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memory [en]code
Building a Collective Memory within a Tabletop Installation

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Abstract

In this paper, we introduce ***memory [en]code****, a project that evolved through an art+science collaboration.* ***memory [en]code*** *is an interactive tabletop installation that visualizes different concepts of human memory in an interactive and exploratory way. Designed to be installed in a public space,* ***memory [en]code*** *enables people to enter their personal memories and to explore memories entered by other people. Reacting to people's interactions,* ***memory [en]code*** *dynamically changes and redefines itself continuously, in ways similar to human memory. Over time* ***memory [en]code*** *forms a collective memory mirroring the experiences and associations of people that have participated in the installation. Within* ***memory [en]code*** *we have approached the concept of human memory in a way that combines art+sciences and that makes the complexity of memory visible and tangible.*

Categories and Subject Descriptors (according to ACM CCS): H.5 [Information Interfaces and Presentation]: Graphical User Interfaces; J.5 [Computer Applications]: Arts and Humanities

1. Introduction

Coming from different disciplines—art and computer science—we began to work collaboratively through an art, science, and technology course offered by the University of Calgary, the Alberta College of Art + Design, and the Banff Centre. The character of our project, ***memory [en]code*** evolved from this interdisciplinary collaboration, was strongly determined by our different backgrounds. On the one hand, our installation contains high level technology and is defined by what we would call *computational aesthetics*, that is computer generated shapes and visuals. On the other hand, it is heavily influenced by art theory and practice. In contrast to objectively defining a problem and finding a solution, as would seem appropriate for scientific methods, we followed a more subjective and exploratory approach, valuing the artistic process. Throughout our collaborative process it was very important for us to contribute equally in the creative process. Rather than collaborating in ways where "science serves the art," for instance in creating tools for artists, or "art serves science," for example by prettying up scientific work, we saw our personal challenge in creating a bi-faceted project in which scientists would recognize the scientific contribution while artists would see the artistic quality. In this paper we describe the artistic contribution of ***memory [en]code***, the result of our art+science collaboration. ***memory [en]code*** is still a work in progress. While it was shown in a public gallery for a brief period of time we are continuing to develop it further.

We will first describe our collaborative process in more detail. From this we will introduce the conceptual framework of ***memory [en]code*** and provide a detailed description of the work. This will be followed by a discussion of different concepts of memory as they relate to the project. We will conclude with a brief look at future work.

2. Collaborative Process

As part of our collaborative process we sought examples of artists and scientists working in a hybrid manner on memory related work to provide a conceptual framework for our project. Karen Ingham, one such artist, expresses how her piece *Garden of Remembrance* becomes a visual manifestation of the collaborative process: "Public engagement with science through art is at the core of my research, and while

I am well aware that this kind of sciart collaboration is unlikely to create new scientific discoveries, it may stimulate new philosophical insights into the nature of memory and memory research. [...] This approach represents a kind of conceptual and visual manifestation of the collaborative process itself: the over-laying of different, and at times conflicting histories, concepts, and hypotheses." [Ing06]. Ingham's approach influenced our work thematically and conceptually. Thematically, we started to focus on the different concepts of memory. Conceptually, we extended our research to incorporate an even larger variety of disciplines allowing various and sometimes disparate concepts about memory to reside in our work. We investigated the different concepts of memory found in computer science, social science, cognitive psychology, neuroscience, and art. Our project incorporates these different approaches to allow for exploring and experiencing them in a combined way. Our intention is to draw people into a participatory experience where they can explore these concepts in a socially collaborative way. We want to create an open ended work that will provide "something like an instigation or an enhanced awareness of how we are all collaboratively and creatively implicated in making a culture," as artist Susan Hiller suggests of her own work in an interview with Mary Horlock [Hor01].

