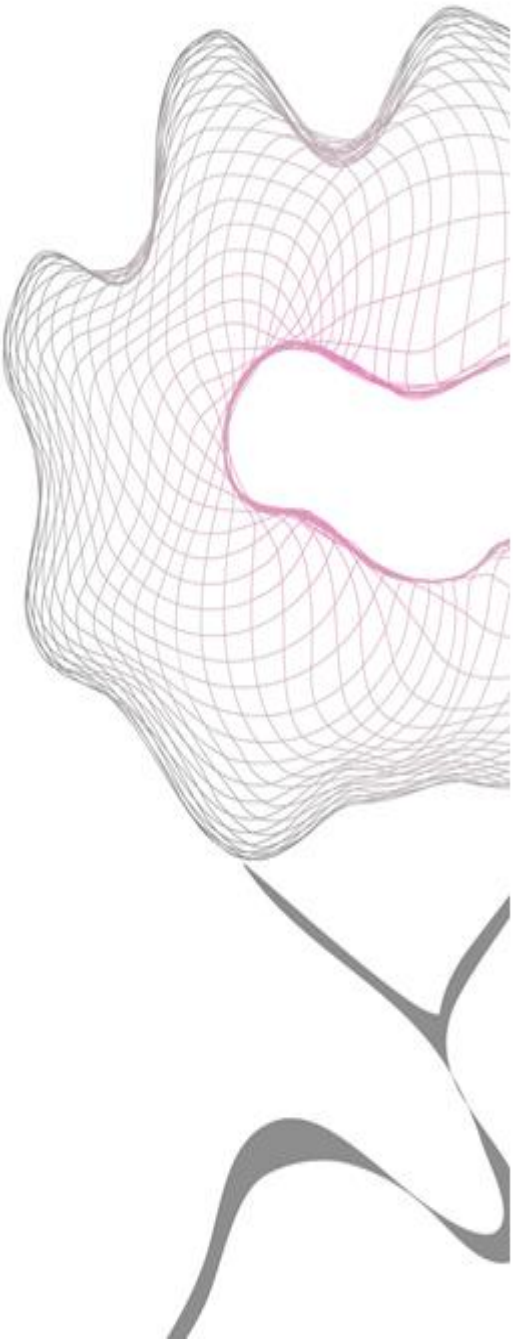

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Bachelor Thesis –

Future Self-Dialogue and its Effect on Connectedness to a Future Self

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Abstract

Many people underrate how present sacrifices can affect future well-being and tend to prefer immediate benefits over delayed future rewards (Bartels & Urminsky, 2011). However, research shows that the more connected people feel to their future self, the more inclined they are to act in ways that would benefit them in the long run, such as to exercise more often (Rutchick, Slepian, Reyes, Pleskus, & Hershfield, 2018). Therefore, we explored whether connectedness to a future self can be increased through a future self-dialogue exercise involving embodiment of the future self from a first-person perspective in two interventions and whether there is a difference observed in the effect of these interventions. It was also investigated whether vividness and valence of a future self can be increased through these interventions because literature supports that both may be related to feeling connected to a future self (e.g., Hershfield, John, & Reiff, 2018; Hershfield, 2011). In a between-groups experimental design we randomly allocated a sample of university students (N = 45) to three conditions. Participants either interacted with their future self by using virtual reality (VR) technology (n = 15), by using a technique called the empty-chair (EC) dialogue from Gestalt therapy (n = 15), or they did not interact with their future self in a control condition (n = 15). The test results did not support the hypothesis that a future self-dialogue exercise leads to a significantly greater increase in connectedness, vividness, and valence towards a future self, compared to the absence of such exercise. Furthermore, contrary to what was hypothesized, the increase in VR was not significantly greater as compared to the EC condition. However, despite non-statistically significance, there was a tendency observed that on average connectedness, vividness, and valence towards a future self increased the greatest in the VR condition, followed by the EC condition, and the lowest in the control condition. Hence, results point in the intended direction, which suggests investigating whether a larger sample size and improving the research design by adding more cues and embellishment that will further increase the embodiment illusion in the VR experience (e.g., by using age-progression software) yield a greater effect in future research.

1. Introduction

When deciding how to act, people vary in their tendency to consider how their behaviors will impact them in the future. Some decisions not only influence the present but also carry important long-term consequences. By not exercising when they should exercise, choosing to eat unhealthy when they should eat healthy, or spending money when they should save, people experience pleasant short-term goals but fail to make decisions that would benefit their well-being over time (Rutchick et al., 2018). Research has shown that people often prefer an immediate reward to a distant reward (Rutchick et al., 2018). When people prioritize needs and desires in the present and de-value future rewards this is referred to as *temporal* or *delay discounting* (Bartels & Rips, 2010; Ersner-Hershfield, Wimmer, & Knutson, 2009a; Parthasarathi, McConnel, Luery, & Kable, 2017; Rutchick et al. 2018).

What influences people's choices when they face dilemmas where they have to make trade-offs between immediate enjoyment and well-being in the future? Research by Bartels and Urminsky (2011) on temporal discounting provides evidence that the degree of connectedness people feel between their present self and their future self is one powerful predictor of the choices they make. Their findings reveal that a greater feeling of connectedness to the future self leads to more patient choices in the present, which benefits future well-being. Other research has found the same positive link between perceived connectedness to a future self and more future-oriented choices (Rutchick et al., 2018; Hershfield, 2018). For instance, Rutchick et al. (2018) emphasize that people find it generally difficult to resist their temptations because a single unhealthy choice does not appear to have serious effects on their long-term future health. However, the authors theorized that people who perceive a greater sense of similarity and connectedness between their current and future self, which they termed *future self-continuity* (FSCon), act more in the interest of their future self because they appreciate that every healthy act today, repeated over time, belongs to the same person. These choices all increment greater health benefits (Rutchick et al., 2018).

Findings like these as well as other research show that FSCon correlates with more future-oriented behavior. This includes reduced temporal discounting (Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, & Knutson, 2009b; Ersner-Hershfield et al., 2009a), increased exercise behaviour (Rutchick et al., 2018), increased saving behaviour (Ersner-Hershfield et al., 2009ab), and reduced procrastination (Blouin-Hudon & Pychyl, 2015). Rutchick et al. (2018) even found some evidence for a causal relation between future self-continuity and subsequent health behaviors in an experiment in which they manipulated

continuity to a future self by having participants complete a writing task. In line with their hypothesis, those participants who were instructed to write a letter to a distant future self, compared to writing to the near future self, were more likely to physically exercise. Similarly, Bartels and Urminsky (2011) provide evidence of a causal relation between a manipulated reduced sense of connectedness to a future self and increased impatient behavior (i.e., temporal discounting). These insights point to the importance of interventions to focus on increasing the felt connectedness between selves over time to help facilitate long-term decision-making.

1.1 Previous Research on FSCon

Interventions seeking to increase FSCon show that it can be helpful to encourage people to interact with their future self through visual representations and to communicate and think about a future self. For example, a study by Hershfield et al. (2011) shows that exposure to a visual representation of one's future self leads to greater FSCon. Furthermore, research involving children shows that conversing about one's future self with an adult, helps them to become more future-oriented and act in interest of their future self, which implies an understanding of a connection between future-events and the present self (even though this effect was greater for close future-events than distant ones) (Chernyak, Leech, & Rowe, 2017). In another study by Pronin and Ross (2006) participants who were asked to contemplate about their future self's thoughts and feelings made more actor-like attributions about this self, which presumes an appreciation of personal continuity. This is because actor-like attributions imply that a person is aware of internal states and therefore more inclined to explain behavior by focusing on situational factors (Pronin & Ross, 2006).

1.2 Conversing with One's Future Self Through Embodiment

Could interventions increase FSCon when they would enable participants to have an actual conversation with their future self by allowing them to alternate between the embodiment of the present and a future self? Although this has not yet been studied, there exist interventions that help participants to better understand their emotional present and past selves by alternating between the embodiment of themselves and a significant other. For instance, therapists make use of a technique called the empty-chair (EC) dialogue from Gestalt therapy in order to help people deal with unresolved emotional issues from their past (Paivio & Greenberg, 1995). This technique entails having an imaginary dialogue with a significant other involved in the emotional issue (Paivio & Greenberg, 1995). Usually, the

therapeutic process starts by expressing an emotional problem to the imagined other sitting in an empty chair placed in front of oneself, and then to switch seats and formulate answers from the perspective of the imagined other (Greenberg and Malcom, 2002). This form of self-dialogue seeks to enhance emotional arousal, which allows participants to confront and restructure inhibited feelings and perceptions toward the self and the significant other (Greenberg & Malcolm, 2002). In a study by Paivio and Greenberg (1995) this, in turn, helped participants to achieve a greater understanding and tolerance of themselves and their significant other. Accordingly, it is interesting to study whether the EC dialogue, in a similar way as it helped to access and restructure inhibited feelings and perceptions, and to understand and tolerate the self and others, would also help people to access future feelings and perceptions, and to understand and tolerate a future self, which may then strengthen the emotional bond between present and future selves.

In the attempt to increase FSCon through interventions, which enable people to engage in dialogue with their future self from a first-person perspective (1PP), sophisticated technology like immersive virtual reality (VR) may add to EC dialogue. In a virtually created world, it might be easier to get people to detach from the present and to imagine being embodied in the future self. This is assumed because a virtual world has the ability to shield people from all real-world visual input. It engulfs them in the sense that they lose themselves in an illusion of actual "presence" in the virtual environment and act as if they experience this place and everything that is happening inside as being real (Van Gelder, Hershfield, & Nordgren, 2013; Slater & Sanchez-Vives, 2014). Over and above being immersed in a place in which they are less distracted from the real world, people's imagination of being ventured into the future might be further stimulated by a virtual body that substitutes their own body. In VR it is possible to induce an embodiment illusion, which means that people perceive virtually created body parts to be part of their own body (Banakou, Kishore, & Slater, 2018). This is due to the conforming of virtual body movements to real body movements, which enhances a sense of agency over virtually created body parts (Osimo et al., 2015). VR also enables to transfer people from one virtual body to another, which could enhance the illusion of traveling back and forth in time, from the embodiment of a present self to a future self. For instance, in a study by Osimo et al. (2015) participants engaged in self-counseling by first explaining a personal problem while virtually embodying their present self, and then giving advice from a 1PP of another virtual body that represented a counselor. Results showed that regardless of whether the virtual body representing the counselor resembled oneself or a look-

alike version of Sigmund Freud, participants experienced an embodiment illusion due to the synchronous body movements.

