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Exergaming in a Multiplayer and Inter-Team Competition Mode with Play Lü: Effects on Adolescents' Moderate-to-Vigorous Physical Activity and Situational Interest

Cédric Roure

University of Teacher Education, Lausanne, Switzerland, cedric.roure@hepl.ch

Patrick Fargier

University of Teacher Education, Lausanne, Switzerland, patrick.fargier@hepl.ch

Guillaume Girod

University of Teacher Education, Lausanne, Switzerland, guillaume.girod@hepl.ch

Valérien Cécé

University of Teacher Education, Lausanne, Switzerland, valerian.cece@hepl.ch

Denis Pasco

University of Bourgogne-Franche-Comté, denis.pasco@univ-fcomte.fr

See next page for additional authors

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Abstract

Objective: The goal of this study was to evaluate the impact of a Play Lü inter-team competition exergame on adolescents' moderate-to-vigorous physical activity (MVPA) and situational interest (SI).

Materials and Methods: A total of 110 students ($M_{age} = 13.7 \pm 1.1$, 12-16 years, 53.7 % girls, $M_{BMI} = 19.9 \pm 3.2$) from a secondary school located in Switzerland participated to the study. They played three separate 20-min games in a counterbalance allocated order: (1) Play Lü multiplayer and inter-team competition exergame; (2) Play Lü single-player competition exergame; and (3) Tic-Tac-Toe multiplayer and inter-team competition game. The participants' MVPA was measured during each 20-min game using ActiGraph GT3X+ accelerometers and SI was measured immediately after each game.

Results: Regarding Play Lü, the results showed higher MVPA and SI scores in the multiplayer and inter-team competition mode than in the single-player competition mode. Moreover, Play Lü elicited greater effects compared to the Tic-Tac-Toe game within a multiplayer and inter-team competition mode.

Conclusion: The Play Lü inter-team competition exergame might be considered as a relevant strategy to improve adolescents' motivation and physical activity, which can be applied in a physical education context.

Authors

Cédric Roure, Patrick Fargier, Guillaume Girod, Valérian Cécé, Denis Pasco, and Vanessa Lentillon-Kaestner

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Cédric Roure^a, Patrick Fargier, Guillaume Girod^a, Valérian Cécé^a, Denis Pasco^b, Vanessa Lentillon-Kaestner^a

^aUniversity of Teacher Education, Lausanne, Switzerland,

^bUniversity of Bourgogne-Franche-Comté

Abstract

Objective: The goal of this study was to evaluate the impact of a Play Lü inter-team competition exergame on adolescents' moderate-to-vigorous physical activity (MVPA) and situational interest (SI). **Materials and Methods:** A total of 110 students ($M_{age} = 13.7 \pm 1.1$, 12-16 years, 53.7 % girls, $M_{BMI} = 19.9 \pm 3.2$) from a secondary school located in Switzerland participated to the study. They played three separate 20-min games in a counterbalance allocated order: (1) Play Lü multiplayer and inter-team competition exergame; (2) Play Lü single-player competition exergame; and (3) Tic-Tac-Toe multiplayer and inter-team competition game. The participants' MVPA was measured during each 20-min game using ActiGraph GT3X+ accelerometers and SI was measured immediately after each game. **Results:** Regarding Play Lü, the results showed higher MVPA and SI scores in the multiplayer and inter-team competition mode than in the single-player competition mode. Moreover, Play Lü elicited greater effects compared to the Tic-Tac-Toe game within a multiplayer and inter-team competition mode. **Conclusion:** The Play Lü inter-team competition exergame might be considered as a relevant strategy to improve adolescents' motivation and physical activity, which can be applied in a physical education context.

