Does the Data Doppelgänger Reside in The Uncanny Valley?

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August 2016

Abstract

Data accumulation by (self-)tracking creates a new type of identity that mirrors, resembles, reflects, mediates and interacts with the user being tracked (data doppelgänger). This paper uses textual analysis and an empirical study to discuss whether the 'uncanny' emerges when our data doppelgänger doesn't resemble our understanding of ourselves. Furthermore it examines what kind of conditions are required in order to (not) let the uncanny (valley) emerge in real-time data-driven storytelling for mobile devices in the case that the main character of the narrative is the data double of the reader.

1. Introduction

Since the 80's we are familiar with the divide between our appearance in the physical world and our appearance in the virtual world. By the increasing technological development in the field of data-mining, Artificial Intelligence (AI) and the related possibilities of linking a wide variety of big data and small data, we are able to create a mirror image of ourselves that is not always familiar to us.

Nowadays one of our mirror images consists of a myriad amount of pixels in the form of a selfie. In our desire to be confronted with a version of ourselves we have become enslaved to the tantalizing quality of these versions. This attraction to selfies appears to be similar to media theorist Marshall McLuhan's reframing of the Narcissus myth in which he explains that 'men at once become fascinated by any extension of themselves in any material other than themselves'. (McLuhan, 1964) McLuhan, in contrast to the popular version of the Narcissus myth, observes that Narcissus did not fall in love with himself – but rather, numb to his image, he could not recognize his reflection as his own. (Wendt, 2014)

Data tracking and personalized advertising is often described as "creepy." (Tene, 2013) Personalized ads and experiences are supposed to reflect individuals, so when these systems miss their mark, they can interfere with a person's sense of self. It's hard to tell whether the algorithm doesn't know us at all, or if it actually knows us better than we know ourselves. And it's disconcerting to think that there might be a glimmer of truth in what otherwise seems unfamiliar. This goes beyond creepy, and even beyond the sense of being watched. (Watson, 2014)

The core of this study is formed by the investigation of the relationship of a user and his/her data doppelgänger. Emotional responses like dread or trust to the doppelgänger's appearance are weighed via Eyetracking in combination with FaceReader software, questionnaires and interviews to examine whether people perceive the data doppelgänger as threat or as a trustworthy identity (that he or she can learn from). The main questions focus on whether and how a sense of uncanny emerges when our data double doesn't resemble our understanding of ourselves.

The practical outcomes of this research could help in the character design of a data double in real-time data driven storytelling. These kind of narratives can contribute to reflect more critically on how big and small data shape (and reveal) our understanding of the world.

The scope of this transdisciplinary study covers different intersecting fields of science ranging from the humanities (a.o. media studies, psychology) including aspects of art (literature) and design to computer science, a common characteristic of research done in the field of new media studies.

This paper is structured as follows: it starts with an exploration of related work in section 2. In section 3 the intended project is described, section 4 describes what kind of experiment is done, and what method is used for this research. Section 5 describes the results and discussion, section 6 describes the design principles emerging from the results, and the last section is used for a conclusion of this investigation.

2. Background and Related Work

The related works on which this study is based will be described in this section. It starts with an introduction of digital entities and identities followed by the subfield of (self) data-tracking. The hypothesis of the Uncanny Valley by Mori (Mori, 1970) is adopted to determine if the data double resides in the uncanny valley. The investigation also contrasts this hypothesis of the Valley with the work of Tinwell and Grimshaw concerning the Uncanny Wall (Tinwell, 2011), and tries to reconcile its differences vis a vis the outcome of this current investigation.

2.1 Digital Shadow

Outside in the sun, everyone has a shadow. And in the digital world, everyone has a shadow too. Our digital shadows are created as we move through the digital environment, collecting trillions of bits of data, which are stored in data centers all over the world.

Unlike our ordinary shadows, digital shadows have a life of their own. They can be affected by others, take on different forms, and change in unpredictable ways. Every time we use digital technologies, our digital shadows grow. We have no control over what our shadows may attach to, or connect to. Likewise, as we interact in the digital community, it's hard to know what our shadows might be associated with, and what this amounts to.

Digital shadow, *datafied self*, *digital self*, *data twin*, *digital double*, *data double*, or *data doppelgänger* are all different names for the same concept. The basic idea is that the data accumulated through (self-) tracking creates a new entity that mirrors, resembles, reflects, mediates and interacts with the tracking user (Ruckenstein, 2014).

2.2 Der Data Doppelgänger

The concept of a data double is a useful way to think about the entanglements of bodies, technologies and selves in digital tracking. Data doubles are configured when digital data are collected on individuals, serving to configure a certain representation of a person (Haggerty and Ericson, 2000). They have their own social lives and 'materiality', quite different from the fleshy bodies from which they are derived.

Data aren’t the first of tools for self-reflection to produce a sense of the uncanny. The original reflective technology, the mirror, gave us the ability to see ourselves as others see us. French psychoanalyst and theorist Jacques Lacan described our fraught relationship with the mirror in the story of a man who sees his own back in the mirror and feels the presence of the ghost, unable to face himself in the reflection. Following Lacan, the uncanny emerges in the act of seeing oneself as the other.

Personalization holds up a data mirror to the self, collapsing the distance between subject and object, and yet it’s impossible for us to face our data doppelgänger with complete knowledge. (Watson, 2014)

Uncanny personalization (Watson, 2014) occurs when the data are both too close and not quite close enough to what we know about ourselves. This is rooted in Sigmund Freud’s famous treatment of the uncanny (Freud, 1919), which he traced to the feelings associated with encountering something strangely familiar. In Freud’s original writing, the uncanny is the *unheimlich*—literally translated as "unhomely," and the opposite of *heimlich*, which is the familiar, comfortable feeling of being at home.

Technologies that are simultaneously familiar and alien may evoke a sense of dread. In the same way, when our data do not match our understanding of ourselves, the uncanny emerges. Freud explains that *heimlich* also means ‘that which is kept hidden’, as in the private sense of the home. So when something becomes unheimlich, what should be hidden is exposed, made public. We might think of our browsing or location history in this way. With digital traces assembled by personalization engines, our most intimate behaviors are uncovered, made public and reflected back at us. We don’t think an ad is relevant to us, but it repulses us because we are worried that it could be. A friend’s Facebook status update captures this idea well: "I am never quite sure if Facebook's advertising algorithms know nothing about me, or more than I can admit to myself.” (Watson, 2014)

In his exploration of the uncanny, Freud also delves into the idea of the double. The doppelgänger is the identical other, and in the literature Freud cites, doubles are often connected almost supernaturally, sharing feelings, behaviors, and actions. Although it is an interesting subject it is beyond the scope of this study to research the character of the double in literature.

Robots act as our mechanical doppelgängers, especially when they are designed in our likeness. Similarly, our digital data echo our actual tastes and activities, often with higher fidelity than our own memories can. The familiarity of our data doppelgänger is uncanny—as though we are able to see our own body at a distance. The doppelgänger invites the strange possibility for self-observation and self-criticism. If we observe our double and we don't like what we see, we worry that the reflection might be more real than our perceptions of our actual selves. (Watson, 2014)

2.3 Quantified Self

The *Quantified Self* is a movement whose objective is, overall, to incorporate technology into data acquisition on aspects of a person's daily life in terms of inputs (e.g. food consumed, quality of surrounding air), states (e.g. mood, arousal, blood oxygen levels), and performance (mental and physical). It is an advanced user community of people who have begun to explore and experiment with novel uses of personal data.

