Connecting with Your Future Self: A Smartphone and Virtual Reality Intervention to Stimulate Future-Orientation and Goal-Achievement

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Abstract

Background: Considering the future is a central aspect of psychosocial functioning and is linked to beneficial outcomes such as better health, academic achievement, and financial decision-making. Conversely, present-focused thinking is associated with impulsivity and self-defeating behaviors. Research suggests that identification with one's future self—encompassing vividness, connectedness, and valence—plays a key role in motivating future-oriented choices and goal pursuit. Interventions that strengthen this connection have been shown to reduce maladaptive behaviors and promote well-being, but traditional approaches often rely heavily on imagination. Emerging technologies such as smartphone applications and virtual reality (VR) offer novel opportunities to make the future self more vivid and tangible, potentially reducing cognitive burden and enhancing intervention effectiveness.

Objective: This study reports the results of a randomized controlled trial evaluating the effectiveness of a digital intervention designed to increase future-oriented thinking and goal achievement by strengthening psychological connectedness to one's future self.

Methods: The intervention was delivered through either a smartphone application or immersive virtual reality (VR), and targeted three components of future self-identification: vividness, valence, and connectedness. Participants were 321 first-year university students who engaged with digital renderings of their future selves over a period of three weeks.

Results: Compared to a goal-setting control group, both intervention conditions yielded significant short-term improvements on all three aspects of future self-identification. Additionally, the intervention buffered declines in future orientation during the study period, and VR delivery led to significantly higher weekly goal achievement. No significant effects were found for other primary or secondary outcomes, such as self-defeating behavior, impulsivity, or academic performance.

Conclusions: These findings suggest that digital interventions leveraging visual and interactive representations of the future self can strengthen future self-identification and support (short-term) goal pursuit. Clinical Trial: The trial is registered on Clinicaltrials.gov (NCT05578755) on 13 October 2022 and the study protocol is publishedfuture self identification, future self continuity, intervention, goal achievement, virtual reality, smartphone application

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Trial Registration: The trial is registered on Clinicaltrials.gov (NCT05578755) on 13 October 2022 and the study protocol is published (see Mertens [38])

Keywords: future self identification, future self continuity, intervention, goal achievement, virtual reality, smartphone application

Introduction

Considering the future is a key component of psychosocial functioning and a ubiquitous part of mental life [1,2]. Individuals who are more future oriented tend to make more informed tradeoffs between the short-term and long-term consequences of their decisions [3] and are more likely to set goals they aspire to achieve over time [4]. This orientation is also linked to various beneficial outcomes, including heightened feelings of competence, better health, increased savings, and stronger academic performance (eg, [4,5]). In contrast, individuals who are more present-focused more often act on impulse and display a preference for immediate gratification [6,7]. Such a focus has been associated with behaviors that offer short-term benefits, but often entail severe long-term costs —i.e., are self-defeating—, such as delinquency, gambling, and substance use (eg, [6,8]). Thus, enhancing future-orientation could contribute to psychosocial functioning in important ways. Here, we examine the effectiveness of an intervention aiming to increase future-orientation and goal achievement by strengthening identification with the future self, using a smartphone application and immersive virtual reality (VR) as delivery technologies.

A Future-Oriented Mindset and the Future Self

Research leveraging the future self to stimulate future-oriented behavior and successful goal pursuit is premised on the idea that the degree to which individuals consider future outcomes is related to how strongly they identify with, and feel connected to, their future self [9]. Rather than emphasizing how current behaviors may carry (negative) remote future consequences in a more generalized way, which is unlikely to resonate with those who have a strong here-and-now orientation, this approach emphasizes the idea of a shared fate between the present and the future self [10]. Experiencing a stronger sense of identification with one's future self contributes to a greater awareness that the possible costs of current actions will ultimately be borne by oneself, even if they materialize only at a later point in time, and also makes the burden of such costs more salient [11]. Conversely, it also promotes the realization that the potential benefits of current effort and sacrifice will get to be enjoyed by oneself, even if reaped only in the future. Thus, stronger identification with one's future self should make it more likely that the interests of this self are factored into decisions made in the present [12].

In support of these assumptions, empirical studies have shown that enhancing identification with the future self can stimulate positive behaviors, such as increased physical activity [9], well-being [13], and savings behavior [12], as well as reducing negative behaviors, such as delinquency [14,15], cheating [16], temporal discounting [17], and procrastination [18].

Future Self-Identification as Vividness, Connectedness, and Valence

Future self-identification (also referred to as future self-continuity) is often conceived as a tripartite structure consisting of the extent to which individuals can clearly and concretely imagine and describe their self in the future (vividness), how similar and connected they feel to it (connectedness), and the positive or negative affect they associate with it (valence) [19,20]. Future self vividness and connectedness in particular have been found to predict intertemporal choice, but are believed to operate through different mechanisms.

Vividness is related to psychological distance, which shapes how events are mentally represented. Events anticipated in the distant future tend to be construed in more abstract and decontextualized terms and with less detail, making them less likely to prompt action [21,22]. Events perceived as temporally near, in contrast, are represented more concretely and are more likely to motivate behavior. One important mechanism driving this is that more concrete representations enhance the perceived likelihood and immediacy of those events; the ability to vividly imagine specific, personal future scenarios can make distant goals feel more immediate and thus more likely to prompt action [2,23]. Furthermore, vivid mental representations also intensify the emotional salience of potential outcomes, which can influence behavior over and above the subjective likelihoods of those outcomes [6,24]. Thus, enhancing the vividness of the future self reduces its psychological distance to the current self and increases emotional salience of remote outcomes and thereby motivates goal-directed action.

Future self connectedness denotes the degree of overlap between the current and future selves one experiences in terms of factors such as shared goals, values, identity, and personality characteristics [20,12,25]. People experiencing high levels of connectedness are more likely to view their future self as an extension of their current identity. In contrast, people who experience only a weak sense of connection with their future self may regard it as distinct and unfamiliar, akin to perceiving a stranger [12,26]. The sense of connection people experience with their future self is consequential as it affects whether people will act in its best interest. That is, similar to how individuals experience varying degrees of psychological connectedness to others —which in turn influences their willingness to make sacrifices on others' behalf— variability in one's sense of connection to the future self can predict the extent to which they engage in behavior that serves the interests of their future selves [11].

