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The effects of real-time Augmented Reality
Filters on self-esteem

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The effects of real-time Augmented Reality Filters on self-esteem

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Abstract - Augmented Reality (AR) creates an interactive experience in a physical environment enhanced by computer-generated perceptual information. This means that AR can make real-time changes to users' image and react to their movements. AR filters are becoming tremendously popular in social network applications and are frequently being used to adjust, enhance, or distort users' facial traits. Besides social media, most video conference applications have AR filter plug-ins available. This study investigated the short-term effects of two AR-filters on state self-esteem in a between subjects experiment (n = 11). A touch-up and a touch-down filter were designed for this experiment. Participants recorded a short personal video using the self-view camera with their assigned filter applied, believing the video would be shown to another participant. State self-esteem was measured using an adapted 4-point version of the State Self-Esteem Scale (SSES). Contrary to predictions, neither filter produced the expected divergence in self-esteem. Instead, both conditions showed a general decline across all measures with no significant between-group differences. Video self-viewing and the pressure of a simulated audience may have swamped any filter effect. Given the small sample size and the use of an adapted scale, all findings should be considered exploratory.

Index Terms- Augmented Reality, Self-presentation, Self-Esteem, Beauty Filters

I. INTRODUCTION

Beauty has always been a major obsession for society. For years, people have found ways to change and improve their appearance from using henna and kohl, to wearing make-up and from body-art to plastic surgery (Robinson, 1998). The pursuit of beauty is a timeless phenomenon that has played a central role in human societies for centuries. In the performing arts, we see all kinds of ways that are used to dramatize (facial) features as means of expression, and to perfect the appearances of the performers (Baltacioglu, 2018). Not only on stage but also in the advertising industry, where airbrushing and retouching images became the standard, subsequently distorting the expectations of how people should look, rather than how they actually look.

Perception of beauty is influenced by culture and physical features, among other things (Dimitrov & Kroumpouzou, 2023). Nowadays, this pursuit of beauty is no longer limited to the physical world. With the rise of digital technologies, including

social media, we are also actively pursuing beauty online. For instance, social media platforms are no longer just a tool for communicating with each other but also a showcase for personal presentations. These social media applications often allow users to edit photos in the application, making photo editing and enhancement more accessible than ever.

Besides editing photos, many social media applications also offer the option to apply AR. AR makes it easier than ever to enhance one's appearance in online environments, primarily because it is immediately visible to the user. AR filters differ from other types of AR in that they can augment the appearance of the user's face, using a digital overlay, while leaving the environment unchanged. Besides filters that can turn users into cartoon characters, there are also filters that can modify and enhance their appearance. These enhancing filters make professional cosmetic editing capabilities available to everyone. AR Filters make use of computer vision algorithms to recognize facial features and environments. One emerging type of AR uses the front-facing camera to overlay digital features onto a user's face, transforming their physical appearance in real time (Javornik et al., 2017). The impact of digital and virtual technology on the self has been demonstrated (Schau & Gilly, 2003; Sheth & Solomon, 2014).

According to Spark AR Studio, a free application that allows users to create their own filter, there are more than 400,000 creators worldwide in more than 190 countries in 2020. These creators published over 1.2 million AR effects on social media platforms Facebook and Instagram. Notably, over half (55%) of Spark AR Studio's creators are women (Young, 2020). Social network application TikTok has been downloaded over 2 billion times globally (Chapple, 2020) and is extremely popular among teenagers (Sandler, 2021). TikTok allows users to create and share videos within the digital world. A popular feature within the application is the filter function, which can be integrated with lip-synching templates. Most of these integrated filters let the user enhance themselves to a perfect, idealized, edited version of themselves. This means that one is not only exposed to filtered others, but also often to one's filtered self.

Besides users using AR filters on social media by sharing and creating, AR filters or beautifying effects are also available in video conferencing applications, e.g. Apple's FaceTime and Microsoft Teams. This means that AR is not only used for entertainment, but it is also used in professional and social video interaction. Zoom offers users the option to touch up their appearance, and Microsoft Teams has a built-in soft focus filter

to reduce the effect of facial wrinkles and cease lines. SnapCamera enables users to apply popular AR filters from Snapchat on their computer in various video conferencing applications. The COVID-19 pandemic has substantially changed the way we work and receive education. Because of the stay-at-home orders, videoconference tools and platforms like Zoom, Microsoft Teams and Hangouts Meet saw a significant increase in downloads (Sydow, 2020). It is expected that the use of these tools will continue to grow.

Because various video conferencing tools often offer, by default, the ability to see oneself during a video call, users are increasingly confronted with their digital selves. Research argues that seeing oneself on a video call for extended periods of time can increase self-consciousness about one's appearance, an effect Bailenson (2021) refers to as the 'all day mirror effect'. Prolonged self-viewing is unnatural and can increase self-criticism and lower self-esteem. According to Objective Self-Awareness Theory, directing attention toward the self automatically triggers a comparison with internal standards, often resulting in negative self-evaluation (Duval & Wicklund, 1972). In a more recent study, researchers found similar results. During a video conference call, individuals are almost forced to watch themselves on screen. Research shows that this mirror anxiety, the discomfort of seeing oneself on video, contributes to greater fatigue, particularly for women (Fauville et al., 2021). According to Kuhn (2022) frequent self-viewing during virtual meetings may contribute to negative attitudes towards them, depending on the user's degree of public self-consciousness.