3. Conceptual Framework—Exploring Memory

Our early discussions about memory focused on computer and human memory. Computer memory is designed to consistently store and retrieve information. In our everyday life, we appreciate its consistent performance and lack of error to the extent that we have developed computers to function as a kind of prosthesis of human memory. A particularly interesting example of the computer program as a prosthesis of human memory can be found in the *Remembrance Agent* developed by Bradley J. Rhodes [Rho97]. This wearable system functions as "a continuously running proactive memory aid that uses the physical context of a wearable computer to provide notes that might be relevant in that context." [Rho97]. The wearer can input information about their context under specific headings and recall that information using a head-up display when presented with that context again. Computer programs such as this are operating in ways that our memory cannot and in this regard they are extending or "aiding" our memory.

We then became curious about the computer as not just a memory aid but rather a metaphor for human memory. In *Metaphors of Memory: a History of Ideas about the Mind*, philosopher Douwe Draaisma discusses the history of the computer metaphor for human memory [Dra00]. He discusses how "[w]ithin the metaphor of man-as-an-information-processing-system there emerged in the 1960s an exchange between the vocabularies for the human memory and that of computers. Terms like 'input', 'read-in', 'encoding', 'back-up memory', 'working memory', 'storage', 'address,' 'matching,' 'over-writing', 'search,' 'retrieval,' 'read-out,' and 'output,' acquired a place in a common vocabulary. In psychological theories they referred to hypothetical processes in memory, and in AI theories to mechanisms and structures for information storage in computers.", [Dra00, p.157]. Draaisma goes on to suggest that computer simulations in the early days of AI and cognitive science, despite this exchange of theoretical terms, revealed the differences rather than the similarities between computer simulations and psychological processes. Howard Gardner called this the 'computational paradox' and according to Draaisma, "[t]his paradox applies in its full extent to memory. The memory of the computer is too good. Its infallibility is its principal short-coming. Human memory is an instrument which, if the need arises, lies and deceives. It distorts, sifts and deforms, takes better care of some things than others. Unlike the computer memory it disobeys commands. It does not bother about instructions to keep one thing and throw something else away, it behaves like the disobedient dog that Cees Nooteboom called it. Whereas circuits in a classical computer are under a central operating system which gives its commands step by step, the human brain seems to be acted upon by scores of impulses at once. Odours, emotions, movements, sounds, perceptions: the memory is a vibrating network of synchronous associations rather than a linear tract of stimulus-storage-reproduction. The computer plays its melodies one key at a time, albeit incomprehensibly fast; the human memory strikes whole cords.", [Dra00, p.161].

Through this notion of the "fallibility" of human memory we discovered its infinite complexity. Far from a simple storage-and-retrieval system, human memory is dynamic and continually changing. Neuroscientists use the term *engram* to describe the "transient or enduring changes in our brains that results from encoding an experience. [...] The brain records an event by strengthening the connections between groups of neurons that participate in encoding experience.", [Sch96, p.58–59]. These connections depend on retrieval cues. In neural network models, memory is a "unique pattern that emerges from the pooled contributions of the cue and the engram"; the present moment and the past [Sch96, p.71]. As neuroscientist Antonio Damasio suggests in his theory of remembering, memories are sensory fragments that are constructed in the retrieval process [Sch96, p.66]. Memory is an act of construction and reconstruction.

Based on this initial exploration and discussion, we chose not to create a computer simulation of a specific theory of memory. Our approach was to explore memory through a wide range of disciplines and create a representation of memory in the broadest sense. This exploration of memory was far reaching and included concepts of computer memory, human memory, collective memory and even an ethics of memory. We discovered and were influenced by a wide variety of theories, metaphors and models for memory which will be discussed in greater detail further on.

4. memory [en]code

Our project was driven by the desire to make concepts of memory visible, tangible, and explorative. We realized this by creating an interactive tabletop installation called ***memory [en]code*** that invites interaction with a layered representation of memory. Incorporating a variety of concepts about memory from varying disciplines, ***memory [en]code*** invites the interactive exploration of differing and at times disparate notions of memory. Our approach to memory has been holistic, synergistic, and collaborative. By bringing together these varied concepts we hope to reflect our process of exploring memory and invite people to do the same.