Valence of the future self regards the positive and negative affect people associate with it. Although it stands to reason that people with more positive views of their future self are likely to invest more in their future, and positive evaluations of one's future self have also been empirically linked to current self-esteem, mental health, and overall well-being, the empirical relationship between future-self valence and future-oriented behaviors is unclear [10]. Research on episodic future thinking also shows mixed findings regarding the relation between valence and temporal discounting, an indicator of short-term thinking [27].

Prior research has tended to either use an index measure of future self-identification that includes all three aspects —vividness, connectedness and valence— or has focused on only a single aspect, leaving out the other two. Index measures are unable to identify which of the three aspects is driving the effect on outcomes and may mask meaningful relations between specific aspects and outcomes. Research focusing on only one aspect leaves the possible effects of the other two unaccounted for. In the current study, we include all three aspects and examine the effects of the

intervention on each of them separately.

Modes of Delivery: Smartphone App versus VR

Traditional interventions to promote future-oriented thinking and behavior often rely heavily on people's imaginative abilities and use exercises that can carry a significant cognitive burden, such as asking people to imagine a possible future event [28] or to write a letter to their future self [29]. Visual and immersive technologies, such as smartphone apps and VR, provide not only visual support through graphic renderings of a future self, but also allow for a sense of interaction with, and, in the case of VR, the possibility of embodiment of, the future self. Hence, such interventions can reduce cognitive load and the dependency on people's imaginative abilities.

Aside from their shared ability to provide interactive visual content, apps and VR also have several distinct characteristics as delivery methods and differ in the way users can interact with them [30]. Smartphones tend to be integrated in people's daily lives, which provides the opportunity to deliver an intervention in their natural environment through frequent exposure and interaction [31,32]. Users can access the intervention content wherever and whenever they want, as they carry the intervention with them 'in their back pocket'.

VR, in contrast, offers the opportunity to provide participants with highly immersive experiences that are tailored to an intervention's goals [30]. For example, VR allows users to embody avatars that differ meaningfully from their own physical or identity characteristics in perceptually convincing ways [33]. Such alterations in avatar design can unconsciously influence users' perceptions or behaviors, even when they remain consciously aware of the artificial nature of the virtual setting, and thereby change attitudes and behaviors [34,35]. To capitalize on this affordance, in the current study, participants embody avatar versions of their future (and current) selves in a virtual environment.

The Present Study

The goal of this study was to evaluate the effectiveness of an intervention developed in the context of the FutureU research program. The intervention aims to foster future-oriented thinking and future self-identification through three broad strategies: (1) prompting participants to imagine their future and desired goals, (2) encouraging reflection on their future self, and (3) enabling interaction with digital renderings of this aged self. These renderings are intended to instill a more vivid image of the future self, to encourage participants to think about their future self in daily life, and stimulate a sense of connection to that self. Through various assignments, participants are exposed to, and interact with, a digital version of their future self 10 years from now (see Table 1 for a description of the different intervention modules).

To help participants imagine and contemplate their future self, the intervention exploits several affordances of smartphone applications and VR to facilitate meaningful interaction with it. We examined intervention effects on future orientation, goal achievement, and self-defeating behaviors, comparing the app and VR experimental conditions to an active, goal-setting control condition. Specifically, we assessed proximal effects on the three aspects of future self-identification (i.e., vividness, valence, and connectedness), as well as distal intervention effects on primary outcomes (i.e., future orientation, consideration of future consequences, self-defeating behavior, goal commitment, and goal achievement), and secondary outcomes (i.e., self-efficacy, academic performance, and impulsivity). In case of significant intervention effects, we compared the two delivery methods (i.e., app versus VR) with each other to establish whether one generated stronger effects than the other. We hypothesized that the intervention would enhance future-self identification and the primary outcomes. No specific hypotheses regarding the most effective delivery method were formulated.

Research suggests that the most effective time to intervene is during transformational events

and contextual shifts [36]. Such transitions typically involve changes in environment, routines, and social networks. Therefore, we evaluated the effectiveness of the intervention among first-year university students—a group undergoing transition from secondary school to university. This period often involves impactful changes, such as moving away from home, relocating to a new city, and adopting new roles, making it an opportune moment for intervention.

Methods

Design and Procedure

The intervention was examined by means of a Randomized Controlled Trial (RCT), with three conditions: 1) a smartphone condition in which participants set goals and received the intervention via the app (an iteration of the app examined in Mertens et al. [37], 2) a VR condition in which participants set goals and received the intervention via immersive VR, and 3) an active control condition in which participants set goals —as in the other conditions— but received no further intervention. Participants were randomly assigned to the conditions on a 1:1:1 ratio with blocks of 9 by the researchers. The random sequence was generated with an online tool by the project manager (see Figure 1 for the flow chart).

< Figure 1 flow chart >

In all three conditions, participants started out with an intake session at the faculty's research lab. During the intake, participants set personal goals, and completed the baseline questionnaire. In the smartphone condition, participants downloaded and installed the intervention app on their own smartphone and created an avatar representing their 10-year older 'future self'. In the VR condition, the three VR intervention sessions were scheduled.

Participants completed online questionnaires during intake (T1/baseline), at weekly intervals during the intervention (T2, T3), immediately after the intervention (T4), and 3- and 6-months after the end of the intervention (T5, T6), or at parallel time points in the control condition. Questionnaires not

completed in time (i.e., within 4 days for T2 and T3, 8 days for T4, 16 days for T5, and 32 days for T6) were treated as missing data. Data were collected between October 2022 and January 2024.

Avatar Creation

In both the smartphone and the VR conditions, avatars representing participants' 10-year older self, i.e., the future self, were created with multiple plug-in services and software specifically developed for the research project.[1] The avatar creation-process differed slightly between conditions. In the smartphone condition, participants took a 'selfie' using the integrated camera of their own smartphone when opening the FutureU app for the first time. This photo was age-progressed by 10-years using a custom-made server and the online service of Change My Face. Subsequently, the aged image was converted into a 3D digital representation via software developed by Avatar SDK, version 'Head 2.0'.

In the VR condition, a (full body) avatar was created at the start of the first VR session (T2). This was a two-step procedure. First, a photo of the participant's face was made using a webcam that was connected to the computer running the VR simulation. The rest of the procedure for creating the avatar's head was identical to the smartphone condition. Second, the avatar's body was created using custom-made software. The software allows for adjusting the proportions of a generic male or female virtual body using a set of sliders to match the participant's actual body and skin color. The upper-body clothing of the present self-avatar and of the future self-avatar differed in color to emphasize the difference between the two.