Key words: competition, cooperation, exergame, physical activity, Play Lü, situational interest

Introduction

Cooperation and competition are two elements explaining the motivation for adolescents to engage in exergame play within a social environment (Marker & Staiano, 2015). Experimental results have shown that exergames involving inter-team competition (i.e., the opposition of two or more groups competing for the same outcome) may elicit greater psychosocial and physiological benefits than single player exergames (Moss et al., 2018). It has also been suggested that competition might increase players' physical activity outcomes during exergames, while cooperation might increase players' motivation (Marker & Staiano, 2015). During an exergame, the multiplayer mode may engender well-lived competition (Peng & Hsieh, 2012) since the negative impact of a poor performance could be diminished when such performance is shared within a team. In addition, inter-team competition elicits cooperation within the team members, due to the strategic incentive to collaborate with teammates to win a competition (Moss et al., 2018; Peng & Crouse, 2013). Consequently, the practice of a competitive exergame in a multiplayer and inter-team mode might be a promising option to enhance adolescents' motivation and physical activity.

Despite the aforementioned benefits, very few studies have used a multiplayer and inter-team competition exergame, to combine the competition and the cooperation elements (Mackintosh et al., 2016). The exergames previously used in research frequently promoted a single-player competition mode to elicit players' motivation and physical activity. According to the motivational perspective, previous studies have demonstrated positive effects of such single player exergames on situational interest (SI), defined as the appealing effect of the exergames

characteristics on individuals (Roure et al., 2020). As a psychological state, SI is characterized by increased attention, concentration and affect experienced during exergame play. A recent clarification of the construct in physical education (Roure, 2020) has defined three factors related to SI: (1) Triggering-SI which corresponds to the capture of students' attention and the perceived accessibility of the content proposed; (2) Maintained-SI feeling which represents the positive affective reaction to the content and the willingness to further explore the content; and (3) Maintained-SI value which refers to a student's meaningful connection to the content and the understanding of its significance in relation to their personal values. Within the exergaming literature, it has been shown that commercial exergames (e.g., Dance Dance Revolution; Huang & Gao, 2013) or design-based exergames (e.g., Greedy Rabbit; Roure et al., 2020) have the potential to elicit players' SI according to their specific mechanisms such as optimal challenge with progressive levels, attention demand on relevant aspects of the exergame, or exploration intention to discover new levels. Such single player exergames also impacted the players' physical activity by promoting a high percentage of MVPA. Although commercial single-player exergames might experience difficulties to reach a high percentage of players' MVPA (Gao et al., 2015), it has been demonstrated that design-based single-player exergames could reach up to 90% of players' MVPA (Pasco et al., 2017).

Even if interesting results have been reported for the effects of single-player competition exergames on MVPA and SI, information is lacking regarding the effects of other forms of exergames which could combine the competition and cooperation elements. Comparisons between single-player and multiplayer exergames are needed using the same platform, to confirm the advantage of an inter-team competition mode (Moss et al., 2018) on players' MVPA and SI. Previous exergames used in research were often based either on a competition mode or on a cooperative mode (Mackintosh et al., 2016). This limitation to integrate competition and cooperation within the same playing session was probably due to the platforms retained, such as Nintendo® Wii, Microsoft® Xbox Kinect, or bike exergaming. These platforms often used a restricted playing area, with games projected on a screen, which has limited the possibility to design a multiplayer and inter-team competition mode.

The recent Play Lü exergame platform (Lü® Interactive Playground, Québec, Canada) has the potential to overcome the aforementioned limitations. With Play Lü, the participants are literally immersed in the games displayed on a giant projection wall (6 X 3 meters). The principal mechanism of Play Lü requires the players to throw balls against the wall (e.g., to reach a target or to activate an object). In addition, this platform offers an interactive playing area allowing up to eight players simultaneously engaged in the same exergame session.

Considering that the Play Lü exergame platform permits a multiplayer inter-team competition mode, as well as a single-player competition mode, this platform was well-suited to examine the following two objectives for this study: (1) to confirm that a multiplayer and inter-team competition exergame is preferable over a single-player competition exergame in terms of players' MVPA and SI; and (2) to compare a multiplayer and inter-team competition exergame to a multiplayer and inter-team competition game widely used in physical education curriculum lessons in the Canton of Vaud (i.e., Tic-Tac-Toe). This study adds to the current research literature since it uses a new promising exergame platform to investigate the impact of a multiplayer and inter-team competition mode on MVPA and SI scores. It also extends current methodology by using an ecologically valid multiplayer competition game to serve as a control condition, which is motivating and based on the same type of activities compared to the exergame (intermittent effort and throwing skills).