In ***memory [en]code*** people initially find themselves in an immersive environment composed of abstract video projections. A subtle soundscape derived from whispers and water-like sounds draws them into the tabletop installation. Upon reaching the tabletop people discover an interface comprised of cellular forms. Generating their own memories in the shape of these cells, people can enter their memories into the system using a typing device embedded in the interface. With a touch of their fingertips they can move cells releasing the memories previously entered.

The computer program created for this installation, does not act as a static archive, storing and displaying the entered memories. In contrast, it acts dynamically, mimicking human memory, by constructing and reconstructing memory. In this way we hope to engage people in an interaction with the system and to initiate a form of communication between people and the system. Eventually, the system will become a dynamic collective memory shaped by both, the memories and the system's characteristics. In the following, we describe the technical and visual aspects of ***memory [en]code***.

4.1. Memory and Technology

The centre of our installation is formed by a digital table, a large horizontal display mounted on a table frame (see Figure 1). We are using a 5'x 3' plasma display as a tabletop surface. Using vision-based input technology [Inc03], our tabletop display enables the simultaneous interaction of two people at the same time. People can interact with their hands and fingers; no additional interaction devices are needed. The tabletop interface is programmed in C++ and OpenGL using the tabletop buffer framework developed by Isenberg et al. [IMC06].

Several tabletop systems have been developed for walk-up-and-use in public spaces [dBS01], [SWS*02], [ART04]. With their immersive and innovative appearance they have been found to be highly successful [Gel06]. Part of the reason for this is that interactive tabletop displays have certain characteristics that make them particularly appropriate for triggering interaction and participation [Gel06]. Due to their physical similarity to traditional tables commonly used in a variety of social and work environments, they generally project a familiar and comfortable atmosphere that invites communication and social activities, such as sharing information and discussing certain topics. The direct touch interaction with the horizontal display is the key for an intuitive and immersive user experience. Virtual information can be directly touched and manipulated by hands and fingers. In this way, information is perceived visually and physically.

Figure 1: *Tabletop display showing memory [en]code.*

To enhance this immersive experience we focused on creating a walk-up interface that invites people to participate in the installation actively and without instruction. Walk-up interfaces are ideal for a public forum where people are approaching a system that is self-explanatory as opposed to requiring training.

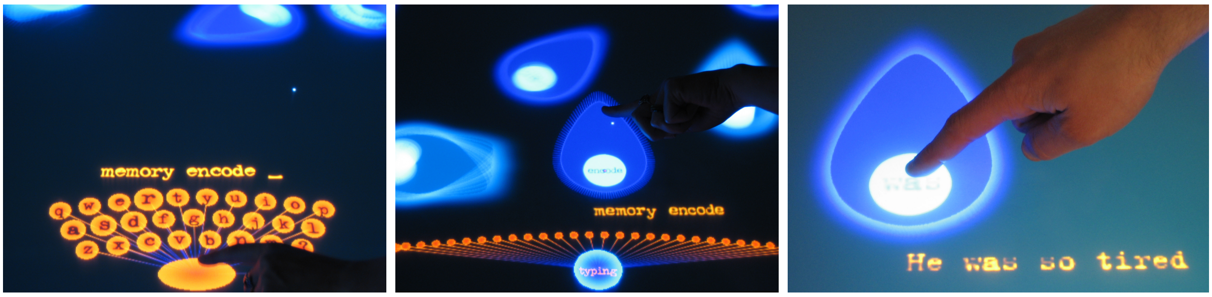
In the next section, we will describe the visual appearance and possible interactions in ***memory [en]code***.