Most video conference applications allow users to enhance their appearance. With a single mouse click, users can apply a full make-up look or remove the appearance of eye bags. AR Filters or virtual try-ons were once mainly used for commercial purposes to promote products. These try-on mirrors allowed people to try on different products, which can be more convenient than trying on physical items. However, AR filters found their way to social media platforms where individuals were able to use the face front camera to change facial features. Extensive research has been conducted on edited images (Tang 2023; Tiggemann et al., 2020; McGovern et al., 2022) where editing is applied retroactively. AR filters, however, operate in real time, making them more dynamic and interactive. Moreover, unlike retroactive photo editing, real-time AR filters confront users directly with their altered appearance. This study therefore investigates the following research question: *Can real-time AR filters influence short-term self-esteem of users during video self-presentation?*

To explore the impact of AR filters on self-esteem, we conducted an experiment in which participants' facial features were distorted (touch up and touch down) through the use of specifically designed AR filters, using SparkAR. A mix of The Rosenberg Scale (RSES; Rosenberg, 1965), the state Self-Esteem Scale (Heatherton & Polivy, 1991) and additional statements are used to assess self-esteem before and after the experiment. Participants in this experiment were told that their video was being shown to the next participant. However, this was not the

case. The social pressure of a real audience was simulated this way.

There is a lot of literature available about the impact of beauty enhancement in images, but real-time enhancement through AR filters has not been investigated much. Most AR filter research is studied at the product and brand level. This research may contribute to scientists' knowledge in the field of self-esteem and AR filters, in addition, the results may be of interest to developers of AR filters, which may contribute to a more conscious and healthy interaction with technology. AR filters are no longer used solely on social media. We also see a shift towards professional use. Understanding their psychological impact is therefore not merely an academic matter. If AR filters influence how users feel about themselves it is important to take the implications into consideration when designing these technologies.

Section II provides a brief literature review. In Section III, the hypotheses for the experiment are formulated. Section IV discusses the methodology for this experiment and section V reports the results. The discussion in section VI interprets the results and relates them to existing work covered in the literature review. As such, this study will contribute to the knowledge of the impact of AR filters.

II. RELATED WORK

In current literature, much is found about self-esteem and digital enhancement. However, self-esteem and real-time enhancement, such as AR, have received little attention.

A. Self-esteem

One of the most commonly studied concepts in social psychology is self-esteem. It is considered a fundamental construct in social psychology, reflecting the degree to which a person views themselves positively or negatively (Baumeister, 1993). Rosenberg (1965) describes self-esteem as an individual's **overall** positive or negative evaluation of the self, encompassing feelings of self-acceptance and self-worth. Rosenberg's global measure of self-esteem is widely used in psychological research.

Self-esteem is understood as a relatively stable trait that develops over time and reflects how individuals assess themselves in different situations (Rosenberg, 1965). Self-esteem is open to momentary changes and can be described as a barometer that rises and falls (James, 1890) based on experiences, such as success and failure (Heatherton & Wyland, 2003). Heatherton and Polivy refer to **state self-esteem**, which captures how an individual feels about themselves at a particular moment, rather than in general (Heatherton and Polivy, 1991). Heatherton and Polivy developed a new scale to measure self-esteem, because they felt that existing scales, such as the Rosenberg self-esteem scale, were not measuring temporary changes and were therefore not sensitive to short-term experimental manipulations.

Many psychologists focus on self-esteem because there is a correlation between high self-esteem and positive outcomes for individuals and society (Baumeister, 1993; Mecca, 1989; Moreno

& De Roda, 2003). The positive outcome of a high self-esteem could be the reason why people focus on how to protect and enhance their self-esteem. Self-esteem and appearance are closely linked. Physical appearance is one of the most significant domains through which individuals evaluate themselves. The subjective evaluation of one's own physical attractiveness is called appearance self-concept. Appearance self-concept has been identified as a strong predictor of overall self-esteem. (Baudson et al., 2016; Palenzuela-Luis et al., 2022). This suggests that contexts which alter self-perceived appearance may have a direct impact on state self-esteem. Dissatisfaction with one's appearance and body has consistently been linked to lower self-esteem (Tiggemann, 2005; Paxton et al., 2006).

Although self-esteem mainly stems from an internal assessment based on an individual's feelings and thoughts, individuals are also influenced by their own environment and by others (Leary & Baumeister, 2000). Individuals tend to compare themselves with others. Social comparison theory provides a useful framework for understanding how this process of comparison works and how it might influence self-esteem (Festinger, 1954).

B. Social Comparison

In 1954, Festinger introduced the **social comparison theory** to explain how individuals understand themselves by comparing themselves with others. Individuals compare themselves with others to evaluate their abilities, and opinions using either downward or upward comparisons (Festinger, 1954).

Upward comparison happens when an individual compares themselves to an individual who they consider as better in a particular area, this could be for example appearance. **Downward comparison** happens when an individual compares themselves with someone whom they consider worse off in a particular area.

Social comparison, upward and downward, does not only apply to comparison with other individuals, but can also be applied to digital or virtual versions of the self. Fribourg et al. (2021) demonstrated that AR filters can alter the way individuals perceive their own face in real-time. Individuals are therefore confronted with an enhanced or a diminished version of themselves. It is possible that a social comparison takes place with their filtered self and their natural appearance.

Social comparison can affect self-esteem negatively or positively (Festinger, 1954). Upward comparisons are known to decrease self-esteem (Collins, 1996). Midgley et al., (2021) showed that frequent and extreme upward social comparisons on social media can negatively impact self-esteem. This suggests that social comparison theory explains how individuals base their self-evaluation on perceived presentations and characteristics of others.

Johnson (2021) researched how individuals make comparisons on social media and what kind of impact this has on well-being. Johnson found that younger and frequent social media users made more upward comparisons. In this study upward

comparison led to a decrease in state self-esteem and an increase of negative mood. Downward comparison had the opposite effect.

C. Self-presentation

The previous sections explained how self-esteem is shaped by internal evaluation and how it can be influenced by social comparison processes. In this section we will look at self-presentation. How do individuals manage the way they are perceived by others and can this influence self-esteem?