As Floridi (2011) posits, "Information and Communication Technologies are, among other things, egopoietic technologies or technologies of self construction, significantly affecting who we are, who we think we are, who we might become, and who we think we might become." We can know ourselves in new and different ways when we engage the novel, digital affordances of data. But what does it really mean to know ourselves through data? And could data be used to reveal parts of ourselves that are critical, strange, or even unsettling?

The digital doppelgänger should not be seen as a final result of (self-)tracking activities, but as a relational actant in a performative process. Clearly, the Quantified Self movement doesn't aim per se at generating data doubles, but these are emerging construct that derive from the practice of self-tracking. There are three intertwined process modes that define "doppelgängering": *enactment* (giving the doppelgänger a form), *existence* (being one with the digital other) and *entanglement* (negotiating with the digital other). (Bode and Kristensen, 2016)

From Plato to Freud, the framing of the self has cycled through many binaries, from the body/soul, to the material/immaterial, the objective/subjective, the noumenal/phenomenal, the id/ego. The Quantified Self still contributes to this dualism, its counter a "qualified" self. When we worry about things in life that could not possibly be captured as data, this dualist opposition becomes clear. Still, the Quantified Self use of data might move towards a reconciliation of the objective and subjective (Latour, 1993) view of the self. Data provides an externalized view of the self, but may only be truly rich and meaningful to an individual as it is inherently subjective and contextual. (Watson, 2013)

In this study self-tracking data are combined with data accumulated by social media sites like Facebook and LinkedIn.

2.4.1 The Uncanny Valley

Whereas data doppelgängers may be a reflection of (self-)tracking data, robots may act as our mechanical doppelgängers, especially when they are designed in our likeness. Similarly, our digital data echo our actual tastes and activities, often with higher fidelity than our own memories can. The familiarity of our data doppelgänger is uncanny—as though we are able to see our own body at a distance. (Watson, 2014)

In his famous essay 'The uncanny valley' (1970) Japanese roboticist Masahiro Mori hypothesized that a person's response to a humanlike robot would abruptly shift from empathy to revulsion as it approached, but failed to attain, a lifelike appearance.

Since the 1970s, theorists have used the term "uncanny valley" to describe the unsettling feeling some technologies give. us. Mori first suggested that we are willing to tolerate robots mimicking human behaviors and physical characteristics only up to a certain point: When a robot looks human but still clearly isn't, see figure 1.

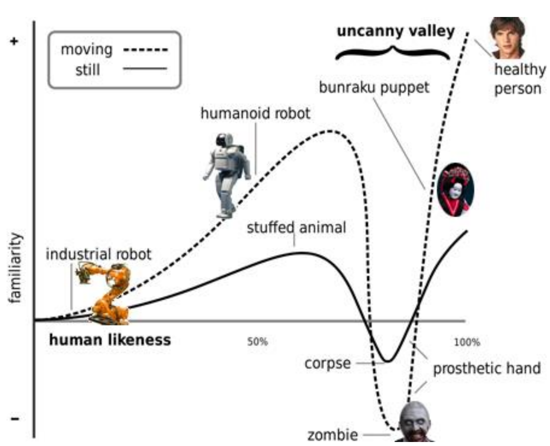

Fig. 1: The Uncanny Valley

To explain how this works, Mori discusses the example of a prosthetic hand. He writes:

> . . . recently prosthetic hands have improved greatly, and we cannot distinguish them from real hands at a glance. Some prosthetic hands attempt to simulate veins, muscles, tendons, finger nails, and finger prints, and their color resembles human pigmentation. [. . .] But this kind of prosthetic hand is too real and when we notice it is prosthetic, we have a sense of strangeness. So if we shake the hand, we are surprised by the lack of soft tissue and cold temperature. In this case, there is no longer a sense of familiarity. It is uncanny. In mathematical terms, strangeness can be represented by negative familiarity, so the prosthetic hand is at the bottom of the valley. So in this case, the appearance is quite humanlike, but the familiarity is negative. This is the uncanny valley. (Mori, 1970)

In other words: if robots are too human-like, yet display behaviors that are less than perfectly human, Mori predicts there will be a steep decline in the level of familiarity, so much so that a deep sense of eeriness, or uncanniness, arises. If their appearance has “high fidelity even slight inconsistencies in behavior can have a powerful unsettling effect ” [Walters, 2008].

Explanations for the existence of the Uncanny Valley are varied. In general terms, one could argue that the sense of eeriness arises when a mismatch occurs between a robot’s appearance and his actual capabilities. If a robot’s looks are quite sophisticated, it seems logical that individuals interacting with it will assume that its behaviors will be quite sophisticated as well – just like we assume a level of behavioral sophistication from our fellow human beings whenever we engage in interactions with them. If there is a (significant) discrepancy between the high level of human-likeness of a robot’s exterior and a low level of behavioral refinement, this provokes a response of disgust and repulsion: the uncanny valley. In the process of finding empirical and theoretical evidence for the uncanny valley, investigations into the matter have migrated from the field of robotics and android science into other research areas as well. For one, it has gained popularity, and found empirical proof, in the field of computer graphics and video game character design. (Schneider, 2007) As Bryant aptly summarizes it:

> "... though originally intended to provide insight into human psychological reactions to robotic design, the concept expressed by [the phrase ‘the uncanny valley’] is equally applicable to interactions with nearly any nonhuman entity." (Bryant, 2004)

2.4.2 The Uncanny Wall

The theory of the Uncanny Valley has been revisited several times in recent years. (Van den Berg, 2010, Dorman, 2006, Bartneck 2007, 2009) According to Tinwell and Grimshaw the Uncanny Valley is impossible to traverse. Their theory proposes that increasing technological sophistication in the creation of realism for human-like, virtual characters is matched by increasing technological discernment on the part of the viewer. One of the goals for achieving a realism that is believable for virtual characters is to overcome the Uncanny Valley where perceived strangeness or familiarity is rated against perceived human-likeness. Empirical evidence shows that the Uncanny can be applied to virtual characters, yet implies a more complex picture than the shape of a deep valley with a sharp gradient as depicted in Mori’s original plot of the Uncanny Valley. Their theory imply that: (1) perceived familiarity is dependent upon a wider range of variables other than appearance and behavior and (2) for realistic, human-like characters, the Uncanny Valley is an impossible traverse, is not supported fully by empirical evidence and the concept is better replaced with the notion of an Uncanny Wall. They propose the theory that, instead of an Uncanny Valley, designers of realistic, human-like characters are faced with an Uncanny Wall, created by the viewers’ continually improving discernment of the technical trickery used in the character’s creation and this discernment prevents complete believability in the human-likeness of that character, see figure 2. (Tinwell, 2011)

The theory suggests that a viewer’s discernment for detecting imperfections in realism will keep pace with new technologies in simulating realism. In this study the imperfections are one of the cores of the research.