4.2. A Visual Representation of Memory

Through our research we discovered a multitude of visual metaphors for memory. A cognitive psychologist we interviewed used the metaphor of tossing a bike into a pond. The bike represents the experience while the ripple is the resulting memory. In contrast to this rather tangible metaphor, a neuroscientist spoke to us about neural networks, pathways, and proteins. Through our research, what started to take shape was a series of abstract cellular forms with strong biological associations with each cell representing a memory. These forms are simple organic shapes with subtle coloration and a varying degree of transparency that speaks to their vividness and fragility. Residing in a fluid-like environment the cell movement resembles cell motility. These forms behave in ways that reflect different concepts of memory.

4.2.1. Memory Cells

Each memory within ***memory [en]code*** is represented as a transparent ovular cell structure (see Figure 2). Similar to organic cells, each memory cell consists of a nucleus, plasma,



(a) Entering a memory into the system... (b) ...will create a new memory cell. (c) Revealing the memory narrative.

Figure 4: *Creating new memory cells.*

and membrane (see Figure 2). The nucleus contains the content of the memory cell, discussed in detail further on, while the plasma enables the cell to move within the interface.

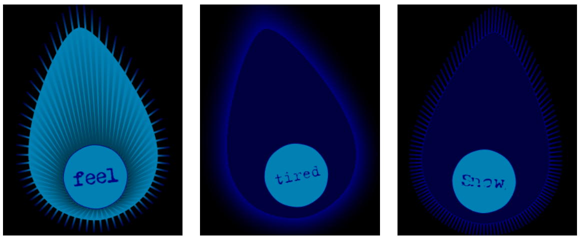


Figure 2: *Visual representation of memory cells.*

Figure 3: *Pushing a memory cell using the fingertip.*

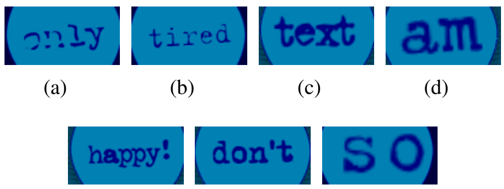
The visual appearance of memory cells is based on a set of specific visual characteristics, such as colour, transparency, and texture. A cell's colour can range from a dark to light blue. Cells can be opaque or transparent, have a subtle striped pattern or a simple solid colour. Furthermore, the membrane of each memory cell can vary, appearing to have hair like strands or a soft semi transparent contour (see Figure 2).

Upon entering a memory, the system "decides" based on the entry time of the narrative on the visual appearance of the related memory cell. This is the moment where the system starts to interpret an individual's memory in a manner that is not directly controllable by the individual.

Memory cells move in a random manner inspired by organic cells. The cells are in a state of constant movement except when people interact with them. People can use their fingertips to touch a cell, push it, pull it, or even toss it across the tabletop surface (see Figure 3). Once released again, the cell will continue along its own path, at times colliding with other cells or forming in groups.

4.2.2. Textual Representation of Memories

In order to add a memory to the system, people have to enter a specific memory using a virtual typing device that is present within the tabletop interface (see Figure 4(a) and 4(b)). This memory is contained in the nucleus of the newly generated cell. The system will randomly select one word from the memory narrative and present it in the nucleus within the cell. This word is always apparent as the cell floats freely within the interface. When a person touches the nucleus of a cell, it will reveal the memory by displaying the complete text (see Figure 4(c)). Each cell is assigned a different typewriter based font by the system. This gives each memory narrative a unique appearance that reflects the individual aspect of the memory (see Figure 5).



(a) (b) (c) (d)

(e) (f) (g)

Figure 5: *Different typewriter fonts.*

4.2.3. Forgetting

A certain lifespan is assigned when a memory cell is created based on the length of the content of the memory narrative. Over time memory cells visually age; the memory's textual content degrades and the cells become more transparent until they completely disappear. Interaction with a memory cell will refresh its lifespan so cells that experience more interaction are visible longer.

