Tailoring Virtual Environments of an Exergame for Physiotherapy: The Role of Positive Distractions and Sensation Seeking

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Abstract

Recent findings have shown that exergames can facilitate physiotherapy. Environmental conditions, such as the inclusion of positive distractions also seem to play a role in health recovery, but prior studies have never analyzed their role in virtual environments. In this study we developed an exergame for the exercise of upper limbs by designing virtual environments with nature elements and testing the impact of including additional positive distractions. Participants (N=124, 81 females) were randomly assigned to one of two virtual environments: positive distractions vs. no distractions. To test whether these two environments matched the users' characteristics, sensation seeking was examined as a moderator. Measures of affect, sense of presence, intrinsic motivation, and vitality, were applied after the sessions and game performance was assessed. Results showed that both environments were positively evaluated for all the dependent variables, regardless the positive distractions and the sensation seeking traits. However, game performance was affected by the environment and the participants' sensation seeking traits, suggesting that the additional distractions can reduce performance, and that individual differences also seem to impact performance.

Keywords: exergames, motivation, virtual environments, tailored physiotherapy

Introduction

An estimated 39.6 million individuals live with any kind of physical functioning difficulty in the United States (Centers for Disease Control and Prevention, 2014). Each patient is unique, urging health practitioners to develop specific physiotherapy sessions that consider their needs, in order to improve well-being and reduce recovery time. Active video games (or exergames) have been used to facilitate the rehabilitation process, with participants suggesting improved motivation to exercise (Reis et al., 2017). Nevertheless, more research is needed on the psychological benefits or drawbacks of using these technologies, by also taking into account the role of the context in which this recovery takes place.

According to Ulrich's Theory of Supportive Design (1991), healthcare environments can improve recovery by including natural elements in the design, such as trees, plants or water. These natural elements may help patients to perceive the recovery environment as less threatening, and contribute to the way patients cope with the stress that accompanies illness and ease their recovery. Additionally, these positive environmental distractors also facilitate several well-being related factors, such as perceived control over stressors, social interaction and support in health facilities contexts.

Ulrich (1991) defines a positive distraction as an environmental element that provides moderate levels of positive stimulation (i.e., neither strongly high nor strongly low), by eliciting positive feelings and interest without stressing the individual, and therefore capable of reducing worrisome thoughts. Previous research in environmental psychology has shown that active stimuli, such as TV or a nature view from the window, have the potential to provide positive distraction in hospital recovery contexts (Andrade, Devlin, Pereira, & Lima, 2017). However, to our knowledge, operationalizations of Ulrich's theory have never been applied to virtual environments. Based on this approach and on previous health findings there is considerable room to improve the environments of exergames.

One aspect that has been valued both in the design of human-computer interaction (Karat & Karat, 2003) and health care (Stewart et al., 2000) is the implementation of user-centered perspectives. The underlying assumption is that a design that matches the patient or the user's needs is more effective than one that mismatches them. For this reason, tailored interventions have proved more effective than universal ones (e.g., Godinho, Alvarez, Lima & Schwartzer, 2015). Regarding distractions in the environment, users might differ in their optimal level of environmental stimulation, even when considering positive stimuli such as nature elements. Several theories have been developed to understand how individuals' optimal levels of stimulation shape our preferences, motivations, and performance (for a review, Zuckerman, 2015). We highlight the sensation-seeking theory which originally considered that "every individual has characteristic levels of stimulation and arousal for cognitive activity, motor activity and positive affective tone" (Zuckerman, 2015, *p*. 315). Although recent research shows the importance of considering sensation-seeking when tailoring interventions (e.g., Sridharan, Jones, Caudill, & Nakaima, 2016), until now this has never been applied to exergames.

In this study we present an exergame that was designed to include natural elements in the virtual environment and programmed to be tailored to the users' needs. In addition to these natural elements in game design, and implemented in the task that required users to exercise the upper limbs, two different environments were created: one with positive distractions, and another with no distractions added.

