Handling digital reproductions of artworks

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Abstract: *The senses are finding their way back into the art museum, but the way paintings are displayed is still constrained by their fragility. We explore whether it would be helpful to use the capabilities of digital technologies to create meaningful somaesthetic experiences with digital reproductions. We conducted an experiment with 19 participants, letting them handle physical paintings and 2D and 3D digital reproductions, while ranking them according to their personal preference. To discover which cultural qualities participants ascribe to artworks in light of their somaesthetic experience, we interviewed participants regarding their experience of ranking three setups. We found that participants regarded the 3D reproductions as having certain material qualities. We argue that by designing the somaesthetic experience of digital reproductions, it might be possible to bring back dimensions of the art experience that were lost with the development of the modern museum.*

Keywords: *somaesthetics, art experience, digital reproductions, post-phenomenology.*

1. Introduction

In the 17th and 18th centuries, museum visitors were typically allowed to handle the objects exhibited in museums. Indeed, handling and touching were seen as an important part of the museum experience that could enhance learning and enjoyment and create a more intimate connection to the artists (Howes, 2014). However, this practice was later replaced by a focus on *contemplation* and rigid bodily constraints in the museum space (Leahy, 2012). For many years, the white cube paradigm has dominated the way we look at art in museums. The script of the museum mediates our engagement with the art and puts the museum in the role of an authority, defining the right way to appreciate it (Duncan, 2005).

More recently, museum research has been shifting toward a more interpretative or constructivist paradigm, where the museum design is recognized as part of shaping the visitor experience and the visitor as an active part in the learning process (Macdonald, 2007). Nevertheless, the physical configuration of art museums remains largely the same, and the shift seems to be more evident in the way museum experiences are discussed and analyzed than in the way art is displayed. This is especially true of exhibitions of classical paintings. This is not only a question of culture but also of practicalities. The originals on display are fragile, unique, and

expensive, and only specially trained personnel can handle them (Howes, 2014; Leahy, 2012). This severely limits the way painting exhibitions can be shaped. However, technology allows us to break free of these limitations. With digital technologies, we can enable new bodily relations with the paintings that are not constrained by the risk of damaging the originals.

In a merge between the classical artworld and the technologically immersive, some venues such as the Lumières venues by Culturespaces[1] and "Van Gogh Alive" by Grande Experiences[2] are exhibiting classical paintings through room-sized digital projections. Through technology, they are pushing the spatial relationship between visitor and painting. The paintings are bigger, cropped in new ways, and wrapped around walls and on the floor, and sometimes details or whole paintings are animated and moving around. However, they reproduce the role of paintings as something hanging on a wall that we view from a couple of meters distance—as an image, not an object.

Is it possible to use the capabilities of digital technologies to create meaningful somaesthetic experiences with paintings? Our bodily actions and relations to paintings and the context in which paintings are met are shaping our experience of them (Dewey, 1934/2005). To explore the design potential of using digitized reproductions to create somaesthetic experiences with paintings, we created an experiment that compares the act of handling paintings in three different setups. We asked 19 participants to look at and consider paintings in the following three formats: physical paintings, paintings represented digitally in 2D, and paintings represented digitally in a virtual 3D environment. The participants were asked to rank them according to what they would like to have in their own home in order to make them focus on their own aesthetic experience. This was followed by a phenomenological interview, where participants were asked to elaborate on their experience and to compare their experience of the three setups. We discuss how the technological mediation and the somaesthetic qualities of each setup are described by the participants and what this can tell us about the design space for technological experiences containing digital reproductions of artworks.

2. Art experience and technology

John Dewey argues in his 1934 book "Art as Experience" that philosophical aesthetics has wrongly removed art from its situatedness in the everyday experience. According to Dewey, art needs to be considered through its relation to the body and the context in which it appears. In our time, art is increasingly being seen on screens, in part because digital media makes it possible for audiences who cannot travel to the museum to view artworks (a very urgent consideration at the time of writing, in 2021, due to restrictions during the ongoing COVID-19 pandemic).

The literature on technology-mediated experiences in museums often reveals a concern among museum scholars and professionals (as well as the wider public) that technology may come to stand in the way of visitors' direct encounters with physical artifacts. Sometimes this concern is referred to as the "heads-down phenomenon"—evoking the image of (young) visitors walking around the museum with their heads pointed down toward their smartphone screens, oblivious to the treasured artifacts on exhibit around them (Hsi, 2003; Lyons, 2009; Petrelli et al., 2013; Walter, 1996; Wessel & Mayr, 2007; Woodruff et al., 2001).

1 https://www.culturespaces.com/

2 https://grande-experiences.com/van-gogh-alive/

Alternatively, research on human computer interaction (HCI) and interaction design has long explored how interaction with technological systems may form part of the aesthetic experience. Both Dewey (1934/2005) and the ecological psychology of Gibson (1979) have been significant influences in this line of research and in the broader humanistic turn in HCI (Bardzell & Bardzell, 2015). The implications of Dewey's view on the art experience extends beyond the domain of art and has formed part of the theoretical foundations for HCI's focus on experiences with technology (McCarthy & Wright, 2004).

