How Cooperation and Game Environment in Exergames Influence Motivation and Relatedness

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Abstract

Previous works on exergames has focused on developing guidelines or comparing exercise with exergames in different game environments, as well as research diving into different social play modes. However, there has not been a focus on investigating how these characteristics influence exergames. This research investigates the impact of different social play modes (competitive and cooperative) and game environments (Virtual Reality and non Virtual Reality) on motivation and relatedness between the players in the context of exergames. To address this, we developed a rhythm-based game consisting on four levels each being an unique combination of social play more and game environment. 12 participants took part in the study and completed the Intrinsic Motivation Inventory and Situational Motivation Scale after each level to asses motivation and relatedness in a 7 point Likert scale. The results indicate that a Virtual Reality environment affects positively the identified regulation (the player recognised the activity as good for themselves) and reduces the external regulation (the player does the activity to earn a reward), with no reported effects with respect to relatedness or social play modes. Further research should address the shortcomings of this study, such as the impossibility to perform a long term study and addressing the problems on the non-Virtual Reality game environment.

1 Introduction

In the latest years, since consoles that allowed for the user to move while playing entered the market, more people have turned to games to get reach their weekly activity goal. The popularity of games such as Nintendo's *Wii Sports*, Ubisoft's *Just Dance* or even Konami's *Dance Dance Revolution* indicates that the players are interested in active games, also called exergames. One recent example of this would be the amount of units that Nintendo's *Ring fit* sold during the Coronavirus pandemic, where everyone was forced to stay at home and they turned to videogames to keep their activity level[1]. Another reason the population turned not only to active games but games in general is to feel less isolated [2].

The objective of this research is to gain insight into which characteristics of exergames might influence motivation and relatedness. Particularly, with focus on the type of social play, cooperative or competitive; and the type of game of game environment, which in this case is Virtual Reality or not Virtual Reality. The goal is to gain a better understanding of the factors that influence motivation to exercise, as well as examining the differences between social modes of play and differences in game environment in terms of their impact on motivation. Furthermore, by examining the effects of the previously mentioned different variables on relatedness, we aim to identify specific types of play that are most effective at promoting social bonds between players.

Overall, this research has the potential to provide valuable information that can be used to design and implement effective exergames and programs for promoting social connections and strengthening relationships between individuals.

2 Background and Related Work

Here we go through a review of existing works in the topics of Exergames and health, social types of play, and game environment.

2.1 Exergames

Exergames, also called active video games or active gaming, are video games that require physical activity or movement in order to play [3, 4]. These games can be played on a variety of platforms, including console systems, computers, and mobile devices, and often involve the use of specialized con-

trollers or peripherals, such as motion-sensing devices. Some examples include Nintendo's *Wii Fit*, Konami's *Dance Dance Revolution*, Beat Game's *BeatSaber* and Ubisoft's *Just Dance*.

2.2 Self Determination Theory

The Self Determination Theory (SDT) is a theory rooted in psychology that has the goal to explain the inherent motivations of human behavior, and that can be used to both understand the behavior of players and to design more engaging video games [5]. The theory proposes that individuals have three basic psychological needs that must be fulfilled: autonomy, competence and relatedness [6].

- *Autonomy* is the psychological need to feel in control of one's life, as well as to have the freedom to make their own choices and decisions. A game that allows players to make choices will increase the player's autonomy.

- *Competence* refers to the need to feel capable and to have the necessary ability to achieve goals and challenges. In a game, adjusting the level of difficulty with respect to the player's skills will help increase competence.

- *Relatedness* represents the need to feel connected to others and to have meaningful social relationships. When the players get the opportunity to interact with each other, the relatedness increases. The players might feel like they are connected with each other and belong to a larger group.

Following SDT, motivation can be broadly classified in three types: [7]

- *Intrinsic motivation*: It refers to the motivation that comes from within the individual and is driven by personal interest and desires. For example, a person may be intrinsically motivated to play a game because they find it enjoyable.

- *Extrinsic motivation*: Motivation that comes from sources external from the individual. For example, a person may be extrinsically motivated to go play a game because they can obtain rewards or incentives from it, such as getting a trophy after finishing a particular task.

- *Amotivation*: Unlike the previous two types, refers to the absence of motivation. Amotivated users do not expect any type of reward and could be seen as similar to helplessness [8].