Following Ulrich's Theory of Supportive Design, and expanding his theory to a new type of context (virtual environment of an exergame), we expected that participants' experience (affect, motivation, sense of presence, perceived vitality, and performance) would be positively higher when using the exergame with positive distractions than playing the exergame without positive distractions. Moreover, to integrate recommendations from a patient centered approach, we also examined whether sensation seeking (SS) moderated the effect of environment condition on the outcomes to test the hypothesis that matching conditions (e.g. high SS in the positive distractions environment; and Low SS in the no distractions environment) would improve the quality of the experience with the exergame compared to the mismatching conditions (e.g. high SS in the no distractions environment; and low SS in the positive distractions). Thus, we expected that participants in the matching conditions would report lower levels of negative affect, higher levels of motivation, of sense of presence, and of perceived vitality, and would register high performance in the exergame when compared with participants using the virtual environments that mismatched their sensation seeking traits.

Method

Participants.

A non-probabilistic convenience sample of 124 participants (81 females, 65.32%), mostly undergraduate students (87.9%), and predominantly Caucasian (only three identified as black and one Latin-American) volunteered. Age ranged between 17 and 36 years (M = 21.52; SD = 4.30). The majority had never interacted with a system similar to the one used in this study (58.9%), and if they had, most (n = 30) had prior experience with the Nintendo Wii. Only one user explicitly stated that he had had previous experience with the Microsoft Kinect sensor. The sociodemographic characteristics of the present sample are similar in both virtual environment conditions (all $p > 0.05$) (see Table 1).

Exergame, Instruments and Measures

An *exergame* was developed in the Unity3D game engine, using the Microsoft Kinect® v1 sensor for Windows with a resolution of 640 x 480 pixels to map in real time the users' body movements into the virtual environment. The graphical interface of the exergame was presented on a 75" Samsung UE75F8000SL LCD TV with a native resolution of

1920x1080 pixels. The game design included nature-based elements (orchard, apple trees) and the game mechanic consisted of using the upper limbs to pick virtual apples displayed in the trees. The users' virtual avatar was set on a third person perspective, standing on top of a tractor, which moved autonomously between two lines of trees in an orchard field. The exergame allows tailoring several features according to the users' specific needs, skills and/or preferences, including the selection of different colors, the duration of each session, the frequency and the position in which the apples appeared in the trees, the speed of the tractor, and the users' arm to be used (left, right, or both), among other attributes (see Figure 1). These parameters are configurable and can be set by the user, or in the future, by a physiotherapist. Users' personal details (e.g., height, age) can be registered to create a profile. Session details (e.g., user performance, angles achieved) can be stored in online servers allowing for the monitoring of users' experience. For this study, the exergame did not allow participants to control the tractor movement, but resting intervals were provided after a pre-determined sequence of four trees. Participants were informed that the goal was to pick as many apples as possible from the trees, and each successful pick was signaled with a clearly distinguishable high pitch sound and the disappearance of the apple from the game environment. To understand their preference between different strategies to achieve the same goal, two options were provided: one with a pre-determined timeframe and another until a specific score was attained.

Participants played the exergame twice using both strategies in a counterbalanced order. In addition, two virtual environments were designed: One with no distractions that only included the avatar and the natural elements of the task (i.e. orchards and the apples); and another with positive distractions in which static and animated objects (e.g., tractors), and animals (e.g., birds) and their sounds, were added (See Figure 2). Independently of the virtual environment, a low volume ambient sound was played that was composed mainly of light breeze sounds, birds chirping noises, and the wheels of the tractor rolling on gravel. These positive distractions were carefully displayed during the resting moments to not distract the participant from the task. To measure participant's *performance*, the exergame provided the aggregated score as the sum of the number of apples the participants were able to pick from the trees, taking into account their color (red apples scored 50 points; green apples scored 100 points). Since participants played twice, we calculated the total number of points scored in both sessions.

For the purposes of this experiment the following features have been configured: the avatar's gender, the presence or absence of positive distractions in the environment, and the session's goal strategies based on a specific timeframe (3 min) or score (2500 points). Gameplay difficult was the same across configurations or conditions.

To measure participants' *affect* immediately after the exergame activity, we used the Portuguese short form of the Positive and Negative Affect Schedule (PANAS-SF, Galinha, Pereira & Esteves, 2014; Watson, Clark, & Tellegen, 1988). Responses to the 10 items were given in a 5-point scale ranging from 1 ("Very slightly or not at all") to 5 ("Extremely").