Ethical Considerations

The study was approved by the independent Ethics Board of the Institute of Education and Child Studies at Leiden University (ECPW2021-320) and was registered on Clinicaltrials.gov (NCT05578755) on 13 October 2022 (see Mertens [38] for the study protocol). All participants provided active informed consent, after reading the information letter and asking any questions they

[1] All custom software development, design and illustrations by Orb Amsterdam (www.orbamsterdam.nl) and Studio Barbaar (www.studiobarbaar.com)

had, at the beginning of the intake before any data was collected. To ensure privacy of the participants, data was handled according to the study's Data Management Plan and Data Processing Inventory Analysis, approved by the Data Manager and Privacy Officer of Leiden University. Data was anonymized and stored on the secured servers of Leiden University, and access to the data was limited to the research team. The photos of the participants were automatically, and permanently, deleted from the secured servers after 24 hours. For completing the questionnaires of T1 to T4, participants received either 8 course credits or 35 euros. For completing both follow-up questionnaires (T5 and T6), they received an additional 20 euros.

Participants

Participants were 321 first-year university students in the Netherlands, predominantly enrolled in Pedagogical Sciences (*n* = 187, 58%) and Psychology (*n* = 133, 41%). Most participants were female (*n* = 287, 89%) with an average age of 19.59 years (*SD* = 2.25). Each of the three conditions consisted of 107 participants. There were no differences between the conditions regarding sex distribution ($\chi^2(2) = 1.05$, $p = .591$, $\varphi = .057$; Women: smartphone $n = 97$, VR $n = 93$, control $n = 97$) and age ($F(2,318) = 0.55$, $p = .579$, $\eta^2_{partial} = .003$; smartphone $M(SD) = 19.40(2.46)$, VR $M(SD) = 19.70(2.02)$, control $M(SD) = 19.65(2.24)$).

Attrition Analyses

Results of the attrition analyses were based on an alpha level of .01 to correct for multiple testing. A series of Little's MCAR tests indicated that at each time point the data was missing at random ($\chi^2 = 0.30\text{-}13.51$, $p = .036\text{-}.861$).

Attrition analyses showed that participants with missing data at T3 ($n = 13$; MANOVA $F(9,311) = 1.08$, $p = .375$, $\eta^2_{partial} = .030$), T4 ($n = 10$; MANOVA $F(9,311) = 1.85$, $p = .059$, $\eta^2_{partial} = .051$), T5 ($n = 67$; MANOVA $F(9,311) = 1.78$, $p = .072$, $\eta^2_{partial} = .049$), and T6 (MANOVA $F(9,311) = 2.31$, $p = .016$, $\eta^2_{partial} = .063$) did not significantly differ at baseline from participants with complete data at the corresponding time point on age and the outcome variables. At T2 there were

differences (n = 10; MANOVA $F(9,311) = 2.60$, $p = .007$, $\eta^2_{partial} = .070$) with participants with missing data scoring lower at baseline on valence ($M(SD) = 5.70(1.83)$) than participants with no missing data ($M(SD) = 6.84(1.21)$). There were no differences on sex distribution between participants with and without missing data except at T6. At T6, participants with missing data (n = 88) were more often men ($\chi^2(1) = 7.38$, $p = .007$, $\varphi = -.152$; n = 16 (18.18%) vs. n = 18 (7.73%)).

Conditions

Intervention Conditions

The intervention started with participants setting personal goals; one that they wanted to achieve in the coming year and another one that they wanted to achieve within the coming month. Additionally, they set a goal for the upcoming week as a first step towards reaching their monthly goal. The researcher supported the formulation of these goals and ensured goals set were specific, measurable, and challenging (though nonetheless attainable) following the SMART-goal model and Zimmerman's criteria [39]. In the app and control conditions, participants independently set weekly goals during each week of the intervention period to attain their monthly goal. In the VR condition, participants received additional guidance for setting the weekly goals from the experimenter at the start of each VR session.

After setting their goals, participants received three consecutive intervention modules. The first module primarily focused on instilling a vivid view of the future self, the second module aimed to motivate future-oriented decision making, and the third module aimed to foster goal achievement. The theoretical foundation of the three modules is presented in Table 1 (see Mertens [38] for more information).

Table 1. Description and features of the three intervention modules

Module	Theory	Core features Smartphone app	Core features VR sessions

Future self identification Stimulating vividness, familiarity, and identification with the future self	• Exposure to and vividness of the future self increases future orientation (McMichael et al., 2021). Additionally in smartphone intervention • Incremental personality theory: The belief that personality can change over time can reduce problematic behaviors (Yeager, 2017). • People's willingness to change on personality traits in socially desirable ways increases after feedback on their current trait levels (Thielmann & De Vries, 2021).	• Complete personal profile of the future self (eg, work experience, skills, accomplishments). • Current scores on personality traits with an indication of norm scores. • Short animation with psychoeducation that personality can change over time. • Set scores of personality traits of future self. • Future self-interaction portal to connect and interact with the future self. The future self asks participants to think about their future self in daily life and gives guided episodic future thinking exercises.	• Time travel portal facilitating mental time traveling in order to 'pre-live' events. • Embodiment of avatar representing future self, bolstering vividness of and identification with the future self. • Interview future self about personal profile (eg, work experience, skills, accomplishments). • A grid containing participant's answers showing a personal profile of the future self.
Future self perspective Cultivate future-oriented choices and increase self-insight by distanced perspective taking aiming to stimulate attitudes and behaviors favoring the future self	• People make more future-oriented choices: 1) for others (i.e., Solomon's paradox; Grossmann & Kross, 2014); 2) when they have a vivid perception of the future self (McMichael et al., 2021); 3) when they can psychologically or temporally distance themselves from the situation (i.e., Construal level theory; Trope & Liberman, 2003). • Wise reasoning is enhanced with third-person self-reflection (Grossmann et al., 2021).	• Short animation clip with psychoeducation that people make more future-oriented choices when they distance themselves from the situation, and when they think about the long-term consequences. • Time portal to take future self perspective for giving advice. • Participants address themselves in the third-person. • Future self-interaction portal: The future self emphasizes that personality can change over time and stimulates decision making with the future self in mind.	• Verbal psychoeducation that people make more future-oriented choices when they distance themselves from the situation and when they think about the long-term consequences. • Ask future self advice on a challenge in the study domain and on an freely chosen domain. Switching perspectives is used to mimic a conversation and facilitates clarification of the challenge/problem and giving advice. • A grid containing participant's answers showing the posed challenges and the future self's advices.

