imagery is laborious and the quality of drawing would not have been as precise. Kolomyjec describes his work as having a menagerie of creatures to use in a program. In Michael Barbadillo's *My Way to Cybernetics* Abstract expressionism influence can be seen in trends leading all the way through the 20th century. Barabadillo observes that the way computers process and emit light reaches a stage of 'Pointillism' in painting, that very much resembles the path of science from the macrocosmic to the

atomic conception of the world. Abstract expression has complete disregard for shape and composition which is the avenue that self expression begins to make its presence to emerge a representation of a subjective world. Where ‘Cubism’ has been aiming to formulate new constraints to a reality for understanding nature. Barabadillo chooses rudimentary shapes as modular elements to build in formation of grid format. The sequencing of each shape is visual language to form poetic rhythm. He believes in the binary structure of matter in the universe (Leavitt).

Alexander explains the various degrees of illusion in modern painting and decorating. The orientation of the lines against some patterns may create a canted perspective of the space within the foreground versus the background. There are modernist artists and researchers that situate their process within a level of experimentation and study with light and color. Rather than attaining realism through deep understanding of psychology of light and color, some of them confess to painting through the mind of a child’s eyes and mind. Alexander describes experiencing the interiors as being “free from experience, prejudice, and imitation” (Alexander).

Fuchs et al. present a systematic overview of the user-study literature on data glyphs and offer a summary of study outcomes to help practitioners select the most appropriate according to different criteria. From this work, they present three methods that stimulate more attention in results overlaid on top of dense visual representation. These works present design strategies that we apply to our own system for studying multiple attributes behind wildfires. Many-to-one mapping is where each data dimension is mapped to one variable. One-to-one mapping is when each shown with a different visual variable. One-to-many mapping is when a data dimension is redundantly represented with many different visual attributes. Synoptic tasks while viewing a glyph include visual search, distinguishing similarity, and detecting trends. The study goals of this paper includes a comparison of various glyphs, variations of single glyphs, and comparing data tables. It is found that various studies that were conducted compared faces of other glyphs. It is discovered that faces and circular profiles are investigated in detail. Qualities like background color influence color perception (Fuchs et al., 2017).

Before the use of sequences of glyphs to read emotions throughout a day, layered glyphs that varied in shape and color to represent emotion measurements were coded for proof of concept. The result was vague and did not include the complexity intended to tell the narrative of emotions throughout a day. Personal narratives unravel like a story when an individual goes to retrieve information about themselves. Layering graphics does not align with the way personal narratives are interpreted.

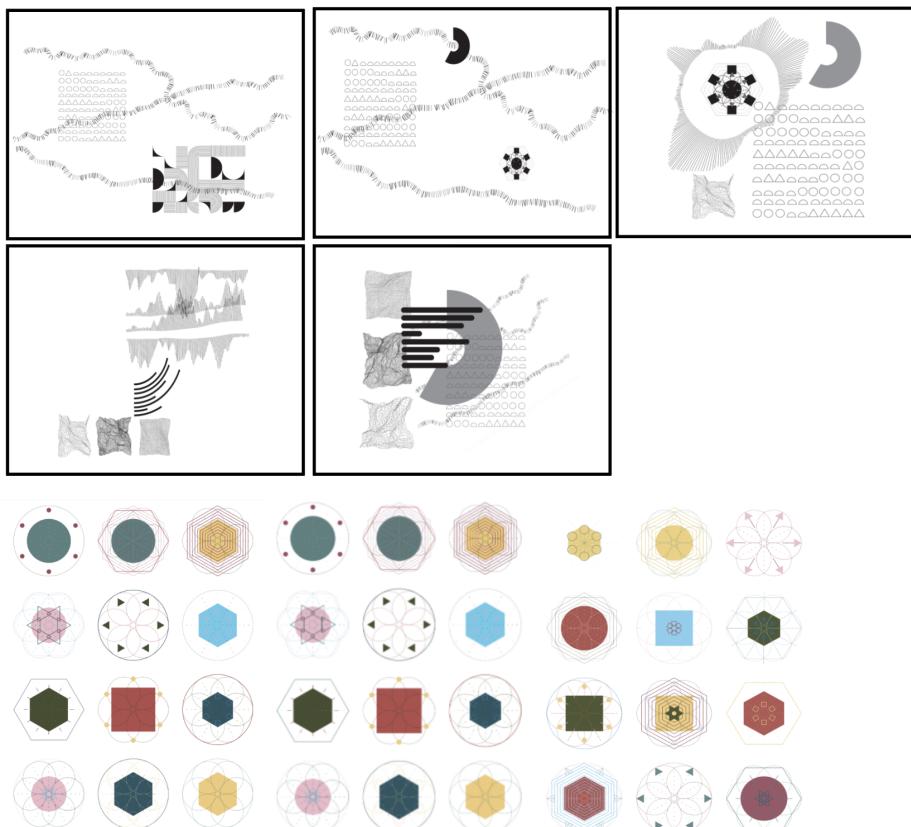


FIGURE 3.3: Top to Bottom: Early digital mock-ups of data patterns and layout on the page. Randomly generated glyphs as an emotion glyph concept.