The Intrinsic Motivation Inventory (IMI, McAuley, Duncan, & Tammen, 1989) was used to evaluate the following dimensions of *intrinsic motivation* to use the exergame: enjoyment, tension, usefulness, effort, and perceived competence. This inventory has been previously used in Portugal in exercise contexts by Fonseca and Brito (2001). In total, 30 items were administered (e.g. "I would describe this activity as very interesting"), and responses were made in a 7-points scale ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). Higher overall scores indicate higher intrinsic motivation. However, tension and effort subscales are negatively scored, with high values indicating high tension and high effort.

Sense of Presence, defined as the experience of feeling "fully immersed in mediated environments" (Weibel, Schmutz, Pahud, & Wissmath, 2015, p. 44) was assessed using a Pictorial Presence scale (Weibel et al., 2015). In each of the 6 items measuring different aspects of virtual presence, participants were asked to choose one of the 5 pictorial manikins to indicate how immersed or "inside" the game environment they felt. The pictorial format scales ranged from 1 to 5. Higher values represented higher sense of presence.

To assess participants' perceived *vitality* after the exergame, we used the Portuguese version of the Subjective Vitality Scale (SVS, Gouveia, Pais-Ribeiro, Marques & Carvalho, 2012; Ryan & Frederick, 1997). This scale is composed of seven items (e.g., "I feel alive and vital") rated on a 7-point scale ranging from 1 ("Not at all true") to 7 ("Very True"). The higher the score, the higher the vitality felt by the participant.

Finally, *Sensation Seeking* was measured using 8 items adapted from the Brief Sensation Seeking Scale (BSSS-8) (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002), which are partly based on the Sensation Seeking Scale - V Form (SSS-V, Zuckerman, Eysenck, & Eysenck, 1978). For the present study, and as suggested by Cox (1980), participants rated their answers on a 7-point scale, ranging from 1 ("Definitely False") to 7 ("Definitely True") to increase the sensibility of the scale (e.g. "I prefer friends who are excitingly unpredictable"), with higher scores indicating higher sensation seeking trait.

Procedure

This study was accepted by the Ethics Committee of the University in which the study took place (Ref: 13/2017). All data was collected in a laboratory room with controlled temperature and lighting conditions. Participants were presented with an informed consent assuring that participation was voluntary, and the resulting data from their participation would be analyzed anonymously. Upon agreement with these conditions, participants responded through the Qualtrics online platform to the Sensation Seeking scale. Participants then moved to a room with 4 x 4 meters where they directly faced the TV on which the exergame was played, facing it at a distance of 2.50 meters. The researcher explained the goal of the exergame and how participants should interact with the system, providing a training session (1:30 min). Participants were asked to remain standing during the experiment. Participants were then randomly assigned to one of two conditions of the virtual environment: one with no distractions (ND; n=59), the other with positive distractions (PD; n=65). Independently of the condition, participants' task was to pick as many apples as possible in each of the two sessions. All participants were exposed to two goal strategies in a counterbalanced order: One in which they had to complete the task in 3 min, another until they reached a total of 2500 points. Scores in each session were registered by the exergame. After the two game sessions, participants responded to a questionnaire that included measures of affect, sense of presence, motivation, vitality, and open ended questions regarding positive aspects of the experience, aspects to improve, and sociodemographic data. At the end, a full debrief was given and participant's questions were clarified. Course credits or a monetary retribution (10€ voucher) were given as compensation. Duration for the entire study was around 30 minutes.

Data Analysis.

The IBM SPSS Statistics for Windows, Version 24, was used to conduct the majority of our statistical analysis. For estimates of reliability we used the *userfriendlyscience* package of the R software (Version 1.1.453) (Peters, 2014). As recommended by Gadermann, Guhn, & Zumbo (2012), we estimated reliability scores for ordinal measures given the Likert-type format of the instruments. In addition to reporting the conventional ordinal Cronbach's alpha (α) values, we added McDonald's omega coefficients (Ω) for being one of the best estimates for reliability (Dunn, Baguley & Brunsden, 2014). Omega total (Ω_t) was used to estimate reliability scores for unidimensional scales, and the hierarchical omega (Ω_h) was used for IMI overall score (Gignac, 2014). Moreover, Confidence Intervals (95% CI) for both reliability estimates (Ω_t and α) were reported. Assumptions to use parametric tests were pre-screened and a threshold of $p < 0.05$ was used for statistical significance. One-sample t-tests were conducted to analyze whether the means in each of the dependent variables were above the midpoint of each scale. The moderation analyses were tested with Multiple Linear Regression Analyses (MLRA). Finally, a one-sample goodness-of-fit chi-square test was used to compare the preferences for the two goal strategies of the exergame.