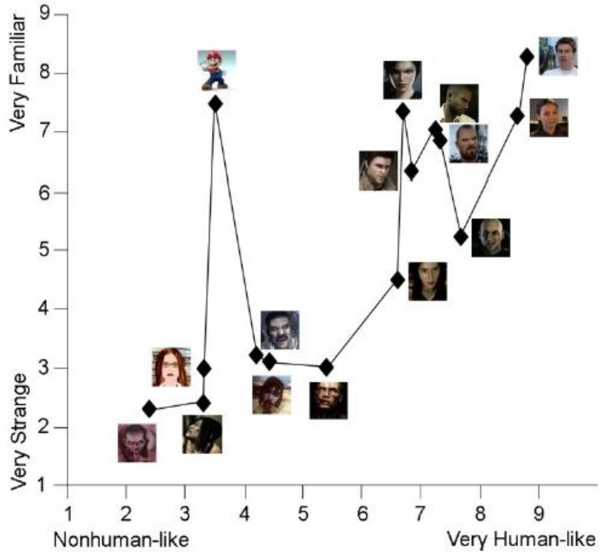

Fig. 2: The Uncanny Wall

2.5 The Data Doppelganger and the Uncanny Valley

The uncanny valley of robotics is grounded in the social cues of the visual. We are repulsed by the plastic skin, by the stilted movements, by the soulless eyes of our robotic counterparts. Whereas robotic doppelgängers may be uncanny for their visual appearance and corresponding expected behavior, data doppelgängers may make us uneasy because of their opaque algorithmic behaviors. Indeed, personally targeted digital experiences present a likeness of our needs and wants, but the contours of our data are obscured by a black box of algorithms. Based on an unknown set of prior behaviors, these systems anticipate intentions we might not even know we have. Our data may not be animate or embodied like a robot, but they do act with agency. Data likeness can't be seen or touched, but neither can our sense of ourselves. This makes the uncanny even more unnerving. (Watson, 2014)

3. Project Description

In this section the project is described. Because the project is a conceptual proposal, the term design fiction is explained.

3.1 The Telling Machine

The Story-Telling Machine is a proposal for a real-time storytelling app that combines data tracking, API's and storytelling. By combining data that are collected by a smartphone as tracking device and the use of API's real-time data are collected. These data are converted into written text by using Natural Language Generation and Artificial Intelligence. It is a form of literal storytelling with data, designed for the mobile device.

The narrative presents the user's data double as one of the main characters in the story. The reader gradually comes to know line by line that its digital double is one of the main characters of the narrative.

A remark has to be made that entering the valley could be considered both good as well as bad.

Although the experience of being confronted with your data double can prove to be scary, by equipping this confrontation with a context of a narrative / story the user is helped and made more aware and critical about the use of data. A narrative, is applied as an affordance is created that enables an intensification of any confrontation with a data double. The challenge being to accommodate the reader with a full descend into the depths of the uncanny valley, in order to create the conditions for a critical awareness of his/her own data-reflection. This in astute contradiction in the case of designing personalized apps and experiences where the uncanny valley has to be avoided.

In this study *The Story-Telling Machine* is used to present the data double of the user as the protagonist in the story, the story is called *The lab*. Eleven customized stories have been developed to investigate the reaction of the user on its own data double, and to research if the uncanny emerges when these data do not match the understanding of the various users.

The short story describes the study itself, how a young man or woman (depending on the gender of the user) takes part in a scientific experiment to investigate why doppelgängers can be really good imitators, but sometimes show some abnormality. The data double of the user is presented as a separate character in a monologue.

3.2 Mobile Storytelling

The handheld mobile phone has been around commercially since the early 1980s, but its secondary use as a device for composing and distributing stories is relatively new. As a point of reference, the first cell-phone novel, *Deep Love*, was created in 2003 in Japan. Other forms of digital stories also have been emerging, with more recent examples drawing on the improved connectivity and robust features made possible by smart technologies. (Farman, 2013)

Yet, there are specific attributes of *contemporary* mobile technologies that do not have precedent in previous media for storytelling. Tapping into this mode of exploration is called “medium-specific analysis”; such an approach asks us to understand the medium’s unique capabilities (and constraints). These affordances and constraints will significantly affect the content of the story and the experience of it. (Hayles, 2004) In line with Marshall McLuhan’s famous adage that “the medium is the message,” a medium-specific analysis understands that the medium will often impact the ways a story is told, distributed, and experienced. (McLuhan, 1964)

With a dystopian bent, much of the early research on mobile devices initially focused on tendencies to disconnect users from surrounding spaces. Discussions, such as those by Janet Murray about nontrivial activities that interfere with immersion, prevailed until recently. (Murray, 1997) The general idea has been that deliberative movement and thought related to interacting with an interface would gain the user’s attention and, so, move it away from the story itself. This disconnection, this break from the state of immersion, has been seen as a negative aspect of born-digital stories. But what if immersion into the object is *not* the holy grail of storytelling and, instead, the goal is to unite the user with a particular space? Could we not find a new quality unique to storytelling that is not beholden to print sensibilities? (Farman, 2013)

3.3 Real-time Storytelling

Real-time storytelling in this case is based on two pillars: (1) the computer software that automatically extract new knowledge from different type of data silos; (2) algorithms that automatically convert this knowledge into readable stories without human involvement. (Latar, 2014) In other words, it’s a set of algorithms which take data and turn them into words by using Natural Language Generation and Artificial Intelligence.

3.4 Object versus Subject

In the beginning of the story the double is presented from the perspective of the third person, the act of seeing oneself as the other. The name of the subject is shortened to just the initial.

> At the start of the experiment <u>M.</u> could not suspect it would kind of get under her skin later on. When asked to participate, she did not need to hesitate long. It served a good cause, aimed at the advancement of science...

Later on the double is presented from the perspective of the first person in a monologue.

> ..."Hi, are you Mara? That's funny, because that's my name too. I'm your double. Are you already spooked out about the possible existence of digital doppelgangers? If so, buckle up! Because I'm 27 !!! ...

3.5 Fiction and Reality

The blurring of boundary lines between 'imagination' and 'reality' are emphasized by presenting the location of the experiment in the story as the usability-lab where the study takes place. Fiction and reality coincide in time and space, (and content).

> ... The laboratory were the experiment took place was situated on the second floor.
> M. was alone in the room. The room looked out over a large part of the city. In the distance she saw the hotel in which a lot of celebrities and artists were lodged.
> M. knew that the researchers were sitting behind the one way mirror. Of course she did not know how many of them would be present, and what they were looking for...

3.6 Past, Present and Real-Time

The first part of the story is told in the past tense, although at a certain moment the time and location coincide with reality (*it's happening right now*).

The second part in which the double presents himself is told in the present tense.

Elements like weather, date and time were used to emphasize the real-time effect.

> ... On a *cloudy Monday morning* in *June* M. stood in front of the entrance of the lab at the main courtyard...
> ...Now it was her turn. It was about to strike *eleven*...

The last part where the story ends (the double has left) is told in the past tense, resulting in a (real-time) question: Now?

> ... And off the doppelganger went. There she was with a text in front of her, about a young women who very much looked like her, yes, perhaps *was* her. The question that remained : What did she feel? Right now?!

4. Method

To measure the value of familiarity in relation to the resemblance of the data double and its user, a qualitative research has been conducted.

4.1 Experiment

The participants were asked to collect data for 2 weeks. The timespan of two weeks is chosen to enable the recognition of weekly patterns. The data are collected by the participants partly by themselves, and partly by setting up a website where they could connect their data-stream via an API key.

The data are analyzed (preferable by algorithms, in this case by human hands) and based on this analysis a data doppelgänger is constructed. This data double is presented to the user in a customized short story. To evade language problems the narrative was presented in Dutch. The story contained personal data like: home-address, age, family, relationship, favorite activities, interests and locations.