2.3 Exercise and health

The literature shows how sports can increase a person's physical and mental well-being. One study had concluded that the most common benefits of sports in children and adolescents were improved self-esteem, improved social interaction and integration and fewer depressive symptoms [9]. Similar findings generalized to the general public have been published [10, 11, 12]. Regarding team-based sports, research has found a higher association with improved health compared to the practice of individual activities due to the presence of social interaction [9].

2.4 Exercise and Exergames

Having established the health benefits of exercise, how does it compare with exergames? When an activity is presented as a game activity, interest and enjoyment are increased [13, 14]. In a study about health benefits and exergames where the participants would play an interactive video game versus a control group that would train as usual, the interactive video game resulted in higher improvements in physical fitness as well as greater attendance. This was measured by taking attendance to a training regime for 6 weeks [15].

2.5 Exergames and social types of play

In general, social types of play – cooperative or competitive- has been found increase adherence to the activity regardless of which type of game that was played versus single play [16]. The sense of belonging that provides group play shows benefits versus single play.

When comparing competitive play versus cooperative play, the cooperative playing mode seems to be the one found to increase motivation, adherence, self-efficacy and pro-social behaviors [17], particularly when looking at exergames [18]. Niedecken et al. found in their study that participants expressed a preference for the cooperative mode because it encouraged communication and social interaction[19]. There is also evidence of competition having positive effects, although they are dependent on the players' and the performed tasks [20, 21, 22].

2.5.1 Exergames and game environment

An example of research focusing in a different game environment is the ExerCube. The ExerCube an immersive game setting that consists of three projectors that project the game environment on three walls surrounding the player, sound, and trackers for the participant to wear [19]. Another experiment evaluating physical activity with a personal trainer

compared with physical activity in the ExerCube found out that the ExerCube is on par with personal training. [23] In addition, Márquez et al. investigated with the help of the ExerCube different design choices and modes of play where they do not only explore the competitive or collaborative characteristic of a game but also the agency of players and the asymmetry of these modes [24].

Other examples of research focusing in different game environment would be research centering in Virtual Reality (VR) exergames. One study using VR exergames to increase the mobility of elder people reached the conclusion that exergaming is a viable alternative to traditional exercise [25]. Another study, also focused on elder people, evaluated the potential of social VR exergames, concluding that playing the game with other people, versus playing alone, was significantly more beneficial for motivation, enjoyment, social connectedness, and physical exertion [26].

2.6 Research gap and goals

As shown above, there is plenty of research about exergames: how do they compare with exercise, as well as the effects of social types of play and game environment. However, instead of comparing exergames with exercise, it would be interesting to investigate if and how motivation in exergames is influenced depending on the game environment. Following this, previous research shows how social types of play on exergames can increase motivation depending on the tasks performed, but there is no detail on whether this varies with respect to the game environment used.

To explore whether relatedness and motivation can be influenced by the type of social play and game environment, we introduce four experiment conditions: the type of multiplayer -cooperative and competitive- and the type of game environment -virtual reality and non virtual reality-. We then define the research questions as:

RQ1: *How do different social play modes (cooperative vs competitive) affect relatedness in an exergame?*

RQ2: *How do different social play (cooperative vs competitive) modes affect motivation in an exergame?*

RQ3: *How does a VR environment (VR vs non-VR) affect relatedness in an exergame?*

RQ4: *How does a VR environment (VR vs non-VR) affect motivation in an exergame?*

3 Equipment and software

3.1 Meta Quest

The Meta Quest is a wireless virtual reality headset which can run games both from an Android operating system and through wired or wireless connection to the Steam platform. The headset is equipped with two 6DOF controllers for positional tracking, four wide-angle cameras and embedded speakers as well as two 3.5 mm audio jack [27].

The controllers are a pair of handheld units each containing a joystick, three buttons and two triggers, one in the back and one on the side. The controllers provide haptic feedback through vibration and the ring in them contains a set of infrared LED's which allows for tracking in the VR space.

Figure 1: Meta Quest

3.2 Game Development

We developed a VR game heavily inspired in Beat Saber [28], a VR rhythm game developed by Beat Games in which players have to hit targets and avoid obstacles at the beat of the music.

The development was made using *Unity* for the software, with *Netcode for GameObjects* for the network for peer to peer communication.