Goal setting and achievement Bolster goal setting and achievement by teaching a growth mindset and Mental Contrasting and Implementation Intentions	• Growth mindset: The belief that people's abilities can develop over time. This mindset aids engagement in thoughts and behaviors to work towards goals (Dweck & Yeager, 2019). • Mental Contrasting and Implementation Intentions (Oettingen & Gollwitzer, 2010): Method in which the desired future is contrasted with the current reality and then reflected upon obstacles in the way of attaining the desired future. Subsequently, a plan is formulated to implement behaviors to overcome obstacles, i.e., implementation intentions, in the format: If situation X, then I will do Y.	• Short animation clip with psychoeducation that abilities can develop over time. • Short animation clip explaining Mental Contrasting and Implementation Intentions. • Practice with Mental Contrasting and Implementation Intentions to work towards goals via filling in a scheme. • Writing a letter to the future self with goals. • Future self-interaction portal: The future self stimulates taking perspective of the future self (in decision making and in goal achievement), provides a guided episodic future thinking exercise.	• Verbal psychoeducation that abilities can develop over time. • Practice Mental Contrasting and Implementation Intentions via interviewing the future self. • A grid containing participant's answers providing a scheme of goal, obstacles and plans to overcome the obstacles.

Note. Reprinted from the protocol paper of the research project [37]

Smartphone Condition

In the app (see Figure 2 for screenshots) participants were asked to interact with the app on a daily basis for a period of three weeks (i.e., 21 days) for approximately five minutes a day. As a reminder to interact with the app, participants received push notifications. When opening the app, they are directed to the chat feature where they interact with a chatbot, 'FI' (see Figure 2a). FI provided psychoeducation, asked targeted questions, and gave instructions for the interaction or assignment of that day.

Roughly every other day, the app sent an additional push notification from the future self. This notification directed participants to a 'future self-interaction' feature. After 'connecting' with their future self by touching the virtual finger of their future self (see Figure 2b), the screen unblurred

and an interaction with their future self-avatar started (see Figure 2c). The consecutive future self-interactions aimed to instill a vivid image of the future self, encourage participants to think about their future self in their daily life, and stimulate a sense of connection with the future self.

< Figure 2 screenshots of the app >

VR Condition

The VR intervention consisted of three approximately 30-minute sessions scheduled one week apart from each other. The virtual environment consisted of a room with a table and a time machine allowing for ‘time travel’ (Figure 3). Sitting on opposite sides of the table were two avatars, one representing the present self, the other representing the future self. The interaction was guided by a researcher-controlled, hovering robot, ‘FI’ (see Figure 3). FI provided psychoeducation and explained the controls and interactions to the participants

During the VR sessions, participants alternated between embodying their present self- and their future self-avatar. While embodying the present self, there were multiple cards with questions lying in front of the participant. They were instructed to read the questions out loud one by one. This process was recorded and, after they finished reading them, they pulled a virtual lever to engage ‘time travel’. Following time travel, they embodied their future self-avatar seated on the other side of the table. The recorded questions were then played back one by one and the participant was invited to respond to them. Again, responses were recorded and, after traveling back to the present, played to the participant who once again was now embodied as their present self. In each session, the first two rounds of interaction between the present and future self-avatars were structured using cards. In the third round, participants were free to ask their own questions to their future self. At the end of each session, participants reflected on their answers, which were shown on a floating grid completed by the researcher during the session.

< Figure 3 overview of virtual environment >

Treatment Adherence

In the smartphone condition, treatment adherence was moderate. During the 21-day intervention period, participants were asked to check into the app daily. Twelve (11.2%) participants checked in each day and 53 (49.6%) participants checked in on 16 or more days. Seventeen (15.9%) participants checked in on 7 or less days. Treatment adherence decreased during the intervention. During Module 1, 44 (41.1%) participants checked in daily, during Module 2, 30 (28.0%) participants did so, and during Module 3, 18 (16.8%) participants did so. The number of participants that checked in at least 5 of the 7 days of a module was 91 (85%), 60 (56.1%), and 52 (48.6%) respectively. On average, participants used the app for 14 days (*SD* = 5.44) with 5.56 minutes (*SD* = 1.75) spent on the app on average per day. Furthermore, 13 (4.0%) participants experienced technical problems with the app of which 1 (0.3%) was not able to install it.

In the VR condition, treatment adherence was adequate. The sessions were intended to be scheduled between 6 to 10 days after intake or the preceding session. Three (2.8%) participants did not receive all three VR sessions. Of all sessions, 1 (0.3%) was scheduled with a shorter time span between one of the three sessions and 43 (13.7%) were scheduled with a longer time span between one of the three sessions. The longer time spans ranged from 11 to 14 days between the sessions (*n* = 32, 10%) to 15 to 18 days between the sessions (*n* = 9, 2.9%). One participant had more than 19 days between session two and three. Furthermore, 17 (15.9%) participants experienced technical problems, such as a distorted voice, during one or more sessions.

Measurements

Proximal Outcomes

Future self-identification, i.e., the extent to which people identify with their future self, was assessed with three subscales: *Vividness* of the future self, *valence* of the future self, and *connectedness* to the future self. These were assessed at each time point.

Vividness of the future self was assessed with 5 items (eg, “I have a clear image of myself in 10 years from now.”) on a 7-point Likert scale (1 = *Completely disagree* to 7 = *Completely agree*;

T1-T6 α = .91-.93) based on [11].

Valence of the future self was measured with a single item: “How do you feel when you think about your future?” (Hershfield [16]) answered with the 9-point Self-Assessment Manikin (1 = *Negative* to 9 = *Positive*).

Connectedness to the future self was measured with the 2-item Future Self-Continuity Measure (Hershfield [16]). These items each consist of a set of seven increasingly overlapping circles representing the present and the future self. Reliability was adequate at T2 through T6 (α = .70-.79), but somewhat low at T1 (α = .54).

Distal Outcomes

Primary Outcomes

Future orientation is assessed with the Future Orientation Scale [3]. This scale contains three subscales, namely time perspective, anticipation of future consequences, and planning ahead. The scale contains 15 items that each consist of a present-oriented and a future-oriented statement (eg, “Some people spend very little time thinking about how things might be in the future, but other people spend a lot of time thinking about how things might be in the future.”). When choosing the present-oriented statement, participants score a 1 (= *Completely true*) or 2 (= *A little bit true*). When choosing the future-oriented statement, participants score a 3 (= *A little bit true*) or a 4 (= *Completely true*). This measurement was assessed at all time points (T1-T6 α = .74-.87). At T2 and T3 a selection of 6 items based on factor loadings and face validity were used.

