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Need Satisfaction Supportive Game Features as Motivational Determinants: An Experimental Study of a Self-Determination Theory Guided Exergame

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Empirical studies have validated that basic needs satisfaction supported by video game play predicts motivation and engagement outcomes. However, few studies specifically manipulated game features for each of the three basic needs specified in the self-determination theory (SDT) to examine how the game features impact players' need satisfaction and game experience. The current study employed an in-house developed exergame and manipulated the game features in a 2 (autonomy-supportive game features: on vs. off) × 2 (competence-supportive game features: on vs. off) experiment to predict need satisfaction, game enjoyment, motivation for future play, effort for gameplay, self-efficacy for exercise using the game, likelihood of game recommendation, and game rating. The manipulated game features led to the corresponding need satisfaction. Manipulated autonomy-supportive and competence-

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supportive game features had main effects on most motivation and engagement outcomes. Need satisfaction of autonomy and need satisfaction of competence were both found to be mediators for the relationships between the game features and the motivation and engagement outcomes. The findings add evidence to support the underlying mechanism postulated by SDT for media enjoyment and motivation as well as the emerging entertainment research conceptualizing enjoyment as need satisfaction. The findings also have practical implications for intervention effort that intends to capitalize the motivational pull of video games.

Enjoyment of video games has recently been studied from the lens of self-determination theory (Ryan, Rigby, & Przybylski, 2006; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). Empirical studies have validated that basic needs satisfaction supported by video game play predicts enjoyment, motivation, and engagement outcomes. However, few studies specifically manipulated game features for each of the three basic needs specified in the self-determination theory (SDT) to examine how the game features impact players' need satisfaction and game experience. Instead, either some game feature that may impact multiple needs was manipulated (Tamborini et al., 2010) or the manipulation for some need satisfaction was outside the game and not based on an innate game feature (Sheldon & Filak, 2008).

Therefore, the purpose of the current study is to examine how two groups of game features prescribed by SDT (Ryan & Deci, 2000c) impact the corresponding need satisfaction, enjoyment, motivation, and engagement. Specifically, an exergame was developed in-house based on two constructs in SDT (Peng, Winn, Pfeiffer, Crouse, & Lin, 2010): autonomy and competence. An exergame (also termed as active video game) is a video game that incorporates physical activity into gameplay by requiring players' body movements to interact with the game system and, thus, combine entertainment with exercise (Biddiss & Irwin, 2010; Peng, Lin, & Crouse, 2011). A set of game features corresponding to the above two constructs were manipulated in a 2 (autonomy-supportive game features: on vs. off) × 2 (competence-supportive game features: on vs. off) experiment. We investigated how theory-informed design choices of game features contribute to psychological need satisfaction, which leads to desired outcomes, such as enjoyment, self-efficacy for exercise using the game, and motivation for future play. We begin with an overview of SDT and recent effort in the entertainment research to define enjoyment as need satisfaction from the perspective of SDT. Following this, we explicate the three core constructs in SDT. Finally, we present an experimental study that tests how need satisfaction-supportive game features influence players' enjoyment, motivation, and engagement.

LITERATURE REVIEW

Self-Determination Theory

SDT is a theory of human motivation. According to SDT, the reasons why individuals choose to participate, exert effort, and persist in an activity can be categorized along a continuum of self-determined regulation. The most self-determined form of behavioral regulation is intrinsic motivation, which is defined as engaging in an activity for the pleasure and satisfaction derived from the activity itself. On the opposite end of the continuum is amotivation, that is, lack of motivation or intention. Situated between is extrinsic motivation, which refers to behaviors that are carried out to attain outcomes unrelated to the activity itself (Deci & Ryan, 1985; Ryan & Deci, 2000b).