Based on this, we assume that similar to how people are able to perceive an embodiment illusion over an avatar that looks like a different person, they might also have an embodiment illusion over a virtual body representing a distant future self, whom they often perceive as a different person on a trait-level basis (Pronin and Ross, 2006), and on neural levels (Ersner-Hershfield et al., 2009a). Although the virtual avatar in this study is not made to look like a future version of one's self, it might stimulate to imagine "being" the future self, as participants are less distracted from visual cues of their real-world body of their present self. Over and above an effective illusion of being embodied in a virtual avatar, Osimo et al. (2015) demonstrated that the embodiment of Freud yielded better counseling outcomes. The authors suggest that embodiment of Freud provided participants access to mental states other than their usual ways of thinking which may have helped them to come up with novel ideas that increased understanding and emotional connection with their present self's problem. This fits with the idea of body semantics, which describes that the illusion of embodying a virtual avatar is accompanied by an illusion of gaining access to mental states that are associated with the type of avatar (Slater & Sanchez-Vives, 2014). Hence, an effective embodiment illusion of the future self may encourage people to come up with novel insights and a more positive attitude towards their own future, just as stepping out of their body and into the perspective of Freud has helped participants to raise their mood and find solutions to personal issues.

In sum, sophisticated VR technology may further stimulate to imagine an embodiment of the future self as it engulfs people in an environment, in which they are less distracted from the real world and the feeling of being in the present. VR can generate an embodiment illusion over a virtual body and has the means to induce the feeling of virtual time-travel. Future self-embodiment in EC dialogue, in contrast, lacks this virtual embellishment and may depend more on a person's ability to visualize themselves at a later point in time. Since there is little research into whether EC dialogue and VR can also be used to increase FSCon, investigating them first and foremost provides knowledge about their effectiveness in this regard, and second, enables direct comparison to see whether one might be more effective than the other and why. This is important because it will help guide future research on how to increase FSCon.

1.3 Conceptualizing FSCon and the Role of Vividness and Valence

According to Rutchick et al. (2018), most definitions of FSCon agree that it describes the extent to which a person feels psychologically connected and similar to his or her future self, for example in terms of sharing personality, beliefs, and values. Research supports this continuity-based account that highlights the importance of feeling connected and similar to a distant self in terms of important psychological characteristics. For example, a literature review by Eisenberg and Miller (1987) reveals that inducing a feeling of similarity to another person increases one's identification with that person and leads to more empathy, which was linked to prosocial behavior. Besides, research by Ersner-Hershfield et al. (2009a) showed that participants who perceived greater similarity to their future self processed future self-relevant information in a way that yielded less temporal discounting, which presumes that feeling a sense of similarity is similar to the feeling of connectedness and therefore makes one act more in the interest of a future self. Lastly, although not summarized as FSCon, Bartels and Urminsky (2011) also regard the feeling of being connected to a future self as perceiving an overlap in personal identity (i.e., similarity in psychological characteristics) between the current and the future self.

According to Hershfield (2011), however, FSCon is not only composed of a sense of connection in terms of feeling similar. He proposes a model that includes two other components presumed to play a role in understanding FSCon: Vividness and valence. Hershfield (2011) argues that just as people feel more connected to victims who are perceived more vividly, a more vividly imagined future self should increase a person's feeling of connection as well. Furthermore, he claims that just as people share a greater sense of connection and form friendships with others whom they like, a person would feel more connected to a distant, future self if that self were perceived in positive terms. Although it is not fully understood how these three components interrelate, Hershfield (2011) believes that they interact in ways that explain FSCon and its effects on decision-making.

Other research supports that vividness and valence might play a role in judging connectedness between selves. There is agreement that how well connected people feel to their future self depends on their ability to vividly imagine how they will look and feel like in the future (Van Gelder, Luciano, Kranenbarg, & Hershfield, 2015; Blouin-Hudon & Pychyl, 2015; Hershfield et al., 2018). Those with greater ability to vividly imagine the future are more likely to develop a thought about the interests of a future self (Van Gelder et al., 2015; Hershfield, Cohen, and Thompson, 2012). Furthermore, a vivid image of engaging in some future action might lead one to experience a greater emotional response (Loewenstein, 1996) and to assume the subjective experience of a future self (Hershfield et al., 2018). This, in turn,

was found to lead to greater anticipation of how actions can have delayed consequences for oneself and therefore to greater consideration for the future self in the decisions that are made in the present (Van Gelder et al., 2015). For instance, a study by Van Gelder et al. (2013) found that increasing vividness of the future self through writing a letter to the future self or through virtual exposure to an age-rendered version of one's self leads to a reduced likelihood of engaging in unethical behavior. We assume this finding can be explained by that a vivid image of one's future self stokes a sense of connection, as Van Gelder et al. (2013) already mentioned that viewing vivid images of victims induces greater sympathy and connection toward them. In addition to evidence for the role of vividness, research emphasizes that people enjoy the company of like-minded individuals (Chen & Kenrick, 2002; Lankau, Riordan, & Thomas, 2005), which confirms that if the valence of a future self is high, this may be accompanied by a sense of connectedness in terms of feeling similar to that self, hence FSCon. Interestingly, research by Blouin-Hudon and Pychyl (2015) found a link between being able to experience greater positive emotions and having higher cognitive flexibility and broadening, which could mean that those individuals are more likely to anticipate goals, feelings and thoughts of a future self and thus more able to establish a connection.

In sum, there seems to be some support for a FSCon model including the three components (similarity, vividness, and valence) as proposed by Hershfield (2011). However, this study continues with the most agreed upon definition of FSCon: the degree of connectedness that is felt through similarities in psychological characteristics to a future self. Vividness of a future self (FSViv) and valence of a future self (FSVal) will be seen as two separate measures representing connectedness to a future self. Together, FSCon, FSViv and FSVal will be summarized as 'future self measures'.

1.4 Are EC Dialogue and VR Possible Means to Increase FSCon, FSViv, and FSVal?

Drawing on the findings above, interventions should focus on increasing the perceived FSCon, as well as FSViv and FSVal between the present and a future self. The current study examines whether VR and EC self-dialogue heightens the degree to which someone perceives FSCon, FSViv, and FSVal.

Since EC dialogue is imaginary (Greenberg & Malcom, 2002), its effects on FSCon, FSViv, and FSVal may be constrained by a person's ability for imagination. However, the act of switching from representing oneself (in one chair) to role-playing the significant other (in a second chair) intends to give the impression of having a lively dialogue between the self and

the imagined other that will over and above induce a sense of being with the other (Greenberg & Malcom, 2002). Thus, EC dialogue might aid the imagination of a future self because it involves embodiment (or role-playing) of the imagined other rather than merely thinking about it. Research by Greenberg and Malcom (2002) found that perspective-taking in EC dialogue enhanced emotional arousal and allowed people to access and re-experience emotions, thoughts and feelings of past selves. This gives reason to believe that in a similar way EC dialogue might aid people to access and experience mental states of future selves. Hypothetically, future self-embodiment should then stoke a more vivid representation of the future self. Likewise, being able to access mental states of a future self through future self-embodiment in EC dialogue may also increase a feeling of similarity toward that self. A meta-analysis by Pettigrew and Tropp (2008) supports that intergroup contact reduces intergroup biases because, among other things, it allows for perspective-taking, judging similarities and facilitates to learn about the outgroup. In a similar way, interaction with a future self through future self-embodiment in EC dialogue might enable one to recognize mutual interests, goals, and values. Lastly, even when EC dialogue involved dealing with negative emotions caused by interpersonal problems it was found to foster positive changes in attitudes and perceptions toward the significant other (Paivio & Greenberg, 1995). Thus, it is believed that when future self-embodiment in EC dialogue involves conversing about something that is fun and engaging, it should also increase positive affect in this case toward a future self. In sum, we hypothesize that a future self-dialogue exercise, involving embodiment of the future self, will lead to greater perceived FSCon, FSViv, and FSVal compared to the absence of such exercise (H1).

This assumption also applies to a future self-dialogue in VR. As mentioned earlier, sophisticated technologies, notably VR, can effectively engulf people in the sense that they lose touch to reality and are able to broaden their imagination. In VR people have the illusion that virtual body parts are belonging to one's own body (Banakou et al., 2018) due to their control over those body parts (Osimo et al., 2015). It is assumed that the mind is tricked into becoming the future self, which may be accompanied by having access to mental states other than the present ones and therefore to be better able to form an association and to judge the similarity between the current and the future self. Hence, it is hypothesized that a high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSCon (H2a). Furthermore, hypothetically, an effective embodiment illusion should also make the future self more vividly experienced. Therefore, it is presumed that a high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSViv (H2b).

Lastly, although less clear, it is hypothesized that a high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSVal (H2c). In this study, participants were instructed to think of a successful future self who just achieved an important goal. Therefore, it is presumed that when the embodiment or role-play of that future self is stronger and they actually come to believe that they are their successful future self, it will likely elicit positive emotions that may come to be associated with the future self. Overall, we hypothesize that a virtual future self-dialogue exercise leads to a greater increase in FSCon, FSViv, and FSVal compared to a future self-dialogue exercise in EC (H2).