Results

The means, standard deviations, and estimates of reliability (α and Ω) for each variable are presented in Table 2. As can be seen, all scales achieved acceptable reliability scores (Murphy & Davidshofer, 1988), with lower estimates for the competence subscale of motivation (ordinal α = .65 [95% CI: .55, .74] and Ω_t = .66 [95% CI: .57, .75]) and higher reliability scores for the value subscale of the same construct (both ordinal α and Ω = .83 with 95% CI: .78, .87). The reliability of negative affect was not estimated because the majority of participants have reported not feeling negative emotions in each of the items for this subscale, therefore almost no variation occurred in responses to negative affect. Therefore, this measure will not be further analyzed.

Overall, the experience reported by the majority of participants was very positive in all the domains, i.e., positive affect, sense of presence, perceived vitality, and intrinsic motivation with all means above the midpoint of the scale (all $p < .001$). The percentage above this cut-point was also very high, ranging from 88.7% (perceived vitality) to 100% (interest, motivation subscale). Tension and effort, which were reverse coded for intrinsic motivation, were reported by 24.2% (tension) and 97.4% (effort) of participants above this cut-off point, indicating a very positive experience with the exergame that successfully lead participants to exercise their upper limbs.

The effects of the environment conditions, while taking into account the potential moderation of participants' sensation seeking (SS) traits on the five main dependent variables, were analyzed with MLRA. The Sensation Seeking was centered, the Environment was dummy coded (no distraction = -0.5, positive distraction = 0.5), and an interaction term between these two variables was computed. Table 3 shows the estimated regression parameters for each dependent variable, including the Koenker χ^2 test (Koenker & Bassett, 1982) showing no evidence of heteroscedasticity (all *p*s > .30), and the variance inflation factor (VIF) evidencing no problems of multicollinearity (Dormann et al., 2013). Table 4 shows the means and standard deviation values for each dependent variable as a function of the environment condition.

Overall, the results only showed statistically significant effects for participant's performance, $F(3, 120) = 3.16$, $p = .027$, $R^2_{ajust} = .05$. The analyses of these estimated parameters indicated that both the environment ($\beta = -.19$, t = -2.14, p = .034), and the sensation seeking trait ($\beta = .21$, $t = 2.33$, $p = .021$) predicted the performance, but the interaction term was not statistically significant ($p = .17$). The main effect of the SS showed that the greater the scores on SS, the better the performance. The main effect of the environment indicated that performance was higher in the environment without distractions condition than in the positive distractions environment.

Finally, we analyzed participants' preferences regarding the goal strategies for obtaining a final score, by running a one-sample goodness-of-fit chi-square test. We found that 58.10% of participants preferred to play the exergame with a time-based objective, while 41.90% chose the point-based objective, but the difference was not statistically significant, $\chi^2 = 3.23$, $p = .07$, indicating that both type of goal strategies are similarly preferred.

Discussion

The present study aimed to understand how participant’s felt, how motivated they were to exercise and how they performed in an exergame created to train the upper limbs. Furthermore, we assessed how participants evaluated virtual environments with different characteristics (positive distractors vs. no distractions) and the possible role of personal characteristics in this evaluation, taking into account the sensation seeking trait.

Overall, participants evaluated the exergame very positively, reporting high levels of positive affect, sense of presence, motivation to exercise, and high perceived vitality regardless of the positive distractions that were included in the virtual environment or of participants’ sensation seeking trait. The high levels of sense of presence indicated that the direct visual, auditory and physical feedback were important features for the positive experience. In fact, the large majority of the participants rated the experience above the midpoint of the scales showing that the exergame experience was unequivocally good. These results indicate that the exergame is engaging and challenging enough to elicit considerable levels of positive emotional states and motivation to exercise.