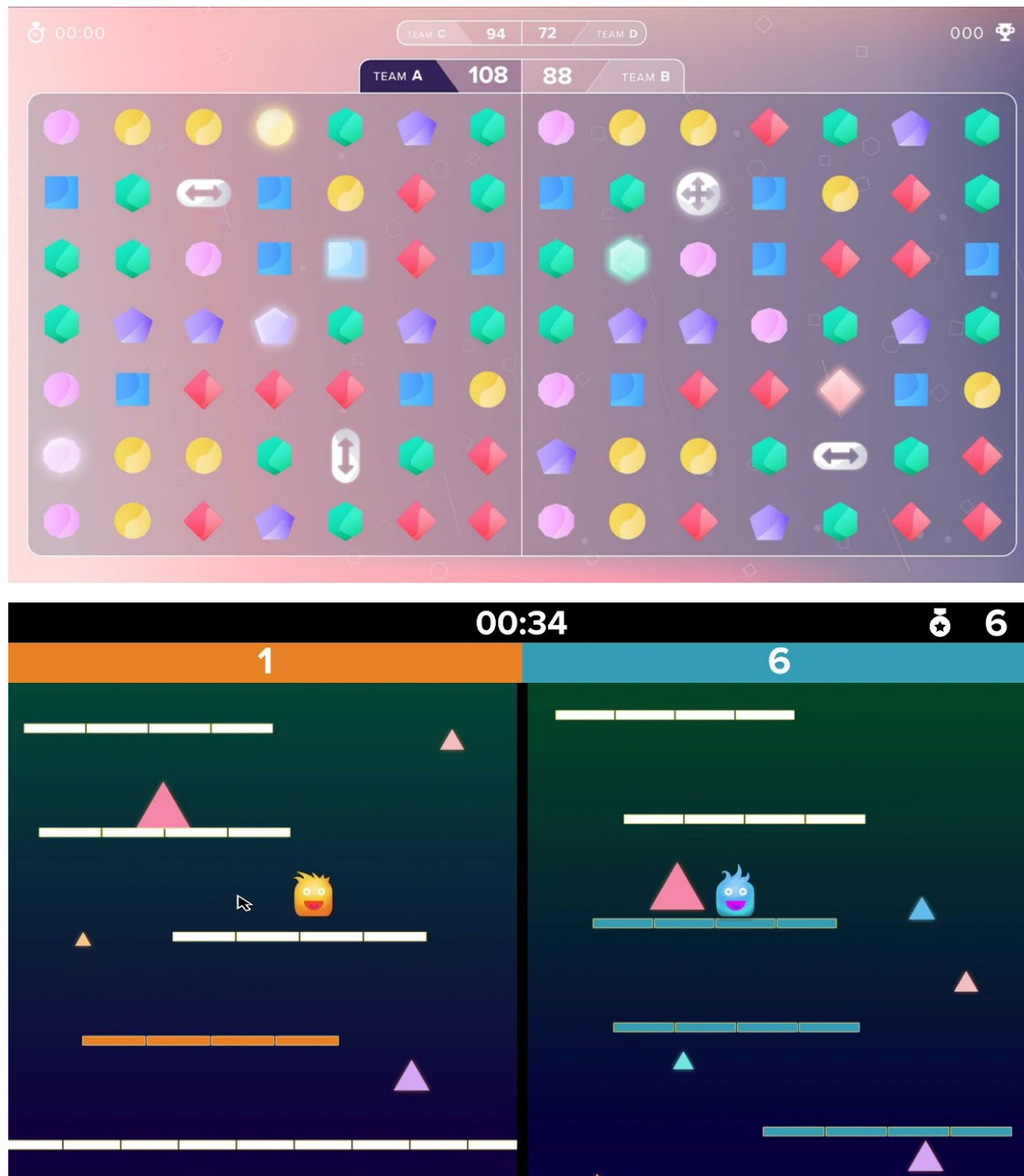
Materials and Methods

Participants

The sample size calculation, using the package ‘pwr’ of R indicated that 65 participants would be sufficient for 90% power ($\alpha = 0.05$, effect size = 0.50) to test the two outcomes of the study (i.e., MVPA and SI).