Taken together, both EC and VR interventions can be used in ways that would help increase a person's perception of FSCon, FSViv, and FSVal. However, sophisticated technology, such as VR, has the ability to get a person to detach from the real world and the present self because it engulfs people in an alternative environment and an alternative body to the extent that they come to believe in actually "being there" in the virtual world and body. Furthermore, it might be easier to simulate a time-travel into the future because VR enables to alternate between different virtual bodies within the virtual environment. The possibility for such virtual cues is an advantage over EC dialogue as it aids a person's imagination of embodying a future self and therefore increases the chance of losing oneself in the illusion.

1.5 Summary of Current Research

This research aims to investigate if connectedness to a future self can be enhanced through experimental manipulations. More precisely, it examines the question: Does FSCon, FSViv, and FSVal increase through a future self-dialogue involving embodiment of the future self, and is this effect stronger in VR compared to EC dialogue? Drawing on existing research, the following hypotheses are formulated:

H1. A future self-dialogue exercise leads to a significantly greater increase in FSCon, FSViv, and FSVal compared to no future self-dialogue exercise.

H2. A future self-dialogue exercise in VR leads to a significantly greater increase in FSCon, FSViv, and FSVal compared to the EC condition.

H2a. A high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSCon.

H2b. A high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSViv.

H2c. A high degree of virtual embodiment adds a positive contribution to the VR condition in predicting FSVal.

These hypotheses were investigated by comparing three conditions, in which participants will either interact with their 10-year-older future self in VR, interact with their 10-year-older future self in an EC dialogue or they will have no interaction with their future self in a control condition.

2. Methods

2.1 Ethics

This research was approved as a two-part study by the BMS Ethics Committee of the University of Twente. All participants gave their consent prior to participation of the first part of the study. Ethical considerations included the right to withdraw and have the data removed at any time. Upon arrival to the second part of the study all participants received a more detailed informed consent including the purpose of the study, procedures, any potential risks and benefits, confidentiality, compensation for taking part in the study, the right to withdraw at any time, and the statement of consent. Inclusion criteria were to be at least 16 years old and a student from a higher educational institution, while exclusion criteria encompassed suffering from any mental disorder. The exclusion criteria were included in the study advertisement displayed in the student participation panel as well as in the informed consent of the second part of the study.

2.2 Participants

This study originally consisted of a convenience sample including a total of (N = 53) healthy university students, but was comprised for analysis to a total of (N = 45) participants after excluding three pilots, and another five cases were there was no identification number and either a pre- or a post-questionnaire was missing. The final sample (N = 45) included participants who were aged between 18 to 28 years (M = 21.36, SD = 2.13), and mostly of female gender (77.8 %). Each participant was randomly allocated to one of three conditions with (n = 15) in each condition. The sample was recruited through the student participation panel for online studies of the University of Twente in Enschede and via advertisement and word of mouth marketing around the campus. The study was online from the 25th of March 2019 until the beginning of May 2019.

2.3 Design

In this research a between-groups experimental design was employed. Participants were randomly assigned to three conditions (control, EC, and VR). All conditions were scheduled as a two-part study, first to fill in a pre-questionnaire and second to visit the laboratory for further collection of post-data. In the control condition, this involved filling-in another post-questionnaire, which was identical to the pre-questionnaire. In the EC and VR condition participants first completed a future self-dialogue exercise either using the EC method or in VR, which was the manipulation in this study. Afterwards they were instructed to fill in another post-questionnaire for collection of post-exposure data. All questionnaires used in the present research were constructed in Qualtrics. The dependent variables on which the three conditions were later compared were the perceived FSCon, FSViv, and FSVal.

2.4 Apparatus and Materials

2.4.1 Control Condition. The control condition comprised two identical 18-items pre- and post-questionnaires. However, 12 of these items are part of a larger study and not relevant to this research. Only the other six items were of interest, of which one item assessed the participant's gender and five items represented the future self measures. These included two pictorial items assessing FSCon. They were phrased: "How connected do you feel to yourself 10 years into the future?" and "How similar do you feel to yourself 10 years into the future?". Each item was followed by an instruction to choose one of seven Euler circles that ranged from *no overlap* to *almost complete overlap*. The design was borrowed from Ersner-Hershfield et al. (2009b). They adopted a psychometric measure of FSCon based on the "Inclusion of Other in the Self" scale by Aron, Aron, and Smollan (1992). Furthermore, two items measured the perceived FSViv on a 7-point Likert scale ranging from *strongly disagree* to *strongly agree*. These items were adopted from Van Gelder et al. (2015) and were phrased as follows: "I find it easy to imagine myself 10 years from now", and "I find it easy to describe myself 10 years from now". FSVal was measured by only one item on a 7-point Likert scale ranging from *don't like at all* to *like a lot*. This item was invented by the researchers and phrased as follows: "In the following, please tell us how you feel about your future self 10 years from now".

2.4.2 EC Condition. For the EC condition a 19-items pre-questionnaire was made use of. This questionnaire was identical to the pre-questionnaire in the control condition except for one additional open-ended item. This was an unrestricted thought exercise about one's prospective future phrased as follows:

"Please try to imagine that in the next 10 years, you can achieve whatever you want. There are no limits, no constraints (for example when it comes to energy, money and knowledge). You can do and become everything you ever wished for. Perhaps you would like to run your own business, write a successful book, build your own house or become a nomad traveling around the world. Think of what you want to do or become without any constraints. Again, everything is possible... you just have to let go of limitations that you have in mind. This might sound like a difficult exercise, but once you think of something you would really like to do or become, your thoughts will start to flow. Take at least five minutes and write down one or multiple things you wish, dream or hope to attain in the next 10 years. Please keep on writing (in English) and aim for a paragraph or two. Try to remember, everything is possible. If everything is possible, then in the upcoming years, I would like to:…".

Of the 19 items in this questionnaire only the open-ended item and the other six items already discussed for the control condition were relevant for this study.

The post-questionnaire contained 27 items, of which 10 items were of interest for the present research. These included the same five items that represented the future self measures and one item measuring gender as discussed in the control condition. Furthermore, we invented four additional items aimed at assessing the embodiment of the future self on a 7-point Likert scale ranging from *strongly disagree* to *strongly agree*. These items were phrased as follows: "When sitting in the chair of my future self, I felt as if I was my future self", "When sitting in the chair of my future self, my thoughts changed from how I normally think", "When sitting in the chair of my future self, I felt as if I was someone else", and "I felt as if someone was sitting across from me".

Besides the questionnaires, the EC condition involved the use of a recording device (Zoom H4nPro), which was adapted to version 2.3.1 of Audacity® recording and editing software (Audacity Team, 2019). Other materials included a box with two buttons, adapted to the record and playback function of the Minim audio library version 2.2.2 (Quartz, n.d.) within Processing 3.5.3 (Fry and Reas, 2004); the transcription program AmberScript (AmberScript B.V., 2018) to transcribe the audio recordings; external loudspeaker; a storage device for safe keep of the data; and 13 paper-version questions, of which four were used as a tutorial to practice the exercise and the other nine for the actual future self-dialogue exercise afterwards. An example of one tutorial question was: "Future self, what did you have for breakfast?" and an example of one question for the actual future-self dialogue exercise was: "Future self, how are you feeling today?" (see Appendix A).

2.4.3 VR Condition. Materials included the same 19-items pre-questionnaire as used in the EC condition, of which only seven items (see control and EC condition) were of interest. Next, this condition comprised a 42-items post-questionnaire. However, only the 10 items as discussed in the EC condition were of interest. These included one item measuring gender, five items representing the future self measures, and four items measuring the embodiment of the future self.

Besides the questionnaires, few materials that were the same as in the EC condition were made use of. These included the recording device (Zoom H4nPro), adapted to version 2.3.1 of Audacity® recording and editing software (Audacity Team, 2019); the transcription program AmberScript (AmberScript B.V., 2018) to transcribe the audio recordings; external loudspeaker; and a storage device for safe keep of the data. The VR equipment included an HTC VIVE head-mounted display controlling head movements, with a field-of-view of 110°, and a resolution of 1080 x 1200 pixels per eye displayed at 90 Hz; two controllers providing control over arms and torso; and two base stations with a 360° play area tracking coverage.

All data assessed by the questionnaires of the three conditions were analyzed using SPSS.

2.5 Variables

2.5.1 Independent Measures. This study mainly focused on three conditions and how they influenced scores on the three dependent variables (FSCon, FSViv, and FSVal). Furthermore, it was investigated whether the embodiment of the future self plays a role in predicting an increase on the three dependent variables (FSCon, FSViv, and FSVal). To check if the manipulation of the embodiment illusion worked in the EC and VR condition participants received four statements about their experience in the embodiment exercise.

The four items were subjected to an exploratory factor analysis (EFA) using principal-axis factor extraction (PAF), to examine whether all had the same latent factor in common, namely the embodiment of the future self. Concerning the factor analysis, it was observed that one item (“I felt as if someone was sitting across from me”) did not correlate above .3 with at least one of the other items (see Appendix B), which can be considered as a cut-off score to determine factorability (Yong & Pearce, 2013). The communalities further confirm that this item shares only little common variance with the other items (see Table 1). Given these indicators, and judging from its wording, it was suggested that this item is not related to the same underlying factor (embodiment of the future self) but rather an overall belief in personal presence and therefore it was removed. However, the Kaiser-Meyer-Olkin measure of

sampling adequacy was .63 (the cut-off is .50 according to Yong & Pearce, 2013), and Bartlett's Test of Sphericity was significant at $p < .05$, which means that it is suitable to conduct an EFA using PAF with the three remaining items.

