The Effect of the Avatar Appearance in Immersive Virtual Reality on Attitude Towards Electricity-Saving Behavior

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Abstract

As the climate crisis continues, action is needed. However, while environmental knowledge and attitudes are rising, this does not seem to translate significantly into sustainable actions of individuals. More research is needed to understand what drives human behavior in the context of pro-environmental actions. Specifically, this research investigated how avatar appearance in Immersive Virtual Reality (IVR) can affect attitudes toward electricity-saving behavior.
A single factor between-subjects experiment was conducted to test whether embodying a virtual avatar whose appearance is associated with electricity saving leads to more positive attitudes toward electricity-saving behaviors, with body ownership moderating this effect. Participants were instructed to do a gamified task in IVR where they turned off appliances. Depending on the condition, participants embodied a hippie or a control avatar. The respondents (N = 38) were students in the Netherlands.
While the analysis did not find significant differences between conditions, the reliability of the results is low due to several limitations including the manipulation being unsuccessful. Findings indicate a need to investigate the role of enjoyment of electricity-saving behavior. Implications for campaigners and future research are discussed.

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1. Introduction

Climate change is one of the largest challenges of this time (IPCC, 2018). Due to human-caused greenhouse gas emissions, global temperatures are rising and environmental consequences are severely impacting the lives of millions (OHCHR, 2016). One step towards the future is changing individuals' behaviors to be more in line with pro-environmental efforts. One possible direction in this is addressing that a lot of electricity is still being wasted by people around the world (Thøgersen, 2005).

While the knowledge and general attitudes towards climate change are generally prevalent and positive, this does not seem to translate significantly into sustainable actions (Thøgersen, 2005) (Colombo et al., 2023). The Theory of Planned Behavior (TPB) is a theory that explains how people's intentions to perform a behavior are influenced. Whereas using general attitudes to predict behavior is ineffective, this theory uses specific attitudes towards a behavior, as well as other factors, to predict behavior (Ajzen, 1991). Since these other factors also play an important role, the effect of behavioral attitudes alone can be limited. In spite of this, behavioral attitudes are an important factor and the TPB framework can be very useful to researchers. The TPB has been used in the context of energy saving before to predict energy-saving behaviors (Chen & Gou, 2022), which suggests that it may be a suitable model for the related field of electricity saving.

Immersive Virtual Reality (IVR) is one of the tools that can be used to change behavior (Plechatá et al., 2022). IVR is a technology that enables users to find themselves immersed in a virtual world. Users wear a virtual headset, also known as a Head-Mounted Device (HMD). This means they can look around and see a virtual world all around them. They can usually interact with this world using controllers. It can be used in conjunction with body tracking. This is where the movements of a part or the whole of the user's body are tracked, using physical trackers attached to the body, and the movement is replicated in the virtual environment. IVR experiences can evoke various pro-environmental attitudinal effects, such as a greater energy-saving attitude when a message is delivered in an immersive virtual environment as opposed to in print or in a video (Kleinlogel et al., 2023).

When a user takes on a virtual body in this virtual world, this body is called the avatar. It represents the person in the virtual world (Yee & Bailenson, 2007). Avatars can vary widely, and research has suggested that which avatar a person uses can have varying behavioral effects such as altering confidence in a negotiation task (Yee & Bailenson, 2007) and implicit racial bias (Peck et al., 2013). An important concept through which these behavioral changes take place is the Proteus Effect. The Proteus Effect is that people act like they believe others would expect their avatar to act (Yee & Bailenson, 2007). Different avatars have been researched and found to have specific behavioral effects (Ratan et al., 2020). A number of these studies investigated the appearance of the avatar. They found different behavioral effects, depending on the appearance of the avatar (Ratan et al., 2020). This suggests that which behavioral effects emerge depends to some extent on the appearance of the avatar. There are research opportunities to apply the Proteus Effect to different areas where positive behavioral changes

are desired to explore a role for IVR avatars. One such area is in the area of electricity-saving behavior. The appearance of avatars could play a role in stimulating electricity-saving behavior, thereby decreasing electricity usage. If an avatar is perceived as being likely to save electricity then, according to the Proteus Effect, a person using this avatar might adjust their behavior inside virtual reality to save more electricity too. This may give them a more positive attitude toward saving electricity, which is an important predictor of intention to save electricity, which in turn predicts electricity-saving behavior.

An important concept for the Proteus Effect is Body Ownership. Body Ownership is the feeling of a person that a virtual body is their own (Kilteni et al., 2012). IVR can evoke a feeling of Body Ownership, which improves immersion and can cause significant behavioral consequences for users in IVR (Kilteni et al., 2013). This is an important mechanism that is related to the observed behavioral effects. Research has investigated the role of Body Ownership and found that it facilitates the Proteus Effect (Mal et al.., 2023).

This research aims to fill the gap in the relationships between avatar appearance, virtual Body Ownership, and attitude toward electricity-saving behaviors. This could provide important insights into how virtual reality can be used to have a positive influence on electricity-saving behavior.

Therefore, central to this study are the following research questions:

> *RQ1: How does the appearance of an avatar associated with saving electricity influence attitudes toward electricity-saving behavior when embodied by a user?*
>
> *RQ2: To what extent does subjective virtual Body Ownership have a moderating effect on the effect of avatar appearance on attitude toward electricity-saving behavior?*

2. Theoretical Framework

This chapter will explain why this study focuses specifically on electricity saving. It then discusses how an intervention be created that leads to pro-electricity saving attitudinal change. It explains how immersive virtual reality can play a role in behavior change. Then more specifically it elaborates on how the avatar appearance can affect attitudes. The way body ownership influences this effect is also described. The chapter concludes by presenting research questions.

2.1 Reducing energy consumption

Climate change is one of the largest threats to the environment and human society (IPCC, 2018). The effects of climate change, such as air pollution, a loss of food security, and more extreme weather (OHCHR, 2016) are a large threat to the well-being of people worldwide. It is estimated that from 2008 to 2014 around 22.5 million people were driven out of their homes because of climate or weather-related disasters each year (IDMC, 2015), and the likelihood of being displaced by a disaster was 60 percent higher in 2015 than it was in 1975 (IDMC, 2015). These numbers are expected to rise as climate change continues (IDMC, 2015). Climate change also has increasingly deadly consequences. According to the WHO (World Health Organization, 2013), climate change is expected to cause approximately 250,000 additional deaths per year between 2030 and 2050. This illustrates the variety and severity of the threats that are caused by climate change.

Collective and large-scale change is needed to tackle climate change. According to the IPCC (2018), reducing greenhouse gas emissions is the main challenge of the 21st century. The United Nations' sustainable development goals 13, 14, and 15 relate to this future-proofing. These development goals concern treating the planet in a sustainable way to protect ecosystems and ensure a sustainable and safe future.

Human actions have caused and are continuing this problem. Human behavior, which this project is also concerned with, is therefore a key aspect of this societal issue. Pro-environmental behavior change is one of the strategies to contribute to mitigating climate change. This project aims to further understand a way to have a sustainable impact through behavior change. Examples of energy-saving actions that are recommended by the Dutch government are turning down the central heating, closing the curtains at night, avoiding using the dryer, showering for a shorter time, and turning devices off completely instead of leaving them on standby (Ministerie van Economische Zaken en Klimaat, n.d.).

Building on the last recommendation, this project will take place in the context of electricity waste. The adoption of sustainable actions is seen to be slow with electricity waste as a result (Thøgersen, 2005). Sustainable actions can save large amounts of electricity. For example, standby power has been estimated to account for up to 40% of a device's total energy use in Canada (Natural Resources Canada, 2014) and is estimated to be responsible for 3–12% of residential electricity use worldwide (Meier, 2001).

Smart devices that manage turning on and off appliances are often seen as a solution. The devices are set up to turn appliances on and off at optimal times, thereby decreasing electricity wastage. While such devices can play a role in saving electricity, they do have their downsides. Besides being expensive and complex, they are not always effective and can cause a rebound effect (Cheah et al., 2018). A rebound effect means that lower costs due to more energy efficiency could cause behavioral changes that lead to more energy consumption, thereby offsetting the reduction in electricity usage (Berkhout et al., 2000). Because of these limitations to technical solutions, it is worthwhile to look at intervention designs for behavioral changes.

2.2 Pro-environmental behavior change

Research has shown that there is a gap between people's attitudes towards the environment and their willingness to take sustainable actions. While sustainable attitudes and environmental concerns are generally high, this does not seem to translate significantly into sustainable behaviors (Thøgersen, 2005; Colombo et al., 2023). The first reason for this is that the behaviors are often habits that are hard to change (Peattie, 2010; Kleinlogel et al., 2023). Consumer values and norms also play an important role in this process (Peattie, 2010). A look at green consumption, an important part of sustainable behaviors, showed that it is a very complex and diverse process, with many different factors that are not well understood influencing people’s behavior (Peattie, 2010). This means that a positive attitude towards the environment does not necessarily translate into significant improvements in sustainable behavior. Researchers should focus on effectuating sustainable behavior change instead of only on general pro-environmental attitude change since this is just one of the factors.

A recent review by Colombo et al. (2023) reviewed different theories that are commonly used in the field of pro-environmental behavior change. The Theory of Planned Behaviour (TPB) is one of the most commonly used theories, and it has significant empirical evidence supporting it, such as in the context of energy-saving behaviors (Colombo et al., 2023). For example, Chen & Gou (2022) showed that it applies to energy-saving behaviors of students in dormitories. According to the theory of planned behavior, attitudes toward a specific behavior are an important predictor of that behavior (Ajzen, 1991). This is a better predictor than general attitudes, which in this case would be general pro-environmental attitudes. The TPB does still have its limitations as its predictive powers are limited (Colombo et al., 2023). However, a change in attitude towards electricity-saving behavior is generally expected to lead to more electricity-saving behavior.

Multiple promotional campaigns have been developed to encourage pro-environmental behavioral changes (Kleinlogel et al., 2023; Colombo et al., 2023). An example of a large campaign is the two-month mass media campaign by the Dutch government in 1990 that aimed to communicate the greenhouse effect to the public using national television, national newspapers, and billboards. Such campaigns aim mostly to encourage pro-environmental behavior by providing information. The idea here is that informing people will lead to behavior change (Colombo et al., 2023). As explained in the previous paragraph, this often does not have the desired effect. This is confirmed by research showing that while these campaigns do

increase people's environmental knowledge, they are ineffective at effectuating behavioral changes (Colombo et al., 2023; Kleinlogel et al., 2023). In the case of the Dutch mass-media campaign, an evaluation showed that the campaign resulted in somewhat increased environmental knowledge but did not cause behavioral changes (Staats et al., 1996). The researchers attributed this to environmental and social uncertainty. Kleinlogel et al. (2023) also explain that increasing general knowledge about climate change issues has a limited impact on pro-environmental behaviors. For this reason, other interventions should also be considered.