4.1 User-Entered Information

The way in which personal narratives are recalled from memory structured the inflow of data that was used in developing drawings each day. The term *implicit memory* refers to when a participant does not deliberately attempt to collect information from the past yet memory is still expressed in the performance of a task (e.g. walking or playing a learned song on the piano). *Explicit memory* is exhibited when participants consciously and deliberately attempt to recollect information from the past , such as life events that are primarily sensory experiences (e.g. recounting a childhood memory of having dinner at their grandparents house) (Marsolek). Self Knowledge requires both implicit and explicit memory to form a personal narrative. The following describes the ways in which data collection parallels memory and functions as the data that makes up the self to be used for daily data drawings.

4.1.1 Automatic API Data Feeds

A survey of data collection was conducted to deepen the understanding between the usage of a device and how the output of data is internalized. A myriad of devices were tested, such as a Fitbit tracker, web API's, an eye tracker, cameras, and sensors to detect the external environment. The selection of data collection methods had to satisfy the following criteria:

- There is a direct and strong connection one's self narrative to the data that is output.
- A wearable device functions symbiotically with the self with minimal disruption during the day.
- There is a low sense of surveillance
- The data can be retrieved on the web via API.

Amongst the aforementioned devices, the Fitbit tracker and Web API's fit the criteria the best. The combination conjured the least amount of awareness of being tracked throughout the day and presented a strong sense of personal connection to the data being output.

4.1.2 Self-Reported Data

While data trails a self leaves throughout the day present implicitly, like heart rate or sleep patterns, some types of data can not be accessed without a conscious retrieval of it from

fitbit	Wearable device	Retrieving data about the physical self
API's	Real time database	Retrieving data about the environment
Eye trackers	Wearable Sensor	Retrieving data about the human eye movement on a screen
Cameras	External device	Retrieving the external environment during the day
Water flow sensors	External sensor	Retrieving data about personal resource usage
Infrared sensors	External sensor	Retrieving data of movement within a space

FIGURE 4.1: The list of devices considered in the process of finding streams of data to use for drawings.

memory. This is the reason self reported data is considered explicit. To do this task, a web based form with simple prompts gives the user the ability to recall three different pieces of information – emotion, social interaction, and thoughts.

To accurately measure emotion, an understanding of discrete emotion and the psychological surveys used to asses self-reported emotions is necessary. It is commonly seen in research to use the Positive and Negative Affect Schedule (PANAS) to measure self-reported manipulations of emotion. The PANAS has problems that causes a failing in the support for the roll of affective processes (Harmon-Jones et al.). Other frequently used surveys used in measuring emotion include the Profile of Mood States (POMS), the Multiple Affect adjective Checklist(MAACL). Because of the lack of assessing a full range of emotional experiences, Harmon et al. developed a questionnaire to asses situationally induced emotions that expand the range of mood states seen previously that asses only specific ranges of emotions such as anxiety, pride, and shame and guilt. The importance of a tool that assesses emotion comprehensively is because the same event occurring in two different individuals' life may evoke two different emotional states between the two. An other reason of importance is the possibility of an event evoking mixed emotions. The Discrete Emotions Questionnaire developed by Harmon et al. includes "basic by prominent emotion theories" that allows individuals to distinguish emotions and determine a level of which they are feeling them. The questionnaire declares eight different broader categories of discrete emotions: Anger, Disgust, Fear, Anxiety, Sadness, Desire, Happiness, and Relaxation. Amongst these larger categories, subcategories consisting of more specific emotions.

Codex Endogenous takes this list of emotions to be checked off each day. To be completed in a way that imposes less burden on the user, there is no scale like there is in the original questionnaire. While there is worth in denoting the intensity of emotions each day and reflecting it in a visualization can be achieved easily, the focus was on minimizing burden in completion of the form while maximizing the sense of being able to identify personal mood states, bring it forth to attention and opening the door for reflection. It is intended that everyday the form would be completed. The submitted data goes to a database for later retrieval and visual encoding during the data drawing stage.