Consideration of future consequences, i.e., the degree to which people take immediate versus distant consequences into account in their potential behaviors, was measured by the Consideration of Future Consequences scale by Strathman [40]. The scale contained 9 items (eg, “I consider how things might be in the future.”) answered on a 5-point Likert scale (1 = *Completely disagree* to 5 = *Completely agree*). It was assessed at T1 and T4-T6 (α = .79-.82).

Self-defeating behavior concerns behaviors with immediate gains but potential long-term

costs. These were assessed with 15 items (based on Van Gelder [11]) assessing self-defeating behaviors (eg, “How often in the last week have you missed classes or work?”) on a 5-point scale (1 = *Never* to 5 = *More than 10 times*). Answers were dichotomized representing 0 (= *Never*) and 1 (= *At least once*) and subsequently summed to form a scale. Self-defeating behavior was assessed at all time points (T1-T6 α = .60-.68).

Goal commitment to the yearly goal set by the participants was assessed with the Goal Commitment questionnaire [41] consisting of 7 items (eg, “I think this goal is a good goal to shoot for.”) answered on a 7-point Likert scale (1 = *Completely disagree* to 7 = *Completely agree*). Reliability was good at T4 through T6 (α = .73-.82), though somewhat low at T1 (α = .56).

Weekly and monthly goal achievement measured the degree to which participants reached their weekly and monthly goals. Both were assessed with 3 items on a 5-point Likert scale (1 = *Completely disagree* to *5 Completely agree*) developed for the present study: “I have often thought about my goal”, “I have worked hard towards my goal”, and “I have achieved my goal”. Weekly goal achievement was assessed after each intervention week, so at T2, T3, and T4 (α = .72-.79). Monthly goal achievement was assessed immediately after the intervention at T4 (α = .75).

Secondary Outcomes

Self-efficacy assesses the degree to which people feel competent to deal with life’s stressors effectively and was measured with the General Self-Efficacy questionnaire [42] consisting of 10 items (eg, “I can always manage to solve difficult problems if I try hard enough.”) answered on a 4-point Likert scale (1 = *Completely disagree* to 4 = *Completely agree*). It was assessed at T1 and T4 through T6 (α = .79-.81).

The average academic results of the participants were obtained from the university’s records at the end of the academic year.

Impulsiveness was assessed with the Barratt Impulsiveness Scale short form [43]. This questionnaire consists of 10 items (eg, “I do things without thinking.”) answered on a 4-point Likert

scale (1 = *Completely disagree* to *4 = Completely agree*) and was assessed at T1 and T4 through T6 (α = .84-.86).

Analyses

The data were analyzed with an intention-to-treat approach in which all participants assigned to the intervention were included in the analyses regardless of whether they received the intervention or not. To include all participants in the analyses, we used Full Information Maximum Likelihood (FIML) procedures with Maximum Likelihood with Robust Standard Errors (MLR) estimation.

The effectiveness of the intervention was examined using a series of Latent Growth Curve (LCG) models in R with the LAVAAN package [44]. LGC models estimate an individual growth curve for each participant based on their initial level (i.e., intercept) and change over time (i.e., slope). These individual growth curves are used as indicators of latent variables that describe the average growth trajectories of the group while allowing for differences in trajectories between participants [45]. Intervention effects show when the slope alters in the desired direction compared to the control condition.

In the current study, growth rates of slopes were specified to indicate the differences in time intervals between the time points, that is 0, 1, 2, 3, 15, 27. We modeled three different types of LGC models, as not all outcomes were assessed at each time point. For outcomes measured at all time points (i.e., T1-T6), we modeled linear piecewise LGC models with a slope for change over time during the intervention (T1-T4), and a slope for change over time during the follow-up period (T4-T6) for each outcome variable separately. For outcomes measured at baseline, immediately after the intervention and at follow-up (T1, T4-T6), we modeled LGC models in which T4 was unspecified to allow for non-linear growth. For weekly goal achievement, measured at T2, T3, and T4, we modeled an LGC model in which T3 was unspecified. Monthly goal achievement and academic results were assessed at only one time point and therefore analyzed with an ANOVA. Sensitivity analyses were conducted to test the robustness of the results (see Supplementary Materials).

The effects of the intervention were assessed by creating two dummy variables (i.e., smartphone and VR condition) with the control condition as a reference group and regressing the intercept and the slope(s) on these two dummy variables. In case of intervention effects in the piecewise LGC models, the effect sizes were calculated using the formula: $d = ((b_{slope\ 1} * duration_{phase\ 1}) + (b_{slope\ 2} * duration_{phase\ 2}))/SD_{outcome\ T1\ pooled}$. In case of intervention effects in the unconditional LGC models, we used the formula: $d = (b_{slope} * duration_{Total})/SD_{outcome\ T1\ pooled}$ [46]. Additionally, when intervention effects appeared for both intervention conditions, these two conditions were subsequently compared by selecting the participants in the intervention conditions and rerunning the model with the smartphone condition as reference group.

Results[2]

The descriptives of the outcomes per condition at the different time points are presented in Table 2 (see multimedia documents) and the model fit statistics of the (different types of) LGC models are provided in Table 3.

Table 3. Model fit statistics of the LGC models of the outcome variables

	CFI	RMSEA	SRMR
Proximal outcomes			
Vividness	.971	.079	.036
Valence	.996	.022	.024
Connectedness	.985	.055	.042
Distal outcomes			
Primary outcomes			
Future Orientation	.969	.095	.047
Consideration of future consequences	.996	.032	.025
Self-defeating behavior	.964	.072	.038
Goal commitment	.827	.148	.064
Weekly goal achievement[a]	.915	.126	.053
Secondary outcomes			

[2] The sensitivity analyses showed generally similar results as the main analyses and are reported in the Supplementary Materials.

Self-efficacy[a]	1.000	.000	.021
Impulsiveness[b]	1.000	.010	.015

Note. [a]Variance S1 constrained to 0 due to small negative variances; [b]Unspecified T4 growth model did not converge, so modeled a linear model with time specified as 0, 3, 15, 27; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Squared Residual.