Kleinlogel et al. (2023) state that the most successful behavioral interventions break habits by letting people experience alternative behavioral options. For example, closing the highway for eight days made people take public transport during that time, letting them experience a different behavioral option and giving them the possibility to break their old habits. This effect persisted one year later (Fujii & Gärling, 2003). However, such interventions are not feasible in many situations. For example, most researchers would not have the resources to close a highway. It is often more achievable to convey pro-environmental messages through media such as text, video, and virtual reality. Immersive virtual reality (IVR) stands out from other media through its ability to immerse the user, and this has additional behavioral effects that allow for more active engagements with the content (Kleinlogel et al., 2023) and responding to content as if it is real (Gonzalez-Franco & Lanier, 2017). Next to having different levels of immersion, media can also have different levels of interactivity. When watching something on a screen, a person does not interact much with the content. When using Immersive Virtual Reality, however, a user has to interact with the medium by physically looking around (Kleinlogel et al., 2023). In most cases, a user can also use controls to interact with the virtual environment to a higher degree. Ahn et al. (2015) found that an experience in a virtual environment with input and haptic feedback was related to a larger behavior change than an experience on a computer where participants could only control the viewpoint. They attribute this to the higher level of interactivity. Kleinlogel et al. (2023) found that when presenting participants with the same message through print, video, and IVR, participants that were presented with virtual reality had a greater positive attitude change and changed their behavior when asked about their behavior two to three weeks after being presented with the information. This effect is attributed to the role of presence and the experiential aspect of learning new behaviors leading to a more active engagement with the content.

Its ability to mimic real life also makes IVR shine as an alternative to real-life interventions aimed at breaking habits (Kleinlogel et al., 2023). In IVR, different real-life scenarios can be simulated that mimic real life, even though they would be difficult to achieve in real life (Gonzalez-Franco & Lanier, 2017). This, in addition to the aforementioned empirically proven benefits, makes IVR a prime candidate for further research in this area.

2.3 VR and behavior change

As established in the previous paragraph, IVR is a promising area to promote pro-environmental behavior change. But how does it work? It is a complex process through which IVR affects behavior.

IVR stands out from many other media through its ability to evoke a unique sense of immersion (Kleinlogel et al., 2023). This has an influence on the feeling of “being there”, also known as presence (Kleinlogel et al., 2023). The heightened immersion that the technology evokes induces a sense of embodiment among users, which refers to the sensations related to being inside, having, and controlling a body, particularly in virtual reality contexts (Kilteni et al., 2012). As explained by Kilteni et al. (2012), this embodiment consists of three components: the sense of self-location, the sense of agency, and the sense of Body Ownership. A sense of self-location is the perception that a virtual body is located where you are. A sense of agency concerns the sense of having control of the body. This means that your actions have the sensory results that you expect, such as seeing your virtual body move like you expect it to. The sense of Body Ownership then concerns that you are the owner of the body and the body is the source of your experienced sensations. The three components may influence each other and may be more or less important to the whole illusion depending on the context (Kilteni et al., 2012). The feeling of presence and the feeling of embodiment make it so that the user feels they really are present in the virtual environment. They react to the content presented to them as if it were real life (Slater et al., 2006; Gonzalez-Franco & Lanier, 2017).

Research has shown that IVR experiences can have various pro-environmental behavioral effects. Effects that can be measured after certain IVR interventions include environmental awareness (Thoma et al., 2023) and socially engaging pro-environmental attitude and behavior change (Chirico, 2023). Such intervention studies aim for a specific behavior change and use IVR to achieve it. It becomes clear that IVR can be used as a tool for attitude and behavior change.

The behavioral effects mentioned in the previous paragraph were found immediately after the IVR intervention, but longer-lasting behavioral effects have also been found. Plechatá et al. (2022) found that IVR influenced pro-environmental dietary change when measured a week after the intervention. They attribute this to IVR increasing the effectiveness of normative feedback on self-efficacy beliefs. Kleinlogel et al. (2023) found an effect on pro-environmental attitude change two weeks after the intervention, which they attributed to IVR leading to higher engagement with the content. Fonseca & Kraus (2016) found that immersive video enhances pro-environmental attitudes as opposed to watching a video on a tablet, which they attribute to higher immersion. This shows that IVR experiences can affect attitudes and behaviors in the short term.

No existing research was found on the long-term effects of IVR interventions in the area of pro-environmental behavior change. However, Gonzalez-Franco & Lanier (2017) do describe that virtual reality experiences feel like reality and that experiences in VR can have behavioral effects similar to real-world experiences. This suggests that experience in IVR could have lasting behavioral consequences. In the field of Psychology research has shown that IVR can be used to administer simple psychological treatments (Freeman et al., 2017). Virtual Reality Exposure Therapy has also been found to have lasting effects on the treatment of phobias (Safir et al., 2012), measured one year after the treatment. Research in other treatments has found similar results (Krzystanek et al., 2021), with the effects of the IVR treatments lasting long term just like non-IVR treatments. It is important to note that

these IVR interventions were not standalone, but took place under the guidance of a therapist and were part of therapy sessions. These findings strengthen the belief that IVR interventions may have long-lasting effects, though they would likely need to be repeated to have such effects, just like non-IVR interventions. Repetition facilitates the forming of new habits and sustainable behavior change (Gardner & Rebar, 2019).

2.4 Avatars and behavior change

For all these behavioral effects, the content presented in the IVR environment determines the behavioral effects. This content is made up of different elements that have to be designed. One such important element is what the person sees when they look at themselves. This is called their virtual body. Because of the immersive nature of IVR, the person can feel this virtual body is really their body (Kocur et al., 2020). Controlling a virtual body in IVR can provide a new perspective and is a unique possibility of IVR (Kocur et al., 2020). In a virtual reality environment, people can either have their body represented by a virtual body or have no virtual body representation. In the case of no virtual body representation, they may have floating hands and a head, or only see their controllers. Alternatively, if they have a virtual body, they can see themselves and have a representation of a virtual body. Using a virtual body in virtual experiences improves the feeling of being present in the virtual world (Unruh et al., 2021). This virtual body, called the avatar, is one of the promising areas within VR (Kocur et al., 2020; Hu et al., 2023; Gorisse et al., 2023). There is a wide variety of avatars that are used in virtual environments. Taking on these virtual bodies of different avatars can have varying behavioral effects such as altering confidence in a negotiation task (Yee & Bailenson, 2007), implicit racial bias (Peck et al., 2013), and divergent thinking (Gorisse et al., 2023). This is why current research is looking into changing the avatars to achieve desired behavioral effects.

Embodiment of a virtual body significantly improves immersion and can have perceptual and psychological effects such as improved Spatial Presence and Involvement (Unruh et al., 2021). Spatial presence and involvement are subscales of presence, which is defined as the feeling of “being there”. Different characteristics of the avatar, such as personalization (Waltemate et al., 2018), its realism (Latoschik et al., 2017), and appearance (Yee & Bailenson, 2007) can influence the behavioral effects associated with the avatar. The appearance of the avatar has already been shown to affect different behaviors inside virtual reality environments such as drumming movement (Kilteni et al., 2013) and confidence in a negotiation task (Yee & Bailenson, 2007). Because of the previous evidence supporting avatar appearance as an important factor, this project will focus on the influence of the appearance of the avatar.

One important theory that explains how these behavioral effects take place is the Proteus Effect. Yee and Bailenson (2007) found that people who were assigned an attractive avatar told more about themselves and stood closer to another person, compared to people who were assigned an unattractive avatar. They also found that people who were assigned a taller avatar showed more confidence in negation, compared to people who were assigned a shorter avatar. Their explanation for this is that people take on this identity of the avatar, and act like how they believe others would expect their avatar to act. They called this the Proteus Effect.

To understand the theory behind this effect, Yee and Bailenson (2007) explain the psychological concepts that the Proteus Effect is built on and how they are applied in the context of IVR avatars.
Firstly, behavioral confirmation is the theory that the expectation of a person causes another person to behave in a way that confirms these expectations. This would mean that if someone else expects certain behavior from someone with a specific avatar, a person using this avatar could be more likely to show this behavior.
Secondly, self-perception theory states that people infer their attitudes by observing their own behaviors. For example, sporters wearing a black uniform showed more aggressive behavior than those wearing a white uniform (Frank and Gilovich, 1988). The explanation for this is that wearing a black uniform makes them identify with the group of people with black uniforms. This group is seen as being tough, mean, and aggressive. Their identification with this group causes them to show similar behaviors and thus display more aggressive behavior. The main identity cue in IVR is the avatar, so people in IVR may identify with their avatar and show behaviors similar to how they expect their avatar to behave.
Thirdly, deindividuation is the concept of a psychological state of a person being more anonymous and less connected to their personal values and responsibilities, which can lead to behavior that they would not normally display. Research shows that deindividuation strengthens the effects of the self-perception theory (Johnson & Downing, 1979). So when a person feels more anonymous they adhere more to identity cues. Online environments contribute to deindividuation due to anonymity and reduced social cues (Kiesler et al., 1984). This means that being in a virtual environment could strengthen the effects of identification with the avatar. These mechanisms provide an explanation for the Proteus Effect, supported by different psychological concepts.

The Proteus Effect has been used in a substantial amount of research (Gorisse et al., 2023)(Mal et al., 2023; Oyanagi & Ohmura, 2019). In such research, a specific avatar is used in order to elicit specific behavioral effects. For example, Gorisse et al (2023) used an avatar representing Leonardo Da Vinci to successfully stimulate divergent thinking. Oyanagi & Ohmura (2019) found that using a bird avatar decreased anxiety about falling and fear of heights in a flying experiment, as opposed to no avatar. A meta-analysis (Ratan et al., 2020) of 46 experimental studies has shown that the Proteus Effect is reliable and has a small to medium effect.

This effect can be observed both inside and outside of social settings (Kilteni et al., 2013). Kilteni et al. (2013) argue that the Proteus Effect is intended for social settings. This is logical since the deindividuation process is usually associated with being part of a group, and behavioral confirmation is related to a social context. Outside of social settings, they attribute this temporary effect on behaviors and attitudes to higher-level cognitive processes. Some of these higher-level cognitive processes were identification with the social group the avatar would belong to and a temporary adaptation of some parts of their cognition. Since there does not seem to be a name for this effect outside of social situations, it will be referred to in this project as the Proteus Effect, even though it is designed for social situations.

Despite the amount of research detailing the behavioral effects of avatar appearance in IVR, there is little research on whether any behavioral effects can be observed after the IVR experience. Yee et al. (2009) found that changes in negotiation confidence in a virtual environment due to the Proteus Effect were also observed in a face-to-face interaction after the virtual experience. This self-perception effect outside of VR was attributed to an observation of their own previous behavior within VR. This shows that IVR avatar appearance can affect behavior after the experience.