A description of the main character was presented, based on the Big Five Model. Big Five is one of the most broadley-accepted models developed by psychologists (Costa & McCrae, 1992, and Norman, 1963). It is the most widely used personality model to describe how a person generally engages with the world. The five dimensions are often referred to by the mnemonic *OCEAN*, where *O* stands for Openness, *C* for Conscientiousness, *E* for Extraversion, *A* for Agreeableness, and *N* for Neuroticism. Because the term Neuroticism can have a specific clinical meaning, the service presents those insights under the more generally applicable heading Emotional Range.

4.2 Participants

The test-group consisted of 11 persons, varying in age from 19 to 28. The participants were experienced smartphone-users, i.e. they are using on a daily base their smartphones to *communicate* (text Messaging, email, calls), to *get informed* (browser) and *to share* (Social Media*)*. The participants in this study were 5 men and 6 women attending the Amsterdam University of Applied Sciences in the bachelor program CMD (Communication and Multimedia Design). Two participants were non-native speakers / readers. Noldus FaceReader software had no settings for Afro-American facial traits, so 1 participant had no results on this measurement.

4.3 Data Tracking

The equipment for (self-)tracking consists of a combination of hardware and software. The hardware was the private smartphone of the participants customly equipped with sensors like the accelerometer, gyroscope, magnetometer, to track movements in space. A typical distinction is made between automatic data recording (or "passive tracking") where data are recorded without a user's direct input and manual data input (or "active tracking"), where users are asked to supply input to express their current moods.

In addition, manual monitoring of their social media (LinkedIn and Facebook) was used to derive from those sources contextual info. As the participants were aware of the fact that data were collected about their lives, they were not aware of the fact that their social media were also used for complementing their data-doubles. In the briefing no mention was made that the study was about their reaction to their data-doubles, but instead that the study concentrated on the influence that personal data exert on the use of personalized apps.

To construct the data double the following apps were used for the tracking of data:

Mappiness is an app that is developed by the London School of Economics and Political Science (LSE). The app asks you to share your mood and blends the results with GPS location, weather data, noise levels and more. Collected data: locations, activities and relations.

Moves is an app that automatically records any walking, cycling, and running activity. The app is always on, so there's no need to start and stop it. Collected data: date, location, longitude, latitude, duration of stay.

RescueTime is a personal analytics service that shows you how you spend your time and provides tools to help you be more productive. It shows the browsing history and use of applications. Collected data: date, duration, activity, document.

SleepCycle is an app that tracks your sleep patterns. Collected data: start, end, sleep quality, time in bed.

The site, **how-old.net**, takes data from an uploaded image to determine the subject's age and gender.

Personality Insights is a service developed by IBM Watson and uses linguistic analytics to infer the personality traits ("Big Five"), intrinsic needs, and values of individuals. The participants were asked to write a text about their daily life in at least 3500 words.

Social media like **Facebook** (not the inner circle) are used to find out about family and friends. **LinkedIn** is used to find out about education and jobs.

4.4 Data-Analysis

In this section the procedure of the analysis is described. The analysis should be done real-time by algorithms. In our case we imagine this process to be automatic. However, due to technical limitations, in this first prototype it was done in a 'Wizard-of-Oz' approach.

To create the facts about the data double the age had to be determined. A picture of every participant was taken and uploaded via *how-old.net* to determine the age. Based on the data of *Moves* the home-address could be found and other locations where the subject regularly stayed, like work or study. Activities were found by the data of *Moves* and *Mappiness.* Religious activities popped up by *SleepCycle* (by chance the collection of data took place in the month of Ramadan). *SleepCycle* in combination with *Moves* disclosed also nightlife activities. Relations and family were found by the data of *Mappiness*, *Moves* and *Facebook*. Ways of transport were found by *Moves*. Jobs were found by *LinkedIn* and *Moves*. The browser-history categorized by *RescueTime* showed interests and was used to make predictions.

To infer personality characteristics from textual information, the Personality Insights service tokenizes the input text and matches the tokens with the LIWC psycholinguistics dictionary to compute scores in each dictionary category. It builds inferences by matching words from the text with words from the dictionary. These words are often self-reflective, such as words about work, family, friends, health, money, feelings, achievement, and positive and negative emotions. Text that is ideal for personality inference contains such self-reflective words instead of merely factual statements. Nouns such as names of people and places do not contribute to personality inference.

The service uses a weighted combination approach to derive characteristic scores from LIWC category scores. The weights are the coefficients between category scores and characteristics.

4.5 Procedure

The study took place in the Usability-lab of the Hogeschool van Amsterdam. To measure the reaction of the user, eye-tracking software was used (Tobii) and FaceReader software (Noldus).

The participant was asked to read 2 texts: (1) a neutral text to calibrate the EyeTracking and FaceReader and (2) the customized story. The personal customized story is divided in two parts, an introduction and the actual part that represents the double.

Immediately after reading the story the participants were asked through a questionnaire to rate on a nine-point scale the resemblance of the data double in a scale between not resembling (1) to very resembling (9).

To measure the perceived eeriness of the data double, participants were asked to rate how strange (eerie) or familiar they perceived the data doppelgänger to be in a scale ranging from very strange (1) to very familiar (9).

The participants were asked to highlight words or sentences in the text on which they had noticed their reaction and express the intensity of that reaction in a scale from scarcely intense (1) to very intense (9).

In an open interview the participants were asked to elucidate their answers and highlights.

By combining the EyeTracking and FaceReading software specific words could be indicated in the text that evoked a certain response, see figure 3a-3d.

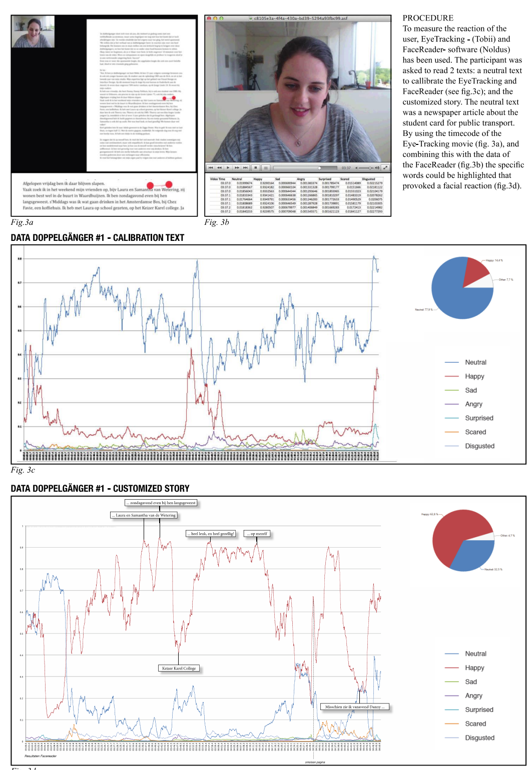

Fig. 3a-3d: EyeTracking & FaceReading combination. See appendix (page 16) for enlargement.

This combination of measuring is also used in the field of neuromarketing. The combination of EyeTracker and Face Reader enables to analyze various product packages, homepages and advertisements both on video and as photos. In this case it is used to measure specific emotional reactions of the subject on the reading of the text.