Figure 1

The Pila (up) and Scala (down) games used in the Play Lü inter-team competition mode.



Considering the risk of missing values inherent to an ecological study, a higher number of participants was included in the present study. Thus, the participants were 110 students (Mage = 13.7 ± 1.1 , 12-16 years, 53.7 % girls, MBMI = 19.9 ± 3.2) from one secondary school located in Switzerland (Canton of Vaud). No specific inclusion criteria for participation were used while the exclusion criteria were any chronic disease or condition that would limit students' physical activity. Permission to conduct the study was granted by the Ethics Committee of the host university. Students and parents were informed about the scope of the study, but left uninformed of any expected results, and gave their written informed consent before the experimentation.

Procedures

Each student completed two sessions in the school gymnasium within two weeks. During the first session, demographic information was collected for all students such as age, sex, height and weight. Height was measured to the nearest 0.1 cm using a portable stadiometer and weight to the nearest 0.1 kg using a calibrated mechanical flat scale. Researchers further used this information to initialize and calibrate the accelerometers for the physical activity measure. Then, each student completed a 10-ball throwing test with a circle target (60 cm diameter) fixed on a wall (5 meters distance with a height set at 1.5 meter). Depending on the results obtained from this test, the students were allocated into heterogeneous teams of three players to ensure equity and fair play during inter-team competition games. Finally, the students completed an individual interest questionnaire to assess their prior interest in exergames (Roure et al., 2021).

Figure 2

The Mire game used in the Play Lü single-player competition mode.



During the second session, participants played three separate 20-min conditions in a counterbalance allocated order: (1) Play Lü multiplayer and inter-team competition exergame; (2) Play Lü single-player competition exergame; and (3) Tic-Tac-Toe multiplayer and inter-team competition game. The Play Lü multiplayer and inter-team competition exergame was based on the opposition of two heterogeneous teams of three players, using the Pila and Scala games (Figure 1). The Pila game consisted of throwing balls at blocks of different shapes and colours, to form a

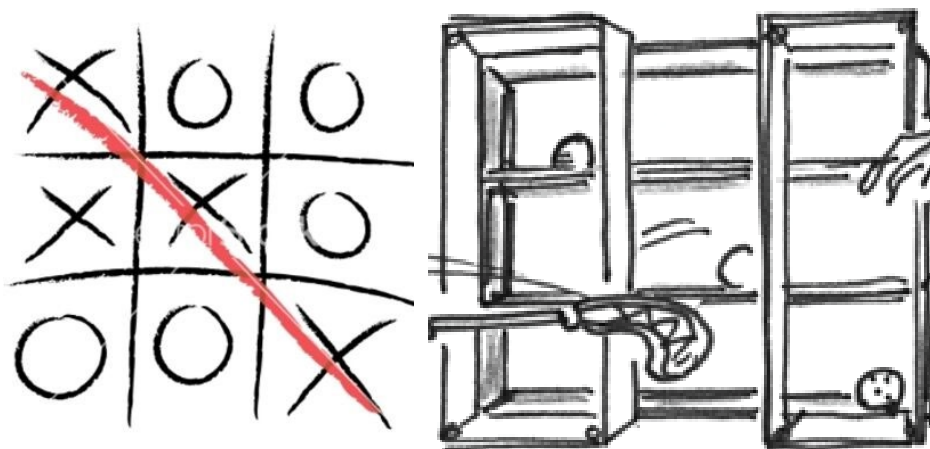
combination of three or more identical blocks and thus scored a maximum of points for their team. In the Scala game, the players had to make a small robot jump from platform to platform by throwing a ball at it. The goal was to climb as high as they could to reach a targeted platform before the other team.