If a person associates a character with saving electricity, they will expect this character to show more electricity-saving behavior. According to the Proteus Effect, if a person inhibits an avatar with the appearance of such a character, they may act in a way where they conform to such expectations. This would mean that they may show more electricity-saving behavior. Since certain effects of VR can be measured after the experience and self-perception theory says people infer their own attitudes through observing their behavior, the following hypothesis is presented:

> *H1: Embodying an avatar whose appearance is associated with saving electricity has a moderate positive effect on attitude towards electricity-saving behavior compared to an avatar whose appearance is not associated with saving electricity.*

2.5 Body Ownership

Body Ownership, one of the three components of embodiment, has been shown to play an important role in facilitating the Proteus Effect. Previous research found that Body Ownership was not influenced by the avatar (Kilteni et al., 2013) but that Body Ownership did significantly influence changes in participants' behavior in a drumming experiment caused by the avatar. Visuomotor congruence is important for a Body Ownership effect (Kilteni et al., 2015). This means that when a person moves their body they can see the correct corresponding movement of their body.
Other important mechanics are visuotactile and visuoproprioceptive information. This concerns sensing corresponding tactile and visual information, and corresponding visual information with the feeling of where the parts of your body are that you cannot see (Kilteni et al., 2015). Virtual reality technologies are essential to facilitating these congruent stimuli (Kilteni et al., 2015). Mal et al. (2023) found that body ownership is an important facilitator of the Proteus Effect, which suggests a role for Body Ownership as a moderator for facilitating the behavior change brought about by the avatar.

As described in the introduction, Body Ownership is the feeling of a person that a virtual body is their own (Kilteni et al., 2012). Virtual Body Ownership has been shown to invoke substantial behavioral consequences inside VR (Kilteni et al., 2013). It is possible for people to feel Body Ownership for virtual bodies that differ from their own (Slater et al., 2010) and the level of ownership when embodying these different bodies can be the same as when embodying a human body (Kilteni et al., 2013; Kilteni et al., 2015; Krekhov et al., 2019).
Kilteni et al. (2013) found that the strength of the illusion of Body Ownership influenced observed behavioral changes caused by the avatar. Since this shows that virtual Body Ownership is important in facilitating behavior change, this could potentially act as a moderator

in the relationship between avatar and attitude towards pro-environmental behavior. The Proteus Effect which makes the player behave like they think the avatar would behave, would only be affected when the player feels like the virtual body is their body. This leads to the following hypothesis:

H2: Subjective Virtual Body Ownership has a positive moderating effect on the effect of avatar appearance on attitude towards electricity-saving behavior.

2.6 Research model

Based on the hypotheses formulated in the previous sections, the following research model is proposed to show the relationships in this research:

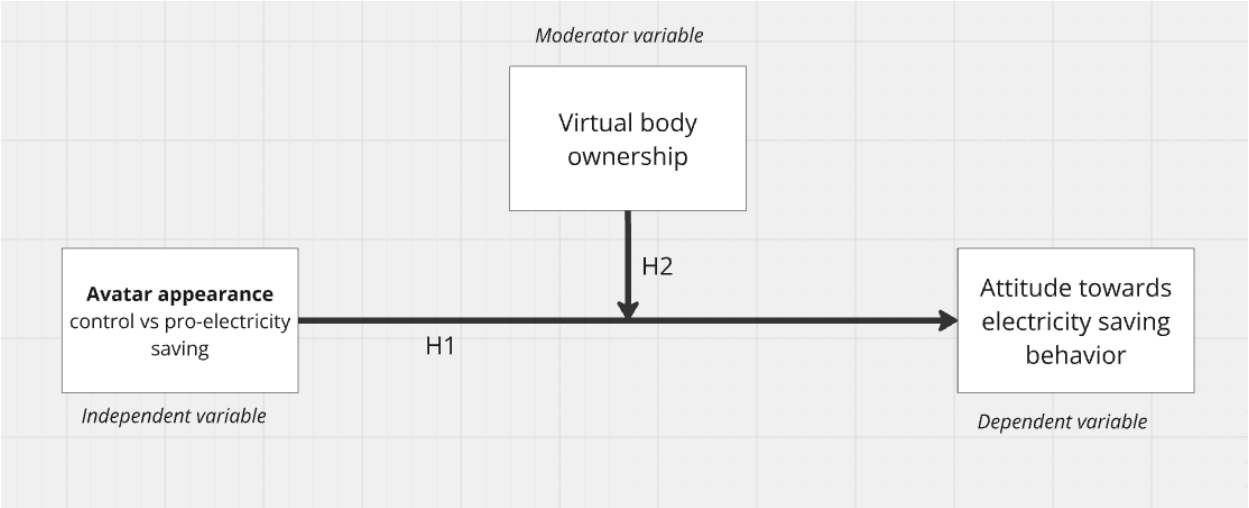

Figure 1: Research Model

3. Method

This chapter presents the methods used to conduct the study. It elaborates on the design, the participants, the procedure, the stimulus materials, and the measurements of the research.

3.1 Research design

A single factor between-subjects experiment was conducted to test the hypotheses and the research model. Participants are divided into two conditions. They undergo a specific virtual reality experience. In this experience, participants in the intervention condition used a pro-environmental avatar, while participants in the control condition used a neutral avatar. Before executing this study, a virtual reality avatar was needed that was associated with saving electricity.

3.2 Avatar survey

I conducted a survey to find which avatar would be well-suited for this study.

Using Qualtrics, I created a questionnaire. It first collected some basic demographic data (age, gender, level of education). The questionnaire then showed pictures of characters and asked questions related to whether participants liked the character, if they identified with the avatar, and whether they associated the character with saving electricity. An open-ended question was included to ask what characteristics of the characters influenced the participants' decisions. Identification data was collected because identification increases the likeliness to perform learned behavior (Bandura & Huston, 1961).

To determine which avatars would be shown in the questionnaire, a search was done for virtual models that are human and are expected to be associated with saving electricity. The models needed to be of high enough quality and suitable for use as VR avatars. Different resources and websites were looked through such as Microsoft Rocketbox, CGTrader.com, and Resonite avatar worlds. The avatars selected from these sources were a farmer, a person dressed as a pumpkin, a hippie, and a person dressed as a plant.

The farmer was selected because they have a close connection to nature and may thus be positive towards preserving the environment. The hippie was selected because, historically, they are associated with liking nature and protecting the environment, and alternative lifestyles that align with environmentalism. The plant and pumpkin-dressed avatars were chosen because they appear to be close to nature and sympathize with the environment. Two of the avatars were male and two were female. See Figure 2 for the images of the avatars.

The questionnaire was pilot-tested with five participants outside of the target audience. Participants were approached by the researcher through convenience sampling. This pilot's aim was to check the clarity of the questions and recognize any problems with the methodology. Participants outside the target group were used not to limit the number of people in the target group who could take the questionnaire after the pilot. One of the pilot respondents indicated that their decision was influenced by what the character was holding and their pose. To improve

this, after the pilot, the images were changed where possible so the characters were not holding anything, had a neutral pose, and had a neutral facial expression. Even after these changes, however, the poses and facial expressions of the avatars still differed. This can be seen in Figure 2.

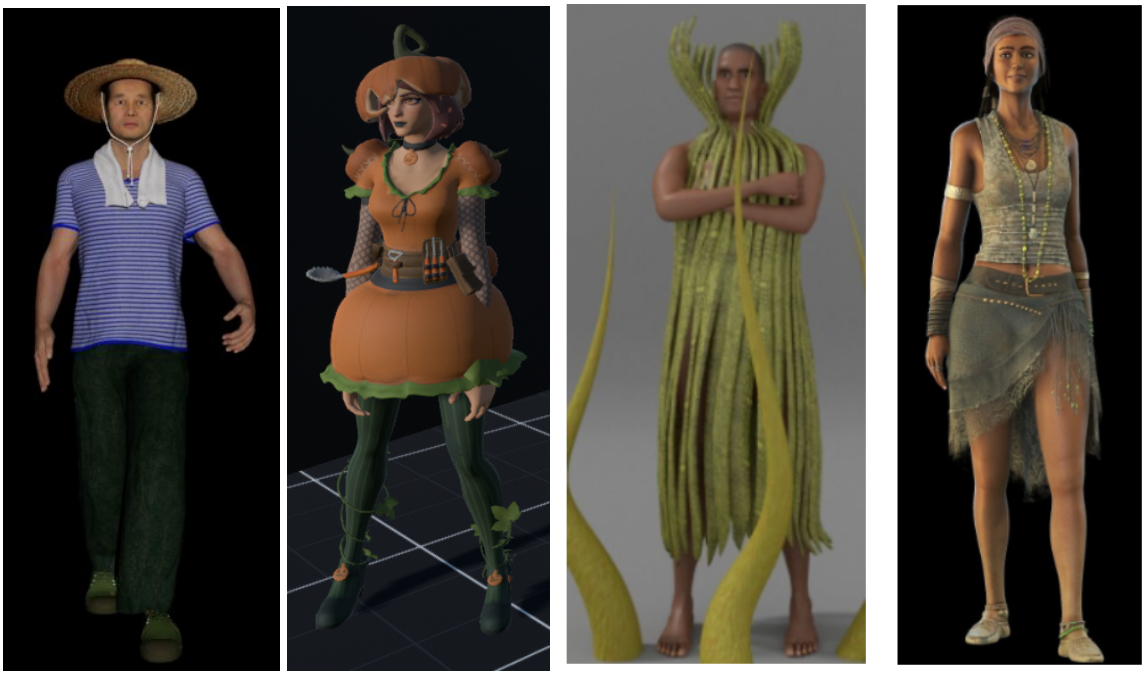

Figure 2: Improved avatar images. From left to right: farmer, pumpkin-dresses character, plant-dressed character, and hippie.

The questionnaire was distributed online and in person using convenience sampling. In-person, a snack was offered as a reward for filling in the survey. After removing incomplete responses, the number of responses collected was 19. The sample was balanced in terms of gender, with 9 men, 9 women, and one participant who preferred not to disclose their gender. There was considerable age variation (M = 24.3, SD = 7.64).

The results showed that the hippie character scored highest in pro-environmental and electricity saving. The hippie character also scored highest at being liked and being identified with. For a visualization of the results, see Figure 3. The hippie avatar was, therefore, chosen to be used for the experiment.