4.2.4. Merging Memories

Besides entering memories into the system, people can actively manipulate the content of existing memories by merging different memory cells together (see Figure 6). When

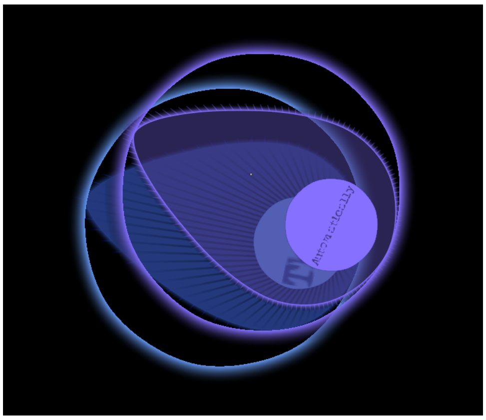


Figure 6: *Fusing memory cells.*

fused, the narratives encased in each cell come together. The text becomes a combination of the narrative fragments from both of the "parent" cells. In a similar way, the appearance and lifespan of the cell emerging from this cell fusion is determined by the appearance of its parent cells.

In the following section we describe how a group of people might experience ***memory [en]code***.

5. Walking Through *memory [en]code*

Entering the installation a group of people find themselves in a darkened room surrounded by video projections showing abstract, out-of-focus forms in shades of blue. The forms appear and disappear, slowly sliding across the surface of the projections. A soundscape of whispering and water-like sounds accompany the projections, creating a feeling of being submerged in an under-water environment.

Moving to the centre of the room they discover a tabletop display where they can see cell shaped forms moving continuously and autonomously over the surface. With a touch of their fingertips they reveal virtual keyboards on each side of the tabletop surface. Invited by the virtual keyboards they begin to type memories into the system. By touching a blue circular shape next to the virtual keyboard a person finds the typed in memory emerging as a cell that drifts out from the keyboard towards the other cells.

At the same time, another person discovers how to interact with the memory cells. She explores how cells can be moved around by touching and dragging them with her fingertips. When she touches the nucleus of a cell the text inside is revealed. The bright orange text appears to float on the surface and she reads the memory entered by someone else. She finds out that she can fuse cells together by moving two cells over each other. When she touches the nucleus of the recently fused cell, she notices that the texts from both cells have merged together forming one text.

From time to time visitors notice that the memory cells become more transparent and eventually disappear. If they interact with these cells their colour becomes more opaque again. If they do not interact with them the cells disappear completely.

6. Discussion

We discovered a variety of concepts associated with memory through literature and interviews with researchers from different disciplines engaged in memory research. While memory is a vast topic of research, certain concepts in particular caught our interest. The following discusses the mapping of certain aspects of memory within ***memory [en]code***.

6.1. Collective Memory, Collective Forgetting

memory [en]code invites people to interact with the memories present within the tabletop interface. Through the touch of their fingertips they can release the memory narrative inside the cell. The textual representation of the memory hovers by the cell for a short duration and then dissipates (see Figure 4(c)). People can act on the potential associations between their own memories and other memories present on the tabletop by fusing memories with each other. In this way the individual memories begin to shape each other and become a form of collective memory.

The act of sharing memory requires communication. "A shared memory integrates and calibrates the different perspectives of those that remember." [Mar02, p.51]. In sharing memories we construct a narrative particular to that moment of recollection. We attempt to capture a unique pattern that emerges from cue and engram in language and in story. As memories are communicated these narratives change. Collective memory like individual memory is a dynamic process of construction and reconstruction.

As Margalit comments in *The Ethics of Memory* [Mar02], shared memory involves a division of mnemonic labor. "[S]hared memory in a modern society travels from person to person through institutions, such as archives, and through communal mnemonic devices such as monuments and the names of streets." [Mar02, p.54]. And, as sociologist Anne Galloway [Gal06] suggests, through our machines. There is an ethical dimension to what is collectively remembered and forgotten that is embedded in our design cultures and practices. In her critical design challenge *Collective Remembering and the Importance of Forgetting*, Galloway poses the question "[w]hat does it mean if the memories held by our machines never change or get forgotten?" [Gal06, p.2]. She articulates a type of oppression of memory that comes from a relentless extension of our memories through the use of computers without human imprecision, without forgetting.