The factor analysis resulted in a one-factor solution explaining 59% of the variance with an Eigenvalue of 1.78. Items that loaded high on this factor were "When sitting in the chair of my future self, I felt as if I was my future self" with a loading of .71 and "When sitting in the chair of my future self, my thoughts changed from how I normally think" with a loading of .77, suggesting that it represents embodiment of the future self. The third item "When sitting in the chair of my future self, I felt as if I was someone else" had a factor loading of .41 (.40 is considered as a cut-off according to Neill, 2008), which was considerably lower compared to the other two items that started with "When sitting in the chair of my future self …". An explanation for this could be that the item was not well worded and therefore unclear whether by "… I felt as if I was someone else" participants actually meant that they felt as if they were their future self. It was decided to exclude this item because this slightly increased Cronbach's Alpha from .62 to .67. Furthermore, factor analysis with the two remaining items revealed a one-factor solution explaining 77% of the variance with an Eigenvalue of 1.55. For simplicity, the composite of these two items (hence "embodiment of the future self") was used in subsequent analyses. The composite score was computed by summing up the raw scores and divide them by the number of items to obtain an average score. In this way, the scale metric was retained, which allowed for easier interpretation.

2.5.2 Dependent Measures. Figure 1 displays the three dependent measures in this study: FSCon, FSViv, and FSVal. To assess the validity of the two items that were supposed to measure FSCon they were also subjected to an EFA using PAF. Preliminary interpretations revealed weak correlations between the two items (see Appendix B), weak communalities (see Table 1), the Kaiser-Meyer-Olkin was just at the cut-off of .5 and Bartlett's Test of Sphericity was not significant with $p > .05$. Although these indicators suggest that factor analysis with both items is not suitable, it is interesting to report that the analysis resulted in a one-factor solution explaining 64% of the variance with an Eigenvalue of 1.28. Both items loaded fairly desirable on the factor, suggesting that to some extent they may have the same latent factor in common (i.e., FSCon) that influences how people answer to those items. However, Cronbach's Alpha revealed that the two items have rather low internal consistency ($\alpha = .44$), which again disconfirms that these two items have the same underlying factor in

common. This outcome is surprising because, according to the literature FSCon is defined as feeling connected and similar in terms of important psychological characteristics (e.g., Rutchick et al., 2018). Hence, it seems like feeling connected and feeling similar go hand in hand, that is, feeling connected to a future self is deemed equivalent with feeling similar on several psychological characteristics. Based on the EFA and practical considerations it has been decided to retain the item "How connected do you feel to yourself 10 years into the future" as a measure of FSCon. It is presumed that judging connectedness may implicitly already involve an appreciation of similarity between the current and the future self. Most importantly, the manner in which the item is phrased reflects directly what this study aimed to research, namely perceived connectedness to a future self. This was just for simplicity and based on other research findings linked with feeling similar to a future self and together summarized as FSCon.

Initially to the EFA using PAF for the two items that were supposed to measure FSViv it was observed that both items correlated highly (see Appendix B), had rather high communalities (see Table 1), Kaiser-Meyer-Olkin was at the cut-off of .5, and Bartlett's Test of Sphericity was significant at $p < .05$. Given these indicators factor analysis was regarded as suitable with both items. Results indicated a one-factor solution explaining 90% of the variance with an Eigenvalue of 1.80. Both items loaded high on the extracted factor, suggesting that it represents FSViv. Cronbach's Alpha of the two items revealed high internal consistency (α = .88). For simplicity, the composite of these two items (hence "PreFSViv" and "PostFSViv") was used in subsequent analyses. Composite scores were computed in the same way as described for embodiment of the future self (see section 2.5.1).

FVal was measured by only one item, which is why there was no EFA performed.

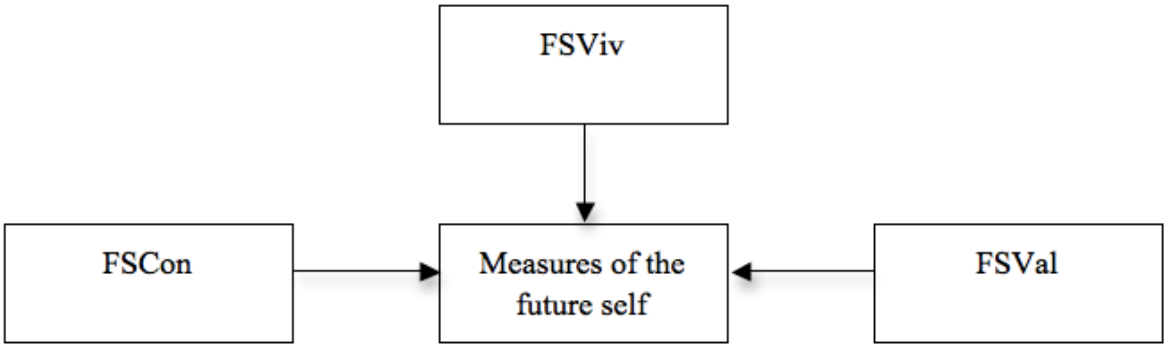

Figure 1. A visual representation of how FSCon, FSViv, and FSVal are related in this study although at the same time investigated as three independent measures associated with connectedness to a future self.

Table 1. *Factor Loadings, Communalities and Cronbach's Alpha based on Principal-Axis Factoring of Embodiment of the Future Self Scale, FSCon Scale, and FSViv Scale.*

Items	Factor loadings	Communality	α
Embodiment of the future self			.67[b]
When sitting in the chair of my future self, I felt as if I was my future self.	.71	.34	
When sitting in the chair of my future self, my thoughts changed from how I normally think.	.77	.32	
When sitting in the chair of my future self, I felt as if I was someone else.[a]	.41	.12	
I felt as if someone was sitting across from me.[a]	.27	.06	
FSCon			.44
How connected do you feel to yourself 10 years into the future?	.53	.08	
How similar do you feel to yourself 10 years into the future?[a]	.53	.08	
FSViv			.88
I find it easy to imagine myself 10 years from now.	.89	.63	
I find it easy to describe myself 10 years from now.	.89	.63	

Note. [a]Items were eliminated from the scale. [b]Cronbach's Alpha without the eliminated items.

2.6 Procedure

All participants were told in advance that the study consists of two parts, with the first part being a 15-minutes questionnaire completed online, while the second part involved coming to the lab for a 45-minutes embodiment exercise scheduled at least one week later. Furthermore, in every condition participants were informed that following completion of the study either receiving one study credit point or 6 Euros would compensate them. How these conditions differed and what participants were instructed to do in each will be discussed in more detail in the following. Figure 2 already provides an overview of the procedural differences between the three conditions.

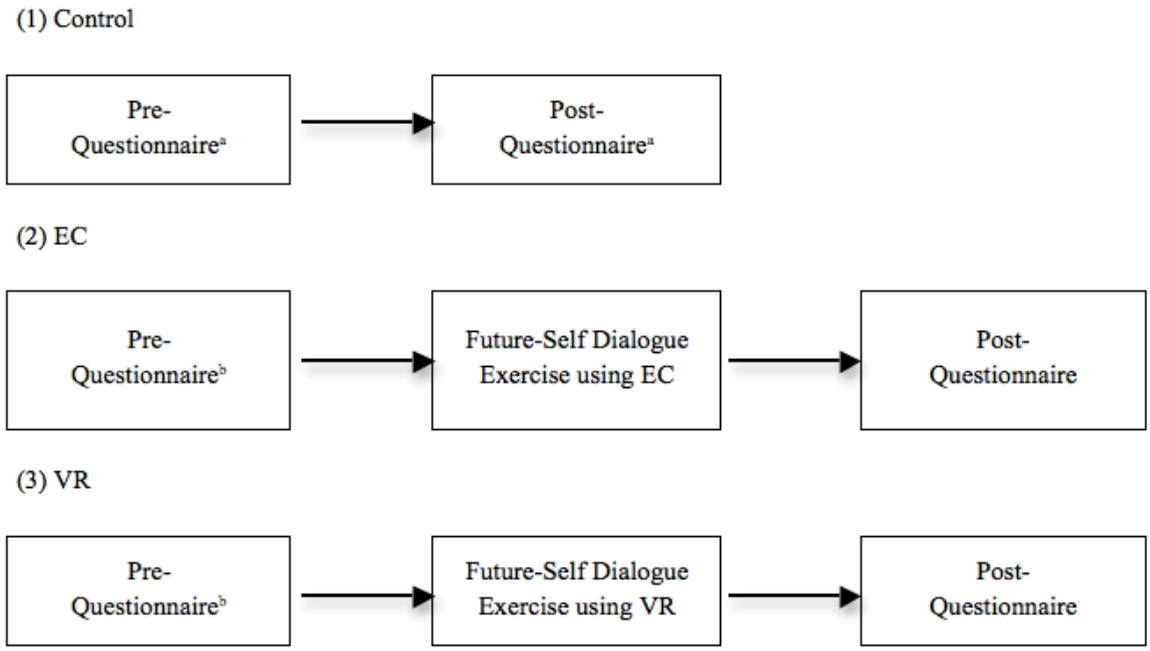

Figure 2. Path diagrams showing the procedural differences between conditions.
[a]Pre- and post questionnaire were the same in the control condition. [b]EC and VR used an identical pre-questionnaire.

2.6.1 Control Condition. In the first part, participants were sent a 15-minutes online questionnaire, which they filled in at home. They were assessed on a number of items which were discussed under section 2.4 "Apparatus and Materials". After completion of the questionnaire, participants signed up for the second part of the study by choosing a date scheduled at least one week later. Upon arrival in the laboratory at the University of Twente they first received a more detailed informed consent and subsequently were instructed to fill in a second online questionnaire, which was exactly the same as in the first part of the study.