A mini theory within SDT, Cognitive Evaluation Theory (CET), further elaborates that humans have three fundamental needs: autonomy, competence, and relatedness. Satisfaction of the above three needs is essential for an individual's intrinsic motivation (Ryan & Deci, 2000a). People experience more self-determined (or internally controlled) types of motivation when the activities in which they participate make them feel that they have autonomy (the power to make their own choices), competence (the ability to effectively perform the behavior), and relatedness (authentic social connections with others). Another mini theory within SDT, Basic Psychological Needs Theory (BPNT), proposes that satisfaction of autonomy, competence, and relatedness needs results in better mood, vitality, physical symptoms, and self-esteem (Adie, Duda, & Ntoumanis, 2008; Ryan & Deci, 2000c). On the contrary, activities or contexts that thwart these needs would negatively impact wellness.

Enjoyment as Satisfaction of Intrinsic Need

Enjoyment is a central concept in the realm of media psychology and entertainment research. Essentially, media enjoyment refers to the preference for and positive response to media exposure. Media scholars have defined enjoyment as an emotion (Vorderer, Klimmt, & Ritterfeld, 2004), an attitude (Nabi & Krcmar, 2004), or a combination of cognition and affect (Raney & Bryant, 2002). More recently, especially in the domain of video game playing, enjoyment has been defined as the satisfaction of intrinsic need (Ryan et al., 2006; Tamborini et al., 2010) based on SDT (Ryan & Deci, 2000c).

Antecedents of media enjoyment include three major parts (Vorderer et al., 2004). The first part includes user prerequisites such as individual differences in terms of willingness to suspend disbelief, interest, empathy, tendency to develop parasocial relationships and feeling presence, etc. The

second part is user motive. In other words, why do users choose to consume the media? The third part refers to media characteristics such as the technological, design, aesthetical, and content of the media. The third part is the most relevant in the current study that examines how different types of game features contribute to enjoyment of exergame play.

Being entertained and enjoying media may lead to significant positive outcomes (Vorderer et al., 2004). From the perspective of SDT, enjoyment is the indicator of satisfaction of three intrinsic needs, which have been linked to psychological well-being (Ryan et al., 2006).

Autonomy

Autonomy concerns an individual's "sense of volition or willingness when doing a task" (Ryan et al., 2006, p. 349). Perceived autonomy is high when there are choices provided to individuals or when individuals engage in activities for personal interest and value. On the contrary, when choices are diminished, or when control or freedom for the methods of action interferes with perceived autonomy, intrinsic motivation can be thwarted (Deci, Koestner, & Ryan, 1999). Simply put, when one has the freedom to pursue an optimal outcome or engage in an activity without any external control, one's sense of autonomy is high and thus increases intrinsic motivation. Daily need satisfaction of autonomy leads to increased wellbeing in domains such as education (Vallerand, Fortier, & Guay, 1997), organizations (Deci et al., 2001), and behavioral health (Turner, Irwin, Tschann, & Millstein, 1993).

Numerous studies have shown the effect of autonomy-supportive conditions in the context of sports and physical activities. Research showed that perceived autonomy support from coaches or exercise class leaders predicted greater intention and motivation to exercise among pupils, university students, young gymnasts, and real-world fitness center users (Chatzisarantis, Hagger, & Smith, 2007; Edmunds, Ntoumanis, & Duda, 2006; Gagne, Ryan, & Bargmann, 2003). The more autonomy-supportive and involved coaches and parents were perceived, the more autonomously motivated these participants were. Such relationships have been validated in populations of different cultural backgrounds, including British, Greek, and Singaporean samples (Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, 2005). Similarly, participants who were given instructions and choices with autonomous communication style displayed greater motivation to play golf compared to those in controlled conditions (Spray, Wang, Biddle, & Chatzisarantis, 2006). In addition to their effects on motivation, autonomy-supportive conditions also have been found to predict adherence to exercise in children (Chatzisarantis, Biddle, & Meek, 1997), influence young gymnasts' attendance at practice (Gagne et al., 2003), increase engagements of moderate-intensity exercise bouts and routines recommended by public health organization (Standage,

Sebire, & Loney, 2008), and predict wellbeing (Gagne et al., 2003; Reinboth & Duda, 2006).