The social and thoughts form works the same way as emotion and is submitted to a database. The user recounts their day and notes memorable names of those who they interacted with during the day. The thoughts form prompts the user to describe their day

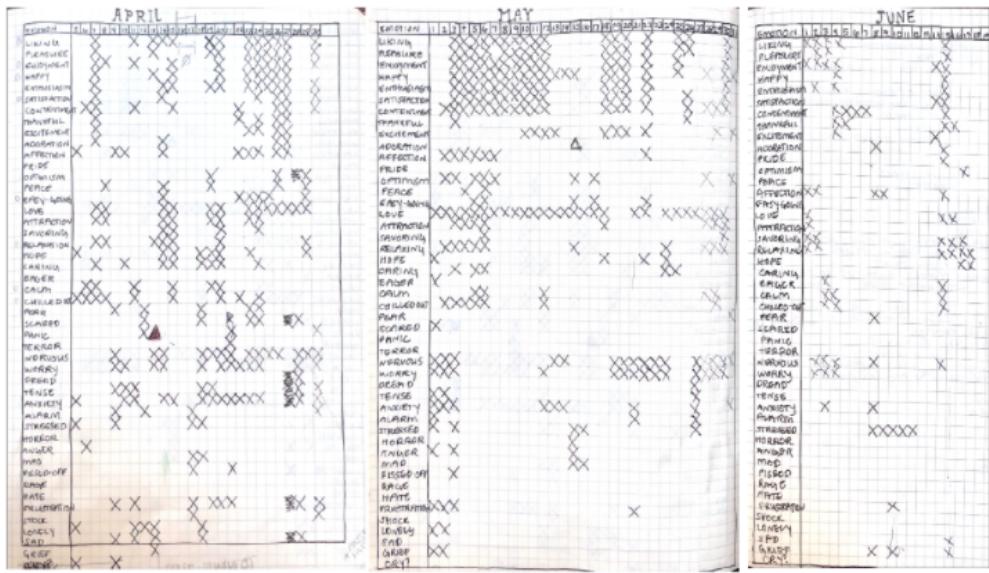


FIGURE 4.2: The early on emotion input by hand. User goes down a list and checks off emotions present once a day.

in 3 simple words. This answer is used to title the drawing. The purpose of the minimalist nature of only writing 3 words is because it creates a task to pull the most important elements remembered from the day and in turn creates less cognitive load when going back into the archive of daily drawings. This feature contradicts the conventional function of keeping a journal where meandering thoughts get written down.

Codex Endogenous was designed to be accessible through a screen based web application and was coded using HTML, CSS, and Javascript. The p5.js library is the main library used to generate daily data drawings. Imagery was created for glyphs pertaining to mood and sleep states using a digital tablet.

5.1 Emotion

In order to represent emotion, a glyph was created for each emotion that exists for each discrete emotion category – Happy, Sad, Fear, Anxiety, Relaxation, Desire, Anger, and Disgust Within each category, there are several emotion states that are visually represented as small glyph that all share the same overall shape with variations of color.



FIGURE 5.1: The "happy" category and the emotions that are included. All of the shapes are circles, but are digitally painted with different designs.

5.2 Heart Rate

Heart rate gives a value every 7 seconds during the course of a 24 hour period. This pattern is visually represented by a single line mapped to a single heart rate reading. The lines "beat" following the path a user chooses to draw onto the page. As the heart rate rises above resting heart rate, it gets longer, darker, with more line weight.

5.3 Sleep

Sleep records 4 different sleep states – Wake, Light, REM, and DEEP. For each state there is a glyph. The full pattern is drawn out as a sequence of different combinations of sleep states that follows the pattern of the user's mouse path. When the sleep pattern is drawn out, the user reads the line of glyphs in order to view the states of sleep they entered in and out of in order.

5.4 Social

Social data is recorded as the names of people that are interacted with throughout the day. The pattern is a network of triangles using delaunay triangulation algorithm. Each time a node is added signifies a new social connection. The first color filled triangle represents the self. The delaunay algorithm generates a network like form that metaphorically represents a network of social connections.

5.5 Temperature

The temperature reading that is recorded when the drawing is made. The reading maps temperature to a spectrum of color. The color will act as the background color of the drawing. The reason being that the temperature is an environmental piece of information, thus the background being a metaphor for the environment.