The Play Lü single-player competition exergame used a different game called Mire (Figure 2). In this game, each player had to throw a ball at a specific color target displayed on the wall. The Mire game was played in two rounds. In each round, the goal for the players was to reach the highest score possible, considering that the players earned one point when their target was touched. During the first round, four players competed against each other by throwing their ball at their target which could appear, disappear and move vertically in a fix column displayed in front of them. The players had to execute a short course (5 meters) between each shot, to avoid a static throwing position, and they completed five repetitions of two minutes. The second round repeated the same organization (five repetitions of two minutes) but with mobile targets which could appear, disappear and move horizontally and vertically anywhere on the wall. The Tic-Tac-Toe multiplayer and inter-team competition game, who served as the control condition in this study, is a game frequently used in physical education lessons in the Canton of Vaud.

During the opposition of two heterogeneous teams of three players (the teams were the same as in the Play Lü multiplayer and inter-team competition exergame), the players had to throw a ball at a frame of nine squares (Figure 3) [Figure 3 near here]. Each time a ball reached a square, the player could place a color plot indicating that their team had validated that square. The first team to line up three identical color plots horizontally, vertically or diagonally, won the game.

Figure 3

The Tic-Tac-Toe game used in the inter-team competition real game mode.



Participants' SI was measured immediately after each of the 20-min conditions, using a validated scale (Roure, 2020). Researchers administered the questionnaires and collected them directly after completion. The participants also wore ActiGraph GT3X+ accelerometers (ActiGraph Co.; Pensacola, FL, USA) using an elastic strap during the entirety of the three conditions at the right hip, just above the right superior iliac crest.

Measures

Individual interest.

The French 14-item individual interest questionnaire (Roure et al., 2021) was used to measure players' individual interest in exergames. The questionnaire includes three factors: (1) positive affect and willingness to reengage (e.g., "if I could choose my physical activities in PE, I would like to do more exergames"); (2) stored utility value (e.g., "after school, I want to continue doing exergames that I've discovered in PE"); and (3) stored attainment value and knowledge-seeking intentions (e.g., "I like to challenge myself and learn new things in exergames"). The items were randomly arranged, and each was rated on a five-point Likert scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. Roure et al. (2021) established the construct validity of the French individual interest questionnaire using exploratory and confirmatory factor analyses (Comparative fit index (CFI) = 0.98, Normed fit index (NFI) = 0.94, Root mean squared error of approximation (RMSEA) = 0.05). They also reported internal consistency (Hancock's H coefficient) for the three factors (ranging from .87 to .92) among secondary school students.

Situational interest.

The French 12-item SI Scale (Roure, 2020) was used to measure players' SI. The scale includes three factors: (1) triggering-SI (e.g., "what we were learning during the game demanded my high attention"); (2) maintained-SI feeling (e.g., "what we did during the game was enjoyable for me"); and (3) maintained-SI value (e.g., "it was important for me to succeed during this game"). The items were randomly arranged, and each was rated on a five-point Likert scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*. Roure (2020) established the construct validity of the French 12-item SI Scale using exploratory and confirmatory factor analyses (Comparative fit index (CFI) = 0.95, Normed fit index (NFI) = 0.90, Root mean squared error of approximation (RMSEA) = 0.05). Internal consistency was also reported (Hancock's H coefficient) for the three factors (ranging from .82 to .88) among secondary school students.

Physical activity levels.

Actigraph GT3X+ accelerometers (Actigraph Co.; Pensacola, FL, USA) were used to assess players' physical activity levels. The GT3X+ is widely used in physical activity research and has demonstrated acceptable criterion validity and reliability for recording physical activity in the field and converting activity counts into different intensity levels of physical activity. Accelerations from the Actigraph GT3X+ were converted into activity counts, summed, and recorded using a specific interval of time called an epoch which can range from 5s to 1 min. In this study, the epoch was set to 5s since acute and intermittent exercise bouts were examined (e.g., exergaming). The same cut-points as in Pasco et al. (2017)'s study was used to determine MVPA for adolescents (≥ 1600 counts per 30s). The percentage of time participants spent in MVPA was used as the outcome variable.