Intervention Effects on Proximal Outcomes

During the intervention period, the LGC models showed moderate positive intervention effects on all three of the proximal outcomes (see Table 4). Participants in both the smartphone and the VR conditions increased more on vividness, valence, and connectedness than participants in the control condition. At follow-up, there was a negative effect on vividness and connectedness in which participants in both intervention conditions decreased more than participants in the control condition. Valence remained stable at follow-up. The effect sizes of the decrease during the 6-month follow-up period were small to moderate and smaller than the increase during the 3-week intervention period. The intervention effects did not differ significantly nor relevantly between the two intervention conditions.

Table 4. Parameter estimates and effect sizes of the smartphone and VR conditions compared to the control condition

		Smartphone condition				VR condition			
		B	*SE*	*p*	*d*	*B*	*SE*	*p*	*d*
Proximal outcomes									
Vividness	I	-0.02	.18	.924		0.24	.17	.171	
	S1	0.24	.05	< .001	0.49	0.17	.05	< .001	0.36
	S2	-0.02	.01	< .001	-0.36	-0.01	.01	.013	-0.23
Valence	I	-0.11	.16	.479		-0.06	.15	.678	
	S1	0.18	.05	< .001	0.44	0.18	.05	< .001	0.44
	S2	-0.01	.01	.167	-0.17	-0.01	.01	.270	-0.13
Connectedness	I	-0.06	.12	.616		0.14	.12	.246	
	S1	0.13	.04	.001	0.43	0.13	.04	.001	0.43
	S2	-0.01	.01	.009	-0.36	-0.01	.01	.015	-0.32
Distal outcomes									
Primary outcomes									
Future Orientation	I	0.05	.07	.505		0.07	.07	.288	
	S1	0.03	.01	.048	0.16	0.03	.01	.013	0.18
	S2	-0.00	.00	.013	-0.18	-0.01	.00	< .001	-0.25
Consideration of fut. Con.	I	0.02	.09	.834		0.13	.08	.094	
	S1	-0.01	.00	.290	-0.21	-0.00	.00	.549	-0.12
Self-defeating behavior	I	-0.19	.24	.433		-0.24	.25	.356	
	S1	0.01	.08	.934	-0.02	0.04	.08	.636	-0.07
	S2	0.01	.01	.515	-0.08	-0.00	.01	.790	0.04
Goal commitment	I	0.09	.07	.201		0.01	.07	.920	
	S1	-0.00	.01	.845	-0.06	-0.00	.01	.536	-0.17
Weekly goal achievement	I	0.10	.11	.382		0.00	.10	.999	
	S1	-0.03	.07	.634	-0.08	0.37	.08	< .001	0.88
Secondary outcomes									
Self-efficacy	I	0.02	.04	.728		0.09	.05	.076	
	S1	-0.00	.00	.427	-0.11	-0.00	.00	.189	-0.17
Impulsiveness	I	-0.01	.05	.836		-0.06	.05	.250	
	S1	0.00	.00	.401	-0.07	0.00	.00	.269	-0.09

Note. I = Intercept LGC model; S1 = Slope 1 LGC model; S2 = Slope 2 LGC model; Positive effect sizes indicate changes in the desired direction.

Intervention Effects on Distal Outcomes: Primary Outcomes

During the intervention period there was a small positive intervention effect on future orientation. Participants in both intervention conditions remained stable on future orientation, whereas participants in the control condition decreased on this outcome. At follow-up, there was a

small negative effect on future orientation for the smartphone and VR conditions compared to the control condition. Participants in the intervention conditions remained stable on future orientation, where participants in the control condition showed a small increase. The effect sizes of the positive effects during the intervention period were almost equal to the effect sizes of the negative effects at follow-up. These effects were similar in both intervention conditions.

There was also a large positive effect on weekly goal achievement in the VR condition compared to the control condition. Participants in the VR condition increased more on weekly goal achievement than participants in the control condition.

No significant nor relevant intervention effects on the other primary outcomes emerged (see Table 4). Additionally, there was no intervention effect on monthly goal achievement (ANOVA $F(1,308) = 0.13$, $p = .721$, $\eta^2_{partial} = 0.00$).

Intervention Effects on Distal Outcomes: Secondary Outcomes

There were no significant or relevant intervention effects on the secondary outcomes (see Table 4). In addition, there was no effect on academic results (ANOVA $F(1,316) = 1.02$, $p = .314$, $\eta^2_{partial} = 0.00$).

Discussion

The present study provides evidence that future-orientation and goal achievement can be cultivated through a digital intervention, delivered via a smartphone app and VR, focused on fostering identification with the future self. Consistent with expectations, the intervention showed robust effects on proximal outcomes, with both delivery modes significantly increasing vividness of, connectedness with, and valence of, the future self during the intervention period. At follow-up, the intervention effect on valence remained stable, whereas a partial reversal of the effects on vividness and connectedness was observed. The pattern of findings for distal outcomes was more nuanced. While the intervention appeared to buffer a decrease in future orientation during the intervention

period, it did not stimulate future orientation at follow-up, although participants in the control condition did show an increase.

Furthermore, the intervention yielded a strong, positive effect on weekly goal achievement when delivered via VR. No effects were found for other primary outcomes (i.e., consideration of future consequences, self-defeating behavior, goal commitment, and monthly goal achievement) nor for the secondary outcomes (i.e., self-efficacy, impulsiveness, and academic performance), signaling room for further optimization.

The effects on future self-identification may be driven by visualization of, and interaction with, the future self, given that both delivery methods, i.e., app and VR, yielded similar intervention effects and both share the opportunity for visualization and interaction. Thus, interventions requiring imagination may be enhanced by adding interactive, visual technologies. Additionally, as both technologies appear equally effective, the specific delivery technology can be determined based on the match with the context, needs of the population, and the intervention's characteristics.

At the same time, the intervention effects slightly decreased over time, albeit less than the initial increase, suggesting that the gains in future self-identification may attenuate over time without continued reinforcement. This suggests that booster sessions or continued exposure to the future self could be necessary to maintain the effects. An intervention app may be best suited for this, as an app can remain installed on participants' smartphones after the intervention has concluded to deliver intervention content, e.g., push notifications and/or future self-avatar messages, or allow participants to use the app on their own initiative.

While the intervention had no effect on goal achievement when delivered via the app, there was a strong effect when delivered in VR. The VR intervention created an immersive experience in which people talked to their future self, embodied this self, and took its perspective. As such, the VR condition created a first-person experience of how it could feel to have achieved personal goals. Imagination of outcomes has been shown to be an important step towards goal achievement [47].