Somaesthetics has received much attention in HCI (Höök et al., 2016; Höök et al., 2015; Lee et al., 2014; Shusterman, 2014). However, there is little work connecting somaestethics to the art experience—although occasionally the results of design projects are themselves exhibited as artworks (e.g., Schiphorst, 2009). More broadly, experiences with technology in museums is a large topic in HCI research (Hornecker & Ciolfi, 2019; Vermeeren et al., 2018), and research has explored how to use embodied interactions to enhance art experiences (Alexander et al., 2017; Steier, 2014). For example, Ryding and Fritsch (2020) present a game for visitors to art museums in which one player controls the movements of another player as a way to challenge the ritualized nature of the museum visit and intensify the visitors' affective encounters with the art.

The interactive art installation "Thresholds" (Tennent et al., 2020) sets up an experience with some similarity to the experiment presented here. Aiming to explore the role of technology in our perception of the world, the installation recreates a 170-year-old photography exhibition inside a virtual space, which is mapped onto a physical space in such a way that visitors donning customized VR equipment have the experience of walking around inside a virtual exhibition gallery that can be explored through touch and other senses. The system allows visitors to virtually select photographs out of the exhibition vitrines using hand gestures to lift the images up for closer inspection. The fact that this feature created significant difficulty for both the creators of the installation and the users—in an otherwise ambitious and highly successful installation—speaks much about the difficulty involved when attempting to facilitate experiences of handling digital artwork.

3. Handling in the museum

According to Howes (2014), museums in the 17th and 18th centuries were hands-on sites, where visitors were expected to touch and handle artifacts. Touching was seen as important for four reasons, as follows: Visitors would be able to learn more through touching, touch was seen as enhancing the enjoyment of art objects, touch allowed for a sense of intimacy with the original creators of the artifacts, and, finally, some rare and exotic objects were believed to have special healing powers. By the middle of the 19th century, the practice of touching in museums had ceased as the reasons mentioned above were no longer considered valid (Howes, 2014). Instead, as described by Leahy (2012), correct aesthetic appreciation became part of a codified bodily practice of walking, sitting, standing, looking, and speaking. Guides were even created that described how to maintain the correct distance from the object that was to be contemplated.

Since the late 20th century, touching and handling have been returning to the museum, first in children's and science museums but later also in art museums. As Howes sums it up:

> *In the museum of the twenty-first century, the senses are making a comeback. Didactic instruction has increasingly come to be supplemented by multimodal*

> *approaches to learning, disinterested contemplation has been offset by affective participation, and the authority to interpret objects has been redistributed.* (Howes, 2014, pp. 264–265)

In a case study exploring the role of touch in relation to sculptures, the authors note that "When allowed to touch, we observed that groups moved, viewed, described, and discussed the works in more diverse ways than when viewing only, and that touch fostered longer and deeper object-related inquiries" (Christidou & Pierroux, 2019, p. 111). Physical sculptures carry their meaning in their shape and form and are often robust. Paintings, however, are primarily visual artworks and are vulnerable to touch. Thus, inviting visitors to touch or handle valuable paintings is obviously not possible. However, the development of new immersive technologies and interaction formats offer interesting opportunities to consider bodily experiences with digital reproductions of artworks. This in turn raises questions about the role of reproductions in art experiences.

4. Reproductions and genuineness in psychological aesthetics

One of the factors that makes it difficult for museums to allow visitors to handle artworks is also arguably one of the main reasons visitors are attracted to museums—the ability to view invaluable (but fragile) artworks in their authentic, original form. For example, Walter Benjamin famously argued that the *aura* of classical artworks such as paintings and sculptures is bound to their cultural and physical properties, which are lacking in reproducible media such as photography. How important is it for the art experience that one is in fact viewing an original and not just a reproduction? Several empirical studies have tried to understand the influence of the genuineness of a piece of artwork on the art experience (Locher et al., 1999, 2001; Locher & Dolese, 2004; Brieber et al., 2014; Brieber et al., 2015). These studies find that viewing original artworks in a museum is rated higher than viewing reproductions in a laboratory in terms of parameters such as being immediate, pleasant, interesting, surprising, liked, and understood (see Pelowski et al., 2017 for a full overview). Considering the medium of reproduction, three of the studies hypothesize that if art viewers can look past the medium, they will evaluate the same image similarly when seen in various media, measured through quantitative and qualitative components of the information content of the images—a phenomenon they call *facsimile accommodation* (Locher et al., 1999, 2001; Locher & Dolese, 2004).

However, in these studies, the role of the context is not clear as the originals are viewed in the setting of a museum or art gallery, and the reproductions are viewed in a lab setting. Brieber, Leder et al. (2015) try to detangle this effect in a study that compares both context and genuineness; however, in the study, neither the context nor the genuineness was found to enhance the participants' evaluation of the artworks. This was attempted again by Grüner et al. (2019), who did find that artworks viewed in a museum are liked more and rated as more interesting when presented in a museum rather than in a laboratory. Genuineness is not found to have this effect.

Pelowski et al. (2017) expand on the comparison of laboratory vs. museum as a factor in art appreciation by presenting a large range of factors that influence the art experience. These factors pertain to the artworks, the museum space, and the visitor. Among the factors related to the artwork itself are texture, immediacy, physical presence, and size (Pelowski et al., 2017). The authors also mention the hanging style as having an influence on the art experience.

Across the studies described above, reproductions take the form of images on computer screens, slide-projections, or even postcard-sized printed images. Bertamini and Blakemore (2019) present two studies in which they asked participants to evaluate hypothetical scenarios of viewing three types of artwork reproductions. The hypothetical reproductions were a painting viewed through a closed-circuit video camera monitor, a painting viewed through a mirror, and a physical reproduction of the painting. They found a large variation in the participants' opinions on the three types of reproduction. In general, the physical copy was preferred over viewing the original indirectly, and a mirror reflection was found to be better than a video image.