4.6 Eyetracking and FaceReading

Tobii T60 Eye Tracker

Tobii T60 eye tracker has been designed for analyzing human behavior in home and office environment. The hardware components of the Tobii T60 eye tracker include the Tobii T60 eye tracking device, which is connected to an external screen to see the users" interaction and cables and adapters to establish a connection. To configure and use the eye tracker, Tobii studios software is installed on the system.
Tobii studio (version 3.4.5) is a software tool that enables the researchers to calibrate eye tracker for participants, record screen activities, analyze and visualize recorded data.

Noldus Face Reader 6

Noldus FaceReader 6 is automatic facial expression analysis software [Noldus, 2015]. It supports the six essential facial expression classifications (happy, sad, angry, disgusted, scared and surprised) and also neutral. It also features head orientation, gaze direction and personal attributes like age and gender classification. FaceReader functions in the following three steps; First, finding a flawless face position. Second, face modelling by synchronizing the active face model over the built-in artificial face model, 500 key points used to define the face location. Third, face classification where the end result is displayed in the form of six basic facial expressions, and a neutral state.

5. Results and Discussion

In this section the results of the survey, the outcome of the FaceReader data and the output of the highlighted texts are presented.

5.1 Survey Results

The data likeness of actual facts scored an average of 7, characteristics 7.5 and behavioral aspects 7.6, see figure 4.

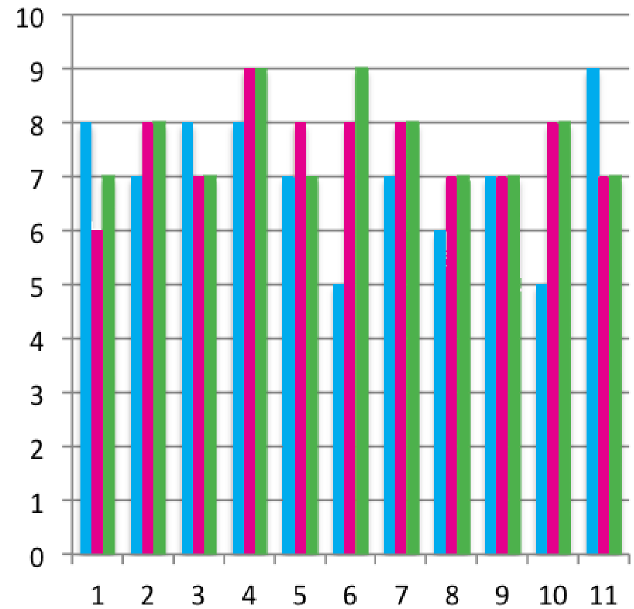

Fig. 4: To what extent does your double look like you in terms of actual facts, character and behavior?

The average level of eeriness based on the actual facts scored 6.2, characteristics 5.4 and behavior 5.5, see figure 5.

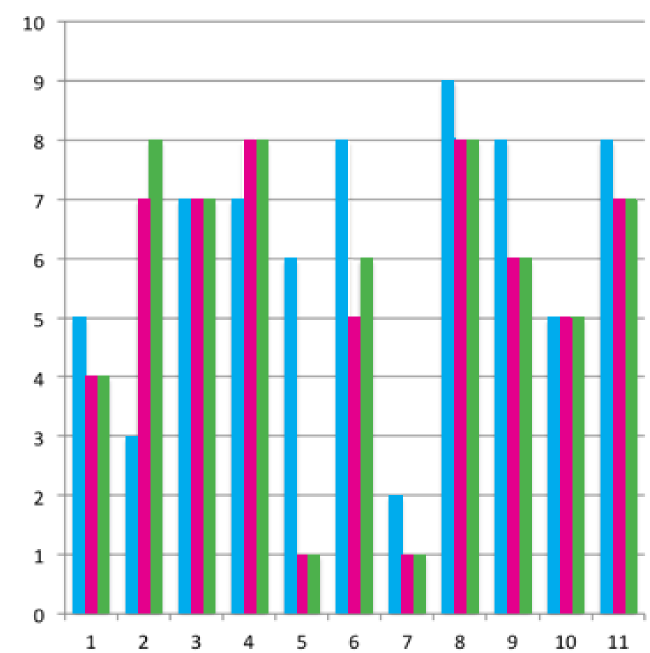

Fig. 5: To what extent does it scare you that your double resembles you, in facts, character and behavior?

More than the average 64% (7/11) were the most scared by the factual data-likeness. Only 18% (2/11) were the most frightened by the data-likeness on a behavioral level. 81% (9/11) judged the level of scare for data-likeness in character the same as data-likeness in behavior, see fig 6a-6c.

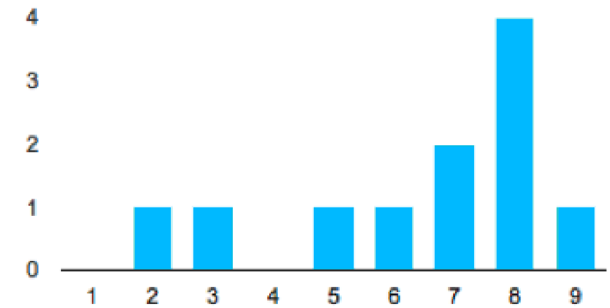

Fig 6a: Facts - 1=Not Scared at all, 9=Very Scared

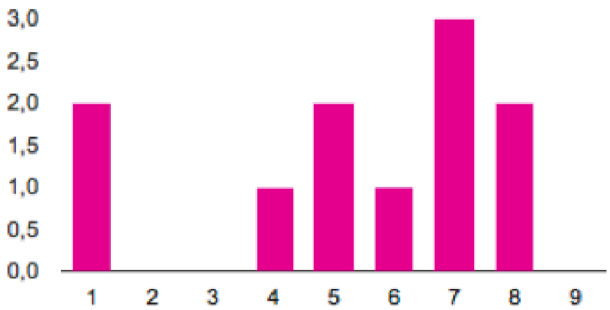

Fig 6b: Character - 1=Not Scared at all, 9=Very Scared

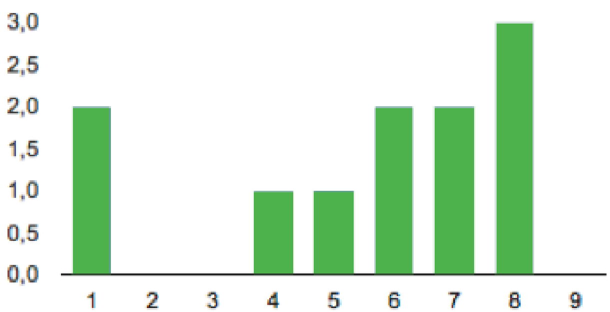

Fig 6c: Behavior - 1=Not Scared at all, 9=Very Scared

Fig. 6: Eeriness-Factor,

It must be acknowledged that a clear dichotomy can be seen in the reactions of the participants on the level of familiarity in facts, characteristics and behavioral patterns.
A small amount grades this experience as not scary at all (2/11). In the interview afterwards two subjects explained:

> "there are many people who are alike me in terms of behavior and character."

This could be explained by the fact that the algorithms of the service of Personality Insight produced quite general texts, and therefore could not be considered as a really personally targeted text. According to the service the majority of the subjects (10/11) would likely use coupons.

Another remarkable comment was made by one participant due to the reaction of 'not scary at all' (1):

> "I just watched a series on Netflix, named Orphan Black. The series is about human cloning, and issues of personal identity."