Nonetheless, besides the intervention's delivery method, the VR condition was different from the other two conditions in a way that may have also affected goal achievement. Since the VR sessions were in person, the weekly goals in this condition, although set independently by participants, were checked on the SMART-principles by the researcher. The possibility that the effect of the immersive VR experience had an effect on the SMART-formulation check can therefore not be excluded.

Intervention effects on broader, more distal, outcomes were limited. The positive effect on future orientation may indicate that enhanced future self-identification indeed cultivates a future-oriented mindset, as theorized. However, more distal and often more deeply embedded behavioral patterns related to a future-oriented mindset, such as self-defeating behavior, may need a stronger and/or more sustained intervention.

Strengths and Limitations

A key strength of this study is its rigorous randomized controlled design and relatively large sample size. Prior work on future self-identification has often relied on cross-sectional data and/or smaller samples (for exceptions, see [48, 49]. Additionally, the inclusion of both a smartphone and VR modality enabled direct comparison of these delivery formats. Furthermore, research on future self-identification has generally targeted one of the aspects of the tripartite structure or used index measures that do not allow for disentangling individual effects, whereas the current study included all three simultaneously and separately.

Several limitations of this study must also be acknowledged. First, although we deliberately opted for first-year university students as this sample allowed us to capitalize on a major life transition phase, which may increase receptivity to interventions, it also limits the generalizability of our findings. The sample was predominantly female and drawn from a relatively narrow university context, a population that may already be relatively future-focused and hence have limited room for growth. Additionally, participants received compensation for completing the questionnaires, which could have affected the results and limits generalization to uncompensated populations. Furthermore,

self-reported measures, especially for constructs like self-defeating behavior and impulsivity, may be susceptible to bias or lack of sensitivity to subtle behavioral changes, which may therefore not have been picked up. Finally, some effects may have been masked by measurement timing; for instance, positive gains in future orientation during the intervention period may have waned by follow-up, while longer-term benefits (eg, academic performance) may not yet have materialized.

Conclusion

The results reported in this study suggest that visual and interactive technologies may serve as promising tools for strengthening future self-identification, cultivating a future-oriented mindset, and contributing to goal achievement. To enhance and sustain effects, future work could explore the integration of booster sessions, more personalized content delivery (e.g., through the integration of AI-powered conversational agents), application in more diverse and at-risk populations, and more targeted interventions. All in all, the results underscore the potential of future self-based interventions using novel technologies, such as VR and smartphone apps as delivery methods, as scalable strategies to support long-term goal pursuit and positive psychosocial development.

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Conflicts of Interest

The authors declare that they have no conflicts of interests.

Data Availability

Data that support the findings of this study are openly available in the Center for Open Science Online Supporting Information can be found at OSF | A Smartphone- and VR-Based Intervention Aimed at Increasing Future Orientation via the Future Self: A Pilot RCT of a Prototype Application and an RCT of the Smartphone- and VR-Based Intervention

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Formal analysis: EM

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Abbreviations

VR = Virtual Reality

App = Application

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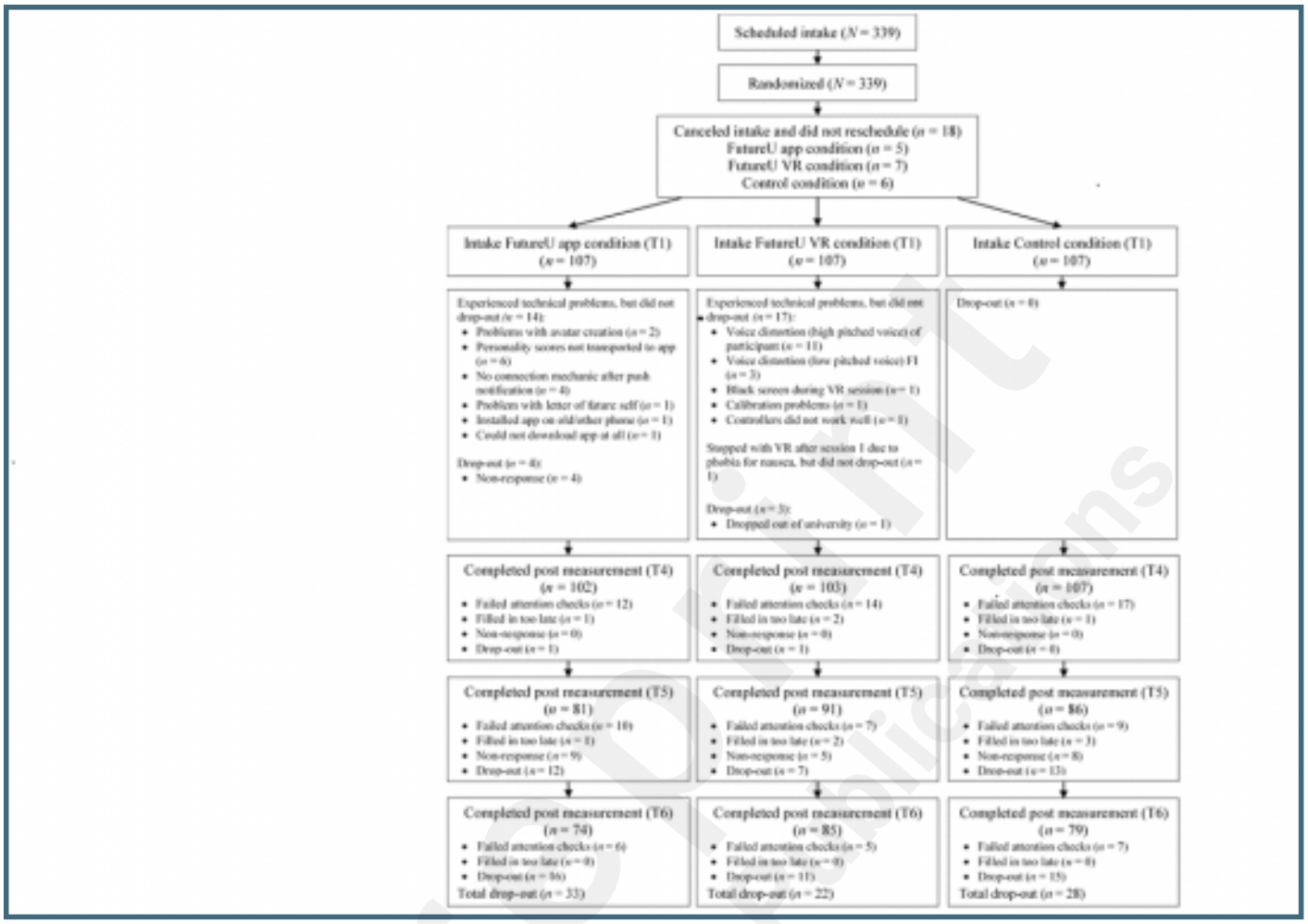
Supplementary Files