These empirical studies seem to indicate that the museum context is important for the aesthetic experience, whereas the importance of viewing an original vs. a reproduction is less clear. Some of the studies indicate that the specific format of the reproduction seems to matter. However, all of these studies were limited to the experience of passively viewing artworks on a wall or in a display. In this article we continue to explore this question from a design perspective, offering an exploration of the design space for digital reproductions that can be virtually handled by the viewer.

5. Handling reproductions: A somaesthetic perspective

Dewey argues that substance and form are central to the art experience: "*what* is said and *how* it is said" (Dewey, 1934/2005, p. 106, emphasis in original). Replicating a piece of artwork in digital media changes its form and subsequently its substance. To understand form with regard to digital media, the literature from the field of interaction design provides a compelling model.

Vallgårda (2014) argues that in interaction design practice, three form elements are closely interconnected: the physical form, the temporal form, and the interaction gestalt. The physical form is the shape and appearance of the system as perceived through our sensory apparatus. The temporal form is the change of states in the system over time. The interaction gestalt is the movement the user performs in relation to the system. These movements have qualities, such as being fast, smooth, or abrupt, and take place in a doing and undergoing relationship with the system. The user acts on the system, and the system shapes the acting.

To better understand how form shapes experience, we turn to post-phenomenology. A post-phenomenological approach implies a particular interest in the relation between participants and paintings and how this relation is being mediated by the technologies used in each setup (Rosenberger & Verbeek, 2015). In this study, we are investigating how the technologies employed reshape the experience of the paintings. Human-technology relations are in the post-phenomenological view characterized by a magnification/reduction structure (Rosenberger & Verbeek, 2015). According to Kiran (2015), this structure is divided into four dimensions of technological mediation: ontological, epistemological, practical, and ethical. These dimensions serve as a helpful framework for analyzing the mediation aspects in the experiment. The assumption behind this experiment is that the technological representation chosen will shape the experience of the artworks in how it *reveals* and *conceals* aspects of the artworks, how it *magnifies* or *reduces* the knowledge available about the artwork, how it *enables* or *constrains* certain practical actions, and in turn how that *involves* or *alienates* the participants from what is considered ethical practice around artworks.

Within this perspective, we find it relevant to pay specific attention to the *aesthetics of interaction*, including the perception of performance. Lim et al. (2007) present the concept of *interaction gestalt* as the shape of interaction: the movements the user makes while engaging with

an interactive system. Lenz et al. (2017) describe the qualities of these movements as *interaction attributes* and find that they are related to experiential qualities. Dalsgaard and Hansen emphasize the social aspect of performance, suggesting that the user of a system continuously acts out the three roles of *operator*, *performer*, and *spectator* (2008). Applied to our experiment, this means that our participants will simultaneously be operating the systems we have put in place while also perceiving the relation between themselves and the paintings and being aware that these actions are a performance for the experiment facilitator and the recording equipment. As Dalsgaard and Hansen (2008) argue, this performance of perception is an integral part of the aesthetics of interaction.

6. Method

The experiment presented in this article bears similarities to the approach of *concept-driven interaction design research* (Stolterman & Wiberg, 2010) in the sense that we are conducting practice-based design research with the aim of exploring a theoretical issue rather than designing new products. Furthermore, our approach is inspired by a *constructive design research* approach (Koskinen et al., 2011), which means that the construction of design artifacts is central to knowledge creation.

In our way of setting up this experiment, we lean on the tradition of performing design experiments in the lab (Koskinen et al., 2011). Contrary to the more common use of experiments as vehicles for deductive reasoning, this experiment is inductive in nature. We are looking for patterns in a design space, not trying to prove them. An important difference between our experiment and those presented by Koskinen et al. (2011) is that the three designs used in our experiment are not made as proposals for future designs. Instead, they are created in order to explore the impact of these different formats on aesthetic experience. We are not primarily interested in the particular designs but rather in the comparison of participants' interactions. In this way, the designs used here are more research instruments than design proposals.

Experiment procedure

The experiment was conducted with 19 participants recruited at our university from the 30th of November to the 4th of December 2020. Fourteen of the participants were master's students or recent graduates in the field of digital design or games, four were faculty within digital design, and one was enrolled in vocational education in the health sector. Ten identified as female and nine as male. The age of the participants ranged between 22 and 36. Sixteen participants said "yes" to being interested or somewhat interested in art, while three did not see themselves as interested in art. All but one had visited an art museum or gallery within the last year, with an average of three visits in the last year. This number should be viewed in light of the COVID-19 situation, where many such places were closed for long periods during the previous year.

The experiment was divided into three different setups. In each setup, the test participants were invited to experience artworks in one of three different formats: framed physical paintings, digital reproductions of paintings displayed as 2D images, and digital reproductions of paintings presented as 3D objects. For each of these setups, the users were invited to pick up the paintings—physically or virtually—in order to get a closer look.

The participants were told that they would be entering a room with three pieces of artwork. They were asked to look at the artworks and rank them according to which they would most like to have in their own home. The rationale for giving the participants this task was to prevent

participants from judging the artworks according to some external ideal and to rather focus on their own aesthetic experience of the artworks. After making their decision, participants exited the experiment room and were interviewed about their experience. This was repeated for each of the three setups. The sequence of the three setups was changed so that participants went through them in a different order each time.