The way individuals control how they are perceived by others is called self-presentation (Leary & Kowalski, 1990). We can do this by changing appearance or behavior (Goffman, 1959). Self-presentation theories are beneficial in that they provide a conceptual framework for comprehending how a situation could constrain and affect people's actions. Goffman (1959) provides a description of self-presentation using a dramaturgical approach where individuals are actors or stage performers (selves) and the interaction is the performance. In accordance with the expectations of the audience, the actor displays various facets of themselves. Goffman's approach seems to be more suitable for in-person self-presentation, where the audience is physically present.

Hogan (2010) introduced a more modern approach, having in mind that interactions are not only in-person, but also could be online, specifically on social media. Hogan describes self-presentation on social media as an exhibit instead of a performance. The artifacts can be selected before showing to an audience. This is similar to a person selecting what they want to display on social media and selecting who the audience will be. People can display different sides of themselves depending on the audience or the situation. Baym (2015) introduces another perspective of online self-presentation, where she talks about "disembodied" identities. The presentations are disembodied; they are separate from the physical body. A person can post pictures of their animal on social media, while that could be entirely separate from their professional LinkedIn profile. These theories provide a general framework to understand self-presentation. Self-presentation through video introduces additional dynamics that need more attention.

Different types of audience and media can influence how people present themselves (Baym, 2015). There is for example a difference between video and phone-based conversations, because video also provides non-verbal communication (Whittaker, 2003).

A study by Taber et al. (2021) shows that both students and office workers present themselves differently when working from home during video calls. The self-view during video calls can make individuals more self-aware. However in this study, this self-awareness did not seem to promote negative self-consciousness. Nevertheless the self-view enhanced participants' control over their self-presentation. This suggests that the self-view does not merely provide passive feedback, but actively shapes self-presentation. Individuals adjust their

behavior based on what they see. Wicklund's (1975) **Objective Self-Awareness Theory** (OSA) fits well with this finding. Wicklund (1975) describes objective self-awareness as a state in which the person takes himself to be an object. Conscious attention is either directed towards the self or the external environment. For instance, a mirror directs attention inward, while distracting external stimuli direct attention outward. This can be applied to the self-view function during video calls. The self-view function draws attention toward the self. This is supported by Silvia and Phillips (2013), who found that self-focused attention, whether induced consciously (e.g., via a mirror) or unintentionally, activated this comparison process without the individual's awareness. Importantly, according to Objective Self-Awareness Theory, directing attention toward the self automatically initiates a comparison between one's current self and relevant internal standards (Duval & Wicklund, 1972; Silvia & Phillips, 2013).

In face-to-face interaction, the audience can freely choose where to direct their attention. In video, however, the person being viewed determines what the audience sees, and can even conceal insecurities. Research suggests that the self-view may enhance users' sense of control over their self-presentation (Seitz et al., 2024).

Self-presentation demonstrates how individuals actively shape their social identity by adjusting their behavior and appearance. This shows that our self-image is not static, but constantly changes due to our environment and interaction with others. This process is reinforced in the digital context, as individuals have more control. Self-presentation therefore forms a crucial link between self-esteem and social comparison, particularly in the digital age in which we live.

D. Digital appearance enhancement and self-perception

The desire to alter one's own appearance is nothing new. For centuries, people have used means such as make-up and clothing to influence their appearance and control how others perceive them (Robinson, 1998; Dimitrov & Kroumpouzos, 2023). In the cultural and creative sectors, such as the theater and film industries, facial features are accentuated and magnified as a means of expression, while in the world of advertising, retouching (the digital alteration of an image) is the norm (Baltacioglu, 2018).

The accessibility of photo-editing applications makes it even easier for users to retouch photos before posting them online on social media. Research shows that editing photos, including selfies, is linked to greater dissatisfaction with one's own appearance and a more negative body image, particularly among young women. (Tiggemann et al., 2020; McGovern et al., 2022; Tang, 2023). Lee and Lee (2021) found in a study that social media photo activity, combined with comparisons based on appearance, contributed to lower body satisfaction, particularly when users edit their photos before posting them online.

Plastic surgeons have also identified a new trend: patients seeking cosmetic procedures to look better in selfies. In 2017,

55% of the surgeons surveyed reported this trend (AAFPRS, 2018); by 2019, this figure had risen to 72% (AAFPRS, 2020). In 2018, the British cosmetic surgeon Dr Tijion Esho coined the term 'Snapchat Dysmorphia' to describe the growing phenomenon whereby patients request cosmetic procedures to resemble a filtered version of themselves (Tweedy, 2018; Hosie, 2018). This phenomenon clearly illustrates how digital self-presentation can influence perceptions of appearance. Rajanla et al. (2018) describe how filtered selfies give people an unrealistic view of their own appearance. This demonstrates how digital self-presentation can influence body image.

AR filters differ from static image processing in that they can alter the user's appearance in real time. The effects move along with the user. Fribourg et al. (2021) investigated how AR filters can influence the perception of one's own face. The researchers found that different filters significantly alter the perceived attractiveness, personality and emotional expression of one's own face. This suggests that AR filters influence how people perceive and evaluate their own faces. Social comparison (Festinger, 1954) is usually limited to comparisons with others, but may also extend to digital versions of the self. In this case, the user does not compare themselves with someone else, but with a filtered version. Schroeder and Behm-Morawitz (2024) introduced the concept of 'social self-comparison'. The researchers wanted to know whether comparing oneself to a filtered image of oneself is more harmful than comparing oneself to a filtered image of someone else.

Their research revealed that comparison processes were strongest when participants compared themselves to a version of themselves with a slimming beauty filter applied. Users who consistently compare themselves to a filtered, idealized version of themselves appear to experience a more significant negative impact on their body image than when they compare themselves unfavorably to filtered images of others.