The game was developed such that it would have a simple enough interface for any participants to use. Upon the start of the game, the player is welcomed with a menu where they have to select the level they are going to play. After this, they are welcomed with an image of two sabers, one red and one blue, and a text that indicates that to start the game they must cut a sphere that is floating in the middle of the screen. When the player cuts the sphere, there are a few seconds of silence for the player to get prepared and then the song starts and a series of cubes start approaching the player at the beat of the music. The player then needs to hit these cubes with the sabers to earn points. The cubes, as the sabers, are color coded. If the players hit a cube that matches the saber color they get 100 points, if they hit it with the incorrect saber they would get only 50 points instead. There are no obstacles and is not possible for the player to lose the game. While playing the level, the player can see their and their partner scores

as shown in Figure 3. After finishing a summary of the scores appears in the screen.

To ensure that all conditions would be as similar as possible, we created a bitmap for the song, such that the cubes to cut would be in the same position in all runs of the experiment. For this task we used *ChroMapper* [29], shown in Figure 2, a software that allows the user to place cubes with respect of the beat of the music with the help of a user interface. The software outputs a *JSON* file with the time and location of the cubes that can be then imported into *Unity*.

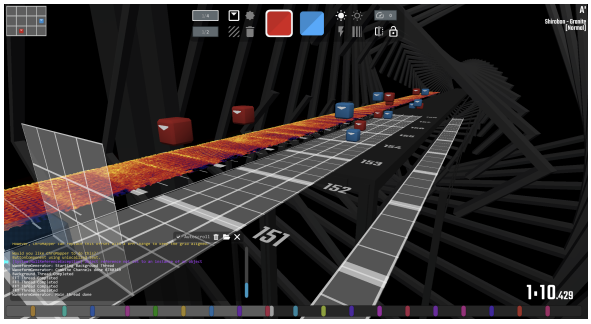

Figure 2: Level editor in ChroMapper

An important objective for the level was that it should not be a hard level, since it should be possible for novices to play without being overwhelming, but it should also be fun for any experience player. For this, we created the bitmap such that the cubes would be within enough distance of each other so they would be easy to hit however, instead of keeping them in the beat, they change to appear to the half beat of the song for the chorus, giving it a layer of added difficulty. The placement of the cubes was also planned so the player can do dance movement to hit them easily. This would make that for inexperienced player the level gets a bit harder but for an usual player it still would keep the level fun and would produce exertion. The music used for the game is *Granite* by *Shirobon*, available to use under a creative commons license on the artist's website [30].

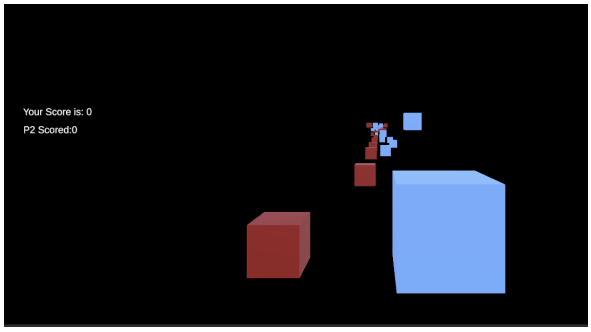

Figure 3: Level screen capture

3.3 Ethics and participant safety

During the experiment the participants, in pairs, will have to perform medium physical activity wearing a VR headset. To prevent any possible discomfort or injury we took several measures while designing the study. The first preventable measure was be to screen all participants regarding their physical state, to make sure that they are able to reach the level of exertion needed. The participants were also asked if they had previously any problems while playing VR games, such as motion sickness. After this, the participants were given a consent form where they were informed of the activities they are going to perform and where is stated that they can stop the experiment or request help at any moment.

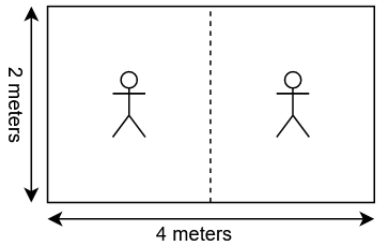

Figure 4: Room disposition. *Oculus* recommends a free space of $2m$ x $2m$ per player to ensure safety while playing.

Due to the nature of the experiment, the participants will be practicing exercise in pairs. For this, we carried the experiment in a big room, to ensure that each of the participants had enough space to move freely without getting too close to their game partner. Figure 4 illustrates a room set up with both participants. Regarding the use of VR, and to make it as safe as possible, we made the choice to use an *Oculus Quest*, since is a headset that can be used standalone. This means that no cables or any other devices were in the room, eliminating this way the risk of the player stumbling while moving with the VR headset on.