The experiment used nine different artworks, presented below. The artworks were deliberately chosen for being ordinary, non-famous artworks of the type that one might buy in a secondhand store (and indeed, the three physical paintings are "thrift store" paintings). The images represented various visual styles to accommodate a variety of aesthetic preferences. The participants were given no information about the artworks other than what they could see for themselves. Note that it was necessary to use different artworks for the three different setups (rather than repeating the same three images) in order to make the task of choosing an artwork meaningful for the participants for each of the three iterations.

In all three setups, the paintings were partially hidden from sight as the participant entered the room, either due to their placement or the image size. This was done to prompt participants to handle the paintings in order to get a closer look at them.

After each setup, the participants were interviewed about their experience and asked to compare their experience with the other setups. The interview was conducted as a phenomenological interview (Thompson et al., 1989). The 19 interviews were transcribed verbatim. Statements describing the qualities of each of the three setups were separated and then organized thematically using affinity clustering.

Physical setup

In the physical setup, the participants were presented with three physical artworks bought in secondhand stores around Copenhagen (see Figure 1). The paintings were chosen to represent a variation of styles. The three paintings were placed in a rack where the paintings were easily accessible, but each partly obscured by the other. The rack was placed on a tall table (see Figure 2).

Figure 1 *The physical artworks bought from different secondhand stores. The print on the left is signed Line Thimm. The painting in the middle is unsigned. The painting on the right is signed S. Engelbrecht.*

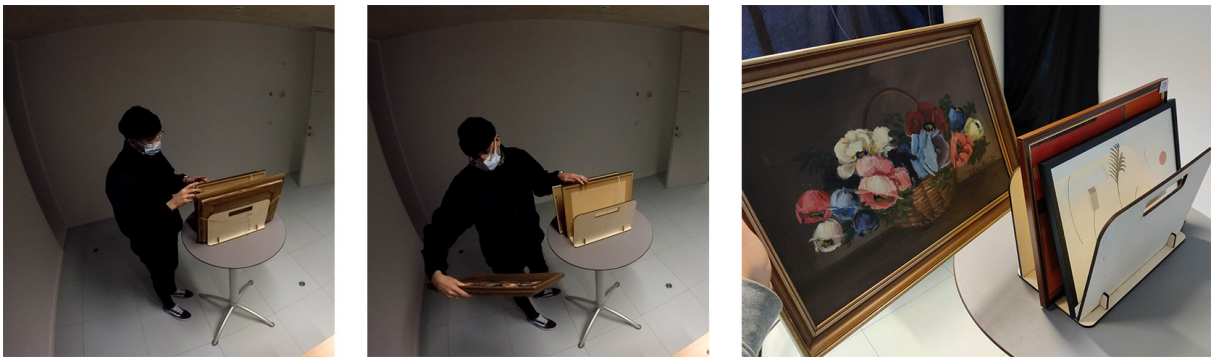

Figure 2 *In the physical setup, the paintings are placed in a rack on a tall table. The first and second image are video stills from the experiment. The third image is a staged closeup.*

Digital 2D setup

In the digital 2D setup, participants were presented with three paintings projected next to each other on the wall of the experiment room (see Figures 3 and 4). The paintings by Bea Mahan and Manjiri were found on their Flickr accounts where they promote their art. The third one is a study by the Danish artist Niels Bjerre. It was found in the database of the Danish National Gallery. The paintings were chosen to represent a variation of styles.

The interface for this setup was created in TouchDesigner in a simple 2D environment (see Figure 4). Frames were added digitally to the paintings. In the middle of the room was a table with a wireless mouse. The paintings were projected in a size that made them too small to view comfortably from the table with the mouse both due to the distance and the resolution of the projector. The participants were made aware that they should use the mouse. When hovering the cursor over the image, it would grow slightly in size, and upon clicking, it would grow to a large size. If the participants clicked outside the scaled-up image, it would shrink to its initial size, and if the click was placed on another image, that one would scale up instead.

Figure 3 *The 2D images with added frames (from left to right: Mahan, n.d.; Manjiri, n.d.; Bjerre, 1934).*

Figure 4 *In the 2D setup, a wireless mouse is placed on a tall table. The participants use the mouse to increase the size of the painting they want to look at. The first two images are video stills from the experiment. The third image is a staged closeup.*

Digital 3D setup

In this setup, the participants were presented with three paintings in a virtual 3D environment (see Figure 6). The painting by Layers was found on Pixabay.com, a stock image site where the artist offers their art for free use. The painting by Miguel Àngel Pintanel was found on his Flickr account where he promotes his art. The painting by Mogens Ballin was found in the database of the Danish National Gallery. Again, the paintings were chosen to represent a variation of styles (see Figure 5).