Isakowitsch (2023) examines how AR beauty filters influence self-perception by comparing them with traditional photo editing. Based on interviews with eight participants, most indicated that using real-time AR filters had a greater impact on their experience than viewing a static photograph. Isakowitsch suggests that AR filters may have a stronger influence on self-perception than traditional photo editing, but the researcher emphasizes that further research is needed to test this hypothesis.

Javornik et al. (2022) found that the use of AR filters can have both positive and negative effects on well-being. These effects depend on the underlying motivation. Use aimed at authentic self-presentation was associated with greater self-acceptance, while use aimed at the ideal self was associated with a decline in mood. A striking finding was a clear gender difference. The majority of boys used AR filters for entertainment, while the majority of girls used AR filters to make themselves more attractive. This is consistent with the findings of Prescott (2020), who found that 10- and 11-year-old girls mainly used AR filters to make themselves look more attractive, citing self-confidence and self-esteem as their motivations. Yim and Park (2019) conducted research into AR virtual try-on, which allows users to

virtually try on products such as sunglasses and make-up. They found that consumers who are dissatisfied with their body image had a more positive attitude towards AR technology experiences than consumers who are satisfied with their appearance. This suggests that people who are more dissatisfied with their appearance are more inclined to use AR filters as a means of self-improvement. The existing literature shows that digital enhancement of one's appearance can influence self-perception and self-esteem. However, the effects are not clear-cut and depend on the nature and intensity of the manipulation.

Participants of an experimental lab study with virtual make-up reported higher self-esteem when holistic AR make-up was applied instead of partial (Javornik et al., 2021). Research suggests that a holistic (full make-up look) provides a more powerful experience in terms of positive self-perception in comparison to partial augmentation (for example just lipstick). A higher Self-Esteem score was measured using a holistic AR filter. Within this study Javornik et al., (2021) also did a study with personalized vs. not-personalized AR. Where expert participants in the personalized condition showed the highest score of self-esteem. Javornik's study showed that AR affects how consumers perceive themselves using AR: both their self-esteem and their purchase intention increased. In a study by Dijkslag et al. (2024), the researchers actually found a decline in body satisfaction following exposure to beautifying filters, while distorting filters had no significant effect. Furthermore, women with high self-esteem were less affected by distorting filters.

The existing literature lacks research into the direct short-term effects of real-time AR filters on state self-esteem during video self-presentation in a social context. The hypotheses of the present study are based on a combination of theory and indirect empirical findings. According to Objective Self-Awareness Theory (Duval & Wicklund, 1972), self-focused attention automatically leads to a comparison between the current self and relevant internal standards. Phillips and Silvia (2005) demonstrated that self-discrepancies have stronger emotional consequences when self-awareness is high — a condition that may be induced by watching a video of oneself. From this perspective, being confronted with an enhanced version of one's own appearance may reduce the perceived discrepancy with the ideal self, which is expected to lead to an increase in state self-esteem (H2). Conversely, a less flattering representation of one's own appearance may increase the discrepancy with the ideal self, which is expected to result in a decrease in state self-esteem (H3).

Although Dijkslag et al. (2024) found that beautifying filters are associated with lower body satisfaction, that study focused on a different outcome measure from the present study, namely body satisfaction rather than state self-esteem. No previous research has directly tested these hypotheses in a comparable setting, but the combination of OSA theory, self-discrepancy research and findings from the AR filter literature provides a theoretical basis for these expectations.

III. HYPOTHESES

Based on the discussed findings in existing literature, the following hypotheses were formulated for the experiment:

RQ: Can real-time AR filters influence short-term self-esteem of users during video self-presentation?

H1. Using touch-up and touch-down AR filters in self-view during a video recording can influence state self-esteem, as measured by the state self-esteem scale, while trait self-esteem, as measured by the Rosenberg self-esteem scale, is expected to stay relatively stable.

H2. Participants using a “touch-up”-filter (condition A) will show an increase in state self-esteem (pre- to post-measurement).

H3. Participants using a “touch-down”-filter (condition B) will show a decrease in state self-esteem (pre- to post-measurement).

IV. METHOD

The aim of this study is to investigate whether AR face filters can influence self-esteem (trait and state self-esteem). To do so, we conducted an experimental study (between-subjects design) in which participants had to record a short video recording using the self-view camera mode with different AR filters (touch up filter vs. touch down filter) applied. Details are further described in the remainder of this section.

A. Subjects and procedures

To be eligible, participants had to be women between 18 and 65 years old who were familiar with AR filters and/or video conference calls. Research shows that women show a higher tendency to engage in selfie editing (Dhir et al., 2016). Therefore it was decided that only female participants were included.

Prior to the experiment, the procedures and the AR filters were informally tested with a small number of male participants, mainly to verify that the procedure was understandable.

Since the questionnaire was only provided in English, English skills were necessary for understanding the questionnaire and to perform the experiment. Participants could decide whether they felt comfortable participating in English after reading the information consent. Due to limited time and participant availability, the intended sample size was set at $n = 20$. Ultimately, 15 participants were recruited. Four participants did not complete the experiment and were excluded, resulting in a final sample of $n = 11$ (touch up: $n = 6$; touch down: $n = 5$). Participants were randomly assigned to a condition and all of the participants were recruited through the researcher's personal network. Participants' ages were recorded in five-years categories. Most participants (8 out of 11) were between 25 and 34 years old. The remaining participants fell in the 35-39, 50-54 and 55-59 years old categories. Ten participants were employed

full-time and one was self-employed. All but one participant used social media, most commonly one to three times a day and most participants made video calls daily. Ten of the eleven participants indicated familiarity with AR filters; the remaining participant was eligible through the use of video calls. Six participants reported at least occasional filter use, four reported never using filters and one did not know whether she used filters. An overview of participants characteristics is provided in the appendix.

B. Design and procedures

The AR filters used during this study were either a **touch-up** or a **touch-down** on the participant's face. Each filter was specifically designed for this study to either enhance (touch-up) or diminish (touch-down) the perceived attractiveness of the participants' appearance.