This outcome could be related to the theory of the Uncanny Wall, that the continually improving discernment of the reader to understand the technical trickery and technology used in the creation of the double prevents complete believability in the human (data)-likeness of that character.
Almost every participant tried to hunt down in what way the data double was constructed. More than 80% had a rough idea what kind of data was collected and 20% (2/11) exactly knew what kind of data had been used.
More than 60% (7/11) had seen the data before they had shared them and was aware of the fact that the mobile device could be used as tracking device, the other 30% (4/11) knew this only partially.
The way how the actual facts of the data double were constructed were pretty easy to explain. In contrast with the description on characteristics and behavior, these were quite difficult to explain, due to the algorithms used by IBM Watson.
Because of ethical deliberations the participants were made aware of the fact that their data were collected and analyzed. In case they were not aware of this fact, the majority (90%) labeled this as very scary.
In general all participants reacted positively on reading the story of their data double. Some of them were enthusiastic about participating in this experiment / study.

> "I found it more enjoyable than expected to participate. I really liked to read the story about my double! I 'm much more aware of the fact what data can do."
> "I found it quite funny to read the text, because I know it's for a study. But when looking at this in another way, I will be very scared of it because they are my personal data."
> "I thought it was a really fun experiment."
> "I was very surprised how much you can find out through data."

In fig. 7 the relation between the data-likeness and the perceived familiarity is shown. What stands out is that the majority of scores resides in the lower part of the graphic indicating that the data double is perceived primarily as eerie. In fig. 8 the average of the participants in the field of facts, characteristics and behavioral aspects are shown.

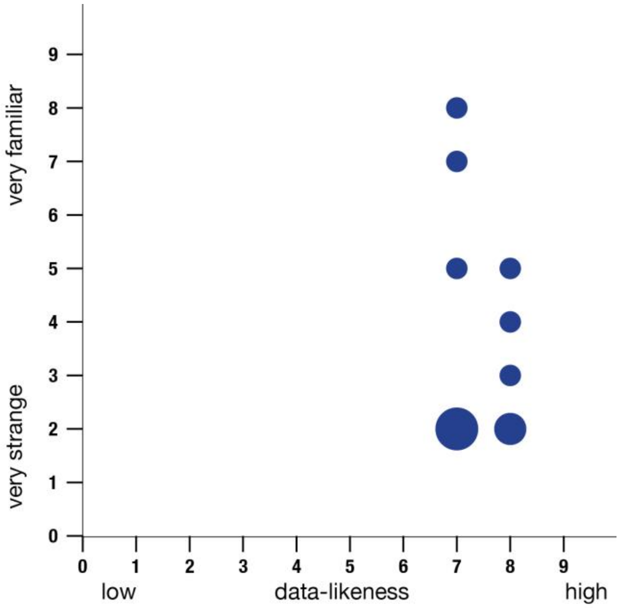

Fig. 7:
X axe: Do you recognize yourself in your Data Double?
Y axe: In what way did your Data Double strike you as weird?

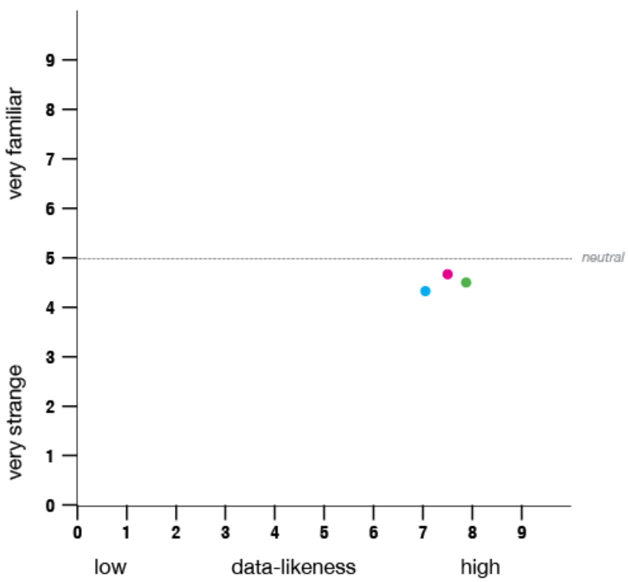

Fig. 8: The relation between the level of familiarity versus the level of data-likeness of the average of all participants.
X axe: To what extent does your double resembles you in terms of actual facts, character and behavioural aspects ?
Y axe: To what extent does it scare you that your double resembles you, in facts, character and behavior?

5.2 FaceReader Results

In general the remark can be made that each subject showed a strong emotional reaction during and after reading the customized story compared to reading the calibration text, see fig. 9-10.

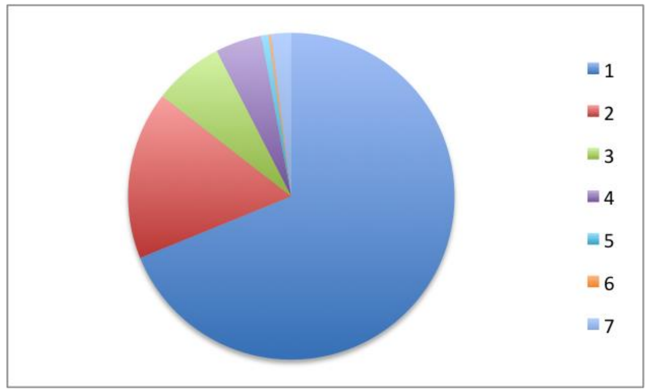

Fig. 9: FaceReader results - All Participants - Calibration Text 1. Neutral 2. Happy 3. Sad 4. Angry 5. Surprised, 6. Scared, 7. Disgusted

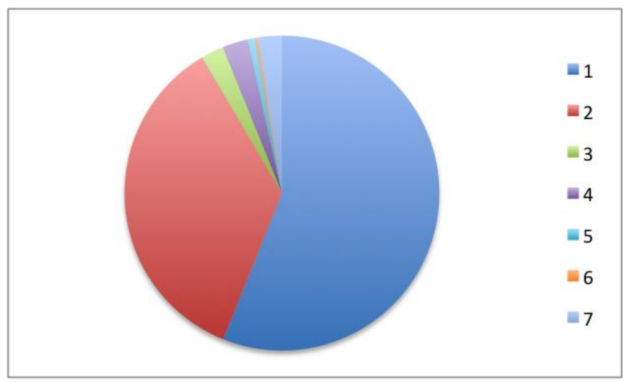

Fig. 10: FaceReader results - All Participants - Customized Story 1. Neutral 2. Happy 3. Sad 4. Angry 5. Surprised, 6. Scared, 7. Disgusted

There is a significant result (0.7%) of difference in reading the calibration text and the customized story resulting in the emotional reaction of 'happy'.
According to Den Uyl, CEO of Vicar Vision, developer of FaceReader and partner of Noldus:

> "It is certainly not uncommon that only 'happy' (one of the basic emotions) scores by performing a specific task. Eye-tracking is typically used to see how people process visual content, texts, images, and websites in user studies. In that situation there is little reason for real emotions, basic emotions are responses to events that affect essential interests, you're

scared when a big scary beast is coming your way, sad when a neighbor dies, etc. Moreover, people when they are behind a computer screen and perform tasks, are not set up to communicate emotions facially." (Email Interview Den Uyl)

Another remark has to be made that the different emotional responses categorized by the software of the FaceReader seemed not very appropriate. Especially the labels 'sad' and 'angry' were not in tune with the own impression of the participant's reaction.