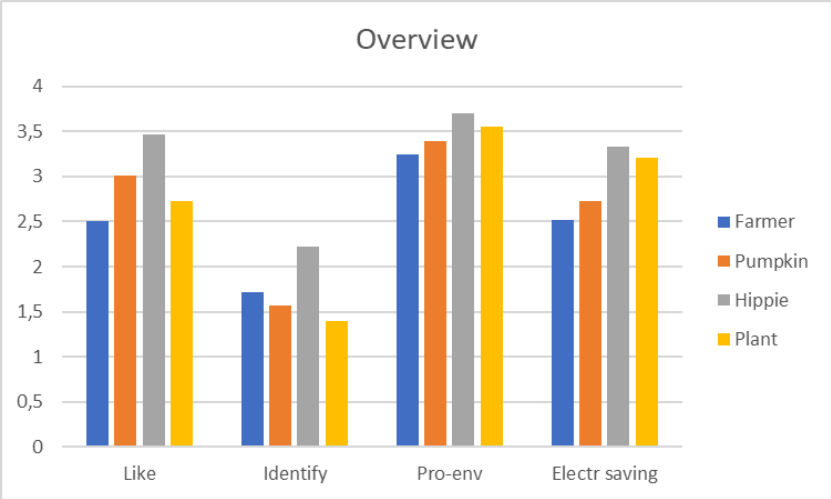

Figure 3: Avatar survey results per avatar

3.3 Participants

Participants were studying in the Netherlands. Exclusion criteria were abnormal eyesight, medical or physiological conditions affecting their safe use of VR, implanted electrical health devices, and having experienced moderate to severe motion sickness symptoms while using a virtual reality headset. Participants were recruited at the University of Twente through convenience sampling. Participants were compensated with a small snack at the end of the experiment. A significant portion of the participants were ATLAS students. Since this study does cover sustainability, the sample may be biased towards higher pro-environmental attitudes and knowledge.

32 participants took part in the study. Three participants were used for a pilot and another participant's data was invalid. Therefore, the final analysis was based on 28 participants. The gender distribution was 36% woman, 61% man, and 3% non-binary. The mean age was 22.8 years, and the age variance SD 2.69. The current level of education was 64% bachelor's and 36% master's. The nationality of 22 participants was Dutch, and six participants had different nationalities. The nationalities of these participants are Argentina, the Czech Republic, Germany, Poland, Russia, and the USA. The participants were split equally over the intervention and control conditions, resulting in 14 participants in both groups. Table 1 shows the distribution of the respondent's characteristics over the conditions. One noticeable difference is that the intervention condition sample includes many men while the control condition has a balance of men and women. There is also more age variation among the intervention condition participants.

		Overall	Intervention	Control
Gender	Male	17	10	7
	Female	10	4	6
	Non-binary	1	0	1

Age	Mean	22.8	22.9	22.7
	SD	2.69	3.23	2.02
Level of education	Bachelor's	18	8	10
	Masster's	10	6	4

Table 1: Distribution of participant characteristics over conditions

3.4 Research procedure

3.4.1 Experimental set-up

The experiments took place in a room in the Citadel building at the University of Twente. For a picture of the experimental setup, see Figures 4 and 5.

A Lenovo Legion 5 Slim laptop was used to run the Virtual Reality Experiments. Specifications include a Nvidia RTX4070 graphics card, a Ryzen 7840HS processor, and 16Gb RAM. The Virtual Reality Head Mounted Device (HMD) used was a Valve Index. It included four lighthouses mounted to pipes on the ceiling for tracking. It was connected to the laptop using a DisplayPort to USB-C converter. 3 Tundra Trackers were used to track player movement, along with a SW4 dongle to connect the trackers to the laptop. NIR EOZ straps were used to strap the trackers to the participants. One belt strap was used for the waist and two utility straps were used for the ankles.

The software used includes Windows 11, Steam VR 2.5, and Resonite version 2024.5. Resonite is a social VR platform that allows users to create custom content.

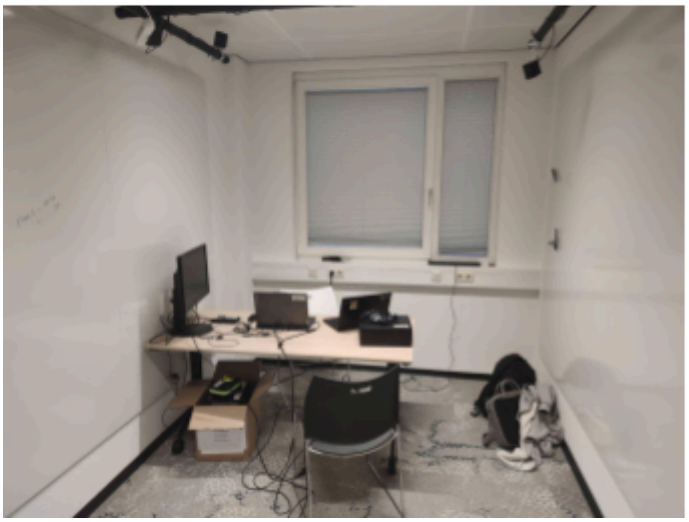

Figure 4: The room in which the experiments took place

Figure 5: A participant.

3.4.2 Experiment procedure

An intake form was distributed through WhatsApp. The intake form enabled participants to choose a day and time for the experiment and allowed them to read the consent form and information brief. It also checked for inclusion and exclusion criteria. Participants were given incomplete information to minimize the demand characteristic in the study: they were not told that the focus of the research was the avatar.

Shortly before the experiment, participants were assigned to conditions using urn randomization with a modifier. This allowed for reducing bias in assigning conditions to participants but still achieving two groups of similar size. Anaconda Notebook was used for this. See Appendix A for the code. Participants were also assigned a participant number. The avatar's height was adjusted to match the participants' self-reported height.

At the start of the experiment, participants read an information brief and signed a physical consent form. Next, they filled out a questionnaire using their phone (see 3.6 for measures). The researcher stayed in the room during this time. After completing the questionnaire and a safety explanation, three trackers are attached to the participant. I decided to use three trackers after testing this on myself, with the goal of striking a good balance between taking a lot of time to put on and having good tracking accuracy. The researcher also explained the controls including teleportation. The participants then entered IVR. Here they embody either the hippie or neutral avatar, depending on which condition they were assigned to.

The feeling of Body Ownership usually takes a few minutes to take effect fully, which is why experiments where a feeling of Body Ownership is desired, practices commonly include full body tracking and seeing yourself in a mirror (Slater & Sanchez-Vives, 2014) (Kilteni et al., 2013) (Yee & Bailenson, 2007). Participants must complete a few simple exercises in front of a mirror to invoke Body Ownership and get familiar with the controls. This means they can see their virtual body which is generally seen to promote Body Ownership.

The gamified task is then explained, and participants must press all buttons once as practice. Then, when the task starts, participants have to press buttons to turn off appliances in the house. They use teleportation to move to the buttons and can also take a physical step in the space. They press the button by touching it using their hands. The participants did not need to press any buttons on the controller. After 15 seconds of being turned off, the appliances would turn themselves on again and the participants have to turn them off again. A display keeps track of the electricity currently being used, and the total electricity used. The participant's goal is to use the least amount of total electricity. This amount is also shown at the end of the task. This final task score is recorded for analysis. During the task, the researcher takes notes of things that stand out such as unexpected behavior, participant opinions on the task or bugs. This is done to document unexpected events and contextualize the results.

After the experience, the participants filled in another questionnaire using their phone. In the debriefing that followed, participants were told that the goal of the research was to look at the effect of the avatar and asked to keep this private from others to maintain the integrity of the study.

Participants provided modular and informed consent. For the script and preparations checklist used, see Appendix B. The CIS ethics committee of the University of Twente has reviewed and approved this research under application nr 230719.

3.4.3 Pilot

A pilot was conducted with three participants who met the inclusion and exclusion criteria. The pilot aimed to refine the experimental procedure and reduce potential problems. Significant edits to the virtual environment were made. The procedure was adjusted as well. There were no remarks on the questions being unclear.

3.5 Stimulus material

For the experiment, two conditions were used. One condition used an avatar associated with saving electricity while the other condition used a control avatar.
The avatar associated with saving electricity was a hippie based on the avatar survey (see Figure 3). The avatar was purchased online and imported into Resonite. It should be noted that the color of the avatar deviated slightly from the color of the avatar displayed in the avatar survey. It became apparent after purchasing the avatar that the image used in the avatar survey had slightly warmer colors. For the experiment, the color of the avatar model was not modified.

A neutral avatar was also needed for the control condition. The appearance of this avatar should be neutral, so the difference between the avatars is whether their appearance is associated with electricity-saving behavior. It would be ideal to change just the clothes of the hippie avatar, so all other aspects of the behavior would stay the same. However, this proved challenging. Therefore, a new avatar was designed using Ready Player Me to look similar to the hippie avatar. The skin tone, hair color, and gender could be matched well. The main differences between the avatars are some facial features, body type, and hairstyle that could not be matched very accurately. The avatar also looks less realistic and younger. See Figures 6 and 7 for images of both avatars.

Figure 6. Hippie and control avatar

Figure 7. Hippie and control avatar in virtual environment

A virtual environment was needed where the participants could perform electricity-saving behavior. I decided to structure the experience as a game. This encourages participants to display the desired behavior. Making sure that participants perform electricity-saving behavior is important for the self-perception theory. Turning off lights and other appliances when not in use is one of the most simple and commonly researched electricity-saving behaviors (Canova & Manganelli, 2020; Suntornsan et al., 2022; Lee & Tanusia, 2016; Niehoff, 2021).

A virtual world was needed where participants could perform the task. An existing Resonite virtual reality world was altered to create the desired virtual world. To find a suitable existing environment to adapt: the researcher looked through publicly available Resonite worlds with the search terms “house” and “home”. I looked for worlds that were the right size for the experiment, had good lighting, and looked realistic, therefore, I decided to use the virtual world 4Room.

Four lamps and a ceiling fan were present in the chosen world, but more appliances were needed for the task. A search was done for common household appliances in Resonite that had the functionality to be turned on and off. A TV was found as a result. In the end, there were six appliances in the house. These included four lamps, a TV, and a ceiling fan. For programming,

Resonite's visual coding language Flux was used. The lamps and ceiling fan could be turned on and off using a button. Four of the buttons had a small light on it that indicated whether the appliance was turned on or off, to provide additional visual feedback. The TV was turned on or off by touching it. The appliances were programmed to turn off again after 15 seconds. A display counted the number of appliances turned on at any time and calculated and displayed the current and total electricity usage. After the task was finished, the total electricity used was displayed. The task lasts for four minutes. Since the task is quite repetitive, it is possible for participants to become bored with the task. This setup allows for investigating if participants in the control condition get bored more easily and achieve worse task scores. Mirrors were placed in the environment so that participants would be able to see themselves in the mirror during the task. This is done to improve body ownership and make sure participants are aware of their avatars. See Figures 8-10 for images of the virtual world.

For credits of the world and other credits, see Appendix C.