3.4 Study design

In order to find a relationship between motivation and relatedness the experiment evaluated four conditions. Two referring to the social play: Competitive and Cooperative; and two referring the game environment: VR and non-VR. Resulting in the combination: VR/competitive, VR/cooperative, non-VR/cooperative and non-VR/competitive.

The participants played the game in pairs and had to do four iterations of the game, one for each combination of the conditions. To ensure that the results

	Group 1	Group 2	Group 3	Group 4
Level 1	VR, Competitive	No-VR, Competitive	VR, Cooperative	No-VR, Cooperative
Level 2	No-VR, Competitive	No-VR, Cooperative	VR, Competitive	VR, Cooperative
Level 3	No-VR, Cooperative	VR, Cooperative	No-VR, Competitive	VR, Competitive
Level 4	VR, Cooperative	VR, Competitive	No-VR, Cooperative	No-VR, Competitive

Table 1: Latin Square Design for the experiment

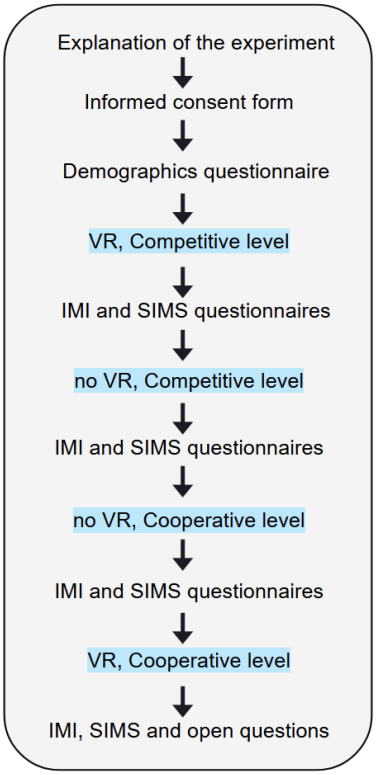

Figure 5: Example of experiment procedure for a participant belonging to Group 1

are not affected by the condition's order, we used a Latin Square Design as shown in Table 1.

During the competitive levels, the players had to compete between themselves to try to achieve the highest score, during the cooperative phase the participants' score is added and the goal is to achieve a goal score. The VR mode was played wearing a VR headset and for the non-VR mode the participants had to play the game using the VR controllers but with the game playing in a TV screen. To make both conditions as similar as possible, and due to the headset weight being not insignificant, the participants wore the headset on the neck. For this levels we used the *casting* feature on the *Quest* which allows sharing the headset's screen to a TV or PC connected to the same network.

3.5 Data collection

In order to measure relatedness and motivation we used the *Intrinsic Motivation Inventory* and the *Situational Motivation Scale*. In addition, the participants responded to open question after the experiment about what they thought the activity they just played could be useful for.

Intrinsic Motivation Inventory: The Intrinsic Motivation Inventory (IMI) is a self-report scale designed to evaluate the subjective experience of participants in a target activity. The IMI is made of seven sub-scales: interest/enjoyment, perceived competence, effort/importance, pressure/tension, perceived choice, value/usefulness and relatedness [31]. However for this study we only use the *relatedness* sub-scale to measure feelings of closeness with the game partner.

Situational Motivation Scale: The Situational Motivation Scale (SIMS) is self-report survey that measures situational intrinsic motivation, extrinsic motivation (through identified regulation: an individual engages in an activity because they consider it relevant to their goals; and external regulation: an individual engages in an activity to receive a reward or avoid a punishment), and amotivation. It consists in 16 questions answered using a 7 points Likert scale.

3.6 Participants

12 participants were recruited using convenient sampling, recruitment posters and an online contact form. Participants had a median age of $Mdn = 24.5$ yr, mean age of $M = 24.58$ yr ($SD = 5.58$, $min = 18$, $max = 39$). 2 participants reported having experienced motion sickness with a PC or VR game, but decided to go forward with the experiment and were able to finish it without any sickness. 50% of participants identified as male, 33.34% as female and 16.67% as non-binary. Only 16.67% of participants had previous experience with VR and VR games, with the rest 83.34% being only vaguely familiar with the system. The experiment took approximately 1 hour per participant to complete.