There are differing theories about forgetting. Some psychologists theorize that we store everything we experience. Given the right cue, we can recall those memories meaning nothing is ever forgotten. Others, in contrast, suggest that some experiences are irrevocably lost. As Schacter points out, the more interesting question may be *why* forgetting occurs [Sch96, p. 77–79]. Illustrating his point he uses Jorge Luis Borges' story *Funes, the Memorious*. In this story, a young man remembers everything in perfect detail but is unable to generalize from his experiences. He reminds us that forgetting is a necessary function of memory presenting the possibility for abstraction. Forgetting holds creative potential. Galloway argues that this potential lies in our ability to imagine the future by forgetting the past [Gal06]. In this regard, forgetting is not an error of memory but an integral aspect of memory that creates new space. Nietzsche refers to active forgetting as a way to overcome traumatic events: "forgetting is not simply a kind of inertia, as superficial minds tend to believe, but rather the active faculty to provide[...]some silence, a 'clean slate' for the unconscious, to make a place for the new[...]those are the uses for what I have called an active forgetting..." [Gal06, p.3]. It is in the absence of memory where we can imagine alternative futures.

While designing computer systems to extend and enhance human memory, we are not taking into account that there is no memory without forgetting. Valuing memory without considering our capacity to forget places us in the situation illustrated by the story, *Funes, the Memorious* [Sch96]. We become trapped in a world of infinite detail without the ability to generalize, make abstractions, or to imagine.

Considering forgetting as an integral aspect and not as an "error" of memory, ***memory [en]code*** incorporates aspects of forgetting as essential to remembering. Memories entered into the system fade over time and disappear. We chose to connect their persistence to interaction with people. The more a memory cell is interacted with the longer its duration in the interface. In this way, we tried to capture a play between concepts of forgetting as both voluntary and involuntary. By interacting with certain cells a person extends the persistence of that memory. By not interacting with certain cells a person increases the fragility of the cell and eventually it will disappear. The "forgetting" of some cells makes it possible for ***memory [en]code*** to accommodate new memories that are being entered on the interface. From this perspective, forgetting makes it possible to create new memories and associations; and thereby a creative potential. This aspect of forgetting is integral to the continuous construction and reconstruction of a collective memory.

6.2. Writing Memory

Memory narratives in ***memory [en]code*** are presented textually. While other representations of memories would be possible, such as sound or images, the textual representation has certain implications that are interesting in regard to the constructive and reconstructive aspect of memory. If, as neuroscientist Antonio Damasio suggests, our memories are sensory fragments constructed in the retrieval process [Sch96], the moment of transcribing memories into text is an interesting one. The sensory fragments of memory—scent, texture, sound, and image—are subjectively vivid and present upon recall and yet: how to translate that into text? We feel compelled to construct a narrative and in the process retroactively fill in the "gaps" or "errors" of memory. The act of writing becomes another layer of representation in the construction and reconstruction of memory.

This is intriguing to consider in light of Freud's essay *A Note upon the Mystic Writing-Pad* [Fre63]. Freud uses a writing tablet as a metaphor for how the psyche records experience. The writing tablet is comprised of a clear plastic sheet above a wax layer. One can write on the surface and upon pulling up the sheet the writing disappears leaving only a trace of the writing on the wax layer below. Freud's thoughts on how this tablet represents the psyche is discussed in the *Electronic Labyrinth* web project. "...[F]or Freud [the *Mystic Writing Pad*] was analogous to the way the psychic system which received sense impression from the outside world remains unmarked by those impressions which pass through it to a deeper layer where they are recorded as unconscious memory." [KMP00, p.1]. To Derrida, Freud's theory of the *Mystic Writing Pad* was more than a metaphor: "None of us apprehends the world directly, but only retrospectively." [KMP00, p.1]; our sense of that which is beyond ourselves is the product of previous memories, previous writings. "Writing supplements perception before perception even appears to itself." [KMP00, p.1].

memory [en]code uses a similar metaphor as the *Mystic Writing Pad*. People are writing on the surface of the interface and their memories pass into another layer—the memory cells. Previous writings influence what will be written and the interpretation of the writing. An immediate visual impression of the tabletop interface is an array of words. There is a multitude of associations among these words that are both literally and figuratively on the move. When written as opposed to spoken, words become removed from the speaker. They become open to unexpected or unintended interpretations. "Signifiers are no longer fixed to their signifieds, but begin to point beyond themselves." [KMP00, p.1].