2.6.2 EC Condition. The first part of the study was similar to the control condition. Participants first received a 15-minutes online questionnaire, with items identical to those used in the pre-questionnaire for the control condition, except of one additional item at the end of the questionnaire, which instructed participants to elaborate on their future if everything were possible. Then, just like in the control condition, participants signed up for the second part of the study by choosing a date scheduled at least one week later. Upon arrival in the laboratory at the University of Twente they, too, received a detailed informed consent. However, unlike in the control condition, participants had to complete an embodiment exercise before they received a post-questionnaire. Participants were told they would have a conversation with their successful 10 years older future self by alternating between the

embodiment of their present self who asks questions and the embodiment of their future self who answers. To prepare this exercise it was first figured out a goal that participants would discuss with their future self based on their answer to the unrestricted thought question. Afterwards, participants were told to create a name card including name, current age and date on one side of the paper, and their name, but age and date 10 years from now, on the other side. Then, after modeling the exercise once, participants were instructed to practice it on their own with four tutorial questions. In order to stoke the embodiment illusion, they were told to imagine how they think and look like 10 years from now whenever they sit in the chair of their future self. To begin the real exercise, the researcher informed participants about starting the audio recording and left the room. During the exercise, participants had to perform several steps. First, as their present self, they picked up a question from a pile of cards, with nine questions in total. They then pressed the red button on a box placed next to them, which begins recording their voice. To stop recording participants had to press the red button again. Next, they switched to an empty chair placed in front of them, to put themselves into the perspective of their future self. Pressing the green button enabled them to listen to the recorded question via an external loudspeaker. As their future self, they thought of an answer and recorded it via the red button. After switching back to the other chair (their present self), participants again pressed the green button and listened to the answer via an external loudspeaker. This continued until the participants asked and gave answers to all nine questions (see Figure 3 for the set up of the experiment). They then informed the researcher that they completed the task, whereupon the audio recording was stopped and participants were asked a few follow-up semi-structured interview questions about their experience during the exercise. Finally, they were assessed on several items in an online post-questionnaire (see Apparatus and Materials for a list of the relevant items).

2.6.3 VR Condition. In the first part of the study, participants underwent the same procedures as in the EC condition. However, upon arrival to the second part of the study and after signing the informed consent, they were told that they would have a conversation with their successful 10 years older future self in VR. It was explained that in the virtual environment they would first ask a question as their present self and then switch to the embodiment of their future self in order to give an answer from the perspective of their future self. Afterwards, just like in the EC condition, it was agreed on a goal that participants would discuss with their future self. Before participants started the real exercise, they were able to practice the steps in a virtual environment that functioned as a tutorial. Participants were fitted with the head-

mounted display, which controlled their head movements, and were given two controllers, which provided control over arms and torso. Upon entering the virtual environment, they found themselves inside a virtual body with the silhouette of either a man or a woman. They experienced this body from a 1PP, where head and body movements were in accordance with virtual movements and the virtual body could be seen whenever participants looked down towards their real body or in a virtual mirror left to them. During the embodiment exercise participants were sitting in a virtual room that looked like an office, with a table and an empty chair in front of them and a mirror to the left. On the table they saw a clock with the current date, a name card saying their name and current age, a box with one red and one green button, and a pile of cards (see Figure 3). Initially to the tutorial exercise participants received several instructions by the researcher. First, participants were told to describe what they see. Then, they were instructed to move their hands, to look in the mirror and move their head, shoulders, arms and torso, and to look down on their legs. This was aimed to increase the feeling of embodiment over the virtual body. Participants were then asked to pick up a question from the pile of cards and subsequently to press the red button with which they would record this question. Afterwards, they pressed the red button again to stop recording and were told to press the green button, which initiated a virtual time travel. It seemed like participants moved to the chair on the other side of the table because the name card and the clock displayed their age and the date 10 years into the future. Whenever being on this side of the table, participants were instructed to imagine embodying their future self. As their future self they first listened to the recorded question, which automatically played back to them after the time travel, and then recorded an answer. Subsequently, they initiated the virtual time travel to listen to their recorded answer back in the virtual body representing their present self. These steps were repeated until all four tutorial questions were being asked and answered without error. After completing the tutorial participants entered another virtual environment to complete the real exercise. Everything remained the same except for the pile of cards, which now included nine questions that were different from those in the tutorial. Before the task participants were again instructed to describe what they see and to perform stretching exercises in order to increase the feeling of body ownership over the virtual body. Afterwards, the researcher informed participants about starting the audio recording and left the room to let them conduct the exercise in private. Participants completed the same steps as in the tutorial until all nine questions were asked and answered. They informed the researcher, whereupon the audio recording was stopped and participants were asked a few follow-up semi-structured interview questions about their experience during the exercise. Finally, they were assessed on

several items in an online post-questionnaire (see Apparatus and Materials for a list of the relevant items).

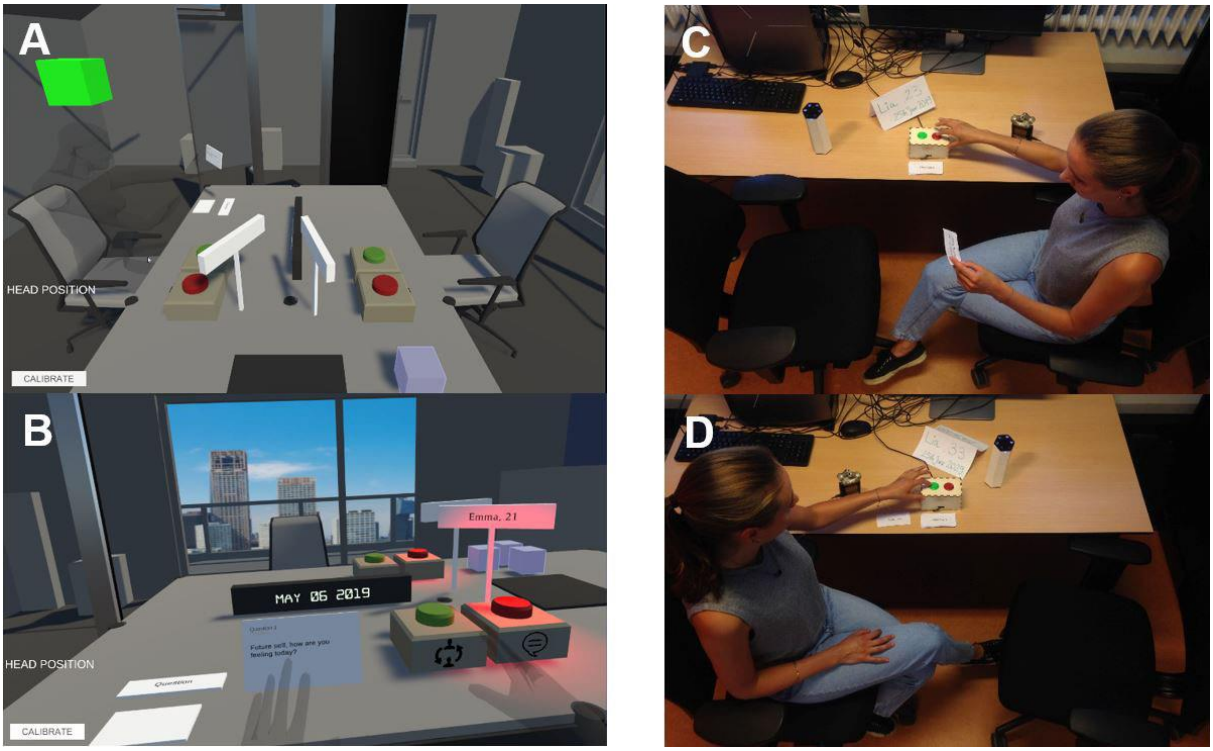

Figure 3. The future self-dialogue exercise in VR and EC. (A) A bird's eye view from the VR environment. The participant is embodied in an avatar that has the shape of either a woman or a man depending on the participant's gender. (B) Stereo 1PP view from the participant embodied in the present self-avatar. The participant sees herself from a 1PP and also in a mirror to the left. Note that there is a name card displaying the participants' name and current age and a clock showing the date of the experiment. When embodied in the future self-avatar the participant will find herself on the other side of the table seeing her age and the date in 10 years from now. (C) The researcher models the recording of a question in the chair of the present self. A name card on the table displays the name, current age and the date of the experiment. (D) Modeling how to listen to the recorded question in the chair of the future

3. Results

3.1 Randomization Check

With the use of cross-tabulation with chi-square it was first checked whether the randomly allocated conditions of control, EC, and VR are by chance solely made up of females or males. Findings of the analysis would in that case only be explained by one of the gender groups and could not be generalized to the whole population. Results indicated that the control condition consisted of 4 males and 11 females, while both the EC and the VR

condition consisted of 3 males and 12 females. The three conditions did not differ significantly by gender ($X^2(2, N = 45) = .26$, $p = .879$).

Furthermore, a one-way analysis of variance (ANOVA) was conducted to compare the age of participants in the three conditions. There was no significant difference found in the age of participants for the control ($M = 20.47$, $SD = 1.46$), the EC ($M = 21.73$, $SD = 2.66$), and the VR condition ($M = 21.87$, $SD = 1.96$) ($F(2,42) = 2.06$, $p = .140$).

Lastly, it was checked for baseline differences between the three conditions on FSCon, FSViv, and FSVal. This is important because if in one condition participants for example already have had a high degree of connectedness to their future self while those in the other two groups did not, this would explain why an intervention worked better for participants in one condition than in another. Results of three ANOVAs indicated that there was no significant difference found between the three conditions in FSCon ($F(2,42) = .25$, $p = .784$), in FSViv ($F(2,42) = .22$, $p = .803$), and in FSVal ($F(2,42) = .37$, $p = .696$). Pre-test scores in all three conditions indicated that participants on average felt around medium FSCon, scored around medium high on FSViv, and scored on average between *like some* and *like* on FSVal. Hence, only on FSVal participant's scores were in the upper quartile. See Table 2 for means and standard deviations.