3.7 Procedure

When the participants signed up for the experiment, they were called in pairs to perform the experiment. Upon arrival they received a participant information sheet and get an overview of the tasks they have to complete. If they agree to continue with the experiment they sign the informed consent form and start filling an initial demographics questionnaire. Then, each of the participants is brought to the a playing placed marked on the floor that ensures there is enough distance between them and they can begin to play the level. After they are done, they participants fill out the questionnaires, they can take a break if needed and then proceed with the rest of the experiment. The participants were allowed to talk between themselves and discuss scores and strategies during the downtime between levels. After finishing all the tasks, the participants would fill the open ended questions besides the IMI and SIMS questionnaire, and were free to share any observation about the experiment, game or levels.

3.8 Data Analyses

After conducting a two-way repeated measures ANOVA to evaluate the results, the only statistically relevant result were: **external regulation** with regards to game environment ($p = 0.008$). Upon a closer look we see that in the VR condition the external regulation is smaller than with the no VR condition, as shown in Figure 6. And **identified regulation** with regards to the environment ($p = 0.04$). However, unlike external regulation, the identified regulation is higher with the VR environment, which can be seen in Figure 7.

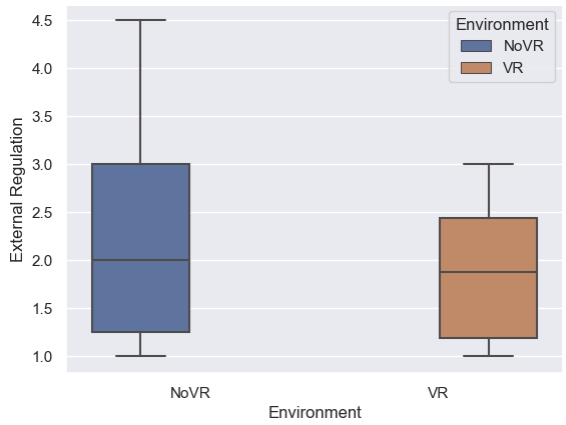

Figure 6: Boxplot showing the values of External regulation with respect to the Environment

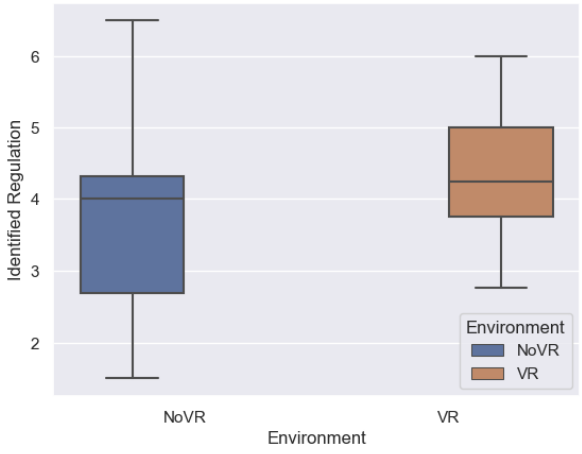

Figure 7: Boxplot showing the values of Identified regulation with respect to the Environment

3.9 Results and Discussion

To answer the research questions:

RQ1. *How do different social play modes affect relatedness in an exergame?* The results indicate that a competitive play mode might increase relatedness, even though the data is not statistically significant.

RQ2. *How do different social play modes affect motivation in an exergame?* There was not found any effect between play modes and motivation. However, almost the majority of participants mentioned that they felt motivated to play better when playing against their partner, and that when the play mode was cooperative, their motivation to reach a high score was to defeat other pair of participants.

RQ3. *How does a VR environment affect relatedness in an exergame?* It does not seem to be any relationship between the VR environment and relatedness.

RQ4. *How does a VR environment affect motivation in an exergame?* A VR environment affects positively the identified regulation and reduces the external regulation. The participants mentioned that the VR levels were more fun to play than the no VR ones, this might explain why the external regulation decreases with the VR levels. A possible hypothesis could be that less external regulation is needed if the game is fun for itself. This could also perhaps explain why the identified regulation increases for VR levels; which increases when the activity is valued and perceived as chosen by the participant.

Even though there was no found relation with respect to relatedness, all participants mentioned that the game would be valuable to make friends or to help people who might be lonely such as people living alone or elderly persons.

The participants also highlighted that, even though they though the game would be good for either exercise or improve eye-hand coordination, if they would play on their free time it would not be for these reasons, but to become better and achieve higher scores.