Data analyses

The statistical analyses were performed using the following steps. Preliminary analyses were conducted on the study variables to examine the normality, multicollinearity, internal reliability of the subscales, and construct validities. Moreover, descriptive statistics for players' individual interest in exergames were calculated prior to the intervention. The principal analyses were conducted in relation to the two objectives of the study. Therefore, two repeated-measures multivariate analysis of variance (MANOVA) were conducted to examine the differences related to the participants' MVPA and SI: (1) between the Play Lü multiplayer and inter-team competition exergame and the Play Lü single-player competition exergame, and (2) between the Play Lü multiplayer and inter-team competition exergame and the Tic-Tac-Toe multiplayer and inter-team

competition game. Follow-up univariate tests were then conducted based on the statistical significance of the MANOVAs tests. Version 26.0 of SPSS (SPSS Inc, Chicago, IL) was used for all statistical analyses.

Results

Preliminary Analyses

The participants reported mean scores of 3.05 ± 1.02 for the positive affect and willingness to reengage factor, 2.73 ± 0.95 for the stored utility value factor, and 3.30 ± 0.93 for the stored attainment value and knowledge-seeking intentions factor. Considering these results, the participants had a medium individual interest in exergames prior to the intervention. Moreover, analysis of the skewness (-.58 to .96) and kurtosis (- 1.04 to 1.57) values revealed that the data were normally distributed. No problem of multicollinearity between variables was found. The internal consistencies of the scales were good with Cronbach's alpha values ranging from .75 to .92.

The Effect of the Play Lü Multiplayer and Inter-team Competition Exergame

The results from the repeated-measures MANOVA revealed a significant main effect in MVPA and SI scores between the two conditions, *Pillai Trace* = .42, $F(4,106) = 22.25$, $p < .01$, $\eta^2 = .42$. Follow-up univariate ANOVAs tests indicated that mean scores for MVPA and maintained-SI value differed significantly between the two conditions. (Table 1) The participants in the Play Lü multiplayer and inter-team competition exergame reported higher scores for MVPA (67.19 vs. 58.27, $p < .01$, $\eta^2 = .39$) and maintained-SI value (3.62 vs. 3.44, $p < .01$, $\eta^2 = .06$), while no differences were revealed for triggering-SI (3.88 vs. 3.92, $p = .60$, $\eta^2 = .00$) and maintained-SI feeling (3.67 vs 3.64, $p = .66$, $\eta^2 = .00$).

Table 1

Differences between the Play Lü multiplayer inter-team competition exergame and the Play Lü single-player competition exergame

	Range	Inter-team competition exergame		Single-player competition exergame		<i>F</i> (1, 109)	η^2
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
MVPA	0-100	67.19	8.92	58.27	10.56	81.26*	.39
Triggering-SI	1-5	3.88	0.74	3.92	0.65	0.27	.00
Maintained-SI feeling	1-5	3.67	0.77	3.64	0.77	0.19	.00
Maintained-SI value	1-5	3.62	0.75	3.44	0.71	7.84*	.06

Note. MVPA: Moderate-to-vigorous physical activity; SI: Situational interest; *F*: test value; * $p < .01$; η^2 : effect size.

Comparison Between Play Lü and Tic-Tac-Toe Games within a Multiplayer and Inter-team Competition Mode

The results from the repeated-measures MANOVA revealed a significant main effect in MVPA and SI scores between the two conditions, *Pillai Trace* = .78, $F(4,106) = 110.58$, $p < .01$, $\eta^2 = .78$. Follow-up univariate ANOVAs tests indicated that mean scores for MVPA, triggering-

SI, maintained-SI feeling, and maintained-SI value differed significantly between the two conditions. (Table 2) The participants in the Play Lü multiplayer and inter-team competition exergame reported higher scores for MVPA (67.19 vs. 48.62, $p < .01$, $\eta^2 = .65$), triggering-SI (3.88 vs. 2.99, $p < .01$, $\eta^2 = .51$), maintained-SI feeling (3.67 vs 2.59, $p < .01$, $\eta^2 = .48$) and maintained-SI value (3.62 vs. 2.18, $p < .01$, $\eta^2 = .70$).