5.6 Wind

The wind reading is recorded when the drawing is made. The reading is mapped to a noise scale as part of a line algorithm to generate swirling lines across the drawing. The bigger the noise coefficient, the more chaotic the lines become symbolizing heavy winds.

5.7 Thoughts

For each day, the self is prompted to describe their day in 3 words. These three words serve as the title of the drawing itself. The reason this is the decision for recording thoughts is to provide a small phrase that can help in recalling memories differently than passages of writings in a traditional journal.

6.1 Data Input

The user-entered information works like a form with a submission button to add information to the database to later be retrieved in the data visualization. In the emotion category, the user is prompted to select all of what best represents emotions encountered in the day. The user scrolls down each category of discrete emotion and selects the choices that reflect them. They can then go to the next module, such as social interactions. Here, a form to create a list of social interactions from memory are able to be added and be submitted. The next module is a form to submit three words that describe the day as thoughts. The thoughts are a concise recount of the day without a fully fleshed out recount of the day's activities.

Throughout the user-entered section, there are graphics designed to support priming the user to understand the patterns to be displayed in the visualization. For example, when a user selects the emotion, the image of the glyph will display alongside highlighting the emotion selected in the list. The purpose of visual priming before the visualization is created is so that there is a growing understanding of the visual language that will be visualizing personal data, thus strengthening self knowledge.

6.2 Data Output

The primary interaction for creating a data visualization is clicking and dragging. Once the data channel is selected, clicking and dragging draws out the data driven patterns. The thoughts previously input are displayed at the bottom of the composition. Some patterns are less of a drag and draw function, but a click to reveal interaction, such as the background for weather and the timeline for sunlight. Once the drawing is completed, there is an option to start over by clearing with backspace or save with the return key.

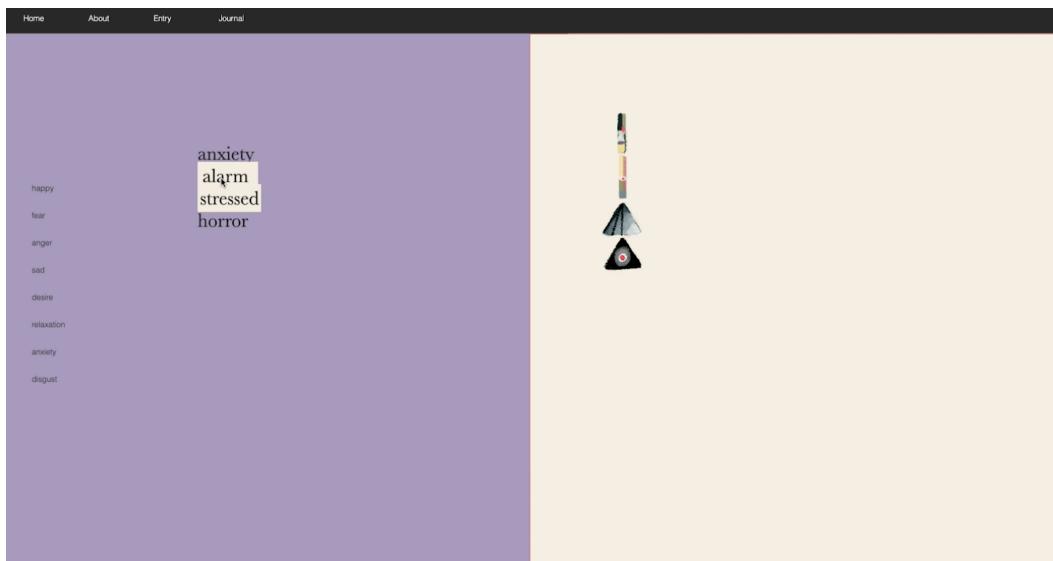


FIGURE 6.1: The emotion input user interface. An example of scaffolding before the drawing is made. This helps with reading the drawing later on. When an emotion is selected, the glyph shows respectively in order to learn the visual language.