"I looked at the results of FaceReader and it surprised me, that they rated me "sad" and "angry" on a quite high level. I didn't experience that in the same way, I thought it was just very funny to read about myself."

"I checked the chart and I must say, I really have no idea why across the board the line 'sad' is displayed. I totally didn't feel sad during the investigation."

5.3 Highlight Results

The participants were asked to highlight words and / or sentences in the text that caused a reaction, and add the value of intensity of that emotional response in a scale from scarcely intense (1) to very intense (9). Although the range ended at 9, certain participants graded some of the words with a score of 10.

The collected (highlighted) words and sentences were divided in 4 categories: actual facts, characteristics, behavioral aspects and other. This last category included e.g. emotional reactions to the state of technology, like their sophistication in their analysis. The results can be seen in figure 11.

Intensity-level	Facts	Character	Behavior	Other
1				
2		1	3	
3	1			
4	3	1		1
5	2	1	1	
6	15	7	4	1
7	12	7	5	5
8	14	5	3	4
9	12	2	3	3
10!	4	2		

Fig. 11: The amount of highlighted results - graded from scarcely intense (1) to very intense (9).

Striking in the results is that in the field of facts the intensity level scores highest, not only in quality but also in quantity. Although the range of possible grades was set between 1 and 9, two participants graded their emotional reaction as a 10!

Based on the grades caused by the specific texts the participants were asked to elucidate their reactions in an interview.

5.4 Discussion

In view of the initial question: does the ‘uncanny’ emerge when our data doppelgänger does not resemble our understanding of ourselves, two prominent issues can be raised.

A first remark has to be made to the group size of participants. It merely consisted of 11 subjects. This amount proved to be too few to derive unequivocal conclusions.

What stands out is that the majority of scores reside in the lower part of the graphic indicating that the data double is perceived primarily as eerie (see figures 7 & 8), as is asserted by the different fields of data-likeness in terms of facts, characteristics and behavioral aspects. But because in the final results a small group graded the data double as quite familiar no conclusion can be made.

Secondarily the discussion concerning the adequacy of adopting the theory of the uncanny valley to this research has to be issued. Especially, because no unequivocal results have been found, so no glimpse of a clear deep valley is revealed. To seek for answers for this, new questions and considerations have come up. One important concern could be singled out based on the comparison between the Uncanny Wall study and this study, as the Uncanny Wall showed that given that increasing technological sophistication in the creation human-like virtual characters is matched by an increasing technological discernment on the part of the viewer. That study showed that in view of the complexities at hand, no graph of a simple valley could be graphed. Like in comparison to the theory of the Uncanny Wall the perceived familiarity or eeriness is dependent upon a wider range of variables other than only the data double likeness. The types of data that amount to striking outcomes are too much dependent on personal differences, like one participant graded the data-likeness of the actual facts as substantially eerie whereas another graded the likeness in character as extremely uncanny.

Similarly the level of intimacy is equally personally biased. For some participants family members names were considered eerie when mentioned, whereas others did not seem to care. So in summa: the data

doppelgänger cannot reside in the graph of the Uncanny Valley, as that representation, and thus its underlying theory is way too much of a simplification of his possible affective responses.
In addition another point of concern can be mentioned, related to a comparison with the Uncanny Wall. In all likelihood it should be considered that in this study the 'first-time' experience contributes to a higher score of the eeriness factor. This can also be related to the fact that when the participants didn't know that their data were tracked and interpreted, the eeriness factor was quite high.
The moment when it has become clear to the participant how the data double is constructed the eeriness factor decreases or to put it differently the level of familiarity increases. This is in accord with the theory of the Uncanny Wall.
Based on these results the conclusion can be drawn that the Uncanny Wall might come closer to our findings, however their stress on the progressive increase of familiarity due to a continually improving discernment of technical trickery used in the character's creation does not match to the findings of this study. The outcomes stressed the prominence of personal reactions that does not seem to originate exclusively from the level of technological sophistication.

6. Design principles

Based on the results of the FaceReader, the questionnaire and interviews three design principles are formulated. These design principles can be used to determine what kind of conditions are required in order to let the uncanny (valley) emerge in real-time data-driven storytelling for mobile devices.

6.1 Design principle 1: The correctness of the data

The data double does not have to be a clean one to one fit. Factual fallacies do not produce a sense of eeriness, moreover they can sometime provide a sense of comfort by the manifest failing of the system, as it forges a divide between participant and its double.
A sense of relief can be the result: "that was not entirely correct"(Nikki). "Ha, ha, that was wrong!"
Jordy: "I prefer that the data is not entirely correct."
Louisa: "Address was not correct, (in her case, not only the number, but also the name of the street was incorrect, therefor not so scary.

6.1.1 Margin of Error

However a mistake of the system unveils another reality, this is not perceived as scary. On the contrary as it seemed in the case of Hizir: he has two brothers, whereas the text made notice of the fact he had two sisters. His reaction: "Yes, it did make me startle, and made me wonder: do I have two sisters that I do not know the existence of? Or are my brothers in fact sisters?"

6.2 Design Principle 2: Intimate data

The more intimate or personal the data is considered, the higher the level of scariness.
Intimate data are data that personally matter to us. But what kind of data did the participants consider as intimate? According to the results of the research, it proved to show a diverse field of subjective grades in the participants reactions. Facts like house numbers, names of close friends, and family matters were considered as high on the level of intimacy for most of the subjects. But in some cases not the actual facts were considered as intimate data, but especially the outcome on characteristics and behavioral aspects were experienced as very personal data that came really close.
So not only the amount of correct data but also the level of intimacy (from general data to small intimate data) could be considered on the x-axis as an important aspect of data-likeness.
Maarten: "Where family is involved, it is scary. because family belongs to you, family is more a private matter. When the data comes too close, it becomes scary."
Nikki: " I took a nap, that's intimate..."

6.3 Design Principle 3: Patterns and Predictions

Predictions based on weekly patterns are perceived to be scary, because they enable a projection into the future, and are not only an entirely correct account of what happened.
Maarten: "Now they know what I do every Friday!"
Nikki: "Because it does a sort of future-prediction, and in this case it is true, because it is an assumption based on your previous data and turning out to be right; that’s kind of scary, as if someone knows what I'm going to do... before it really happens, ..."

7. Conclusion

On the one hand this investigation is about the state of technology, how precise are we able to create a double of a person based on specific collected and analyzed data, on the other hand it raises the question how well are we capable of understanding ourselves through data and in what way can technology accommodate a more precise understanding of one self, who we are, who we think we are, who we might become, and who we think we might become. This novel use of data may help people to reflect more critically on how big and small data shape (and reveal) our understanding of the world and our relation to them.

The fear of technology is a familiar feature of our culture.

To define data-likeness in this alternative model of the uncanny valley not only the amount of data is important, but also the type of data, in this case the level of intimacy, in other words if the quality of the data reaches a high level of intimacy, the level of familiarity changes from familiar to unfamiliar.

Understanding trust relationships between data-systems and our comprehension of data are quite complex and can not be determined in a to-do or not-to-do list of design choices. This delicate relation between tracker, writer and reader therefore needs more research on the topics of agency and the design of trust in the changing landscape of big, small and personal data.