According to Katherine N. Hayles [Hay99] they might become flickering signifiers. "When a text presents itself as a constantly refreshed image rather than a durable inscription, transformations can occur that would be unthinkable if matter or energy, rather than informational patterns, formed the primary basis for the systemic exchanges. This textual fluidity, which users learn in their bodies as they interact with the system implies that signifiers flicker rather than float." [Hay99, p.30]. Hayles further illustrates her point with an example of herself composing a text on her computer. The multiple layers of code intervene between what she sees on her screen and what the computer reads. In contrast to writing with ink, dramatic changes can be made to the text with one command. "In informatics, the signifier can no longer be understood as a single marker...[r]ather it exists as a flexible chain of markers bound together by the arbitrary relations specified by the relevant codes." [Hay99, p.31].

This textual fluidity is interesting to consider in relation to the text input device embedded in the interface of ***memory [en]code***. The creation of a text using touch input cannot be considered separately from the physical gestures required to generate the text. The gestures can be regarded as a series of signs that become internalized and performed as a kind of body memory. The body becomes attuned to a process of merging and altering text with a simple gesture. Between this gesture and the text that appears on the surface of the tabletop is a series of intervening codes. In ***memory [en]code*** it is possible to merge memory cells together and, in that way, transform the narrative and its possible interpretations.

6.3. Public and Private Experience

The relationship between the tabletop display and the surrounding environment is integral to the kind of interaction it supports. We wanted to create a space for both private reflection and public sharing. The immersive environment suggests a contemplative space while the physical size of the tabletop display implies a public space. People interacting with ***memory [en]code*** are in the position of enacting a private experience in a public forum. Their memories are made visible and tangible for others.

Memory is perceived as private and intimate; it is not typically shared with strangers. Yet, ***memory [en]code*** asks people to share memories in a public situation. The textual representation of memories within ***memory [en]code*** ameliorates this apparent conflict. The text based memory narrative cannot be referred back to its author. The act of typing in a small area on the tabletop interface, in contrast to the act of speaking in a public area, allows for greater anonymity.

The location of the installation will influence how people approach ***memory [en]code*** and the memories they will share. For example, if ***memory [en]code*** was placed in an airport, the shared memories might include narratives about immigration, displacement, exotic travel and so on. The collective memory is shaped by this location and the mind set of the participants.

7. Conclusion and Future Work

We have introduced ***memory [en]code***, a tabletop installation resulting from an art+science collaboration that provides a visual interactive representation of various concepts of memory. ***memory [en]code*** is a work in progress. At this stage, we have displayed ***memory [en]code*** in a public gallery for a brief period of time. The responses we received during this time were positive. Many visitors spent a considerable amount of time engaged in the interaction. They entered their thoughts and memories into the system and interacted with the cells. Most people found the visual appearance and the interaction inviting and thought provoking resulting in return visits to the installation. Those that interacted with ***memory [en]code***for a longer period of time entered thoughtful and compelling memories. Some preferred to enter their memories in private waiting until others left the installation. Others enjoyed the social aspect of entering memories and sharing them with other people. After displaying it in the context of a public gallery we would like to continue to refine *memory [en]code* and install it in various public spaces such as libraries, coffee shops, airports, or museums. We are interested in observing how the collective memory formed within ***memory [en]code*** would change depending on the character of different places. ***memory [en]code*** is an installation that takes shape from the environment in which it is installed. It only becomes meaningful and alive by the participation of people that provide their memories, experiences, and interpretations.

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