# Codex Endogenous: Designing Interactive Self Data Visualization Tool for Trauma Impacted Individuals

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#### Abstract

The Quantified Self is best described by Gary Wolf as "selfknowledge through numbers." William James' theory of the consciousness of the self and the study of coping inspires drawings that retell personal narratives. 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 and collected like pages in a book. Daily data drawing is a method of journaling with naturally emitted data from the self, creating an oracle into an individual's brain body connection. This paper evaluates the characteristics of what daily data drawings are, methods of collecting data, and the possibilities of using data collection and visualization as a mindful-ness practice for people who are diagnosed with post-traumaticstress disorder.

#### Keywords

Data Visualization, Mental Health, Journaling, Therapy, Tools, Generative Art,

#### Introduction

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 taskto 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 [13]. A common symptom of Posttraumatic Stress Disorder is a sense of losing one's body and mind connection. There is a part of the brain responsible for sensing the self called the "default state network" (DNS). It's how we know we are alive. Patients with PTSD showa startling lack of activation in the self-sensing parts of the brain [10]. Neurofeedback is used as a treatment that uses visualization of the "electrical symphony" of a patient's brain waves to cause emotional arousal and in return enhances the sense of identity [9]. In effort to build a similar mirroring effect, Codex Endogenous provides a reflection of the self each

day. Generated from naturally emitted data, daily entries have the ability to be recorded through a network of devices.

*Codex Endogenous* aims to construct a narrative about the self by examining drawings produced from devices that collect biometric, environmental, and self-reported information. A daily representation of data is translated into patterns that make up a visual language mapped on a canvas. A user may collect pages that adds to their own narrative, positively rein-forcing identity and relation to one's own environment.

The inspiration for this project came from the practice of meditational drawing. The process involves sketching a simple mark on the paper repetitively in a meditative state and watching the pattern build and grow into a larger complex form. Then the creation of a new pattern begins, builds complexity and exists against all the previous patterns on the page. With the ability to create graphics with creative codingand integrating devices that are best described as the *Internet of Bodies*, a term described by Giorgia Lupi as technology that captures and stores information about a person's location, bodily functions, audio and visual perception and even self recorded information that would reflect an individual's thoughts [4].

### Background

This project is situated heavily in generative design as an art form. Imagery is created by constraints defined by the data that is streaming through a program. The art form originated in cybernetics and general systems theory in the late 1960's. Roy Ascott coined the term "cybernetic vision", referring to concepts drawn from computer science. Methods of computing to mathematically display graphics using algorithms derived from artificial intelligence or artificial life [1].

*Codex Endogenous* utilizes self-tracking, otherwise known as 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-reflectionand interaction [8]. The quantified self is defined by using "invisible technology" in order to collect data that reflects the daily lives of people, like a data double. Motivation to collect such data comes from a desire to change or improve.

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 [2]. 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.

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 [12]. The collection of the data for this work aims to seek information that makes up the empirical self. WilliamJames 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 thatinclude bio-metric, sleep, and environmental information canbe 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 dayis classified as the social self. In effort to support the spiritual self, thought and emotional data through daily survey is collected.

The way in which personal narratives are recalled from memory inspired the modality, origin, and meaning of data that was used in developing drawings each day. The philosophy behind the method of data collection is heavily informed by the concept of "Data Humanism", coined by Giorgia Lupi. The idea addresses the issue that as a result of the rise of Big Data, attempts at complex infographics become merely eye- candy and leave us with copious amounts of unreadable and cheap graphs and pie charts. In actuality, the conventional nature of these visualization lacks depth and exploration in possibilities of what *could* represent more meaningful data to theviewer [7].

#### Self Data Visualization and Trauma

Semiotic explorations within personal data have been used as a tool for simulating and representing the inner experiences of individuals using data trails [3], but there is an absence in work regarding tools for individuals who are prone to experience lack of self, such as patients diagnosed with Post Traumatic Stress Disorder. The combination of using self data as visual feedback integrated as an artistic representation is designed to act as an intervention to promote self-healing. Codex Endogenous was developed as a tool for an individual to acquire information to act as scaffolding to one's own selfconcept, a collection of beliefs and thoughts that make up an individual's perception of the self. A negative self- concept is commonly reported amongst patients diagnosed with Post Traumatic Stress Disorder [6]. The page like structure of Codex Endogenous provides a narrative based experience similar to collecting pages in a journal. It is a procedure of data collection that is then translated into markings on a page through the means of generative art and data visualization. The form of the markings are completely determined

by variables that change based the data collected for graphical output onto a page. This means that the graphical form of the artistic daily data drawing is completely unique upon the self, metaphorically acting as a mirror and acting on an individual's inner experience. For trauma-impacted individuals whose inner experience also includes the lack of sense ofself [11], this intervention is designed to stand in as scaffolding that otherwise is hindered or disabled.