In the context of video game playing, autonomy refers to how much choice players are given within the game domain (Ryan et al., 2006). Ryan et al. (2006) argued that video game play outside of the experimental setting is almost always voluntary, thus, need satisfaction of autonomy among video game players should be high. Need satisfaction of autonomy can also vary depending on autonomy-supportive features afforded in the video game design, such as game features that provide flexibility over game strategies and character development, movement, choice over tasks and rewards (Ryan et al., 2006). Ryan et al. (2006) found that players who experienced higher level of autonomy within the game itself had more positive experiences than those who played games that did not offer a great degree of autonomy within the game. Two recent studies showed that need satisfaction of autonomy in video games resulted in positive outcomes such as increased enjoyment (Przybylski, Rigby, & Ryan, 2010; Tamborini et al., 2010) and desire for future gameplay (Przybylski, Ryan, & Rigby, 2009).

The exergame is a type of video game that requires body movements similar to exercise. We suggest that in exergaming, similar to what has been found in the domain of sports and exercise as well as nonactive video gaming, autonomy-supportive game features would satisfy players' need of autonomy, which further leads to increased enjoyment (Przbylski et al., 2009; Ryan et al., 2006; Tamborini et al., 2010), motivation for future play (Ryan et al., 2006; Przybylski et al., 2009), and recommendation intention (Przbylski et al., 2009). In addition, related to recommending the game to others, we suggest that need satisfaction of autonomy would lead to more positive ratings of the game. Furthermore, we posit that effort put into the activity would be especially important as an indicator of intrinsic motivation, particularly given the nature of the exergaming environment. In sum, we propose that game features such as offering freedom of character customization and choices in autonomous communication style as well as choices in rewards could satisfy the need of autonomy in exergaming, which mediates the relationship between autonomy-supportive features and the outcome variables.

H1: Autonomy-supportive game features will increase players' a) need satisfaction of autonomy, b) enjoyment, c) effort for gameplay, d) motivation for future play, e) game recommendation to others, and f) rating of the game.

H2: Need satisfaction of autonomy will mediate the effect of autonomy-supportive game features on players' a) enjoyment, b) effort for gameplay, c) motivation for future play, d) game recommendation to others, and e) rating of the game.

Competence

Competence reflects the need that people have to be able to effectively produce their wanted outcomes and avoid undesired events. It is a "need for challenge and feelings of effectance" (Ryan et al., 2006, p. 349). Need satisfaction of competence has been found to have positive association with adherence to an exercise program and enjoyment (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997), subjective vitality (Wilson, Longley, Muon, Rodgers, & Murray, 2006), and strenuous exercise (Edmunds et al., 2006). In addition, elevated need satisfaction of competence was correlated with experiencing more positive than negative emotions during a typical exercise session (Wilson et al., 2006). Research also showed that need satisfaction of competence was positively associated with more self-determined exercise regulations, which was also positively correlated with exercise behavior, attitudes, and physical fitness (Wilson, Rodgers, Blanchard, & Gessell, 2003).

Competence in the video game context involves a need for challenges and feelings of effectiveness at meeting those challenges set by the video game (Ryan et al., 2006). Need satisfaction of competence may be accomplished in games by allowing players to easily learn new skills, by providing challenges with increased difficulty as the game progresses, and by providing natural and effective control of the hardware and software. Need satisfaction of competence was one of the most important predictors of a satisfying game experience as indicated by enjoyment (Przbylski et al., 2009; Ryan et al., 2006; Tamborini et al., 2010), motivation for future play (Przbylski et al., 2009; Ryan et al., 2006), and recommendation intention (Przbylski et al., 2009).