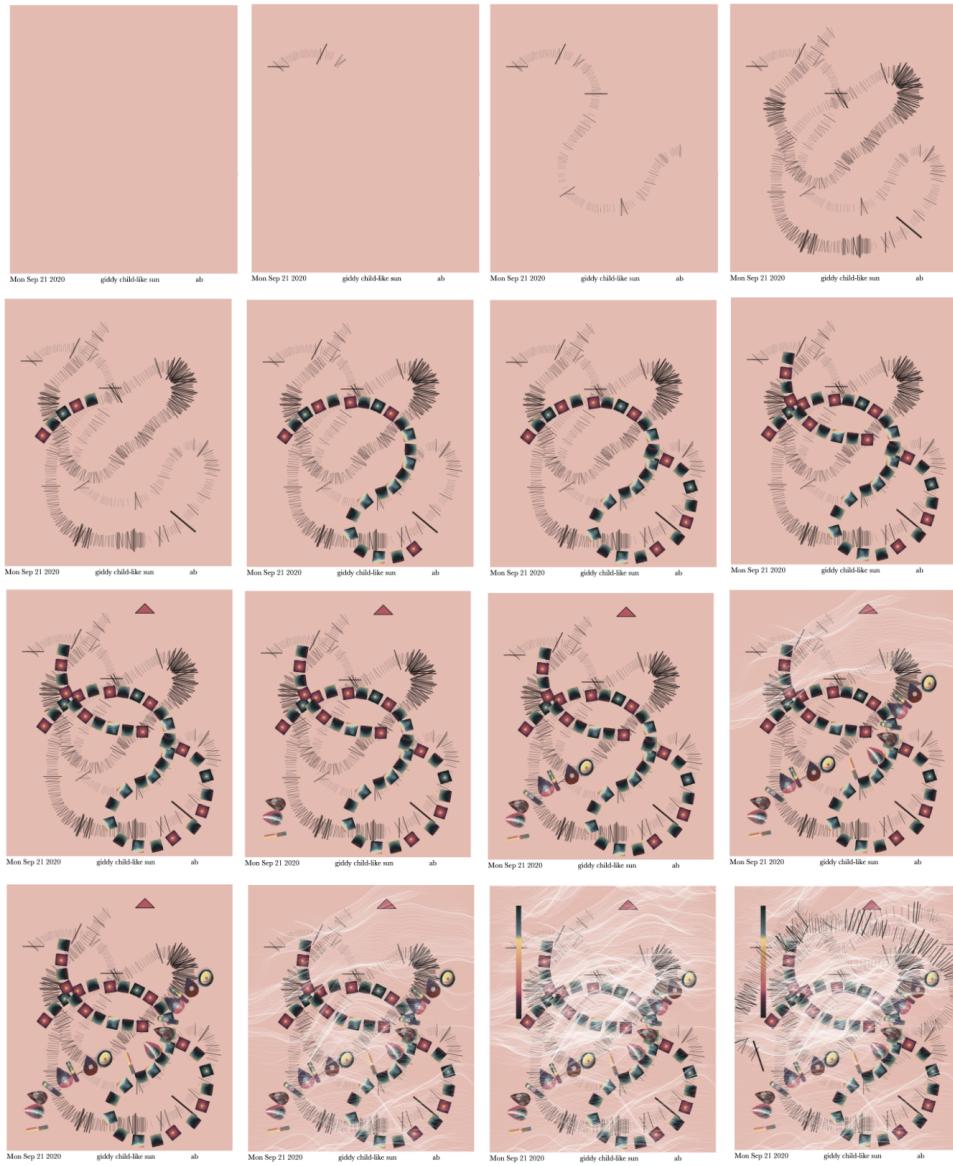


FIGURE 6.2: Example of a drawing in progress going in order of drawing temperature, heartrate, sleep, social, emotion, wind, then sunlight.

7.1 Legends

A legend is a useful tool for referencing and decoding data visualization. The legend is useful for looking through data drawings and looking back at as a reference. But the goal over time would be to be able to recognize the patterns once the visual language is learned.