We can imagine a simple scenario for the use of daily data drawings. A person is diagnosed with PTSD and starts to receive outpatient care. Their treatment plan includes establishing care with a psychiatrist and regularly seeing a counselor for talk therapy. While they are receiving care on their own, they start to think about journaling as a form of selfcare. *Codex Endogenous* provides them with a free form interface to draw out their own daily data trails which provides them with feedback about their self-information generated from factual data. Their idea of self is now more enhanced than purely what they would originally write in a journal.

#### Methods

The thought process behind the format and visual representation in this project is informed by an understanding of hu- man memory. 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) [5]. 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.

Given this information. *Codex Endogenous* proposes that there is a connection between data as personal narrative from memory and the modality in which data from devices are collected. When translated into the visual output, the journallike output for personal use is a form of Data Humanism. This is because visually representing self-data in respect of self psychology, such as the empirical self or what makes upa person's self-concept and human memory, we can approach the design of a visualization with more meaning and thoughtfulness. Iterating on Lupi's words - "We are ready to question the impersonality of a merely technical approach to data and to begin designing ways to connect numbers to what they really stand for: knowledge, behaviors, people [7].", this work takes into consideration a humanistic approach with respect to the physical and mental experience of whom interacts with their self data.

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 was 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:



Figure 1: Example of beginning, middle and end using a mouse-drag interaction to draw out patterns for a daily data drawing.

- There is a direct and strong connection oneself 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.

The Fitbit tracker and Web API's fit the criteria the best. For information that requires a conscious recall, a screenbased visual interface that includes input for emotional, social, and thought data that is then collected and stored in a database. If you can imagine yourself living out each day, think about what information your body and mind "outputs". The chosen modalities of data collection were designed to carry out a composed way of getting self feedback to an individual. This includes heart rate or sleep patterns - the type of data that is retrieved automatically through the use of our devices. In a sense, they are an extension of ourselves when it comes to the data it is capable of generating. In this model, the data that is collected through automatic means like the Fitbit and data from Web API's is considered implicit. The data that is collected from the visual interface is considered explicit. The collection process combined with the content being self information is metaphorically represented as retrieving memory about the self.

In this project, the method of collection the implicit memory data is straightforward. This is because implementation isbased on setting up the stream of data and making it available be used when it comes time to create a daily drawing. Thiswas done using JavaScript. On the other hand, it was a more involved design process to achieve a accessible and meaningful web interface that collects emotions, social information and thoughts.

Because of the lack of assessing a full range of emotional experiences in previous surveys to measure emotion, 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. Another 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 being able to identify personal mood states, bring it forth to attention and opening the door for reflection. It is intended that every day 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 in 3 simple words. This answer is used to title the drawing. The purpose of the minimalist natureof 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

heart-rate				Low					High			
sleep					Wa	ake	Ligh	nt	REM	De	ep	
social					se	lf		٢				A
sunlight				nig	ht	sunr	s ise	elf wi	h many ay	y people sunse	t	night
wea		high winds low winds					ten	temperature				
happy	() Biking	pleasure	enjoyment	happy	enthusiasm	satisfaction	contentment	thankful	excitemen	advertion	affection	optimism
relaxation	easy-going	bove	attraction	aworing	relaxation	hoping	caring	eager	calm	chilled out		
desire	longing	wanting	craving	desire	need	anticipation						
anxiety	anxiety	alarm	stressed	horror								
fear	ا fear	scared	<b>M</b> panic	terror	<b>A</b> nervous	<b>*</b>	dread					
anger	anger	<b>pissed off</b>	nge	Date:	frontration	shock						
lonely	<b>I</b> onely	sad .	grief	empty	<b>W</b> depression	devastation						
disgust	R prosed out	<b>N</b> revulsion	Name	N sickened	<b>∼</b> diseust							

Figure 2: Legend to each pattern correlating to heart rate, sleep, social, environmental and emotional data ©Respect Copyright.

archive of daily drawings. This feature contradicts the conventional function of keeping a journal where meandering thoughts get written down.

## Conclusion

*Codex Endogenous* seeks to provide groundwork for a procedure to concurrently collect personal data pertaining to aspects of the self. Two main processes make up the procedure: observation of self data trails, including biometric andenvironmental data produced by our network of devices and an intervention for collecting emotional, social, and thought data. The journal-like collection of daily data drawings aimsto provide an accessible and non invasive way for individualsto receive a *semblance* of neuro-feedback, as a complimentary tool to be combined with professional psychiatric treatment and counselling for PTSD patients.

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