The AR filters were developed using **Spark AR Studio**. Spark AR is a platform developed by Meta (formerly Facebook). The platform allows users to develop AR experiences for Meta's social media applications, such as Facebook and Instagram. In addition to creating and testing filters, users can also make them public on social media for other users. As of January 2025, Spark AR Studio has been taken offline. The development of the AR filters and the execution of the experiment took place before the software was taken offline.

Creating a filter in Spark AR Studio involves a combination of computer vision techniques, 3D modeling, texture mapping and real-time rendering. Using built-in computer vision algorithms, Spark AR Studio detects the user's face. Using the camera feed, the user's face is identified and facial features such as lips, eyes, nose and face shapes are determined. These features are recognized as reference points and this causes the filter to move with the user's head and facial expressions. Once the facial features are determined, Spark AR generates a 3D mesh that matches the user's facial features. This 3D mesh is used as a base on which to apply effects and textures.

Filter Design

Filters were designed by exploring existing filters on social media platform Instagram and reviewing existing literature. Popular AR beauty filters on social media platform Instagram were informally reviewed. To collect existing filters, the keyword: *beauty* was used. A total of nine filters were observed based on the enhancement features. The exploration showed that the following facial elements were given a touch-up: enlarging lips, narrowing nose, removing skin imperfections through blurring. A study showed that eyes, hair and teeth are considered the most important craniofacial elements for attractiveness (van Cruchten et al., 2021). The absence of blemishes and facial skin smoothness has a positive influence on attractiveness in both male and female faces. (Jaeger et al., 2018; Tsankova & Kappas, 2016). Besides attractiveness, the smoothness of a skin also affects the perception of trustworthiness and health. (Tsankova & Kappas, 2016).

Touch-up and touch-down filter design

As for the touch-up filter, the choice was made to make it look as realistic as possible. Minimal adjustments were therefore chosen, but enough adjustment that there is a noticeable difference between the normal camera image and the image with a touch-up or touch-down filter applied. The touch-up filter (Figure 3) was designed based on findings from the literature. Therefore, it was decided to make the following adjustments: enlarging and coloring *the lips*, reducing the size of *the nose*, whitening the *whites of the eyes*, optically *tanning* the face by contouring, making the skin appear more bright (*highlighting and adding blush*) and smooth and narrowing the face.

Opposite adjustments were made for the touch-down filter (figure 1): enlarging the facial width and nose and dark circles were added to make the participants look more tired. For this condition, blemishes were not removed, nor was contouring applied.



Figure 1
Examples of faces with the AR touch-down filter applied



Figure 2
Examples of faces with no filter applied. During the experiment, only the touch-up and touch-down filter was used. The normal camera settings are shown in this image only for comparison.



Figure 3
Examples of faces with the AR touch-up filter applied

Demographic questions

Participants were asked a few demographic questions, including how often they use social media and if they post videos and/or images of themselves. Participants were also asked how often they have video calls and if they use AR filters. Participants' gender was not asked since we only recruited female participants. Participants who were familiar with neither video calls nor AR filters were excluded from this study.

Self-esteem measure

Two different methods were used to measure self-esteem. Participants completed both the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965) and the State Self-Esteem Scale (SSES) (Heatherton & Polivy, 1991) on a 4-point scale ranging from 1 (strongly agree) to 4 (strongly disagree).

With Rosenberg's Scale, global trait self-esteem is measured by measuring (10-item) positive and negative feelings about the self. Positive items were reverse coded. Higher scores reflected higher self-esteem. A composite score was computed as the mean of all 10 items.

The State Self-Esteem Scale measures social, performance and appearance-related self-esteem. The original SSES uses a 5-point scale 1 (not at all) to 5 (extremely). In this study we adapted the scale to a 4-point scale, equal to the RSES scale. Scores are reported on a 1–4 metric and can't be compared to the SSES norm. The SSES appearance subscale was designated as the primary outcome, as it mostly reflects the nature of the experimental manipulation.

A total of 7 statements were added to the scale. With the additional statements, we were mainly interested in how participants felt about their appearance and how comfortable they were looking at themselves. These items are not combined into a composite score. They are treated as exploratory and reported descriptively.

Procedures

Participants were invited personally. The invitation stated that the study was about video conference calls and that participants should record a video during the study where they had to present something. Participants were told that the next participant of this experiment would see their recording. In addition to recording the video, it was also made clear that participants had to complete a few questionnaires. Participants were informed that the study was divided into three parts: **1)** completing a set of questions and statements **2)** performing a task in which participants recorded a video using the self-view mode and presented something about a given topic, and **3)** completing a second questionnaire. The title of the study in the invitation was: *The Digital Mirror*. Participants could take part in their own environment, provided the researcher was present during the experiment. When participants agreed to participate they were asked to give informed consent and after that they were

randomly assigned either a touch-up filter or a touch-down filter. Data collection took place in August 2024.

The pre-experiment questionnaire was administered a day in advance to reduce the risk of participants remembering their previous answers when completing the post-experiment questionnaire. On the day of conducting the experiment, participants were told the exact assignment. Participants were asked to present something personal. This was a deliberate choice to ensure participants would provide their own input rather than recite prepared content. Participants were instructed to watch a recording of another participant and were told that they had to record a similar video that would be shown to the next participant. However, the video shown was not a previous participant, but an actor. The video shown had been recorded prior to this study and each participant was shown the same video. This deception was intended to make participants feel they were presenting to a real audience. In reality, the video was never shown to others and was deleted after completing the last questionnaire. The idea that one had to present in front of an audience may also distract participants from the real objective of this study. Following the experiment participants were asked how many times they had recorded the video before they were satisfied with the result.