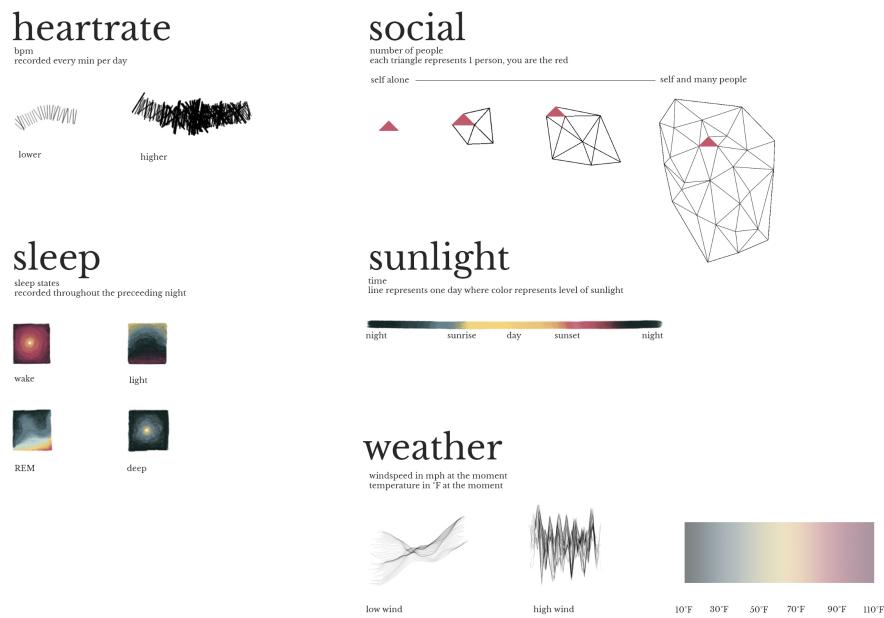


FIGURE 7.1: The legend for all available data patterns

emotion

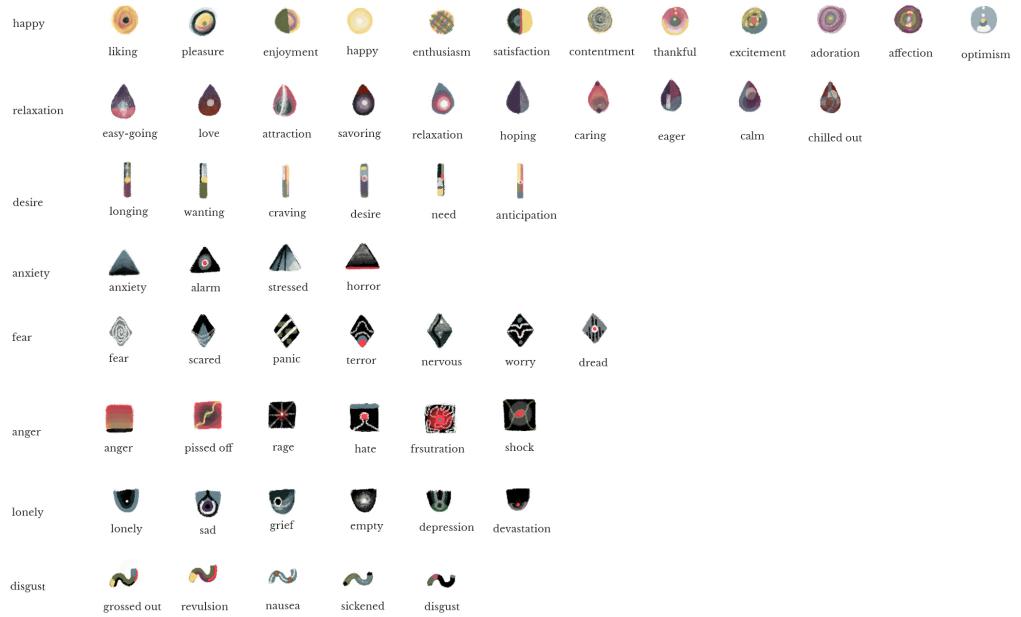


FIGURE 7.2: The legend for all discrete emotions glyphs

7.2 Month Long Study

For thirty-one days in July of 2020, a study of 31 daily drawings was completed in order to discover the effects on self knowledge. After the 31 days, a increase in ability to communicate to self and others took less work to recall after completing the drawing.