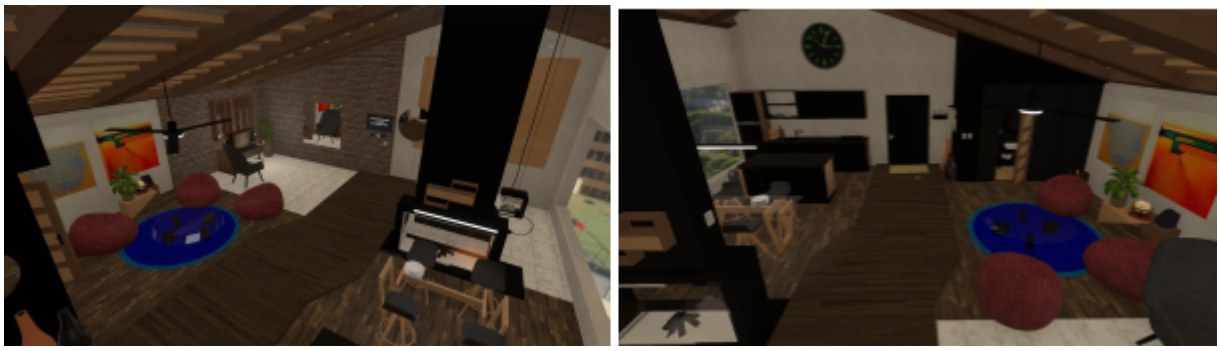

Figure 8. Two images of the virtual world in which the experiment took place.

Figure 9. The device that counted the electricity being used and the total electricity used.

Figure 10. View of the mirror where participants did simple exercises.

3.6 Measurements and Reliability

3.6.1 Measurements

The measurement instrument consisted of questions about demographics, questions measuring the dependent variable and covariates, manipulation check questions and explanatory open questions. Most of the items were partially adopted from previous research. For the complete list of items, see Appendix D.

The items measuring the concept of *Attitude Towards Electricity-Saving Behavior* were adapted from Conner, Norman & Bell (2002), as suggested by Ajzen & Fishbein (2008). It was originally used for attitudes in the context of healthy eating and used 7-point bipolar semantic-differential scales. It was adapted so it can be used in the context of saving electricity. The sentence “My eating a healthy diet would be/is...” was adjusted to “I believe saving electricity is” and a 5-point scale was used instead of a 7-point scale. The six semantic-differential scale items remained the same.

The items measuring the concept of *Body Ownership* originate from Blom et al. (2014). Out of their ten questions, the first four measured *Body Ownership*. They used an anchored 5-point Likert scale with 1 as ‘strongly disagree’ and 5 as ‘strongly agree’. These four questions were used for this research, using the same 5-point Likert scale. However, due to an error in editing the questionnaire administered during the experiments, the fourth item incorrectly stated “Even though the virtual body I saw did not look like me, I felt that the virtual body that I saw was someone else” instead of the correct “I felt that the virtual body that I saw was someone else”.

Seven manipulation check questions were created. They were used firstly to check that the participants were aware of the avatar they inhibited, corresponding to their condition. This construct was named *Special Appearance*. The manipulation questions also checked to what extent participants associated their avatar with electricity saving. This construct was named *Electricity Saving*.

Additional questions inquired about the participant's age, nationality, level of education, experience with IVR, and experience with IVR with body tracking. For inquiring about their gender we used the response options suggested by Spiel et al. (2019).

Three explanatory open-ended questions were also incorporated. They were aimed at getting participants' insights on the effect of the avatar, influences on task performance, and the avatar’s gender influence.

3.6.2 Construct Validity and Reliability

The validity and reliability of the scales were examined to ensure the quality of the measurement instruments. The validity was tested with an exploratory factor analysis and the reliability was tested through a reliability analysis using Cronbach's alpha. The software IBM SPSS Statistics was used for the analysis. See Appendix D for the complete list of items.

3.6.2.1 Attitude Towards Electricity-Saving Behavior and Body Ownership - Validity and Reliability

As mentioned in 3.6.1, item BO4 was formulated wrongly in the questionnaire due to an error. This may have compromised the question's validity, which will be checked in the factor analysis.

The pretest and posttest values of *Attitude Towards Electricity-Saving Behavior* were combined for the factor analysis. Before conducting the factor analysis, Bartlett's test of sphericity was conducted which was significant ($p < 0.001$). The sampling adequacy was also measured and found to be unacceptable, with a Kaiser–Meyer–Olkin (KMO) value of 0.44. This could be due to different reasons, but a low sample size is an important contributing factor. This makes the data not suitable for factor analysis. Items can be removed to attempt to raise the KMO. The individual MSO scores and factor loading scores were examined to decide which variables should be removed.

An exploratory factor analysis of Attitude Towards Electricity-Saving Behavior and Body Ownership was conducted with a cutoff of 0.5. The factor analysis showed that item BO4 did not load onto the factor correctly and several factors from attitude loaded onto Body Ownership instead. To fix the issue of several factors from attitude loading onto Body Ownership, Attitude Towards Electricity-Saving Behavior was split into two factors. In a factor analysis with three factors, attitude items 3 and 4 load onto a separate factor from attitude items 2, 5, and 6. Attitude factor 1 still loaded onto Body Ownership. Items BO4 and ATESB1 were thus discarded. The discarding of BO4 is likely related to the incorrect phrasing as mentioned before.

Afterward, the KMO was 0.41. This was still unacceptable. ATESB6 was found to have a very low MSA value. This lowered the KMO significantly. Removing ATESB6 increased the KMO from 0.41 to 0.55. This is a significant improvement. However, this is still terrible, so the factor analysis results have low merit. This is most likely due to the low sample size. Together, the three factors explain 71% of the variance. Out of the 10 initial items, seven items remained.

After removing ATESB6 a clear split in the attitude items remained. Items ATESB3 and ATESB4 coded as their own factor, separate from ATESB2 and ATESB5. This is unexpected because the scale was previously validated in a different domain.
Items ATESB3 and ATESB4 concern whether the behavior is pleasant and enjoyable. This factor is called "*Perceived Enjoyment of Electricity Saving*". ATESB2 and ATESB5 concern whether the behavior is beneficial and wise. This factor is called "*Perceived Benefits of Electricity Saving*".

Using these factors, Cronbach's alpha was calculated for each factor. For attitude, the pretest and posttest reliability were calculated separately. Since the results from the factor analysis

have low validity, Cronbach's alpha values are not expected to be very high. Table 2 gives an overview of the results of the validity and reliability analyses.

Construct	α (pre/post)	Item	Component 1	Component 2	Component 3
Perceived Benefits of Electricity Saving	0.68 / 0.50	ATESB5 I believe saving electricity is Foolish-Wise			0.85
		ATESB2 I believe saving electricity is Harmful-Beneficial			0.80
Perceived Enjoyment of Electricity Saving	0.64 / 0.83	ATESB4 I believe saving electricity is Unenjoyable-Enjoyable	0.93		
		ATESB3 I believe saving electricity is Unpleasant-Pleasant	0.91		
Body Ownership	0.64	BO3 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body I saw was my body.		0.83	
		BO2 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body that I saw when I looked down at myself was mine.		0.76	
		BO1 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body I saw in the mirror was mine.		0.69	

Table 2: Factor analysis results of Attitude Toward Electricity-Saving Behavior and Body Ownership

3.6.2.2 Manipulation Check - Validity and Reliability

Before conducting the factor analysis, Bartlett's test of sphericity was conducted which was significant ($p < 0.001$). The sampling adequacy was also measured and found to be adequate (KMO = 0.7).

The factor analysis included seven items and the two factors explain 80.4% of the variance.

After the factor analysis confirmed the factors, Cronbach's alpha was calculated for each factor. Table 3 gives an overview of the results of the validity and reliability analyses.

Construct	α	Item	Component 1	Component 2
Special Appearance	0.92	MC6	0.94	
		MC5	0.91	
		MC7	0.86	
		MC4	0.86	
Electricity Saving	0.85	MC2		0.95
		MC1		0.95
		MC3		0.74

Table 3: Factor analysis results of the manipulation check

3.6.3 Manipulation Check Results

Two independent sample t-tests were performed to evaluate the result of the manipulation checks.

First, the manipulation check regarding the avatar being associated with electricity saving was performed. This is items MC1-3. On a scale of 1-5, the mean of the intervention condition is 3.79 and the mean of the control condition is 3.40. A Levene Test showed that the variance of both groups cannot assumed equal ($p = 0.045$). A Welch t-test showed that the null hypothesis failed to be rejected ($p = 0.323$, $t(21.0) = 1.01$). The effect size is low to medium (Cohen's $d = 0.383$). The means of the two groups are not significantly different.

Then, the manipulation check regarding the avatar being dressed in a special way was performed. This is items MC4-7. On a scale of 1-5, the mean of the intervention condition is 3.34 and the mean of the control condition is 1.93. A Levene Test showed that the variance of both groups is cannot be assumed equal ($p = 0.033$). Since the groups cannot be assumed to have equal variance, a Welch t-test was performed. This showed that the null hypothesis was rejected ($p < 0.001$, $t(18.6) = 5.38$). The effect size is very large ($d = 2.034$). The means of the two groups are significantly different.

4. Results

The current chapter outlines the results of the study. This includes main effects, moderating effects, additional findings, and qualitative results.

4.1 Main effects

Our first hypothesis was that the participants embodying the avatar associated with saving electricity would have a significant increase in *Attitude Towards Electricity-Saving Behavior*. *Attitude Towards Electricity-Saving Behavior* has been split into *Perceived Benefits of Electricity Saving* and *Perceived Enjoyment of Electricity Saving*. The appearance of the avatar is expected to influence both of these. Difference scores are used for the analysis. For *Perceived Benefits of Electricity Saving* and *Perceived Enjoyment of Electricity Saving* the difference score is determined by subtracting the average posttest score by the average pretest score.

Two t-tests were used to test whether the independent variable has a significant effect on the dependent variables when not controlling for Body Ownership. The average difference score of *Perceived Benefits of Electricity Saving* is higher for the intervention group (M = 0.250, SD = 0.700) than the control group (M = -0.710, SD = 0.332). The first t-test showed that this difference is not significant (P = 0.133, t(26) = 1.552). The effect size was medium (d = 0.587). Variance was assumed equal, levene test p = 0.076.
The average difference score of *Perceived Enjoyment of Electricity Saving* is lower for the intervention group (M = -0.107, SD = 0.561) than the control group (M = 0.036, SD = 0.458). The second t-test showed that this difference is not significant (p = 0.467, t(26) = -0.738). The effect size was low (d = -0.279). Variance was assumed equal, levene test p = 0.467.

Two ANCOVAs were then used to control for Body Ownership. The first ANCOVA examined the effect of the condition on the *Perceived Benefits of Electricity Saving* when controlling for *Body Ownership*. The covariate body ownership was checked to be independent of the condition (p = 0.559). The interaction term of body ownership and condition was checked to be insignificant (p = 0.183). The ANCOVA revealed no significant effect of the condition on the *Perceived Benefits of Electricity Saving* when controlling for *Body Ownership* (p = 0.174). The effect size was medium (η^2 = 0.073).