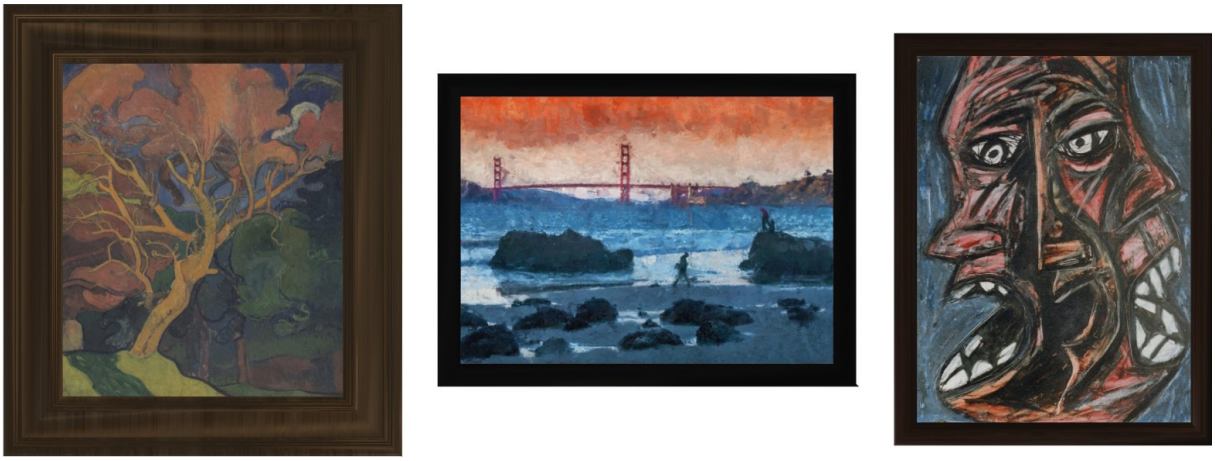

Figure 5 *The 3D images with added frames (from left to right: Ballin, 1890; Layers, n.d.; Pintanel, n.d.).*

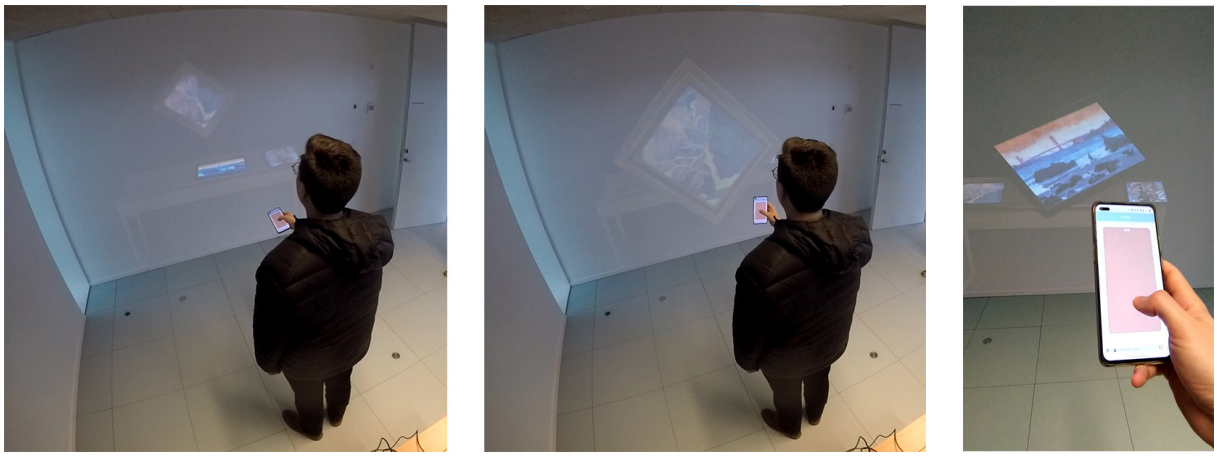

Figure 6 *In the 3D setup, the participant uses a smartphone to control a cursor on the screen. It can be used to pick up, move, and tilt the virtual paintings. The first two images are video stills from the experiment. The third is a staged closeup.*

The 3D environment was projected in 2D on the wall of the experiment room in a forced perspective that corresponded with the position where the interviewer would tell the participant to stand when entering the room. The paintings were shown lying on a (virtual) wooden table. On the projection was a white cube acting as a cursor hovering over the paintings.

The participants were given a smartphone and instructions on how to use the smartphone to interact with the paintings. The smartphone could be used in a manner similar to a laser pointer: When pointing the top of the smartphone toward the projection, the white cube would follow the movements of the phone. By pressing with their thumb on the screen, participants could "pick up" a nearby painting, which would attach itself to the white cube. Pointing the phone upward would move both the white cube and the painting closer to the virtual camera so that the painting could be inspected more closely. The orientation of the painting would map to the orientation of the phone, allowing the participant to tilt and rotate the painting to allow for examination from various angles. If the participant removed their thumb from the screen, the painting would fall down. If the image fell toward the ground, it would disappear outside of the projection and reappear on the table. In this setup, the frames and canvases were 3D-modeled, and the paintings were added as textures to the 3D models.

This interface was also created in TouchDesigner as a 3D environment with a bullet-solver engine to simulate gravity and other forces. The smartphone interface was based on the Google XY-Fi project (Uglow et al., 2017). The smartphone ran a website that records device orientation and touch events and passed it via socket.io to the webserver that forwarded it to the TouchDesigner instance running the simulation. The "pick up" mode is not a part of the original XY-Fi project but was programmed by the first author, extending the original JavaScript program.

7. Results

We now present our observations and insights from presenting the study participants with each of the three setups.

Physical setup

As the participants entered the room for the physical setup the experimenter would give the following instruction: "Please have a look at the artworks and rank them according to what you would like to have in your own home. Let me know when you have made your choice." The participants moved to the rack, many hesitating a bit before picking up the artworks. Almost all participants asked the experimenter whether it was okay for them to touch the artworks, either right before or right after taking one from the rack.

Most participants then proceeded to pick up the artworks one by one, studying each one for five to 15 seconds before putting it back in the rack. Others held a painting in each hand next to the one left in the rack, comparing all three at once. A few participants picked up some of the artworks a second time. One participant held the artworks against the wall of the experiment room. From the video recordings, it can be seen that the participants spent between 25 to 90 seconds (median: 54) before indicating that they had made their choice.