It is important to highlight that against our initial predictions no significant effects were found for both the environment condition and the interaction with the SS traits on all the subjective evaluations of the environment. There were, however, significant main effects of both the environment and the SS on performance.

The effects of environment on performance revealed that participants had a better performance in the environment with no distractions than in the positive distractions. Despite being in contrast with our predictions, these results indicate that adding positive distractions to an environment that has already positive elements of nature, may reduce their performance, possibly because they may have distracted participants from the goal-relevant stimuli of the task. According to perceptual load theories (Lavie, 2005), the presence of distractors may affect the ability of individuals to remain focused on the task, thereby decreasing their levels of performance. Studies also suggest that task difficulty may reduce the distractors interference because it requires more full attention to the task (Lavie, 2005). However, in our study task difficulty was kept constant in both game environments, and it is also plausible that the levels of cognitive load required by the tasks were considered low or moderate by our healthy and young sample of participants. Thus, under these conditions, maybe the positive distractors interfered with processing of task-relevant stimuli (e.g., apples). Another plausible explanation is related to the short experience of participants with the game, with players being, in both conditions, at an initial stage of learning and enthusiasm. Future studies should examine whether adding more positive elements to these environments will improve the game experience after these initial stages. In fact, one problem with the systematic use of exergames in physiotherapy is boredom (Tobler-Ammann et al., 2017). Therefore, the inclusion of positive distractions in the virtual environment might overcome this concern at later stages. In addition, our results may be due to the natural elements that were displayed in both environments, and not necessarily related to the positive distractions themselves. This possibility also stems from Ulrich's theory, since both environments portrayed natural landscapes, having elements such as trees, mountains and blue skies. The inclusion of natural elements in both environments may have provided a high level of overall well-being, "overshadowing" the possible incremental benefits that positive distractions could add. In future studies it would be interesting to examine whether the absence of natural elements in a game would impact the user's experience by comparing our exergame conditions with an environment only composed of artificial features (e.g. buildings, highways, lit rooms). Moreover, our results also add to the understanding of Ulrich's theory (1991) applied to physical activity, given the innovative context in which our study was conducted. Thus far, the beneficial effects of positive distractions were examined mostly for passive behaviours, such as resting and recovering in bed (e.g. Andrade, Devlin, Pereira &

Lima, 2017; Quan et al., 2016), but to our knowledge, there is no prior evidence of distractions' role on active behaviours such as exercise. Thus, our results suggest that positive distractions may be perceived differently as a function of the context, the role (passive, active) assigned to individuals, and the task difficulty levels. Future research should continue to investigate other potential applications of Ulrich's theory.

The results of increased performance for higher levels of sensation seeking are in line with previous studies indicating that high sensation seekers tend to be more prone to actively engage in exercise (De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006), indicating that this trait is a relevant predictor of performance. However, further reasons that may explain this outcome should be investigated, since we were not able to differentiate subjective reports of motivation, affect, sense of presence, and vitality, based on sensation seeking traits.

The prediction that sensation seeking would moderate the effect of the exergame environment on the outcomes was not supported. Nevertheless, we cannot generalize these findings to other individual characteristics. Also, these results do not suggest that the exergame should not be tailored to the individual's needs. On the contrary, the importance of designing exergames tailoring to users' needs has been well established. The exergame that we designed will enable future users to customize the exergame based on individual's own needs and preferences. Thus, further studies should investigate other individual characteristics and environment features that may play a positive role in exergaming to allow further improvements in the design and system configurations.

We should also consider several limitations of the present study. First, we used a non-probabilistic convenience sample composed mainly by healthy university students. It will be important for future research to test the exergame on populations of different ages and health status, to further adapt the game to patient's needs. Second, our results correspond to a limited time-frame of using the exergame. Future studies should investigate whether the levels of motivation are maintained over time, since physiotherapy usually takes weeks or even months. Third, with the exception of performance, our study relied on self-report measures that were only assessed after gameplay. It would be relevant in future studies to include continuous measures, namely objective physiological indicators of engagement and health outcomes, such as energy expenditure, oxygen consumption, heart rate levels (Peng, Lin, & Crouse, 2011), and heart rate variability (Benzing, Heinks, Eggenberger, & Schmidt, 2016). Future studies could also take advantage of the Kinect sensor's ability to track the users' head position and record their levels of attention on the different features of the environment. The use of eye-tracking would allow a better understanding of the stimuli that captures the attention of participant throughout the activity, including his or her attention on task-irrelevant stimuli such as positive distractions. Although the distractions were designed to not be obtrusive to the game experience, it is possible their interference on the task, requiring additional cognitive demands from participants (Lavie, 2005). In addition, future studies could benefit from integrating other methods, such as retrospective and concurrent think-out-loud protocols (e.g. Olmsted-Hawala & Bergstrom, 2012).