July 2020

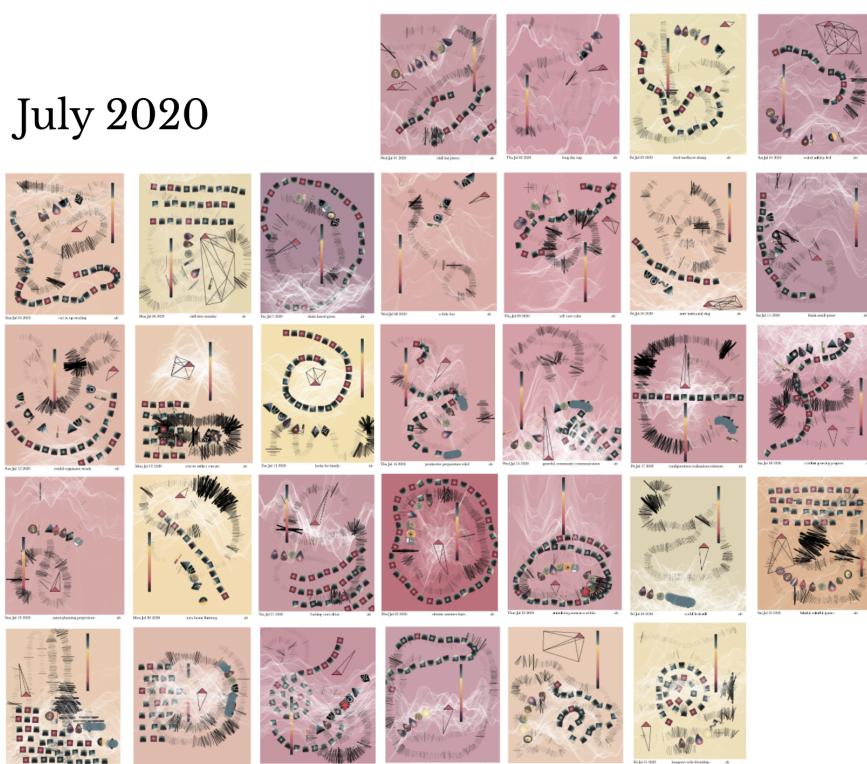
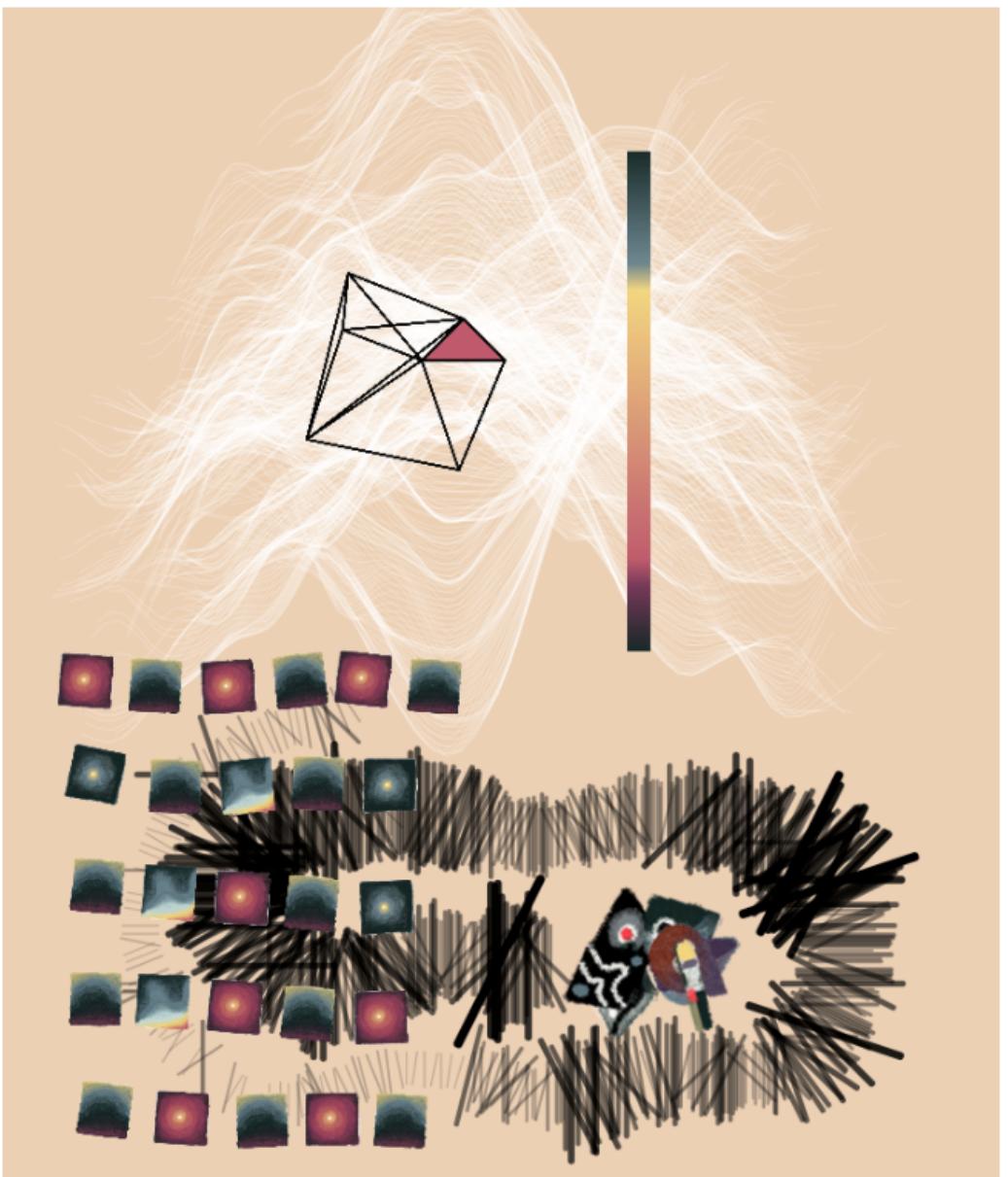