The second ANCOVA examined the effect of the condition on *Perceived Enjoyment of Electricity Saving* when controlling for *Body Ownership*. Body ownership was already shown to be independent of the condition in the previous ANCOVA. The interaction term of body ownership and condition was checked to be insignificant (p = 0.993). The ANCOVA revealed no significant effect of the condition on *Perceived Enjoyment of Electricity Saving* when controlling for *Body Ownership* (p = 0.524). The effect size was small (η^2 = 0.016).

The mean of *Perceived Enjoyment of Electricity Saving* was significantly lower than the mean of *Perceived Benefits*. A Welch t-test confirmed this for both the pretest (p < 0.001, t(43.4) = -9.53) and posttest data (p < 0.001, t(41.9) = -10.3). The effect sizes were very high (η^2 = -2.546 and η^2 = -2.749 respectively). See Table 4 for means and standard deviations.
Participants already had a high attitude towards the perceived benefits of electricity saving. The pretest mean was 4.63 on a 5-point Likert scale. This is very high.

	Mean pretest	SD pretest	Mean posttest	SD posttest
Perceived Enjoyment of Electricity Saving (1-5)	2.89	0.832	2.86	0.837
Perceived Benefits of Electricity Saving (1-5)	4.63	0.484	4.71	0.460

Table 4: Means and standard deviations of Perceived Ejnoyment of Electricity Saving Behavior before and after the experiment.

Since no significant main effect of the condition on *Perceived Benefits of Electricity Saving* or *Perceived Enjoyment of Electricity Saving* was found, H1 is not supported.

4.2 Moderating effects

Body ownership was hypothesized to moderate the effect of the condition on *Attitude Towards Electricity-Saving Behavior*. It is important to note that no main effect of the condition on *Attitude Towards Electricity-Saving Behavior* was found. This could mean that due to an unsuccessful manipulation no moderating effect can be found either.

Two moderation analyses were run using Andrew Hayes' Process macro for SPSS v4.2. First, the possible moderation of *Body Ownership* on the effect of *Perceived Benefits of Electricity Saving* was examined. No significant moderating effect was found ($p = 0.183$, $t = -1.373$, $b = -0.515$). Subsequently, the possible moderation of *Body Ownership* on the effect of *Perceived Enjoyment of Electricity Saving* was examined. No significant moderation effect was found ($p = 0.933$, $t = 0.400$, $b = -0.034$).

As no significant moderating effects of Body Ownership were found, H2 is not supported.

4.3 Additional findings

Some more analyses were run that did not have a hypothesis. Noteworthy results are highlighted.

The effect of the condition on the *task score* was examined while controlling for *experience with VR* and *experience with VR with body tracking*. No significant effect was found.
However, strong correlations were found between *experience with VR* and *task score* ($p < 0.001$, $r = 0.706$), and between *experience with VR with body tracking* and *task score* ($p = 0.004$, $r = 0.528$). A simple regression shows that *experience with VR* strongly predicts *task score* ($p < 0.001$, $\eta^2 = 0.964$). Note that this is a negative correlation since lower task scores are better task scores. More experience with VR is correlated to a lower, and thus a better, task score. See Figure 11 for a scatterplot of experience with VR and *task score*.

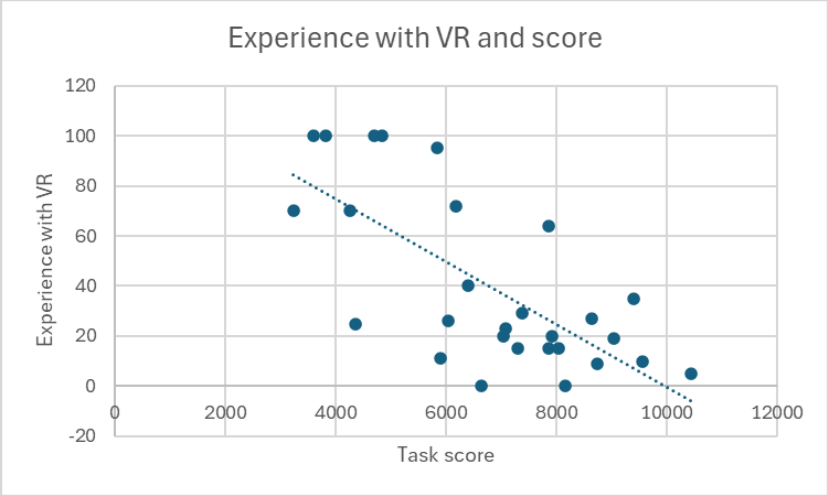

Figure 11: Scatterplot of experience with VR and task score

No significant effect of condition on Body Ownership was found. The average level of Body Ownership is moderately high. The average score per item on the 5-point Likert scale is 3.75 with a standard deviation of 0.52. Blom et al. (2014) from where the scale is adapted described a median of 4 as high Body Ownership for items BO1, BO 2, and BO3. In the current study, the responses to items BO1, BO2, and BO3 have a median of 4 as well. This means the level of Body Ownership is similar to the level of Body Ownership found by Blom et al. (2014) which they described as a high level of Body Ownership. So the level of body ownership of participants in the current study could be described as high.

4.4 Observations and open-ended questions

4.4.1 Observations

During the experiments, observations were written down by the researcher. These observations could give additional insights. Noteworthy results from these notes are described below.

Some participants mentioned during the task that it felt like the task did not make much sense. The appliances seemed to them to be using a lot of electricity because they kept turning themselves on. This made some participants feel like their efforts at reducing the energy used were futile.

Some issues with the avatar models were observed. On multiple occasions, the hair of the control avatar was blocking the view of the participants. The posture of the control avatar was occasionally inaccurate to the posture of the participants. It also happened on multiple occasions to both avatars that the feet of the avatar sunk into the floor. On other occasions, the body tracking did not work properly all the time. This led to virtual body parts being in an incorrect and unnatural position for a short time. This seemed to temporarily take participants out of the experience a bit but they recovered from this quite quickly.
The tracker straps were also not very well suited for all body sizes. For example, for participants with a small waist, the belt strap was a bit loose.

Multiple participants used a strategy where they did not take any steps and used only teleportation to move around the space. Most participants who did this started out taking physical steps as well and at some point during the task transitioned to using only teleportation to move around the space. Some participants also started rotating their view using the joystick instead of physically moving around. This was not thought of as the intended way of rotating their view.

Multiple participants mentioned that they were not very aware of their avatars during the task. During the task, participants were focused on the task and did not look into the mirror much. Because the participants teleported to the buttons, they did not pass the mirrors. This meant that they saw themselves in the mirror on very few occasions.

It happened frequently that participants would press a button twice when they tried to press it once, which turned the appliance on again.
The program did suffer occasional lag spikes. This is likely hardware-related and can decrease immersion or cause motion sickness. A possible cause could be the use of a DisplayPort to USB-C adapter. Participants did not mention being severely hindered by this.

4.4.2 Open-ended questions

The results of the open-ended questions were looked through and relevant answers and answers that were mentioned multiple times are described below.

Avatar Appearance
Some participants stated they were not very aware of their avatars. Some also stated they thought the avatar didn't influence their experience much. Regarding the avatar appearance, one participant wrote: "*I don't believe it affected my experience at all. I was not paying attention to how the character looked.*". Another participant wrote that the avatar appearance did not influence their experience much because they were "focused on saving electricity".

Factors Impacting Task Score
Multiple participants stated that familiarity with VR was quite an important factor in determining task performance. Two participants mentioned being competitive as influencing their task score. Being scared to hit the wall has led some participants to be more careful and negatively impacted their performance. The cable of the headset was mentioned by three participants as hindering their performance.

Gender
Almost all participants said that the gender of the avatar did not significantly influence their experience if the gender of the avatar was different from their gender.

5. Discussion

This research investigated the relationships between avatar appearance, body ownership, and attitude toward electricity-saving behavior. The results of the study will be discussed, along with their implications. Additionally, the limitations of the study and recommendations for future research will be addressed.

5.1 Discussion of results

The pro-environmental avatar failed to be significantly more associated with saving electricity than the control avatar. Additionally, the anticipated result of the pro-environmental avatar increasing electricity-saving attitudes was not found. The study's limited sample size decreases the reliability of the results.

5.1.1 Main effects

The two ANCOVAs showed no significant effect of the condition on the *Perceived Enjoyment of Electricity Saving* and *Perceived Benefits of Electricity Saving*. An explanation for why the *Perceived Benefits of Electricity Saving* did not increase is most apparent. Participants already possessed a very positive attitude towards the benefits of electricity saving before the experiment (mean = 4.63 out of 5). This makes it unlikely for the mean to increase significantly. In terms of why *Perceived Enjoyment of Electricity Saving* did not increase, several factors may have contributed to this.

Firstly, the hippie avatar may not have been sufficiently associated with saving electricity. The manipulation check showed that the hippie avatar was not significantly more associated with saving electricity than the control avatar. This is not expected because, in the avatar survey, the hippie was chosen as most associated with saving electricity. It was therefore expected that the hippie would be significantly more associated with saving electricity than the control avatar. A possible explanation for this is that the participants did not associate the hippie avatar with electricity to the desired extent, even though the avatar was selected through a survey to be the most associated with saving electricity. An alternative explanation is that the control avatar was not neutral as intended. Another explanation may be that the avatar was not well integrated into the environment and the task. A hippie may not be expected to live in such an apartment. Avatar-environment congruence can significantly affect the experience a participant has (Mal et al., 2023). Research by Mal et al. (2023) found that while avatar-environment congruence was not shown to influence the Proteus Effect, it did influence the plausibility concerning the avatar and the environment. The metropolitan area that can be viewed through the window may not be realistic for participants. For example, Dutch participants may not be very familiar with such areas and perceive the environment as less plausible. Additionally, the differences in appearance between the two avatars, such as apparent age, figure, and facial features, could have influenced the results. For example, if the control avatar was perceived as younger than the hippie avatar this could influence the results, as younger people are generally perceived as more supportive of sustainable actions (Yamane & Kaneko, 2021). Since no data was gathered on such differences in appearance between the avatars and how participants

may have perceived them, so it is not clear whether this may have been an influential factor.

Secondly, the participants may not have seen the avatar enough during the task in the virtual environment. Observations during the experiments revealed that participants did not see themselves in the mirror much during the task. The manipulation check showed that the participants were generally aware of their avatar's appearance. However, the competitive nature of the task may have hampered the awareness of the avatar during the task since the task took up a lot of concentration.

Thirdly, participants may have not felt like they were undertaking realistic electricity-saving behavior since the appliances kept turning themselves on again. Multiple participants mentioned that this made their efforts feel futile. This could mean that participants did not fully see the behavior as saving electricity.