V. RESULTS

The data from the experiment were analyzed using a 2 x 2 mixed design. The factors were condition (touch-up vs. touch-down) and time (pre vs. post). For each participant, a difference in score (post - pre) was measured for each outcome measure. The Mann-Whitney U-test is reported as the primary analysis alongside independent t-tests. Effect sizes for the Mann-Whitney U-tests are reported as rank-biserial correlations with 95% confidence intervals. All analyses were conducted using JASP.

State Self-Esteem was measured using a modified 4-point scale. The scores are reported on a 1-4 scale, with higher scores indicating higher self-esteem.

Prior to the main analyses, the consistency of all scales was assessed using Cronbach's alpha. The RSES pre-experiment ($\alpha = .71$), the SSES total ($\alpha = .78$), the SSES appearance subscale ($\alpha = .75$) and the SSES performance subscale ($\alpha = .73$) showed acceptable consistency. The SSES social subscale ($\alpha = .49$), fell below the conventional threshold of .70. After the experiment all values decreased substantially: RSES ($\alpha = .51$), SSES total ($\alpha = .60$), SSES appearance ($\alpha = .36$), SSES social ($\alpha = .45$) and SSES performance ($\alpha = .15$).

Table 1
Descriptive Statistics for Self-Esteem Measures by Condition and Time

Measure	Touch-down (n=5)		Touch-up (n = 6)		Cronbach's α	
	Pre measure (SD)	Post measure (SD)	Pre measure (SD)	Post measure (SD)	α pre	α post
SSES	2.89 (0.23)	2.78 (0.14)	3.10 (0.14)	2.93 (0.07)	.78	.60
SSES appearance	2.70 (0.38)	2.70 (0.25)	2.97 (0.07)	2.86 (0.19)	.75	.36
SSES social	2.94 (0.28)	2.71 (0.27)	3.17 (0.21)	2.86 (0.09)	.49	.45
SSES performance	3.00 (0.32)	2.91 (0.08)	3.14 (0.24)	3.05 (0.07)	.73	.15
RSES	3.16 (0.21)	2.94 (0.15)	3.23 (0.31)	3.13 (0.12)	.71	.51

Note. Scores are based on a modified 4-point scale (1-4) SSES.

Note. The above scores are based on an adapted 4-point version of the State Self-Esteem Scale (1-4), including subcategories (appearance, social and performance). A higher score indicates higher self-esteem. Touch-down n = 5 and touch-up n = 6.

Table 1 shows the descriptive statistics for each outcome measure, broken down by condition and measurement point (pre or post experiment), including Cronbach's Alpha for each scale. Both conditions showed a decrease from pre-experiment to post-experiment on all measures. The touch-up condition scored higher than the touch-down condition on virtually all measures pre-experiment, which limits the comparability of the groups at baseline and must be taken into account when interpreting the results.

State Self-Esteem by Filter Condition

To test whether the polarity of the AR-filter influenced state self-esteem, the scores (post-experiment minus pre-experiment) were compared across conditions using Mann-Whitney U-tests. On the SSES appearance subscale, the touch-down condition showed no mean change ($M = 0.00$, $SD = 0.41$), while the touch-up condition showed a slight decrease ($M = -0.11$, $SD = 0.20$). This difference was not significant ($U = 19.50$, $p = .453$, effect size = $-.30$, 95% CI $[-.77, .39]$). See figure 4 for a visual representation of individual changes. See figure 5 for a visual representation of the mean difference scores per condition (SSES, total appearance, social and performance and RSES).

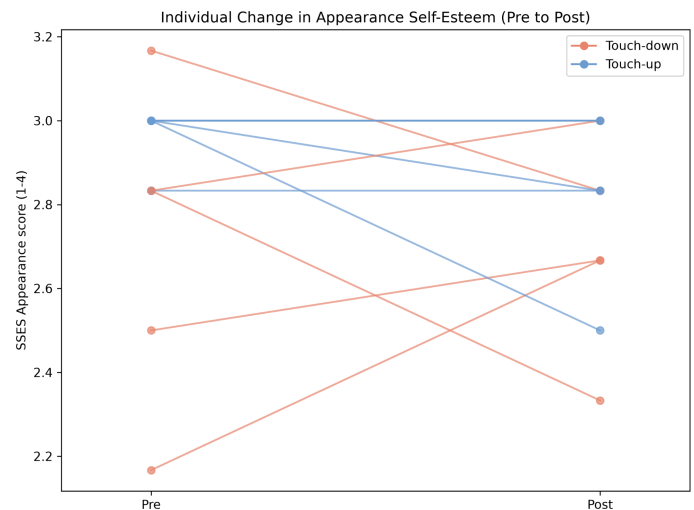


Figure 4
Individual Change in Appearance Self-Esteem (Pre to Post experiment)

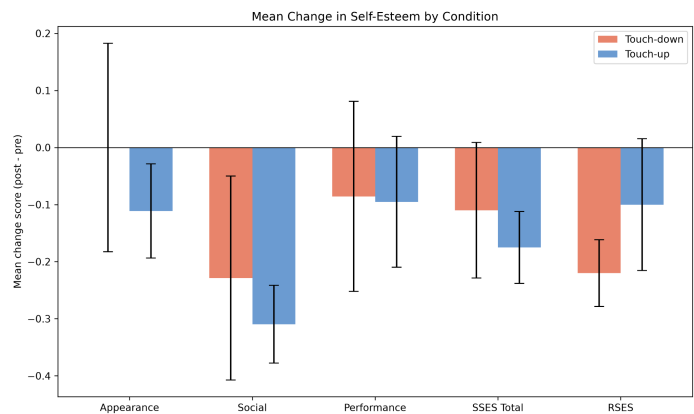


Figure 5
Mean Change in Self-esteem by Condition

The same pattern of non-significant differences applied to the other SSES subscales. On the SSES social scale the conditions showed a decrease. The changes on the SSES performance scale were minimal. On the SSES total, both conditions showed a decrease with no significant difference between them.