There's clearly much more research work to be carried out in this direction, yet the results so far seem promising. In conclusion, the contribution offered to the community of researchers, designers and critics is twofold. On one hand, the design principles derived from this study may help reduce the sense of uncanny in personalized apps. On the other one, and maybe most importantly, this study underlines the importance of a critical and design-based reflection on data, self-tracking, narratives, and our sense of self.

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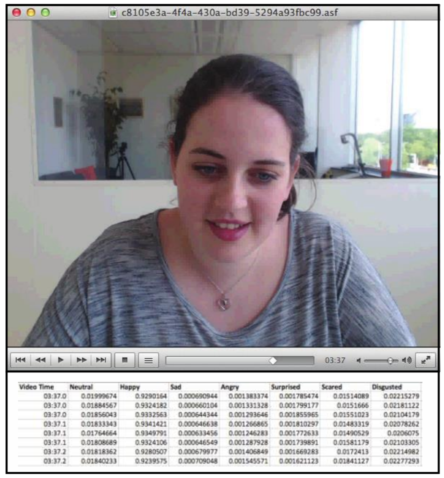
Fig.3a



Video Time	Neutral	Happy	Sad	Angry	Surprised	Scared	Disgusted
03:37.0	0.01999674	0.9290164	0.000690944	0.001383374	0.001785474	0.01514089	0.02215279
03:37.0	0.01884567	0.9324182	0.000660104	0.001331328	0.001799177	0.0151666	0.02181122
03:37.0	0.01856043	0.9332563	0.000644344	0.001293646	0.001855965	0.01551023	0.02104179
03:37.1	0.01833343	0.9341421	0.000646638	0.001266865	0.001810297	0.01483319	0.02078262
03:37.1	0.01764664	0.9349791	0.000633456	0.001246283	0.001772633	0.01490529	0.0206075
03:37.1	0.01808689	0.9324106	0.000646549	0.001287928	0.001739891	0.01581179	0.02103305
03:37.2	0.01818362	0.9280507	0.000679977	0.001406849	0.001669283	0.0172413	0.02214982
03:37.2	0.01840233	0.9239575	0.000709048	0.001545571	0.001621123	0.01841127	0.02277293

Fig. 3b

PROCEDURE
To measure the reaction of the user, EyeTracking - (Tobii) and FaceReader- software (Noldus) has been used. The participant was asked to read 2 texts: a neutral text to callibrate the EyeTracking and FaceReader (see fig.3c); and the customized story. The neutral text was a newspaper article about the student card for public transport. By using the timecode of the Eye-Tracking movie (fig. 3a), and combining this with the data of the FaceReader (fig.3b) the specific words could be highlighted that provoked a facial reaction (fig.3d).

DATA DOPPELGÄNGER #1 - CALIBRATION TEXT

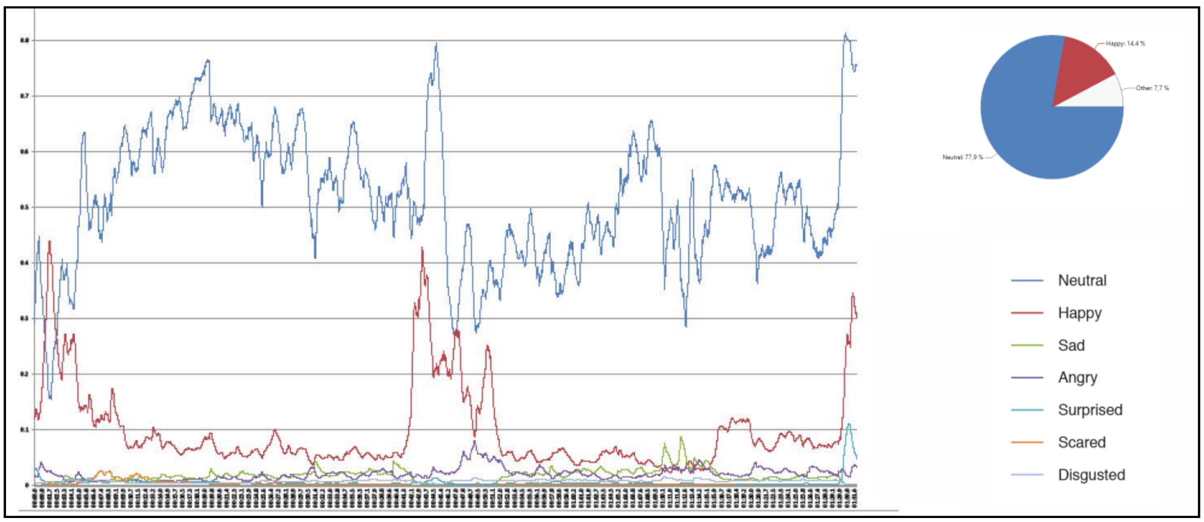


Fig. 3c

DATA DOPPELGÄNGER #1 - CUSTOMIZED STORY

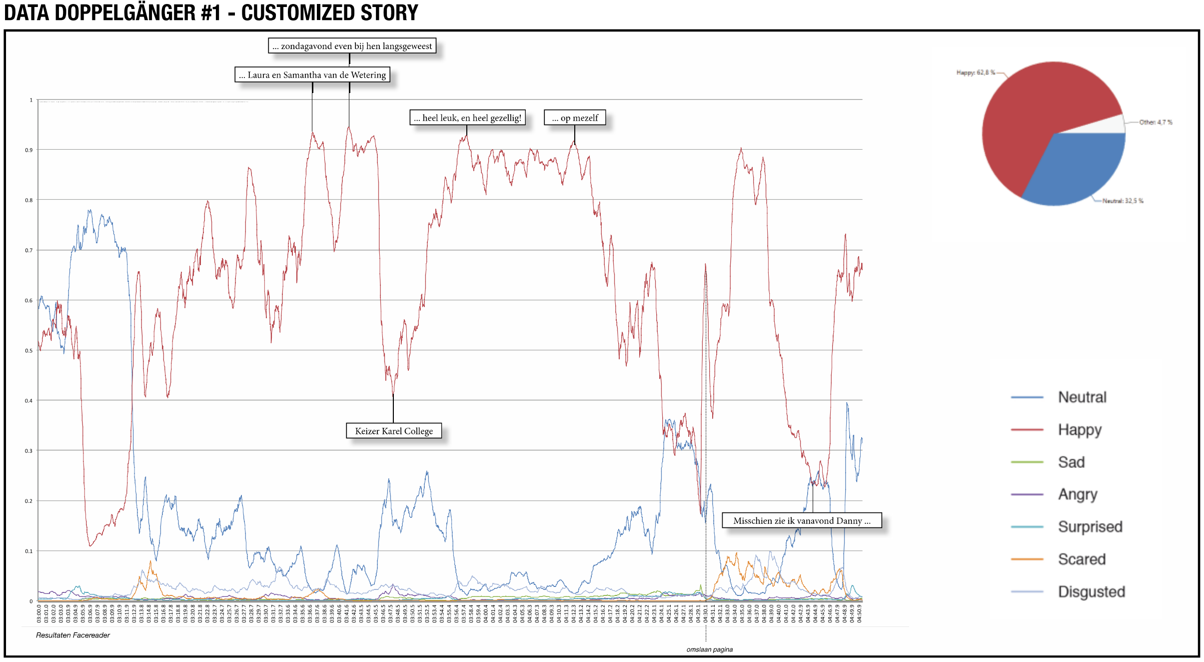


Fig. 3d