Fourth, the experience may not have been concerned with the enjoyableness of electricity saving appropriately.

Lastly, the limited sample size would make it more difficult to find significant results. The sampling adequacy was low (KMO = 0.55).

5.1.2 Moderating effects

No significant moderating effect of body ownership on the relationship between avatar appearance and attitude towards electricity-saving behavior was found.

Since no main effect of condition on attitude towards electricity-saving behavior was found, this may have suppressed any potential moderating effects.

5.1.3 Additional findings

The analysis of scales indicated that *Attitude Towards Electricity-Saving Behavior* should be subdivided into two concepts. The two concepts were defined as *Perceived Enjoyment of Electricity Saving* and *Perceived Benefits of Electricity Saving*. There was a large difference between the means of responses to the two concepts. *Perceived Benefits of Electricity Saving* was very high while the *Perceived Enjoyment of Electricity Saving* was much lower. It is possible that the scale is not suitable in the context of electricity-saving behavior. However, these results suggest that a distinction can be made between these two subconcepts of *Attitude Towards Electricity-Saving Behavior*. The results also suggest that there is not much room for the *Perceived Benefits of Electricity Saving* to increase. The low sampling adequacy and the low amount of items per factor reduce the reliability of these findings. Existing research does point to the perceived enjoyment of electricity-saving behaviors as an important factor. Fatoki (2022) described intrinsic benefits as benefits obtained from the enjoyment of activities. This is similar to the concept of *Enjoyment of Electricity-Saving Behavior* used in this study. They recommended that, next to stimulating extrinsic benefits, intrinsic benefits should be stimulated to improve attitudes towards electricity saving.

A potential explanation for the distinction between perceived benefits and perceived enjoyment

could be that the importance of the climate crisis and taking action is broadly recognized, while personally taking action is seen as unenjoyable. This complements existing research that states that while people find climate action important, pro-environmental behaviors are not performed to the expected extent (Thøgersen, 2005; Colombo et al., 2023). The behavior being seen as unenjoyable could be an important roadblock to performing the behaviors, even though they are seen as important. Thøgersen (2005) refers to intrinsic motivation, which is related to the enjoyment of behavior, as an important factor in pro-environmental behavior change.

The results show that experience with VR and experience with VR with body tracking are highly correlated to task scores. Because of the competitive nature of the task, familiarity with the controls seems to have been the most important determinant of task score.

5.2 Implications of results

The first context in which these results may have implications is regarding the sociotechnical challenge of climate change. An intervention was investigated with the aim of increasing attitude towards electricity-saving behavior, which is a specific and small part of this complex issue. By investigating what drives people to display electricity-saving behavior, findings may be able to be used in the broader context of pro-environmental behavior change. The current study found some data pointing towards a distinction between two subconcepts of *Attitude Towards Electricity-Saving Behavior*. Since the sampling adequacy was low and few items per factor were included, the reliability of the findings is limited, and further research is needed. Future work should investigate if indeed a distinction can be made between these two subconcepts, being *Perceived Enjoyment of Electricity Saving* and *Perceived Benefits of Electricity Saving*. If such a distinction exists, similar distinctions may also be found when examining attitudes toward other forms of pro-environmental behaviors as well. This could help to understand what drives people to display pro-environmental behavior.

Campaigners and organizations that promote saving electricity may benefit from focusing their efforts on promoting the perceived enjoyment of electricity-saving behaviors. This study found that *Perceived Benefits of Electricity Saving* was found to be much higher than *Perceived Enjoyment of Electricity Saving*. Since the perceived benefits of electricity saving are already high, attempting to further raise this may not have much effect. In terms of the perceived enjoyment of electricity saving, however, this is currently relatively low and could be an important factor preventing electricity-saving behavior. Intervention efforts should therefore focus on increasing the *Perceived Enjoyment of Electricity Saving*. Campaigns, incentives, or activities that emphasize the enjoyment and satisfaction of saving electricity are expected to have a stronger positive effect on electricity-saving behavior than those that emphasize the benefits of the behavior.

Several implications for intervention research in this area were found. It is important to ensure that the task a participant is assigned produces some results. In the case of the current study, the appliances that participants had to turn off kept turning themselves on again. This demotivated some of the participants since turning off the appliances felt pointless. It would be important to ensure that participants feel like they are displaying meaningful pro-environmental behavior. Even though the task was set up as a way for participants to save electricity, the feeling of their efforts being futile could be detrimental and the nature of such tasks should be carefully considered to avoid such limitations. It has also become apparent that characters that may seem like they would be highly connotated to saving electricity do not always show this effect. The hippie character, which was chosen through a survey, was not seen as significantly more connected to saving electricity than the control avatar. This suggests that it is challenging to make a character seen as connected to saving electricity based solely on their appearance and careful consideration and testing are needed. Next, since the results of this study suggest that the enjoyment of electricity may be more important to emphasize than the benefits of the behavior, future research could emphasize the enjoyment and satisfaction of electricity-saving behavior. Lastly, such interventions may profit from considering character-environment congruence. This can increase the plausibility of the character and the environment, which can be beneficial to ensure that the intended effect of the character is achieved.

5.3 Limitations and recommendations for future research

The study is limited to the methods used and the data gathered, so it is important to note the limitations of the study. Additionally, recommendations for future research are discussed based on the findings and limitations of the current research.

5.3.1 Methodological Limitations

The hippie avatar used in this project to be associated with electricity-saving behavior was not significantly more associated with saving electricity than the control avatar. This is an important limitation of the research and severely limits whether the effects of using a different avatar on attitudes toward electricity-saving behavior can be found. A limitation of the avatar survey is that no control avatar was tested. Therefore, the hippie could not be compared to a control avatar before the experiment. Future research should ensure that the avatar is properly associated with the intended behaviors.

The experiment was set up as a between-subjects experiment. This meant that there were significant interpersonal differences between subjects and this likely made it more difficult for underlying patterns to emerge, despite the filtering effect of pretest posttest testing. A meta-analysis of 46 quantitative experimental studies on the Proteus Effect found that the mean sample size was 84 (Ratan et al., 2020). Mal et al. (2023) stated that a sample of n = 59 can be too small to find the Proteus Effect since interindividual variance appears to be high. This illustrates that important patterns may not appear in the results due to the limited sample size of n=28.

The different poses and facial expressions in the avatar survey could have also influenced the results. Character pose is often associated with certain character traits (Islam et al., 2011). This

could cause bias. For example, the hippie character is smiling while the other characters are not (see Figure 2). This could lead to higher scores in terms of liking the character, identification with the character, and/or the electricity-saving associations with the character. If this process of choosing the avatar is unreliable, this could help to explain why the hippie avatar was not seen as significantly more associated with electricity-saving behavior than the control avatar.

In the virtual world, it was possible to turn around either by turning physically or by using the joystick. This meant that some participants turned around by turning physically while other used the joystick to turn around. This makes the experience less consistent between the participants and could influence body ownership. In future research, it may be better to disable the ability to turn around using the joystick if possible.

Another limitation is the gender imbalance. While the number of men and women in the control condition was balanced, the eleven men in the intervention condition far outnumbered the four women. This may have skewed the results. However, no significant effects of gender were found during the analysis.

Additionally, the sample of respondents was diverse. One aspect that could affect results is skin color. Having a similar skin color to the avatar could improve identification and potentially influence the results. The diversity of the sample also includes cultural differences. Participants from different cultures may associate the avatars differently and may have varying experiences in the virtual environment.

5.3.2 Limitations of the Virtual Experience

During the task in the virtual environment, the participants could rarely see themselves in the mirror. In the design of the environment, an attempt was made that participants would see themselves in the mirror during the task, but because of teleportation, the participants did not see themselves in the mirror much. In future research, the design of the experience should be designed even more carefully so that participants see themselves in the mirror and are aware of their avatar during the experience.

The length of the avatar in the experiment was calibrated based on self-reported height. It was found that this was on multiple occasions not a precise enough reflection of the person's length. Due to the control model having some issues when not calibrated correctly, this caused some weird behavior. In the future, the model should be tested with impacted calibration to make sure there are no issues. Alternatively, the avatar could be calibrated more accurately, for example by taking the length of the participants. In future research, the experience in virtual reality would likely benefit from not being competitive. In the current experiment, participants were very focused on the task and this may have led them to be less aware of their avatar and less susceptible to its influence. Additionally, when a task is set up in such a competitive format, experience with VR is likely more influential to the behavior than the appearance of the avatar.

Another limitation of this research is the novelty effect. Since most participants did not have much experience with using IVR with body tracking, this may increase their engagement. Once

people have more experience with this technology, their engagement with the content may be lower.

5.3.3 Limitations of measurements

The social desirability bias effect may have positively skewed the measures of attitude toward electricity-saving behavior. Since electricity-saving behavior is generally seen as desirable (Kleinlogel et al., 2023) and the researcher was still in the room, this is a possibility.

The question inquiring about the participant's "current study" may have to be explained differently in future research since multiple participants were unsure how to interpret the question.

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Appendices

During the preparation of this work, the author used ChatGPT in order to find articles and structure their writing. After using this tool/service, the author(s) reviewed and edited the content as needed and takes full responsibility for the content of the work.

Appendix A: Urn Randomization Code

Urn randomization
Instructions: when a participant is added to a certain group, it adds a ball to the other group.

```
#Main function
DivideParticipantIntoGroup()
```

```
#Check the data
print("Control group participants: ", Current_control_group_participants)
print("Intervention group participants: ",
Current_invervention_group_participants)
```

```
#Save the data
f = open('participants.txt', 'w')
f.write(f'{Current_control_group_participants},
{Current_invervention_group_participants}')
```

```
#Load the data
groups = []
with open('participants.txt', 'r') as f:
   data = f.read().split(',')
   for line in data:
       line = line.strip()
       if line:
           groups.append(int(line))
Current_control_group_participants = groups[0]
Current_invervention_group_participants = groups[1]
print("Control group: ", Current_control_group_participants)
print("Intervention group: ", Current_invervention_group_participants)
```

```
#Import library
import random
```

```
#Function definition
def DivideParticipantIntoGroup():
   #Import global values
   global Current_control_group_participants,
Current_invervention_group_participants
```

```
   #Display current number of participants per group
   print("Control group participants: ", Current_control_group_participants)
   print("Intervention group participants: ",
Current_invervention_group_participants)

   #Determine chance per group using urn randomization
   ReduceRandomnessModifier = 10; #Increase this number to have a stronger
leveling effect
   controlgroup_balls = 10 + Current_invervention_group_participants -
ReduceRandomnessModifier
   interventiongroup_balls = 10 + Current_control_group_participants -
ReduceRandomnessModifier
   total_balls = controlgroup_balls + interventiongroup_balls
   chance_controlgroup = controlgroup_balls / total_balls
   random_number = random.uniform(0.0, 1.0)
   print("Chance of controlgroup: ", chance_controlgroup)
   print("Chance of intervention group: ", (1-chance_controlgroup))

   #Check if the participant is placed in the control or invention group
   if(random_number) < chance_controlgroup:
       Current_control_group_participants += 1
       print("\n Result: Controlgroup \n")
   else:
       Current_invervention_group_participants += 1
       print("\n Result: Intervention group \n")
```

```
#Reset the data
Current_control_group_participants = 12
Current_invervention_group_participants = 9
```

Appendix B: Script and Preparations Checklist

Script

[Welcome the participant]
[Write down the time + participant number]

Just to check, do you have your phone with you? Because you will need it later.
[Yes]
Ok great. And have you already read the information brief for this study?
If not -> That is oke, please take your time to read the information brief and consent form. This informs you about the study and any possible risks. If everything is clear and you agree, please sign the consent form.
If yes -> That is great, if you want to check something you can still read it here, and you are free to ask any questions now. You can also read the consent form. When everything is clear and you agree, please sign the consent form.