Table 2

Differences between the Play Lü multiplayer inter-team competition exergame and the Tic-Tac-Toe inter-team competition game

	Range	Inter-team competition exergame		Tic-Tac-Toe inter-team competition game		$F(1, 109)$	η^2
		M	SD	M	SD		
MVPA	0-100	67.19	8.92	48.62	13.13	235.99*	.65
Triggering-SI	1-5	3.88	0.74	2.99	0.86	130.80*	.51
Maintained-SI feeling	1-5	3.67	0.77	2.59	1.06	118.53*	.48
Maintained-SI value	1-5	3.62	0.75	2.18	0.81	297.50*	.70

Note. MVPA: Moderate-to-vigorous physical activity; SI: Situational interest; F: test value; * $p < .01$; η^2 : effect size.

Discussion

The present study investigated the impact of a Play Lü inter-team competition exergame on adolescents' MVPA and SI. Two objectives were established for this study: (1) to confirm that a multiplayer and inter-team competition exergame is preferable over a single-player competition exergame in terms of players' MVPA and SI; and (2) to compare a multiplayer and inter-team competition exergame to a multiplayer and inter-team competition game widely used in physical education lessons in the Canton of Vaud. These two objectives structured the discussion of the study.

The Positive Effects of the Play Lü Inter-team Competition Exergame

By demonstrating that a Play Lü multiplayer and inter-team competition exergame is preferable over a Play Lü single-player competition exergame in terms of players' MVPA and SI, this study confirms previous experimental results suggesting that exergames involving inter-team competition may elicit greater psychosocial and physiological benefits than single-player exergames (Moss et al., 2018). More precisely, the Play Lü inter-team competition exergame results in higher scores for adolescents' MVPA and maintained-SI value. Regarding the interest theory, the positive effect on the maintained-SI value factor is well-suited since this is the most important factor for the adolescents' SI to sustain and persist over an extended episode in time. According to previous studies (Linnenbrick-Garcia et al., 2013; Roure & Lentillon-Kaestner, in press), the maintained-SI value factor corresponds to a more involved and deeper form of SI in which adolescents begin to forge a meaningful connection with the content and realize its significance in relation to their personal values.

Considering that the cooperation element within the exergames might increase players' motivation (Marker & Staiano, 2015), it could be hypothesized that the strategic incentive to collaborate with teammates, to win a competition during the Play Lü inter-team competition exergame, has made sense for the adolescents and leads them to consider the Play Lü content as personally important and significant. This result is congruent with previous study demonstrating that social interaction, induced by cooperation, is the most important factor to influence players' interest and involvement during a 20-week exergaming intervention (Staiano et al., 2012).

Accordingly, the effect on students' maintained-SI value extends current knowledge related to SI as previous studies investigating the effects of exergames on players' SI only reported short-term positive effects (Pasco et al., 2017; Roure et al., 2020). Moreover, it has been demonstrated that an increase in adolescents' maintained-SI value was clearly an indicator explaining the transition from SI to individual interest (Roure & Lentillon-Kaestner, in press). This suggests that the inter-team Play Lü competition exergame has the potential to maintain adolescents' SI and to develop their individual interest in exergames. This motivational mechanism is particularly important given that the inter-team Play Lü competition exergame also have a positive effect on adolescents' MVPA. The adolescents were more physically active when the cooperation element was added to the competition element. In that sense, it seems that the cooperation element is a key factor, within the exergames, to increase adolescents' MVPA and SI. This result extends previous conclusions showing that competition increase players' physical activity outcomes during exergames, while cooperation might increase players' motivation (Marker & Staiano, 2015).