Table 2. *Results of the One-Way ANOVAs Comparing the Pre-Test Scores in FSCon, FSViv, and FSVal between Three Conditions*

	Condition				
[a]Variable	Control	EC	VR	*F*	*p*
FSCon	3.67 (1.95)	4.13 (1.96)	3.87 (1.55)	.25	.784
FSViv	4.13 (1.86)	4.23 (1.74)	3.83 (1.54)	.22	.803
FSVal	5.87 (1.41)	5.47 (1.36)	5.53 (1.36)	.37	.696

Note. FSCon was measured by seven Euler circles ranging from *no overlap* to *almost complete overlap*. FSViv was measured on a 7-point likert scale ranging from *strongly disagree* to *strongly agree*. FSVal was measured on a 7-point likert scale ranging from *don't like at all* to *like a lot*.

[a]Variables are denoted as mean (SD).

3.2 Testing the Hypotheses

3.2.1 Experimental Conditions Compared Against Control. First of all, it was hypothesized that a future self-dialogue exercise leads to a significantly greater increase in FSCon, FSViv, and FSVal compared to no future self-dialogue exercise (H1). To test whether participants in the EC and the VR condition had a significantly greater increase in FSCon, FSVal, and FSViv compared to the control condition new variables displaying the "difference score" had to be computed for each of these three dependent variables by subtracting the post-test score from the pre-test score. Subsequently, three separate one-way ANOVAs were employed to test whether the "mean difference scores" for each dependent variable differed significantly between the three conditions. The first one-way ANOVA revealed that there was no statistically significant difference between conditions in the increase on FSCon at the $p < .05$ level ($F(2, 42) = .15$, $p = .865$). More specifically, by inspecting all possible pairwise comparisons a Tukey post hoc test revealed that the increase in FSCon was not significantly higher after performing a future self-dialogue exercise in EC ($M = .40$, $SD = 2.06$, $p = .975$) and VR ($M = .60$, $SD = 1.59$, $p = .854$) compared to the control condition ($M = .27$, $SD = 1.39$). The second one-way ANOVA found no statistically significant difference between conditions in the increase on FSViv at the $p < .05$ level either ($F(2, 42) = .15$, $p = .864$). More specifically, a Tukey post hoc test indicated that the increase in FSViv was not significantly higher after performing a future self-dialogue exercise in EC ($M = .57$, $SD = 1.39$, $p = .988$) and VR ($M = .73$, $SD = 1.07$, $p = .859$) compared to the control condition ($M = .50$, $SD = 1.16$). Lastly, the third ANOVA revealed that there was again no statistically significant difference between conditions in the increase on FSVal at the $p < .05$ level ($F(2, 42) = 2.44$, $p = .100$). The Tukey post hoc test indicated that the increase in FSVal was not significantly higher after performing a future self-dialogue exercise in EC ($M = .23$, $SD = .49$, $p = .350$) and VR ($M = .40$, $SD = .66$, $p = .087$) compared to the control condition ($M = -.07$, $SD = .59$).

All in all, these results suggested that H1 must be rejected, because although it seemed like that on average participant's scores on FSCon, FSViv, and FSVal tend to have increased more after having had a future self-dialogue exercise compared to when participants conducted no such exercise (see Table 3), these differences were not found to be statistically significant. In other words, it cannot be ruled out that these differences have simply occurred due to random chance. Interestingly, it was observed that on average FSViv had the greatest increase from pre-test to post-test, followed by FSCon and lastly FSVal. Furthermore, it is notable that the difference in the mean scores for FSVal (indicating the change from pre-test

to post-test) between the VR and the control condition was almost significant at an alpha level of .05.

3.2.2 VR Compared Against EC. Secondly, it was hypothesized that a future self-dialogue exercise in VR leads to a significantly greater increase in FSCon, FSViv, and FSVal compared to the EC condition (H2). Based on the previous analyses it is not expected that the two conditions will differ significantly in the change from pre-test to post-test on these dependent variables. Nevertheless, it must be verified whether there is a trend effect that is relevant for future research. For this purpose, three separate one-way ANOVAs were employed. Results indicated that the differences between the EC and the VR condition in the average increase in FSCon ($F(1, 28) = .09$, $p = .769$), the average increase in FSViv ($F(1, 28) = .14$, $p = .715$), and the average increase in FSVal ($F(1, 28) = .61$, $p = .441$) were not found to be statistically significant at the $p < .05$ level. See Table 3 for means and standard deviations.

Overall, these results indicated that H2 must be rejected as well. Although participants had on average a slightly greater increase in their scores on FSCon, FSViv, and FSVal after having completed the future self-dialogue exercise in VR compared to EC, these differences were not found to be statistically significant. It cannot be ruled out that they actually occurred due to random chance. Rejecting H2 means that it becomes redundant to test whether embodiment of the future self adds predictive value to the VR condition (as compared to the EC) in predicting an increase in FSCon (H2a), FSViv, (H2b), FSVal (H2c).

Table 3. *Results of the One-Way ANOVAs Comparing the Change from Pre-Test to Post-Test in FSCon, FSViv, and FSVal between Conditions*

	Condition				
[a]Variable	Control	EC	VR	*F**	*F***
FSCon	.27 (1.39)	.40 (2.06)	.60 (1.59)	.15	.09
FSViv	.50 (1.16)	.57 (1.39)	.73 (1.07)	.15	.14
FSVal	-.07 (.59)	.23 (.49)	.40 (.66)	2.44	.61

Note. [a]Variables are denoted as mean (SD).
*Non-significant differences between control, EC and VR. **Non-significant differences between EC and VR.

3.3 Exploratory Findings

3.3.1 The Role of Embodiment. Since H2 has been rejected there is no reason to test for H2a, H2b, H2c anymore. It is interesting, however, to explore whether there was an effect of the embodiment of the future self in general and if this differed significantly between the two experimental conditions. For this reason, an independent-samples t-test was performed to first compare the mean scores on the embodiment of the future self between the EC and the VR condition. There was no significant difference found in the scores for embodiment of the future self between the EC (M = 5.20, SD = .98) and the VR condition (M = 4.63, SD = 1.29) at the $p < .05$ level ($t(28) = 1.36$, $p = .186$). We also compared the medians for EC (Mdn = 5.50) and for VR (Mdn = 5.00) as another measure of central tendency. Despite the non-statistical significance, it is still interesting to see that contrary to what was initially presumed participants in the EC condition did on average score slightly higher on the embodiment of the future self.

Furthermore, it is interesting to explore whether high embodiment of the future self, independent of the condition, does predict an increase in FSCon, FSViv, and FSVal. Three separate simple linear regressions were performed. The first simple linear regression found that embodiment of the future self only explained almost 2% of the variation in the increase of FSCon (R^2 = .02, $F(1, 28) = .46$, $p = .504$). It was found that embodiment of the future self did not significantly predict an increase in FSCon (b = -.13, $t(28) = 1.00$, $p = .327$). Results of the second regression indicated that embodiment of the future self only explained 11% of the variation in the increase of FSViv (R^2 = .11, $F(1, 28) = 3.47$, $p = .073$). It was found that embodiment of the future self did not significantly predict an increase in FSViv either (b = .33, $t(28) = -1.13$, $p = .269$). Results of the third regression indicated that embodiment of the future self only explained 2% of the variation in the increase of FSVal (R^2 = .02, $F(1, 28)$ = .59, $p = .450$). Embodiment of the future self was no significant predictor of an increase in FSVal (b = .14, $t(28) = -.07$, $p = .942$).

Based on the previous analyses it is interesting to check whether there is any relation between the embodiment of the future self and the observed difference from pre-test to post-test in FSCon, FSViv, and FSVal at all. Spearman rank correlations only found a significant, positive correlation between embodiment of the future self and the observed difference from pre-test to post-test in FSViv ($r(43) = .42$, $p = .022$). Hence, when the embodiment of the future self was high, the change in the FSViv score from pre-test to post-test was high as well. However, there was almost no relation between embodiment of the future self and the

observed difference from pre-test to post-test in FSCon ($r(43) = -.06$, $p = .770$), and a positive, but non-significant correlation between the embodiment of the future self and the observed difference from pre-test to post-test in FSVal ($r(43) = .17$, $p = .368$).

3.3.2 Qualitative Analyses. A few preliminary analyses with six cases were performed to see whether future research could benefit from a content analysis of the future self-dialogue. Taking participants narrative style into account might be worthwhile because it could provide additional information on how well embodied they felt in their future self. In a study by Chernyak et al. (2017), the number of personal pronouns was used to determine children's ability to project themselves into the future. They found that children used more personal pronouns when they talked about events in the near future compared to temporally distant events. Based on this, it was interesting to explore how the number of personal pronouns (including I, my, myself, we) used during the future self-dialogue exercise in this study relates to (1) embodiment of the future self, (2) the degree of FSCon, FSViv, and FSVal in general, and (3) the increase in FSCon, FSViv, and FSVal. Due to the small sample, it was not expected to find significant relations. Nonetheless, Spearman's rank correlations indicated that the number of pronouns correlates positively and more strongly with embodiment of the future self ($r(4) = .70$, $p = .123$) compared to when correlating the number of pronouns per words with embodiment of the future self ($r(4) = .33$, $p = .518$). Furthermore, Spearman's rank correlations found that the number of pronouns used had a negative correlation with FSCon ($r(4) = -.50$ $p = .312$), no correlation with FSViv ($r(4) = .06$, $p = .913$), and a positive correlation with FSVal ($r(4) = .49$, $p = .326$). Lastly, results of Pearson product-moment correlations revealed a negative correlation with FSCon ($r(4) = -.54$, $p = .270$), a positive correlation with FSViv ($r(4) = .60$, $p = .205$), and a positive correlation with FSVal ($r(4) = .48$, $p = .336$). In sum, although it is difficult to draw meaningful conclusions with six cases, the analyses showed that the relations between pronouns and embodiment of the future self; pronouns and FSVal; and pronouns and the increase in FSViv and FSVal are into the intended direction.