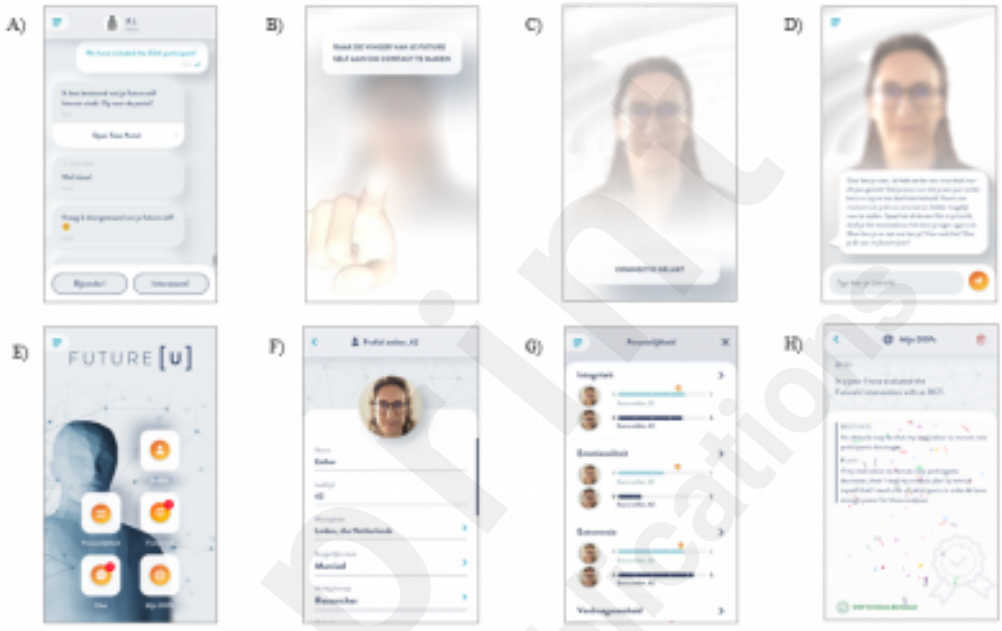
Untitled.
URL: http://asset.jmir.pub/assets/63e84f4148dcc5b7339e4062261c927e.docx

Figures

Flow Chart.


Scheduled intake (N = 339)
Randomized (N = 339)
Canceled intake and did not reschedule (n = 18)
FutureU app condition (n = 5)
FutureU VR condition (n = 7)
Control condition (n = 6)
Intake FutureU app condition (T1) (n = 107)
Intake FutureU VR condition (T1) (n = 107)
Intake Control condition (T1) (n = 107)
Experienced technical problems, but did not drop-out (n = 14):
Problems with avatar creation (n = 2)
Personality scores not transported to app (n = 6)
No connection mechanic after push notification (n = 4)
Problem with letter of future self (n = 1)
Installed app on old/other phone (n = 1)
Could not download app at all (n = 1)
Drop-out (n = 4):
Non-response (n = 4)
Experienced technical problems, but did not drop-out (n = 17):
Voice distortion (high pitched voice) of participant (n = 11)
Voice distortion (low pitched voice) FI (n = 3)
Black screen during VR session (n = 1)
Calibration problems (n = 1)
Controllers did not work well (n = 1)
Stopped with VR after session 1 due to phobia for nausea, but did not drop-out (n = 1)
Drop-out (n = 3):
Dropped out of university (n = 1)
Drop-out (n = 0)
Completed post measurement (T4) (n = 102)
Failed attention checks (n = 12)
Filled in too late (n = 1)
Non-response (n = 0)
Drop-out (n = 1)
Completed post measurement (T4) (n = 103)
Failed attention checks (n = 14)
Filled in too late (n = 2)
Non-response (n = 0)
Drop-out (n = 1)
Completed post measurement (T4) (n = 107)
Failed attention checks (n = 17)
Filled in too late (n = 1)
Non-response (n = 0)
Drop-out (n = 0)
Completed post measurement (T5) (n = 81)
Failed attention checks (n = 10)
Filled in too late (n = 1)
Non-response (n = 9)
Drop-out (n = 12)
Completed post measurement (T5) (n = 91)
Failed attention checks (n = 7)
Filled in too late (n = 2)
Non-response (n = 5)
Drop-out (n = 7)
Completed post measurement (T5) (n = 86)
Failed attention checks (n = 9)
Filled in too late (n = 3)
Non-response (n = 8)
Drop-out (n = 13)
Completed post measurement (T6) (n = 74)
Failed attention checks (n = 6)
Filled in too late (n = 0)
Drop-out (n = 16)
Total drop-out (n = 33)
Completed post measurement (T6) (n = 85)
Failed attention checks (n = 5)
Filled in too late (n = 0)
Drop-out (n = 11)
Total drop-out (n = 22)
Completed post measurement (T6) (n = 79)
Failed attention checks (n = 7)
Filled in too late (n = 0)
Drop-out (n = 15)
Total drop-out (n = 28)

Screenshots of the FutureU Smartphone Application: A) Chat, B) the Connection Mechanic, C) Future Self Interaction, D) Home Screen, E) Personal Profile, F) Personality Menu, G) Goal Scheme.



Note. Reprint from protocol paper of current research project [38]

General overview of the FutureU VR environment.

Note. 1 = Robot controlled by researcher; 2 = Present self-avatar; 3 = Future self-avatar; 4 = Cards with questions; 5 = Recording light; 6 = Handle to travel through time; 7 = Time machine; Reprint from protocol paper [38].

Multimedia Appendixes

Table 2. Descriptives of the outcomes per condition per time point.
URL: http://asset.jmir.pub/assets/2312b9ae3364fec1096bda7f2d64dbef.docx

Supplementary Materials.
URL: http://asset.jmir.pub/assets/cfa08271fc09b6563d0237bb81620dae.docx