In the interviews, most of the participants brought up the physical qualities of the artworks. They mentioned weight, texture, tactility or tangibility, materiality, and the ability to feel the paintings as qualities that were significant. One participant expressed it like this:

> *I like that I was able to pick up the paintings and feel it, and look at it in the light, and look at it pretty close and study some of the details, and then be like: "That was nice to see." It gives you something, when you are far away and close to paintings, I think.* (Participant 11)

In addition to holding the artworks up close, participants mentioned the options of turning them around and moving them back and forth, and one highlighted the feeling of having control of the handling of the paintings. A few participants mentioned that it was difficult to handle the paintings in this setup, "[…] because I could only hold two at once, it was hard to see all three at the same time. So, I had to remember to hold one in my mind and then look at the others" (Participant 17). Another participant mentioned being anxious about accidentally breaking the artworks.

As compared to the other setups, half of the participants mentioned that only the physical setup gave them the full impression of the painting, especially with regard to colors: "I prefer having them physical because then I can just see more and I can trust my perception more, because if it's like I'm shopping in an online shop, I don't actually see the color. If I'm checking it out in real life, then I know exactly what I will get" (Participant 15).

In this setup, some participants talked about the importance of the frame for making their choice: "For me it's very important how the frame looks on the paintings, so I also investigate how old they are, and whether they are worn, if they are new, and how much they look like they have just been printed on laser printer and put in a black frame. But I am sure none of these are" (Participant 13). Another participant found a specific frame enticing, "It weighed heavily in my decision of what I wanted, that there was a name I could recognize [S. Engelbrecht, ed.], but also that it was a nice painting, and that it was heavy and a nice frame" (Participant 10).

Several participants made comparisons with the act of browsing through artifacts in commercial settings, such as posters in an art museum gift shop, paintings at a flea market, or records in a record store. For some, this was a positive, fun experience:

> *It's like crate digging in a record shop. You're kind of fiddling through them. You can look, you can stand it. You know, it feels more like you're kind of taking a cultural artifact in a different kind of mode. That's sort of exciting. You know, there's joy to holding a painting. It's something almost naughty.* (Participant 19)

However, others felt unease when handling the physical paintings. One participant mentioned that it devaluated the artworks being presented in this way:

> *I felt that it was like when exiting a museum, and then there's this thing where you browse through the posters. My immediate experience was that I really felt that I was in the gift shop of a museum. I also think, that in relation to other things, this took away much of the feeling of quality.* (Participant 2)

In general, participants found that this setup gave them the best impression of the paintings. The paintings were evaluated for more than their pictorial content, such as the frames and their weight, yet the presentation was unfamiliar, causing a level of unease.

Digital 2D setup

Upon entering the room for the 2D setup, the experimenter gave the same task instructions as for the physical setup, but this time added: "You may use the mouse on the table." With no further instructions, almost all participants would walk to the mouse and start clicking, figuring out by themselves how to enlarge the paintings. Participants spent 19–160 seconds (median: 40) before they indicated that they had made their choice. All participants went through the images at least once, spending 1–7 seconds looking at each enlarged picture for the first time. Most participants looked at the enlarged images multiple times.

Most participants said that this setup was easy and straightforward and felt like an everyday interaction: "It was easier because everything was just lined up, instead of having to make that somewhat cumbersome movement of lifting the paintings up. […] So, it was a faster decision to decide what you like, but with less opportunity for investigation" (Participant 13). One participant noted that the ability to see the three images at the same time made it easier: "Even if the paintings weren't that big [when not enlarged], I already kind of saw what they were portraying" (Participant 15). Many participants talked about how it was easier to get an overview or compare the images in this setup. Participants also said that it was more efficient and had less distractions than the other setups, and some remarked that it was easier to investigate details in this setup. Several compared this setup to an online image experience, such as Google Image Search.

In contrast, a few participants said that it was difficult or even impossible to make a proper decision in this setup because necessary information was missing from the presentation of the paintings. Over half of the participants talked about missing information aspects, such as the physical dimensions of the paintings, texture, and the exact colors. Curiously, four participants furthermore stated that the images in this setup did not have frames (even though frames had in fact been added digitally, as described above).

One participant said this setup was just like images hanging on a wall. Another compared it to a slideshow:

> *I felt it was like a slideshow that I had to click through, and it pulled me out of the world where I am supposed to be immersed in the art. You feel that you have a mission and that is to be done with it. You kind of have to see it to the end, and then proceed with the next instead of immersing yourself.* (Participant 12)

In general, the participants seemed less enthusiastic about this setup than the other two. Some participants said it was boring, others used the term static, and a few used the term distanced in comparison with the other setups. The task was solved quickly and efficiently, but the images in this condition were not talked about as having any sort of physical or spatial properties.

Digital 3D setup

When entering the 3D setup, the experimenter would hand the participant a smartphone and ask the participant to stand in the middle of the room in front of the projected image. Then, the experimenter would help the participant to calibrate the phone interface and explain the functionality: "You can move the white cursor around by pointing the phone. You can press on the screen to grab a painting, and if you point the phone toward the ceiling, the painting you have picked up will come toward you. You can then tilt the phone to orient the painting you have picked up." Then, the experimenter would repeat the task and step back to let the participant use the interface on their own while answering any clarifying questions.