To summarize, the role of different types of virtual environment and personal traits were tested on several outcomes that previous research identified as predictors for exercise and engagement. Our results indicated that the exergame was considered highly intuitive, useful and fun to use, providing high levels of intrinsic motivation to exercise, high sense of presence in the environment, and high positive affect, regardless the game environment and sensation seeking traits. Therefore we conclude that both environments achieved a good balance between challenge and novelty. New insights into Ulrich's Theory of Supportive Design applied to physical exercise were provided, given that environments with positive distractions lead to low performance, but is in line with theories of perceptual load (Lavie, 2005). In addition, we found the exergame performance to be higher for participants with high levels of sensation seeking. Overall, our study represent a new line of research that should be continued. As exergames are considered a viable and entertaining complement to traditional physiotherapy, future research should continue this patient-centered approach to produce effective and fun healthy games.

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Table 1.

Sociodemographic Characteristics and Previous Experience with Exergames for the Total Sample and as a Function of Environment Condition

	Total Sample		Environment: No Distraction		Environment: Positive Distraction		
	(N = 124)		(n = 59)		(n = 65)		
Variables	*N*	%	*n*	%	*N*	%	χ^2
Gender							1.71
Male	43	34.7	17	28.8	26	40	
Female	81	65.3	42	71.2	39	60	
Education							3.15
High School	79	63.7	39	66.1	40	61.5	
Bachelor	30	24.2	11	18.6	19	29.2	
Masters	14	11.3	8	13.6	6	9.2	
Doctorate	1	0.8	1	1.7	-	-	
Occupational Status							2.10
Worker	18	14.5	9	15.3	9	13.8	
Unemployed	3	2.4	1	1.7	2	3.1	
Student	89	71.8	40	67.8	49	75.4	
Working-Student	14	11.3	9	15.3	5	7.7	
Ethnicity							1.35
Caucasian	120	96.8	57	96.6	63	96.9	
Of African Descent	3	2.4	1	1.7	2	3.1	
Latin-American	1	0.8	1	1.7	-	-	
Previous Experience with Exergames							3.70
No	73	58.9	40	67.8	33	50.8	
Yes	51	411	19	32.2	32	49.2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*
Age	21.5	4.3	21.6	4.5	21.4	4.1	0.29

Table 2.

Means, Standard Deviations, and Estimates of Reliability for all the Main Variables, one Sample t-tests comparing the Means with each Scale Midpoint, and Percentages above each Scale Midpoint of the Dependent variables.

Variables (range)	*M*	*SD*	α [95% CI]	Ω [95% CI]	*t*	% (above scale midpoint)
Positive Affect (1-5)	3.51	0.69	0.78 [0.72, 0.84]	0.78 [0.72, 0.84]	16.24*	90.2
Motivation (Overall) (1-7)	4.83	0.57	---	.77	26.05*	97.6
Interest	5.60	0.78	.79 [.73, .85]	.80 [.74, .85]	29.88*	100
Competence	4.62	0.85	.65 [.55, .74]	.66 [.57, .75]	14.65*	88.7
Value	5.22	0.98	.83 [.78, .87]	.83 [.78, .87]	19.49*	93.5
Tension	2.55	1.17	.78 [.72, .84]	.78 [.72, .84]	-9.01*	24.2
Effort	5.90	0.73	.72 [.64, .80]	.72 [.64, .80]	36.45*	97.6
Presence (1-5)	3.75	0.54	.70 [.61, .78]	.70 [.62, .78]	25.97*	98.4
Vitality (1-7)	4.66	0.95	.76 [.70, .82]	.68 [.61, .76]	13.50*	88.7
Sensation Seeking (1-7)	4.53	1.06	.70 [0.62, 0.78]	.71 [0.63, 0.79]	--	--

Note. $N = 124$ * $p < .001$. High values on the scales indicate high positive affect, motivation, interest, competence, value, tension, effort, sense of presence, and perceived vitality. CI: Confidence Intervals; α: Cronbach's alpha; Ω: McDonald's omega.