3.3.3 Gender and Age as Covariates. Since it was found out that the three conditions did not differ significantly on gender nor on age it can be investigated whether the effect of condition on greater increase in FSCon, FSViv and FSVal changes after controlling for the effect of gender and the effect of age. For this purpose three separate one-way between subjects ANCOVAs were performed, first with gender and then with age. Results indicated that the

covariate, gender, was not significantly related to the increase in FSCon ($F(1, 41) = .38$, $p = .543$), the increase in FSViv ($F(1, 41) = .10$, $p = .749$), and the increase in FSVal ($F(1, 41) = 1.74$, $p = .195$). After controlling for the effect of gender, the three conditions still did not significantly differ in terms of greater increase in FSCon ($F(2, 41) = .16$, $p = .850$), in FSViv ($F(2, 41) = .15$, $p = .858$), and in FSVal ($F(2, 41) = 2.26$, $p = .117$). Similarly, age was not significantly related to the increase in FSCon ($F(1, 41) = .12$, $p = .731$), in FSViv ($F(1, 41) = .00$, $p = .989$), and in FSVal ($F(1, 41) = .35$, $p = .560$). After controlling for the effect of age, the three conditions still did not significantly differ in terms of greater increase in FSCon ($F(2, 41) = .18$, $p = .833$), in FSViv ($F(2, 41) = .13$, $p = .875$), and in FSVal ($F(2, 41) = 1.86$, $p = .169$). In sum, it appears that after controlling for the effect of gender and the effect of age, the effect of condition on greater increase in FSCon, FSViv and FSVal did not change substantially. This means that gender and age had no additional moderating influence.

3.4 Summary

Overall, there was no support found for H1, which means that a future self-dialogue exercise did not lead to a significantly greater increase in FSCon, FSViv, and FSVal compared to no future self-dialogue exercise as it was previously expected. Despite this it was interesting to see that on average participants' scores on FSCon, FSViv, and FSVal tend to have increased more after having had a future self-dialogue exercise compared to when the participants conducted no such exercise. Furthermore, it was observed that on average FSViv had the greatest increase from pre-test to post-test, followed by FSVal and lastly FSCon, and that the greater increase in FSVal in the VR condition compared to the control condition was almost significant at an alpha level of .05.

Likewise, when testing for H2, it was observed that participants had on average a slightly greater increase in their scores on FSCon, FSViv, and FSVal after having completed the future self-dialogue exercise in VR compared to EC. However, these differences did not turn out to be significant, which is why H2 had to be rejected as well. Thereupon, there was no need to test the three sub-hypotheses, which hypothesized that in predicting an increase in FSCon, FSViv, and FSVal, high scores on embodiment of the future self adds predictive value to the VR condition.

Nonetheless, a few exploratory analyses were performed and revealed that participants in the EC and the VR condition did not significantly differ in how well embodied they felt in their future self. Furthermore, findings indicated that embodiment of the future self, independent of the condition, was not a significant predictor of an increase in FSCon, FSViv,

and FSVal. Qualitative exploratory analyses with six cases found non-significant but positive relations between the number of personal pronouns used during the future self-dialogue and embodiment of the future self, FSVal, and the increase in FSViv and FSVal. Lastly, exploratory findings revealed that there was no substantial change observed in the effect of condition on the greater increase in FSCon, FSViv and FSVal after controlling for the effects of gender and age.

4. Discussion

This study examined if connectedness to a future self (hence FSCon) can be enhanced through interventions using a future self-dialogue exercise in which participants embodied their future self from a 1PP either in EC or in VR, and to see whether one intervention worked better than the other. Furthermore, it was investigated whether FSViv and FSVal can be increased through these interventions, as the literature supports that both may be related to feeling connected to a future self (e.g., Hershfield et al., 2018; Hershfield, 2011). Hence, the study, more specifically, investigated the research question: Does FSCon, FSViv, and FSVal increase through a future self-dialogue involving embodiment of the future self, and is this effect stronger in VR compared to EC dialogue? This is important to investigate because research already found that feeling connected to a future self is associated with more future-oriented behaviors, such as less temporal discounting (e.g., Ersner-Hershfield et al., 2009b) and increased exercise behavior (Rutchik et al., 2018). Some research even found a causal relation between connectedness to a future self and more health-aware behaviors (Rutchik et al., 2018). In other words, feeling connected to a future self increases the likelihood to act in ways that would benefit that self.

The most important findings were that, contrary to what was expected, participants who conducted a future self-dialogue exercise in EC and VR did not have a significantly greater increase in FSCon, FSViv, and FSVal compared to participants in the control condition. Unexpectedly, there was also no significant evidence found that the manipulation worked better in VR compared to EC. Hence, H1 and H2 had to be rejected. This outcome cannot be explained due to baseline differences between conditions in these future self measures. Nor can it be explained due to already high levels in FSCon and FSViv. Participants' medium-ranged baseline levels in FSCon is comparable to Adelman et al. (2017) who used the same age of the future self and the same measurement scale (besides that we excluded the similarity item). Even though they used a different scale and a 15-year-old time

difference between present- and future self, the baseline level in FSViv in a study by Van Gelder et al. (2015) is around the middle of the measurement scale (indicating *don't disagree/don't agree*), which is similar to ours. In the case of FSVal, it was difficult to find comparable studies, in which pre-test scores were not manipulated and which used comparable age groups and measurement scales. Nonetheless, based on that participants scored on average in the upper quartile of the scale, it is assumed that they already had high levels of FSVal and therefore it might explain why the increase in FSVal was the lowest among the future self measures in all conditions because there was less room for improvement. Although the differences were not statistically significant, it is notable that the results pointed into the intended direction. On average the increase in FSCon, FSViv, and FSVal from pre-test to post-test was the greatest in the VR condition. The EC condition had the second greatest increase and the control condition the lowest. When looking at this tendency only it seems like results are not entirely at odds with what was hypothesized and somewhat fit with the ideas mentioned in the literature.

In particular, past research has repeatedly demonstrated that vividness of a future self can be experimentally manipulated and that one way to do this is through the use of VR (Hershfield et al., 2018; Van Gelder et al., 2013; Hershfield et al., 2011). For example, in a study by Hershfield et al. (2011) immersive VR hardware increased the vividness of a future self because it enabled participants to interact with realistic age-progressed versions of themselves. However, in the current study, it was not made use of age-progression software, instead vividness and imagination was aided through, for instance, a virtual time travel that enhanced the feeling of switching from a representation of the present self to the embodiment of a future self. As exemplified by a study by Osimo et al. (2015), the embodiment of a virtual avatar can be vivid, in the sense that people come to feel some sort of "presence" due to control over virtual body movements, even when this avatar does not resemble oneself. Hence, the potential for such virtual embellishment to the 'imagined experience' may provide some understanding of why there was a slightly greater increase observed in FSViv for participants who were in the VR condition compared to those in EC.

Moreover, a slightly greater increase in FSCon is in line with the assumption by Hershfield et al. (2018) that just like people feel more emotionally connected and inclined to help someone in need when this person is made more vivid, increasing FSViv may simultaneously increase the connection felt towards that self. Indeed, research suggests that vividness interventions using VR are successful in, for instance, increasing saving behaviors

(Hershfield et al., 2011) and decreasing delinquency (Van Gelder et al., 2013), because they enhance connectedness to a future self.

Besides FSCon and FSViv there was a trend observed that on average the scores in FSVal increased more after having had a future self-dialogue exercise in VR or EC while in the control condition they slightly decreased on average. If ignoring the non-statistically significance, this result would fit with the idea that manipulating participants to imagine a successful future self increases a positive attitude toward that self. Interestingly, there was almost a significant difference found between VR and the control condition, which indicates that it is worth to examine whether VR significantly increases FSVal when repeating the experiment with a larger sample. The observed difference (although non-significant) between VR and EC, on the other hand, may be explained by Hershfield et al. (2011), namely, that interventions using VR are more engaging and fun to follow through than more traditional techniques. We also believe that conversing with a future self in VR is a particularly exciting venture and could have elicited greater positive emotions, which were then associated with the future self. In a study by Osimo et al. (2015) it was found that embodiment of a virtual body that looked like the self as well as one that resembled Freud led to mood improvements in participants with minor personal issues. Besides, it can be useful to refer back to research by Blouin-Hudon and Pychyl (2015), which found a link between being able to experience greater positive emotions and having higher cognitive flexibility and broadening. With regard to this finding, it is interesting to consider whether greater positive emotions elicited due to the use of VR made it likely that participants were able to better imagine their successful future self and therefore came to like the idea of being that self more.

Nonetheless, any interpretation of the change observed in the future self measures must be treated with caution, because as already mentioned, there were no statistically significant differences found between the conditions. In most cases, the p-values were large, indicating that results are likely due to random chance. The only effect that was almost significant was the difference between VR and the control condition in the change in FSVal. Furthermore, there were large standard deviations observed, which indicate a less consistent reaction and that data tended to be rather spread out from the sample mean. While the change in the future self measures was large for some participants, it was not for others. Hence, the experiment cannot address the issue as to whether the greater increase in FSCon, FSViv, and FSVal in EC and VR compared to the control condition was due to the manipulation specifically or whether the differences observed (also between EC and VR) were due to

random chance. This could also be inferred just by looking at the mean scores of the control condition, which revealed that there was an effect where none was expected.

Interestingly, results showed that of the three future self measures the average increase was the highest for FSViv in all conditions. Increased FSViv in the control condition could mean that simply asking people to think and answer questions about their future self already makes it more vividly imagined. A slightly greater increase in EC compared to control could be explained by that conversing with the future self is more vivid than only contemplating about it. Research shows that EC dialogue increases emotional arousal and enables to access and re-experience emotions, thoughts and feelings that were suppressed in the past (Greenberg and Malcom, 2002). Hence, it was expected that EC dialogue might help to access mental states of future selves and therefore to make the future more vividly experienced. As already discussed, VR adds embellishment to the 'imagined experience', which is why it might have had the greatest increase in FSViv. Yet, interpretations must be treated with caution because these differences between conditions were not significant and might as well be due to random chance. Especially the difference between EC and the control condition in the increase in FSViv and FSCon was highly non-significant, which makes it difficult to draw conclusions about the effectiveness of the intervention.