In this setup, participants spent between 62 to 250 (median: 94) seconds after entering the room before they indicated that they had made up their mind. The instruction and calibration phase took 23–46 seconds. The participants would pick up the paintings one after the other and tilt the phone to make it come closer. The participants kept standing in the same place while holding the phone in one hand extended from the body. They spent between 4 and 26 seconds looking at a picture zoomed in when looking at it for the first time. Some participants picked up one of the paintings one more time before revealing their choice. One participant played around with the paintings for another two minutes after explaining his choice.

At the beginning of their interaction with the setup, many of the participants experienced chaotic interactions. Participants often accidentally dropped the paintings, knocked them off the table or sent them flying out of the screen:

> *You had to get used to it and find out how to maneuver the painting. [...] Sometimes the painting moved a bit fast and ended in the top right corner. It was a bit hard to keep the painting in focus, which made it difficult to analyze the painting you were looking at. But it was a fun way of doing it.* (Participant 10)

Many participants said that this was a different or novel way of interacting with art, but many also remarked that the interface involved a learning curve since they needed to learn how to use the tool before they could focus on the paintings. About half of the participants used the word fun about this setup, and a few more talked about it as being playful. One participant, however, found the interaction difficult, making it a "stressful" and somewhat "humiliating" experience (Participant 16). Some also experienced a certain unease about handling the paintings in this setup: "I felt that I was treating the art a bit badly by accidentally throwing it around and by

rotating it. In any case, I would find it awkward if I ended up doing that with [the artworks in] my own hands" (Participant 7). Another participant had a similar experience but appreciated that the artwork had lost a bit of its authority:

> *There were some times when you dropped the precious paintings and those kinds of things. And then you go like, it's not normal to be out looking at art, holding some priceless artwork and then, whoops, dropping it or it flying away. But I actually think that gave it a really cool playful approach, that you dare more to look at it and do something with it. You don't dare that when you're in a museum, then you just go: Okay, I can look at things […] maybe it makes the art less authoritarian [sic] that you can throw it around like that. But I actually think that's very cool.* (Participant 11)

Some participants talked about this setup being playful or like a game. While being playful and fun, one participant found that it was "just feeling like a gamified distraction from the task at hand" (Participant 16). Participant 8 also felt this way: "For a long time, I had much focus on just controlling it, and I found it fun, and that was where my focus was. I forgot the task a bit." An additional two participants mentioned this.

Similar to the 2D setup, a few participants said that they found it hard or impossible to complete the task because the digital image of the paintings did not give them all the information they needed. A few participants talked about a missing materiality or tangibility; however, others talked about this setup being more material, tangible, or physical than the 2D setup. Other factors that were mentioned as missing were weight, real size, and exact colors. One participant talked about this setup being a tradeoff between the two others:

> *[the 3D setup] seems like it's sort of awkwardly in the middle. There's something that's material that's happening there that is nice, but it's also fiddly and it's also occluded in some sort of image sense. [...] It's harder to see, but it does kind of give you a sense that you're semi-present, which I don't know if that's a good trade off yet.* (Participant 19)

In this setup, the participants also talked about frames. One participant said that the frame did not play a role, "[…] because you could not feel the image in the same way, even though there is a frame" (Participant 10). On the other hand, another participant said:

> *[…] it really did do something, that there were frames on. […] It gave me more the feeling that they were actually paintings existing in real life, instead of just being a Google image you had downloaded and put into the same system. Here, I have a feeling that these paintings exist somewhere.* (Participant 6)

Several participants found that the 3D setup did have some qualities to it that the 2D setup lacked. Three participants said that this was more like holding a real painting than the 2D setup. One said that it had "objectness" (Participant 1), and another that it was easier to imagine it on a wall. Another three participants talked about the 3D interface as a room, implying a sense of spatiality.

8. Discussion

Remarks made by the participants seem to indicate that the 3D setup did succeed to some degree at facilitating an experience that afforded a sense of handling the artworks. Participants also noticed the frames of the paintings more in 3D than in 2D. It is particularly interesting to note the unease felt by some participants in not being able to treat 3D artworks with appropriate care. However, participants still noted a lack of materiality, and problems with the 3D interface and image quality seem to have reduced the vividness of the experience for some.

To explore how the 3D setup affects the aesthetic experience of the artworks, we will consider the insights from the experiment in relation to Kiran's (2015) four suggested dimensions of technological mediation: practical, ontological, epistemological, and ethical. For each of these dimensions, we offer some thoughts on how designers might further explore the experience of virtually handling digitized artworks.

In each setup, the form of the artworks afforded different practical ways for the participants to handle them. The three setups demanded three very different ways of bodily engagement, from the careful handling of a heavy physical painting, to the fine flicks of the wrist when using a mouse, to the somewhat unfamiliar movements needed to control the smartphone interface. The movements in the 3D setup land somewhere in between those of the 2D and the physical setups: The participants were lifting, pulling, placing, and tilting the paintings, although it was done via a tool for remote control and with much smaller and lighter movements than in the physical setup. These affordances allowed the participants' bodies to play a role in the art experience. In future work, designers might explore how to further prompt and enhance the affordances for practical handling to extend the ways bodily movement might affect aesthetic experience.