4 Limitations and Future Work

There were some limitations in the study. Firstly, due to the short time available, it was not possible to conduct a long term study. Secondly, due to the selecting participants through convenient sampling, the demographic for all participants ended up very similar with the majority of them being university students of around 20 years old. Thirdly, since the experiment was done in a small time window and to use the minimum number of participants necessary we used a withing-subject design. However, this meant that all participants had to test all four conditions, which made the time of the experiment longer than ideal and caused that some of the participants got tired and frustrated towards the end of the experiment. Lastly, during the experiment design we did not take into account how long it would take for the participants to get used to the system if they were not familiar with VR. Even though there was some time allocated to let the participants get used to the controls, we badly underestimated how long this would take, which caused that the experiment would take between 1 hour and 1h30 instead of the 30 minutes originally planned.

As mentioned in the results, even though there was not any significant effect between play modes and motivation, not only almost all participants mentioned the competitiveness as a motivation factor, but also during the cooperative levels they mentioned that their motivation was to score higher than other participants.

Some comments that should be taken into account for any possible future work are the ones with respect the no VR conditions. In this case we used the same game, playing from the headset and casting the image into a TV screen. However, this caused that people not familiar with VR headsets would get confused with depth perception and the controls, since they could still use the sabers with 6DoF.

Lastly, it was also mentioned that the cooperative levels made them get closer to their partner not because they were collaborating to reach a goal but, because they felt like it was them versus all the other participants and wanted to get the highest scores. They also insisted that they would have liked to have a global leader-board and receive it at the end of the study so they could compare their scores with the rest of the participants.

5 Conclusion

This research explored the influence of social play modes (cooperative and competitive) and game environment (Virtual Reality and non Virtual Reality) in motivation and relatedness in the context of exergames. The results of the experiment show that a Virtual Reality environment affects positively the identified regulation of the player and reduces the external regulation. While the experiment poses limitations, the findings give rise to further research on

how different modes of social play and game environment may correlate to influence motivation and relatedness.

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A Situational Motivation Scale

Read each item carefully. Using the scale below, please circle the number that best describes the reason why you are currently engaged in this activity. Answer each item according to the following scale: 1: corresponds not all; 4: corresponds moderately; 7: corresponds exactly.

Why are you currently engaged in this activity?							
1. Because I think that this activity is interesting	1	2	3	4	5	6	7
2. Because I am doing it for my own good	1	2	3	4	5	6	7
3. Because I am supposed to do it	1	2	3	4	5	6	7
4. There may be good reasons to do this activity, but personally I don't see any	1	2	3	4	5	6	7
5. Because I think that this activity is pleasant	1	2	3	4	5	6	7
6. Because I think that this activity is good for me	1	2	3	4	5	6	7
7. Because it is something that I have to do	1	2	3	4	5	6	7
8. I do this activity but I am not sure if it is worth it	1	2	3	4	5	6	7
9. Because this activity is fun	1	2	3	4	5	6	7
10. By personal decision	1	2	3	4	5	6	7
11. Because I don't have any choice	1	2	3	4	5	6	7
12. I don't know; I don't see what this activity brings me	1	2	3	4	5	6	7
13. Because I feel good when doing this activity	1	2	3	4	5	6	7
14. Because I believe that this activity is important for me	1	2	3	4	5	6	7
15. Because I feel that I have to do it	1	2	3	4	5	6	7
16. I do this activity, but I am not sure it is a good thing to pursue it	1	2	3	4	5	6	7

Codification key: Intrinsic motivation: Items 1, 5, 9, 13; Identified regulation: Items 2, 6, 10, 14; External regulation: Items 3, 7, 11, 15; Amotivation: Items 4, 8, 12, 16.

Table 2: SIMS questionnaire

B Intrinsic Motivation Scale. Relatedness subscale

For each of the following statements, please indicate how true it is for you, where 1: not at all. 4: somewhat true and 7: very true.

I felt really distant to this person. (R)	1	2	3	4	5	6	7
I really doubt that this person and I would ever be friends. (R)	1	2	3	4	5	6	7
I felt like I could really trust this person.	1	2	3	4	5	6	7
I'd like a chance to interact with this person more often.	1	2	3	4	5	6	7
I'd really prefer not to interact with this person in the future. (R)	1	2	3	4	5	6	7
I don't feel like I could really trust this person. (R)	1	2	3	4	5	6	7
It is likely that this person and I could become friends if we interacted a lot.	1	2	3	4	5	6	7
I feel close to this person.	1	2	3	4	5	6	7

Table 3: Relatedness questionnaire

To score this instrument, you must first reverse score the items for which an (R) is shown after them. To do that, subtract the item response from 8, and use the resulting number as the item score. Then, calculate scores by averaging across all of the items.