Table 3.

Linear Regression Estimates for the Dependent Variables as a Function of Sensation Seeking and Environment Conditions

Model	B	*SE*	β	*t*	*p*	95% CI [LB, UB]	R^2_{ajust}	VIF	Koenker χ^2
DV: Positive Affect							0.01		0.46
(Constant)	3.53	0.06		55.12	.000	[3.40, 3.65]			
Envir.	0.72	1.28	0.05	0.57	.573	[-1.81, 3.26]		1.04	
SS	-0.01	0.06	-0.01	-0.15	.882	[-0.13, 0.11]		1.07	
Envir*SS	-0.08	0.06	-0.12	-1.30	.197	[-0.20, 0.04]		1.02	
DV: Motivation							0.01		1.49
(Constant)	4.82	0.05		92.02	.000	[4.72, 4.93]			
Envir.	1.44	1.05	0.13	1.37	.172	[-0.64, 3.51]		1.04	
SS	-0.01	0.05	-0.03	-0.27	.784	[-0.11, 0.09]		1.07	
Envir*SS	0.02	0.05	0.04	0.38	.701	[-0.08, 0.12]		1.02	
DV: Presence							0.02		1.12
(Constant)	3.74	0.05		75.28	.000	[3.64, 3.84]			
Envir.	0.44	0.99	0.04	0.44	.660	[-1.53, 2.41]		1.04	
SS	0.01	0.05	0.02	0.26	.793	[-0.08, 0.11]		1.07	
Envir*SS	0.04	0.05	0.09	0.93	.355	[-0.05, 0.14]		1.02	
DV: Vitality							0.04		3.15
(Constant)	4.67	0.09		54.38	.000	[4.50, 4.84]			
Envir.	2.30	1.72	0.12	1.34	.184	[-1.10, 5.70]		1.04	
SS	0.15	0.08	0.17	1.82	.071	[-0.01, 0.31]		1.07	
Envir*SS	-0.09	0.08	-0.09	-1.04	.301	[-0.25, 0.08]		1.02	
DV: Performance							0.05		0.87
(Constant)	7524.75	141.07		53.34	.000	[7245.45, 7804.06]			
Envir.	-6050.06	2821.36	-0.19	-2.14	.034	[-11636.16, -463.96]		1.04	
SS	315.83	135.41	0.21	2.33	.021	[47.74, 583.93]		1.07	
Envir*SS	188.35	135.41	0.12	1.39	.167	[-79.74, 456.44]		1.02	

Note. SS = Sensation Seeking (centered), higher values correspond to higher SS; Envir = Environment (dummy codes: no distraction = -0.5, positive distraction = 0.5); *SE*: Standard Error; CI [LB, UB] = Confidence Intervals [Lower Bound, Upper Bound]; VIF = Variance Inflation Factor (used to evaluate collinearity); Koenker χ^2 test (used to evaluate heteroscedasticity).

Table 4.

Means and Standard Deviation for all the Dependent Variables as a Function of the Environment Condition

	No Distractions (n = 59)	Positive Distractions (n = 65)
	M (SD)	*M (SD)*
Positive Affect	3.47 (0.69)	3.55 (0.70)
Motivation (Overall)	4.76 (0.51)	4.89 (0.61)
Sense of Presence	3.72 (0.53)	3.77 (0.55)
Vitality	4.50 (0.94)	4.79 (0.95)
Performance	7798.30 (1590.22)	7326.15 (1538.84)