Designers might explore (at least) two different aspects of this design space: the control interface and the type of display. Regarding control, one might experiment with interfaces that facilitate more natural movements, thus mapping more closely to the handling of physical artworks. For instance, one might create a tangible interface with a form like that of a physical painting that could be mapped to the digital image to allow participants to use natural movements to lift and turn the digital image. To bring the experience even closer to the physical, one might move away from the digital projection on the wall and instead simply use a tablet computer embedded in a frame. However, this would require that the images be reduced drastically in size and adapted to the aspect ratio of the tablet display, which would run against the artistic intentions of many artworks in which size is an important aesthetic factor. A different solution might be to move the experience into a substitutional reality environment in which a virtual reality environment is combined with physical props to facilitate the experience of handling objects physically, as demonstrated in Tennent et al. (2020). Furthermore, designers and artists might be interested in experimenting with interfaces that offer types of interaction that do not match closely to the experience of handling a physical painting, such as introducing elements of discomfort (see Benford et al., 2012), for example, through sensory misalignment (see Marshall et al., 2019). One might also consider the degree to which the participants should control the experience—perhaps experimenting with degrees of contested or negotiated control (see Benford et al., 2021).

Considering the ontological dimension, both the 2D and the 3D versions of the artworks are virtual representations, but participants felt that the handling of virtual 3D has more qualities associated with physical objects. When going from the physical to the 2D setup, the experience of "objectness" seems to disappear. The participants called the physical paintings "the real thing,"

whereas the 2D paintings seem to be treated more as a reference to an object existing in some other realm. Interestingly, when encountering the 3D paintings, a level of "objectness" seemed to return as some participants said that the experience of engaging virtual space is a bit like handling real paintings.

Designers might explore designs that would enhance the experience of "objectness" in relation to the digitized artworks. In the past, museums have experimented with ways to facilitate more personal encounters with artworks, such as through Cooper-Hewitt's "The Pen," which allowed visitors to digitally collect objects that interested them in the museum (Chan & Cope, 2015). In Blast Theory's design "Gift", museum visitors are invited to collect objects digitally and to use them to craft gifts for their loved ones (Spence et al., 2019), setting up an experience that is "interpersonalized" (Ryding et al., 2021). Petrelli et al. (2017) introduced the concept of "tangible data souvenirs," which are created on the basis of data collected during a museum visit and that serve as a connection between a physical and a digital experience. Benford et al. (forthcoming) used a similar approach in a design in which emotion-capture techniques were used to craft personalized experiences based on the visitors' emotional responses to artworks in the Munch Museum in Oslo, Norway. At the end of the experience, visitors were given a postcard showing the painting that had prompted their strongest emotional response, with their own emotion data printed on the back. Future designers might build on such approaches to further experiment with ways of turning digitized artworks into "objects."

Considering the epistemological dimension, it is notable that the physical artworks seem to contain important information that becomes unavailable in the two digital setups. Some of this loss—blurry images, low resolution—is due to inefficient display technologies and might easily be mitigated using a screen or a better projector. In fact, by using high-resolution images such as the "gigapixel" images created by the Google Cultural Institute (St. John, 2016), one may display an even larger and sharper representation of the paintings than can be seen directly on the physical canvas. Information about physical size can also be communicated digitally. In the 2D display, it is easy to imagine scaling the images 1:1 to their physical counterparts. With the 3D interface, this is less trivial since scale is determined by the distance to the virtual camera lens as it moves back and forth. Other information, such as weight, is simply lost due to the nature of digital representations. The 3D version, however, does convey the sense of being an object since participants can look at it from the front, sides, and back. Using better display technologies, it might even be possible to see the artificial light bouncing off the texture of the 3D canvas.

Considering the ethical dimension, it is worth noting that participants drew parallels to experiences that have similar interactional qualities. The physical setup was likened to the act of browsing posters in a gift shop, the 2D setup was compared to browsing images on the web, and the 3D setup reminded participants of the Nintendo Wii controller. These three examples are very different in their cultural status and refer to contexts in which artworks are given very different roles. Posters in a gift shop are commercial products, stereotypical examples of art as a commodity. In contrast, images that appear in google searches are deprived of their monetary value (other than the indirect monetization of the platform enterprise). Meanwhile, in the 3D setup, paintings regain some of their "objectness," but they tend to lose their status as art, becoming instead merely quasi-physical objects that get tossed around like toys.

The change in form also affects the social status of the artworks and even devaluates them. An important question for further research would be to search for ways to present the digitized artworks that do not devaluate them. One possibility would be to design an interface that to a large degree affords careful treatment of the paintings, simulating the care and respect that

such physical objects require. For instance, the physics of the simulation could be constrained so that all movements would be slow and smooth and that the paintings would find their way back on the table when let go. Another approach could be to integrate consequences of actions in the software. If the artworks were to break or disappear for good when dropped, this artificial fragility might affect the role of the paintings in the participants' perception. Alternatively, the reckless treatment of paintings could instead be turned into a theme for the experience and explored further in the design, using the experience of unease to explore the role of digitized artworks.

9. Concluding remarks

Can the experience of handling digitized artworks be used to enrich the art experience? The experiment presented here did not aim to offer a viable prototype for such an experience, and indeed the participants' responses indicate that the setup would need to be further developed to be experienced as appropriate for an art-viewing experience. However, the experiment did demonstrate that there is potential for facilitating art experiences that afford a dimension of "objectness" to digitized paintings.

While the digitalization of artworks may seem to lead to art experiences that are immaterial and disconnected from the physical reality of our bodies, this also makes it possible to bring back a dimension of the art experience that was lost with the development of modern museums such that spectators can experience artworks by holding them, tilting them, turning them around, lifting them up, and even throw them away. This opens up new avenues for further research in the intersection of somaesthetics, HCI, and sensory museology.

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