Table 2 provides an overview of all Mann-Whitney test results. In all cases, the confidence interval for the effect size included zero.

Table 2

Mann-Whitney U-Comparisons of Change Scores Between Conditions

Measure	U (statistic)	p	Rank-Biserial Correlation	95% CI
SSES	18.00	.647	-.20	[-.73, .47]
SSES appearance	19.50	.453	-.30	[-.77, .39]
SSES social	14.50	1.000	.03	[-.59, .63]
SSES performance	14.00	.925	.07	[-.57, .65]
RSES	8.50	.268	.43	[-.25, .83]

Trait Self-Esteem

As a secondary measure the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965) was examined. The RSES is a trait measure that assesses general, stable self-esteem. The scale is not designed to shift substantially within a single experimental session. The results should therefore be interpreted with caution and will be discussed in the limitation section.

However, the touch-down condition showed a greater decrease ($M = -0.22$, $SD = 0.13$) than the touch-up condition ($M = -0.10$, $SD = 0.28$). The difference was not significant, $U = 8.50$, $p = .268$, effect size = .43, 95% CI [-.25, .83].

Evaluation Hypotheses

H1 stated that the use of AR filters can influence state self-esteem (adapted SSES), while trait (RSES) is expected to be stable. As the design only allowed for a directional comparison between the touch-up and touch-down conditions, and no filter free control condition was included, H1 could not be directly tested. No significant difference between the conditions was found on any SSES subscale. H1 was not supported within the limitations of this design.

H2 proposed that participants in the touch-up condition would show a relative increase in state self-esteem. The touch-up condition actually showed a slight decrease on the primary measure. Therefore H2 is not supported.

H3 predicted that participants assigned to a touch-down filter would show a decrease in state self-esteem. Although the touch-down condition did show the greatest decrease on the RSES, this difference was not significant. H3 is not supported.

VI. DISCUSSION

Key findings

This study used an experiment to investigate whether real-time AR face filters (touch-up and touch-down) influenced state self-esteem (modified SSES) during a video self-presentation. None of the three hypotheses was supported. No significant differences were found between the conditions on a modified SSES scale. Instead of the expected divergence between the conditions, both conditions showed a general decline in self-esteem. Notably, both conditions also showed a decline on the RSES, whereas H1 predicted that trait self-esteem would remain relatively stable. Although the greater decrease in the touch-down condition is directionally in line with H3, the RSES is a trait measure rather than the state measure to which H3 refers, so this pattern cannot be taken as support for the hypothesis. Based on the current findings, it cannot be concluded that real-time AR filters influence self-esteem during video self-presentation. Possible explanations are discussed in the following section.

Possible explanations

Participants in both conditions showed a decline in self-esteem after the experiment. This is not what we had expected, but it can be explained to some extent by existing research.

One explanation for why both the ‘touch-up’ group and the ‘touch-down’ group showed a decline may be that simply watching a video of oneself has a critical effect, regardless of the filter. A study by Zilka (2020) found that the majority of preservice teachers reported self-criticism after watching recordings of themselves teaching. This suggests that seeing oneself on a video recording tends to elicit critical self-evaluation. This is also consistent with Duval & Wicklund’s (1972) Objective Self-Awareness theory. When attention is focused on oneself, one automatically compares oneself to internal standards. This often leads to a more negative self-evaluation. Watching the video back in this experiment may therefore have acted as a mirror. Bailenson (2021) argues that constantly seeing oneself in a video call feels unnatural and makes people more critical of their appearance.

An alternative explanation is that participants felt pressure because they expected their video to be viewed and evaluated by another participant. In a study by Gruenewald et al., (2004) participants were randomly assigned to complete a task with social evaluation present or absent. Participants in the evaluation condition showed larger increases in shame and larger drops in social self-esteem. This pressure from an audience may have contributed to the effect.

Another explanation for the lack of significant results lies in the reliability of the measurements themselves. At the pre-measurement, the items within each scale showed acceptable internal consistency, but this broke down at the post-measurement. This was most evident in the performance subscale, which dropped to $\alpha = .15$. The problem therefore seems

to lie in the measurement itself, even before any real comparisons can be made. Comparisons between the conditions rest on unreliable measurement, which by itself can obscure existing effects. This may be a more direct explanation for the non-significant results than the filter design or the audience pressure discussed above.

Several factors may have contributed to this drop. It may be due to the small number of participants: with so few participants, a single participant can skew the alpha. However, this alone does not explain why the values were acceptable at the pre-measurement. In addition, the adapted version of the SSES was not validated, and items may have functioned differently after the manipulation. A third explanation could lie in the manipulation itself. Participants filled out the first questionnaire in advance, before the manipulation had taken place. As a result, their answers stemmed from a general sense of how they felt about themselves. This is also reflected in the acceptable pre-measurement alphas. After the experiment, participants answered based on their specific reaction to the video, which primarily concerned their appearance. Consequently, the responses no longer moved in unison. The reduced variance at the post-measurement (see the standard deviations in Table 1) is consistent with this interpretation.

Possible explanations for the lack of difference between the two conditions may relate to the filter design. Javornik et al. (2021) found that a full make-up look (holistic AR filter) had stronger effects than partial adjustments. The filters in this experiment were designed in such a way that it was clear they were filters, but an effort was made to keep them as realistic as possible. Furthermore, Dijkslag et al. (2024) found that beautifying filters can reduce body satisfaction, which is consistent with the decrease also observed in the touch-up group.

Beyond these explanations, the baseline imbalance between the two groups complicates the interpretation of the results. Although participants were randomly assigned, the touch-up group scored higher on virtually all measures at the pre-measurement. In addition, the three oldest participants and the three least active social media users were all assigned to the touch-up group. With a sample of $n = 11$, such imbalances can easily arise. This raises the question of whether the absence of a significant difference reflects a true absence of an effect, or whether it reflects the fact that we compared two groups that already differ from each other and may therefore respond differently.