FIGURE 7.3: Thirty-one days of data drawings for the month of July 2020



Mon Jul 13 2020

receive reflect reroute

ab

FIGURE 7.4: A particularly hard day



Wed Jul 22 2020

chronic summer haze

ab

FIGURE 7.5: A pleasant and lazy summer day

Introspection of a days worth of information can be a hard task for most when life moves fast. This is why keeping a journal proves to be an effective method of introspection. The accompaniment of data is a tool for grounding reality and put constraints on easily writing about dense items about the past and future rather than the present.

Today ownership of personal data is constantly fought over by distant entities. Oblivious usage of public data is a cause for insecurities around intimate information about oneself. There is fear around big corporations manipulating personal data for profit, detaching from the humanistic qualities and historical qualities of one another. *Codex Endogenous* is a speculative idea around not just finding clarity around self knowledge, but also claiming ownership and personal records of the data that we can control around us. Trails of data are inevitable from now and for centuries beyond. Because of this, thinking about how to form a healthy relationship with being tracked and measured is crucial.

When the project began, there was a concern around ethics of recording the space around one person constantly. This concern shows the oblivious mindset we are already in as a society, to no fault of our own. Being data driven is now the normal state of civilization. Throughout creation of this work, mindfulness continues to be a focus around creating a way to manage the influx of information becoming overstimulating. One can only work with what they can control. *Codex Endogenous*, through a small cluster of data channels, provides a space to control your data and produce a data visualization with a individual creativity element. For a while, the orientation, proximity for placement of patterns became a complex problem to solve.

The decision to utilize mouse x and y coordinates supported this conceptual idea that the self can work with what they have control over for data that is "now".

The growth of *Codex Endogenous* is ongoing and will be expanded upon. The 30 day daily drawing study has shown to hold truth in aiding in self concept in comparison to a full month of no tracking or visual output. Before there are new iterations, a hand bound artist book is in the process of being crafted.

The purpose of the hand bound artist book is to serve as a one-of-a-kind recount of one month's worth of data in the form of a real codex to support the concept of this thesis. Because of the handcrafted quality of the book, discovery of self through flipping through the pages serves a way to attain self knowledge as a sensory experience.

The modular design of the pattern-like data channels allows for additional channels of data to be added and decided upon by the user. While there is only one legend that has been predetermined, there is potential to create customization tools for each pattern. After the 30 day daily drawing study, the lack of variability caused for concern of boredom in composition. In order to do this, creating models for a customization tool should open up a door for more personalizing of this style of data visualization.

The reason why this type of design for personal data is pertinent to mindfulness is because the process prompts the evaluation the "now" instead of rumination of past or irrational planning for the future. The data channels listed ask to evaluate the present day, but some data capture the exact moment of user input. There could be further expansion on aggregating several points in the day's data. Due to the fact that these categories are bound to fluctuate even over the span of 24 hours, a system to view a true 24 hour's fluctuations could add more granularity to visual output.

Complete and intentional forgetting when recalling information about the self rose a question on how to visualize information one seeks to acknowledge but choose to "redact" from memory. During the iteration phase, the idea to pick and choose info to include a visual encoding that acts as a redaction was explored. During a month-long study, this interaction was added at the end instead of during self-entered data entry. In the future, implementing redaction during the entry phase can accurately represent how intentional and complete forgetting actually functions psychologically before information is recalled from memory.

The input process emulates common surveying processes used in psychological surveys to evaluate mental states. The style of evaluation poses a question to psychologists on weather the integration of data input like this could be used in a practical way to visualize their patient's mental health. If a pattern driven output can help compartmentalize concepts of the self and be used to fine correlations, a person seeking mental health services can decode their data in a way that is self reliant.

Another future of this project is studying the use of pattern like visual outputs to those who are non-verbal, like those with autism and dementia. Otherwise, the process can be a grounding tool for those who experience depersonalizing types of dissociation and other traits of psychosis. The most effective result of the project was the increase in ability to recall items about the self to others. A concise record of information serves as a positive reinforcement for certainty about self information. The process to decode information from true self data creates a "practicing" of searching, recalling, and achieving reassurance that their information is accurate self knowledge.

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