In the present study, the only difference between the Play Lü conditions was the addition of the cooperation element in the inter-team Play Lü mode (the competition element was present in both conditions). Therefore, the cooperation element might explain the positive effects observed on adolescents' motivation and physical activity.

Differences Between Play Lü and Tic-Tac-Toe Games

In the present study Play Lü was found to elicit greater effects on MVPA and SI scores compared to the Tic-Tac-Toe game within a multiplayer and inter-team competition mode. This result confirms Gao et al. (2015)'s meta-analysis related to the effects of active video games on health outcomes among adolescents which reported that exergames are more attractive and enjoyable for adolescents in comparison with traditional games. Large effect sizes were reported for the differences between both conditions on the three factors related to adolescents' SI (with coefficients ranging from .48 to .70). With respect to the SI construct, this mean that Play Lü has the potential not only to trigger adolescents' SI but also to maintain the SI over time. The specific characteristics of the Play Lü environment, such as a giant projection on a wall and an interactive playing area adapted for cooperation between players, can grab the adolescents' attention and offer them accessible gameplay in terms of perceived difficulty. In that sense, there is no surprise that Play Lü triggers adolescents' SI since this platform uses specific stimuli to capture the players' attention and favor collaboration. For instance, in the Pila game, the adolescents are attracted by the blocks of different shapes and colours, and are intuitively encouraged to collaborate in order to find a combination of three or more identical blocks (e.g., a student can give an advice to their teammate to throw their ball at the right block).

The underlying mechanisms of the Play Lü games are specifically designed to trigger adolescents' SI, similarly to other exergames (e.g., Roure et al., 2020). Furthermore, this study revealed that the effect of Play Lü was also positive in relation to the maintenance of adolescents' SI. Considering the definitions of the maintained-SI feeling and value factors (Roure, 2020), it might be considered that the aforementioned mechanisms of the Play Lü games can engender

positive affective reactions from the adolescents and the willingness to explore the game as the contents are significant and important for them. In addition to the positive motivational effects, the Play Lü inter-team competition exergame also resulted in higher scores for adolescents' MVPA, compared to the Tic-Tac-Toe game. The difference almost reached 20% of time spent in MVPA, which represented four minutes for the 20-min sessions played by the adolescents. Considering that the Play Lü inter-team competition exergame can be used several times in physical education classes, the advantage in terms of adolescents' MVPA can help to fight the current prevalence and trends of insufficient PA among the population of school-going adolescents aged 11-17 years (Guthold et al., 2021).

Finally, this study extends current methodology in exergame research by using an ecologically valid multiplayer competition game to serve as a control condition, which is motivating and based on the same type of activities compared to the Play Lü (intermittent effort and throwing skills). The Tic-Tac-Toe inter-team competition is a game widely used in physical education lessons in the Canton of Vaud. This choice for the control condition is quite different from the majority of previous studies which compared exergames sessions to traditional games or activities (e.g., McDonough et al., 2018 used a treadmill walking as a control condition). Consequently, this study extends current knowledge by demonstrating that the inter-team Play Lü competition exergame is also preferable than its counterpart as a traditional physical education game (Tic-Tac-Toe).

Conclusions, Limitations and Future Perspectives

This study is the first attempt to provide evidence about the impact of a Play Lü inter-team competition exergame on adolescents' MVPA and SI, thus fostering new knowledge that can be applied to exergame play in physical education context. According to the results of this study, the Play Lü inter-team competition exergame elicits greater psychological and physiological effects compared to a Play Lü single-player competition exergame and an inter-team competition game. However, there are some limitations that must be addressed. First, this study was completed in one geographic location using a sample of adolescents from a secondary school located in Switzerland (Canton of Vaud), thus limiting the generalizability of our findings. Therefore, future researchers should implement Play Lü among a more diverse sample of participants from multiple schools or universities. Second, the results are based on sessions of Play Lü or Tic-Tac-Toe consisting of 20 minutes. Future studies may consider longitudinal design (repeated sessions over time) to analyse the evolution of adolescents' MVPA and SI.

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Author Discloser Statement

All authors report that no competing financial interests exist.

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