A difference in baseline self-esteem may also have played a role. Javornik et al. (2021) found that the effects of AR filters depend on how low or high a person's self-esteem already was. Furthermore, as the video was not recorded immediately after the questionnaire was completed, external events may have had an effect on the participants' self-esteem.

Limitations

This study has several limitations and therefore readers should be cautious when interpreting the results of this study. The sample size was small ($n = 11$) and the study was therefore underpowered, meaning that meaningful effects may have gone undetected. All of the participants were recruited through the researcher's personal network. Also, all of the participants were women, although this was a deliberate choice given the higher prevalence of selfie editing and AR filter use among women (Dhir et al., 2016; Javornik et al., 2022). However, this limits the generalizability of the findings to other populations. Because the sample size was small, all findings should be regarded as exploratory.

Although participants were assigned randomly the touch-up group scored higher than the touch-down group on all measures at baseline (pre experiment). This is probably a consequence of the small sample size. This limits the interpretability of the differences between the two conditions. The design of the experiment only allowed for a directional comparison between the touch-up condition and the touch-down condition, therefore H1 could not be tested directly. Future research should include a condition without a filter.

To measure State Self-Esteem we used an adapted version of the State Self-Esteem Scale (SSES; Heatherton & Polivy, 1991). In the adapted version there were four response options instead of the original five and for the anchor type we used agree/disagree instead of the original intensity scale ranging from 'not at all' to 'extremely'. Because we used an adapted scale the scores are not comparable with published SSES standards.

The pre-test was intended to be conducted approximately one day before the experiment. In practice, the interval between the pre-questionnaire, the experiment (including post questionnaire) varied considerably between participants, ranging from approximately five hours to almost four days. Between the pre-test and the second measurement, other events may also have influenced the participant's self-esteem. Only the experiment and the second measurement were conducted in the presence of the researcher. The degree of control over the setting may have influenced participants' responses. In addition, the participant was told that the next participant would be watching the video. The idea that another participant would be watching the video could potentially lead to a decline in self-esteem. This makes it unclear exactly what caused the decline. More research is needed to verify the results of this study.

Recommendations

Given these limitations, future studies should use a larger and more diverse sample. An additional condition should be added. A condition without AR filter is needed to test H1. Unmodified, validated scales, such as the original State Self-Esteem Scale, should be used. A standardized time interval should be implemented between pre- and postmeasurements. Finally, a more pronounced filter manipulation should be considered.

VII. CONCLUSION

This study investigated whether real-time AR filters influence self-esteem during video self-presentation. None of the three hypotheses was supported. Both conditions (touch-up or touch-down) showed an overall decline in self-esteem, with no significant difference between the two groups. Given the small sample size, all findings in this study should be regarded as exploratory. Future research involving a larger sample size, a control condition and a validated measurement scale (e.g. SSES) is required to answer the research question.

APPENDIX

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Appendix

Rosenberg Scale statements (Rosenberg, 1965)

1 = Strongly agree 2 = Agree 3 = Disagree 4 = Strongly disagree

1. I feel that I am a person of worth, at least on an equal plane with others.
2. I feel that I have a number of good qualities.
3. All in all, I am inclined to feel that I am a failure.
4. I am able to do things as well as most other people.
5. I feel I do not have much to be proud of.
6. I take a positive attitude toward myself.
7. On the whole, I am satisfied with myself.
8. I wish I could have more respect for myself.
9. I certainly feel useless at times.
10. At times I think I am no good at all.

Rosenberg, M. (1979). *Conceiving the Self*. New York: Basic Books.

State Self-Esteem Scale (Heatherton and Polivy, 1991)

1. I feel confident about my abilities
2. I am worried about whether I am regarded as a success or failure
3. I feel satisfied with the way my body looks right now
4. I feel frustrated or rattled about my performance
5. I feel that I have trouble understanding things that I read
6. I feel that others respect and admire me
7. I am dissatisfied with my weight
8. I feel self-conscious
9. I feel smart as others
10. I feel displeased with myself
11. I feel good about myself
12. I am pleased with my appearance right now
13. I am worried about what other people think of me
14. I feel confident that I understand things
15. I feel inferior to others at this moment
16. I feel unattractive
17. I feel concerned about the impression I am making
18. I feel that I have less scholastic ability right now than others
19. I feel like I'm not doing well
20. I am worried about looking foolish

The subcomponents are scored as follows:

Performance Self-esteem items: 1, 4, 5, 9, 14, 18, 19.

Social Self-esteem items: 2, 8, 10, 13, 15, 17, 20.

Appearance Self-esteem items: 3, 6, 7, 11, 12, 16.

Heatherton, T. F. & Polivy, J. (1991). Development and validation of a scale for measuring state self-esteem. *Journal of Personality and Social Psychology*, 60, 895-910.

Questions pre experiment

1. What is your age?
2. What is your current employment status?
3. How often do you use social media? (e.g Instagram, Snapchat, TikTok etc.)
4. How frequently do you post photos and/or videos on social media?
**photos and videos in which you are visible. Including temporary photos and videos and photos and videos which are only visible for a selected group of people (like best friends and family)*
5. How often do you make use of video calls? (e.g FaceTime, Teams etc.)
6. Do you know what (augmented reality) filters are?
7. Do you ever make use of any filters in photos and/or video (calls)?

Questions post experiment

1. How many times did you record the video before you were satisfied with the result
2. What is the reason that you recorded the video multiple times?

7 additional question (post-experiment)

1. Whenever possible, I like to look at myself in the mirror
2. I am satisfied with my appearance
3. I am satisfied with how I appear to others
4. I find that people often present themselves differently online than in real life
5. I like to look at myself
6. Online I can be more myself than in real life
7. I like to take pictures of myself