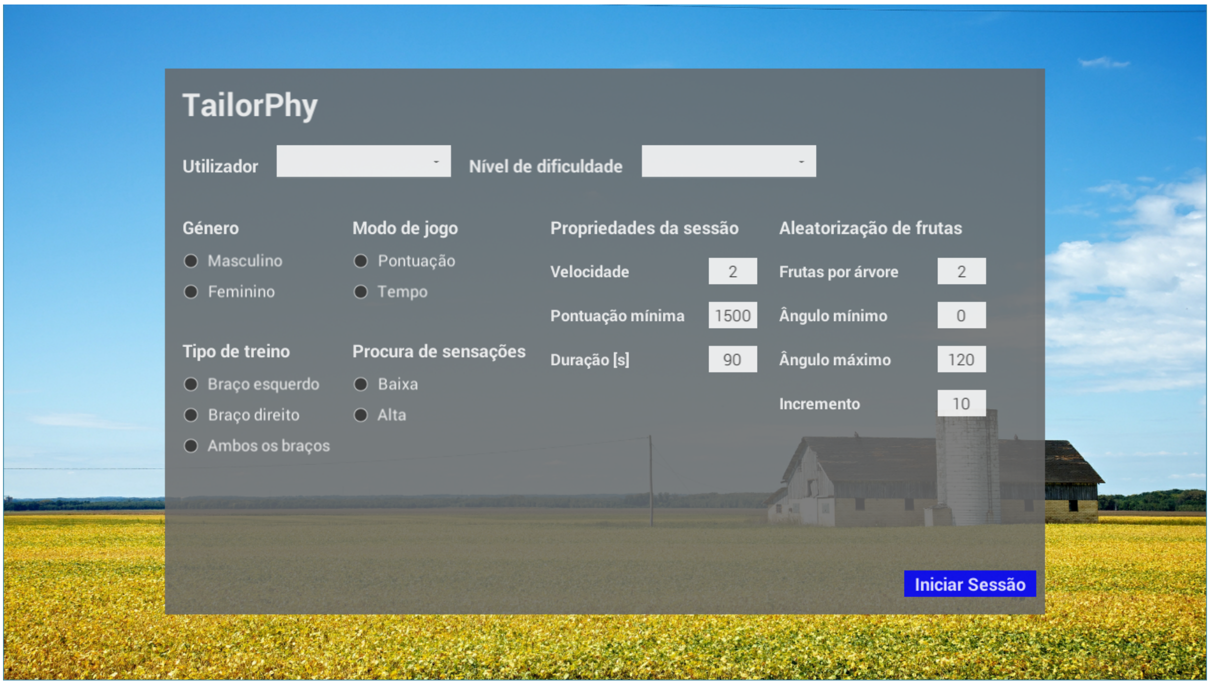

Figure 1.

Screenshot of the Exergame's Configuration screen. It includes: User and difficulty level options, gender, session goal (time-based vs score-based), type of training session (left-arm, right-arm or both arms), Positive Distractions (None vs Present), Speed of the Moving Cart, Minimum Required Score, Duration (in seconds) and Fruit Randomization (Number of Fruits per tree, minimum and maximum angle displayed, and angle increment).

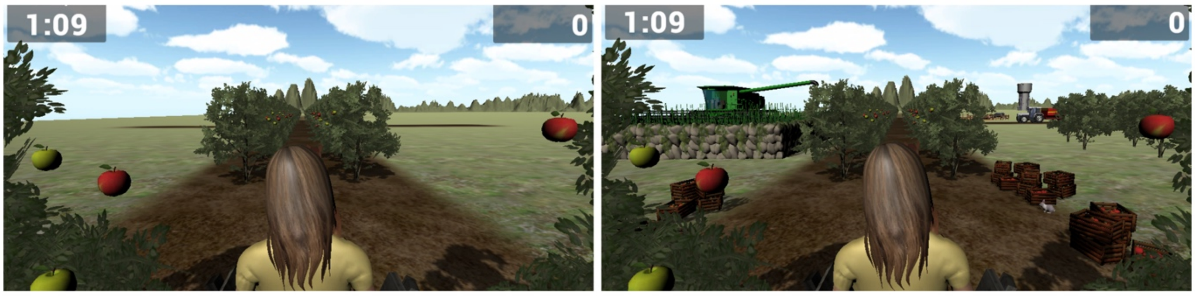

Figure 2.

Screenshot of the Virtual Environment with the Female Avatar for Each Condition: No Distractions (on the left) and Positive Distractions (on the right)