[Participant reads information brief and consent form, and signs consent form]
As you now know, you can withdraw from the experiment at any time for any reason.
Then, for the experiment I will need your height. This number will not be saved, it's only used during the experiment for calibration of the VR setup. What is your height? [Fill it in in Resonite]
[If they don't know] -> Can I take your height? You can leave your shoes on.

I would now like to ask you to fill in a questionnaire. You can scan this QR code to fill in the questionnaire using your phone. You will be asked to fill in your participant number. Your participant number is [...]. When you are finished, please show me the end screen.
[Participant fills in questionnaire]
[Researcher disables laser + enables teleportation]
Could you show me the end screen? (if they didn't show it yet). Ok thank you.

In a moment you will get a head mounted display to enter the virtual world. First I will lay down some basic rules for your safety. You can rotate physically to rotate in the virtual world. To move around in the virtual world, you can either physically move in that direction or teleport. You should only take one physical step forward to avoid bumping into the wall. So for most of the moving around in the environment, you will use teleportation. I will explain the controls of this later. There will be boundaries in the virtual world that you should not cross in order to avoid the walls and objects in the real-world. They will look like a blue grid. If you are close to the wall, I can intervene and tell you you are too close. Would it also be okay if I touch your shoulder to intervene if needed?

The cable that connects the headset to the pc can also get tangled around your legs if you turn around a lot. In such a case, you can turn back or step over the cable. I will also try to warm you if this happens. In general, you should listen to my instructions if I give them. Virtual reality also has a slight risk of motion sickness. If you feel motion sickness, you can take off the headset. I want to remind you that you can always take off the headset, if you feel uncomfortable for any reason.

[Get the sensors]
So first: in this study, trackers will be attached to your waist and ankles. This movement will be used as input, so that in the virtual world, your virtual body will move the same way. You don't have to do anything with the trackers, they just work passively. Could you put the belt around your waist first, so that the letters are upright and the tracker in the front in the middle?
[Participant does this]
Oke, is it alright if I then put the other two trackers around your ankles?
[Place the foot sensors on the participant]

[I give them one controller]
These are the controllers that you will use. I will now explain some of the controls, but I will go over it once again once you are in the virtual world. You can use the joysticks that your thumbs are resting on to teleport around the virtual environment. You can use either hand for this, the controllers are the same. If you move one of them forward and aim it at the ground, you will see a circle on the ground. This circle is where you will teleport when you let go of the joystick. Please do not use the other buttons as this could disturb the experiment. If you accidentally press this button or this button [show which ones I mean] a menu may pop up. If that happens, you can use the same button to close them again.

Okay, the next step is to put on the headset. You can put it on your head and then turn this knob to fasten or loosen the headset. If you give me the controller for now then you have your hands free to put the headset on.
[I let them put on the head mounted display]
Does it fit comfortably? And can you see sharp? [I help them adjust if needed]

I will now give you the controllers again.
[I give them the controllers]

Please don't click anything yet. Let's go over the controls again first. Can you physically turn so that you face the large mirror on the wall of the living room?
[Participant does that]
Ok good. Can you now teleport to the mirror using your joystick?
[Participant does that]
Ok good. Can you see your virtual body in the mirror?
[Participant says yes]
Ok good. Can you wave at yourself to make sure the tracking is working properly?
[Participant does that]
Ok good. Can you lift one leg and see yourself doing this in the mirror?
[Participant does that]
Ok good.

Ok, I will now explain what your task will be. Your task will involve turning off appliances in this room. The appliances are lamps, a tv, and a ceiling fan. When you turn them off, they will eventually turn themselves on again. Your task is to keep turning off the appliances so that as little electricity as possible is used. The electricity usage is displayed on the right side of the mirror. You

can see the current electricity usage, and after the task has started you will be able to see the total electricity usage. The task will start after the explanation, when you press the “Start” button.

We will now go over the different appliances that you can turn off.
Please look to the left of the large mirror. There is a tv. Please touch the tv with your hand to turn it off. You don’t need to press any button.
[Participant does that]
Ok good. Now look at the desk lamp next to the tv. Please press the white button at its base to turn it off..
[Participant does that]
Ok good.
Now please teleport back to the large mirror. On the right of the mirror, underneath the start button, there is a button to turn off the light above the bed. This button also has an indicator light. When the lamp is on, the indicator light on the button glows green. When the lamp is switched off, the indicator light is also switched off. There are multiple buttons with such an indicator light. Please press the button now.
[Participant does that]
Ok good. Now please look towards the electric fireplace. On the right side of it, there is a button to turn off the light above the table. Please press the button.
[Participant does that]
Ok good. Now please look towards the bathroom. This is to the right of the kitchen. There are two buttons that turn off the ceiling fan and the light of the ceiling fan. Please press both buttons.
[Participant does that]

Ok good. Now please stand in front of the large mirror again where you started.

Ok. You are almost ready to start the task. It will take a couple of minutes. As a reminder, your task is to turn off the appliances, and keep turning them off after they turn themselves on again. When the task is finished you will hear this sound: [plays sounds]. Please press the start button. This will start the task.
[Participant does the task]
[After four minutes, the task is finished]
Ok, you have finished the task. Now, you can take off the headset and put down the controllers. You can also take the trackers off.
[Does that]
I would like to ask you to fill in a last questionnaire now. Please scan this QR code when you are ready. As a reminder, your participant number is [...]. When you are finished, you can show me the end screen.
[Participant does that]
[Researcher writes down the score]
Can you show me the end screen?
Ok, thank you.
Now I will do a short debriefing. Just to let you know, the goal of the research is to look at the effect of the virtual avatar on attitude towards electricity saving behaviors. Please do not discuss this with other people as this could influence the results in case they want to participate. If you want, you have the right to retract your data from being used for the study.

Thank you a lot for participating! :)
[Note the time]

Do you have any questions? Was there anything unclear or weird? Any comments you would like to make?

Guidelines for answering questions during the experiment

Questions topics to answer:
Controls, procedural, ethical, safety questions

Question topics not to answer:
Goal of research, detailed study design, about other participants

- Then answer: “I cannot disclose that for the integrity of the study”. (if applicable, add: “I can share that after the experiment is finished” or general answer)

If participant is distracted during task explanation for more than 10s:
“Let’s focus on the instructions again” + repeat instruction

If participant too close to the wall and it looks like they may hit it soon:
“Could you take a step back, you are too close to the wall” [+step {this} way]
“Please watch out, you are about to hit the wall”

If tangled up with cord:
“You are getting tangled in the cord, please step over the cord or turn your body”

Preparations checklist

Setup:

- Disable nametag
- Make sure to have four lighthouses for good body tracking
- Participant not able to see pc

Have to check between participants:

- Use a copy of the world
- Set up boundaries correctly
- Set up sensors correctly
- Activate all mirrors
- Have audio to play as example for finish
- Set session to private
- Volume set to max

Always do between participants:

- Assign participant number
- Assign condition
- Note paper ready
- Setup correct avatar

- Water + snack ready
- Reset task
- Untangle cable
- Setup ready to input height

Appendix C: Credits

Resonite world used

- “4Room” by dfgHiatus

Assets used

- The interactable old TV asset from Resonite’s Creator Jam 26 Wake Up! Escape Room - by Creator Jam and Medra

Resonite tools used

- Ukilop’s component searcher
- Ukilop’s redprint v2.4.2

Avatars used

- Control avatar - created using Ready Player Me
- Hippie avatar - *Neo Hippie Jessica Low-poly 3D model* purchased from Nukemut on CGTrader

Images for the avatar survey

- Hippie image - *Neo Hippie Jessica Low-poly 3D model* by nukemut on CGTrader
- Farmer image - *farmer avatar Low-poly 3D model* by heromodel on CGTrader
- Plant person - *The plant man 3D model* by lukman123 on CGTrader
- Pumpkin person - Resonite’s *Human Avatar Hub* by Ryjira

Appendix D: Questionnaire Items

Items measuring Attitude Towards Electricity-Saving Behaviors

I believe saving electricity is

ATESB1 Bad-Good
ATESB2 Harmful-Beneficial
ATESB3 Unpleasant-Pleasant
ATESB4 Unenjoyable-Enjoyable
ATESB5 Foolish-Wise
ATESB6 Unnecessary-Necessary

5-point Likert scale

Items measuring Body Ownership

Please answer the following questions

BO1 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body I saw in the mirror was mine.
BO2 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body that I saw when I looked down at myself was mine.
BO3 Even though the virtual body I saw did not look like me - I had the sensation that the virtual body I saw was my body.
BO4 Even though the virtual body I saw did not look like me - I felt that the virtual body that I saw was someone else.

5-point Likert scale. Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree.

Manipulation check questions

Please indicate the extent to which you agree or disagree with the following statements about the character whose appearance you took on in the virtual world

MC1 I believe the character cares about behaving in a pro-environmental way
MC2 I believe the character cares about saving electricity
MC3 I associate this character with saving electricity

5-point Likert scale. Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly Agree.

Please indicate the extent to which you agree or disagree with the following statements about the character whose appearance you took on in the virtual world

MC4 The character is dressed in a special way
MC5 The character is dressed like any person I see on the street
MC6 The character is dressed in an unusual way
MC7 The character is dressed in an ordinary way

5-point Likert scale. Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly Agree.

Items measuring experience with VR and body tracking

How much experience do you have with…

- Virtual Reality using a headset
- Virtual Reality using a headset and Full-Body Tracking

Two sliders from 0 to 100 with the anchors 0 = “None at all” and 100 = “A few times a week for more than 6 months or equivalent”

Open questions

How did the appearance of the avatar you embodied relate to your experience?

What do you think might have influenced your performance, either positively or negatively, of the task in the virtual reality world?

If the gender of the character whose appearance you took on was different from your gender, how did this impact the experience?