Due to the non-significant differences, it could not be reliably concluded that the manipulation worked better in VR compared to EC and thus there was no need to test whether embodiment of the future self adds predictive value to the VR condition in predicting an increase in FSCon (H2a), FSViv (H2b), and FSVal (H2c). Still, a few exploratory analyses were conducted. The most important findings were that there was no significant difference found between the two experimental conditions in how well embodied participants felt in their future self. Both, in VR and EC, participants seemed to feel on average only "somewhat" embodied in their future self, and although not significant, there was a slightly greater embodiment observed in the EC condition. These findings stay in contrast with what was expected. Based on research by Banakou et al. (2018) significantly higher embodiment in the VR condition would have made sense, because they found that embodiment of a virtual avatar, even though this avatar looked like Albert Einstein, triggers the illusion that the virtual body is one's own body. Other research findings, summarized in the literature by Banakou and Slater (2014), reveal that the same illusion was observed when light-skinned people embodied a dark-skinned virtual avatar, when average-sized adults embodied a smaller or larger virtual avatar, and when adults embodied a child-like virtual avatar. Hence, in order to feel an embodiment illusion, a virtual avatar does not have to look like oneself. However, the

median for future self-embodiment in the VR condition is comparably lower than the medians for two similar embodiment items ("vrbody" and "agency") that measured the degree of embodiment in a virtual avatar representing Einstein in a study by Banakou et al. (2018). This could be explained by the design of this study: unlike Banakou et al. (2018) and those studies reported by Banakou and Slater (2014), the avatar in this study was less realistic because it was merely a silhouette of a man or a woman. Therefore, the illusion of being embodied in one's future self greatly depended on one's ability for imagination.

Lastly, exploratory analyses revealed that embodiment, independent of the condition, did not significantly predict an increase in FSCon, FSViv, and FSVal. This makes sense, considering that the embodiment manipulation did not work as well as expected in the experiment. However, correlation analyses revealed a moderate, positive and significant relation between embodiment and FSViv. This means that as embodiment increases, FSViv increases as well. This is plausible because when having the illusion of embodying a future self, this should also come with the greater vividness of that self. Conversely, when an intervention is more vivid, participants likely come to believe in the embodiment illusion more.

4.1 Limitations and Future Directions

One limitation of the current study, which explains why the manipulation might not have worked as well as intended, was that the experimental set up, in both EC and VR, still very much depended on someone's imagination. It was predicted that using VR technology would be a particularly effective method that does not rely heavily on differences in one's ability to envision the future because it adds embellishment to the 'imagined experience' by presenting people with a new environment and a new body, as well as virtual cues such as a virtual time-travel. However, results and participant's remarks revealed that even in the VR condition it was at times still hard to imagine being one's future self. This study did not make use of age-progressed renderings of the future self; in fact, the virtual avatar was merely a silhouette that resembled a man or a woman. Over and above the virtual body, participants advised that changing the voice of the future self might have aided their imagination as well. Furthermore, it was observed that the control condition did not reveal stability in the future self measures from pre-test to post-test. This serves as another indication that mitigates the effects of the manipulation. Even without the manipulation, there was change observed in connection, vividness and liking towards the future self. It could be the case that the questionnaire alone, and therefore being confronted with questions about one's future self,

already accounts for some change. Future research may benefit from technology that further increases the imagination of the future self in VR, such as age-progression or voice changer software. The experiment cannot address the issue as to whether the result is due to a lack of imagination, which is why future studies might want to check for baseline differences in the ability for imagination.

A second limitation was that the scale measuring the embodiment of the future self might not have worked as intended, because it was not found to be highly reliable. The item "When sitting in the chair of my future self, I felt as if I was my future self" clearly measures embodiment of the future self. The other item was phrased as follows: "When sitting in the chair of my future self, my thoughts changed from how I normally think". Research provides evidence that virtual embodiment (Osimo et al., 2015) and EC embodiment (Greenberg & Malcom, 2002) can lead to cognitive changes and allows to step out of one's own body and into the perspective of another. It could be, however, that participant's misinterpreted this item because it does not clearly ask whether one experiences the thoughts of the future self. Preliminary analyses with six cases revealed that it might be worthwhile for future studies to dig deeper into qualitative data from the future-self dialogue exercise as an additional measure of the embodiment of the future self. Although non-significant, results revealed a positive correlation between the number of personal pronouns used and the embodiment of a future self.

Furthermore, FSCon was measured by only one item after factor analysis revealed low internal consistency between the item "How connected do you feel to yourself 10 years into the future?" and "How similar do you feel to yourself 10 years into the future?". FSCon is a rather abstract construct, which is why a single item might not grasp its essence. Especially, depicting connectedness to a future self through overlapping circles might be too vague and participants might have difficulties to accurately portray what they feel. Hence, it might be worthwhile to improve the measurement scale in future research by adding items that assess FSCon in more than one way.

This leads to another possible limitation, namely that FSCon, FSViv, FSVal, and the embodiment of the future self were assessed via self-report measures. For this reason, it is for example not guaranteed that participants answered honestly, or even if they tried to be as honest as possible it may be that they lacked the ability to give accurate answers. Abstract constructs such as the embodiment of the future self or changes in FSCon might happen on a subconscious level. To increase trust in results it is advised to add behavioral outcome measures, such as to give participants the choice between a healthy or an unhealthy snack as

compensation for participation. The healthy choice might indicate greater FSCon as it implies an understanding of how eating behavior affects well-being in the future.

Next, the period in which the study was conducted may be too short in order to have a significant influence on how connected a person feels to a future self, how vividly a future self is imagined or how much it is valued. Being confronted with one's future self over a longer time period rather than a single-shot setting might have had a greater effect because people have time to let the experience sink in and to properly reflect on how they felt. Hence, future research could benefit from an experiment that lasts over several weeks.

Another limitation is the size of the sample. This was inferred from the large spread observed in the "difference mean scores" on the future self measures. Including more participants in future studies helps obtain a sample statistic with less variability and therefore provides a more precise estimate of a population parameter. A further indication for increasing the sample size was an almost significant difference between the increase in FSVal in VR compared to the control condition.

Lastly, some participants reported having problems with the record and playback buttons during the experiment, both in EC and VR. They either did not work occasionally or were confusing and therefore distracted from the actual task. Participants reported the buttons reminded them of reality and thus mitigated the illusion of being embodied in the future self.

4.2 Implications

This study aimed to explore whether a future self-dialogue exercise in VR or EC can increase FSCon, FSViv, and FSVal and whether one intervention worked better than the other and why. Findings revealed that both interventions do not significantly increase FSCon, FSViv, and FSVal, which is why it cannot be reliably stated that the manipulation worked. It is relevant to note, however, that despite this non-significance there was a tendency observed that in VR the increase was the greatest in all future self measures and in both experiments it was greater than in the control. Instead of discarding the idea that both interventions could have any practical value due to the non-significant effects, this trend effect suggests that they might have potential. Especially with regard to an almost significant difference observed between VR and the control condition in the increase in FSVal. Researchers can build on this knowledge and focus on improving the research design by adding more cues and embellishment that will further increase the embodiment illusion of a future self in VR, and investigate whether this as well as increasing the sample size changes the intervention's outcome. Furthermore, as results indicated that the embodiment of the future self did not

significantly predict the increase in the future self measures, it directs future research to look into other factors that could possibly have influenced the tendency observed, such as the ability for imagination.

Concluding, this study directs future research in that it gave important insights into whether a future self-dialogue exercise in EC and VR can be used in order to increase FSCon, FSViv, and FSVal. Although there was no support found, in terms of significance, the results were pointing into the intended direction. A future self-dialogue exercise in EC and VR tended to increase FSCon, FSViv, and FSVal more compared to the absence of such exercise, and the greatest increase was observed in VR. Knowing this gives hope that there is potential for improvement. Not every intervention works for every person, but the trend effect revealed that it did work for some while not for others. Hence, although the added value of VR is not yet entirely clear, this research can serve as a guide on where to improve future interventions aimed at increasing connectedness to a future self and therefore to foster long-term oriented thinking and behavior among individuals.

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Appendix A

Four Tutorial Questions and Nine Experiment Questions Used in the Future Self Dialogue Exercise in the EC and VR Condition

Tutorial	Experiment
Future self, what did you have for breakfast?	Future self, how are you feeling today?
Future self, do you eat that everyday?	Future self, what are you celebrating? Who is coming? What are you guys going to do?
Future self, where are you going on vacation this year?	What does it feel like to finally achieve this?
Future self, how much will this vacation cost?	Future self, what did you do or change in the last years that helped you achieve this?
	What were some difficult experiences you overcame and how did you deal with them?
	What one lesson did you learn from these experiences?
	Future self, what advice would you give me to start working towards this goal?
	Future self, what are the best parts about being you?
	Think of a question you would like to ask your future self and ask it. Start the question with: Future self…

Appendix B

Correlation Matrix for the Items of the Embodiment of the Future Self Scale, FSCon Scale, and FSViv Scale

Item	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
When sitting in the chair of my future self, I felt as if I was my future self. (Q1)	1	.54	.29	.24				
When sitting in the chair of my future self, my thoughts changed from how I normally think. (Q2)	.54	1	.31	.15				
When sitting in the chair of my future self, I felt as if I was someone else. (Q3)[a]	.29	.31	1	.12				
I felt as if someone was sitting across from me. (Q4)[a]	.24	.15	.12	1				
How connected do you feel to yourself 10 years into the future? (Q5)					1	.28		
How similar do you feel to yourself 10 years into the future? (Q6)[a]					.28	1		
I find it easy to imagine myself 10 years from now. (Q7)							1	.79
I find it easy to describe myself 10 years from now. (Q8)							.79	1

Note. [a]These items were eliminated.