In exergaming, one of the distinctive features is to implement different types of controls to increase players' intuitive mapping between their body movements and character movements. In addition, a feature like dynamic adjustment of difficulty of the challenges in the game can increase players' perceived competence and efficacy. This can be further enhanced by showing the players their achievements. Based on the research in the domain of sports and exercise (Gagné et al., 2003; Hagger & Chatzisarantis, 2008) as well as video gaming (Przybylski et al., 2010; Ryan et al., 2006; Tamborini et al., 2010), in the same vein as our rationale for the hypotheses with regard to the autonomy-supportive game features, we propose that competence-supportive game features will have similar effects on enjoyment, effort for gameplay, motivation for future play, game recommendation intention, and game rating. Additionally, given the special case of the exergame—gameplay that involves physical body movements—we posit that the competence-supportive game features can not only increase players' competence and efficacy of playing the game but also their efficacy of using this game for exercise. Therefore, the following hypotheses are proposed.

H3: Competence-supportive game features will increase players' a) need satisfaction of competence, b) enjoyment, c) effort for gameplay, d) motivation for future play, e) game recommendation to others, f) rating of the game, and g) self-efficacy for exercise using the game.

H4: Need satisfaction of competence will mediate the effect of competence-supportive game features on players' a) enjoyment, b) effort for gameplay, c) motivation for future play, d) game recommendation to others, e) rating of the game, and f) self-efficacy for exercise using the game.

Relatedness

A third psychological need within SDT is relatedness, which enhances well-being and intrinsic motivation when this need is satisfied. Specifically, relatedness focuses on the need of being connected to others and the feeling of being involved in a social environment (Ryan & Deci, 2000a; Ryan et al., 2006). For example, in sports, players build strong relationships with their teammates, which bolsters their desire to perform well. Within the video game arena, a lab experiment found that playing video games with another player rather than playing alone contributed to need satisfaction of relatedness, which led to enjoyment of gameplay (Tamborini et al., 2010). A survey of massive multiplayer online game players also showed that need satisfaction of relatedness was positively associated with players' game enjoyment and motivation for future play (Ryan et al., 2006). Based on the previous literature, for an exergame, features that enable players to compete or collaborate with other players either face-to-face or over the Internet seem to be the most relevant ones to support the need satisfaction of relatedness. However, due to the lack of resources, this study was not able to manipulate game features for relatedness adequately. Therefore, this study focused only on two of the three core constructs in SDT: autonomy and competence.

METHOD

Participants

Participants were recruited in two ways. First, a random sample of 5,000 domestic undergraduate students was obtained through the registrar's office at a large Midwestern university in the United States. Second, recruitment was conducted in large introductory communication courses at the same university. An email invitation containing a URL to an online screening questionnaire was sent to the sample followed by two additional email reminders. In total, 893 students filled out the screening questionnaire.

As the game used in the experiment was designed to increase physical activity for insufficiently active young adults who play video games,

we only invited individuals from the target audience to participate. The screening criteria are listed as follows: First, we calculated the total time participants engaged in moderate and vigorous physical activities in the past seven days. Time spent in vigorous physical activity was multiplied by two to convert it to time spent in moderate physical activity. Those who engaged in no more than 225 minutes of moderate activity in total, after incorporating the conversion of vigorous activity time, were eligible for participation in this experiment. Second, only individuals who play video games at least one hour a month were eligible. Last, individuals with current or past physical conditions that may prohibit them from engaging in physical activities (i.e., asthma, fainting, dizzy spell, heart condition, etc.) were excluded.

In total, 372 participants were eligible and 160 (111 male and 49 female) participated in the experiment (40 in each condition). On average, participants were 21 years old and played video games 21–40 hours per month. Out of the 160 participants, 32 (20%) were freshman, 39 (24.4%) sophomore, 46 (28.8%) junior, and 43 (26.9%) senior. One hundred twenty-five (78.1%) were White, 14 (8.8%) African American, 13 (8.1%) Asian, 1 (0.6%) Native Hawaiian or other Pacific Islander, and 7 (4.4%) did not disclose race and ethnicity information. Four participants identified themselves as Hispanic, Latino, or Spanish origin. Sixty percent of these participants' fathers and 57% of their mothers had graduated from college or received higher degrees.

Stimuli

We tested two constructs in SDT—autonomy and competence—in an in-house designed game entitled *Olympus*. The game was developed and tested by the development team for one and a half years, including alpha and beta playtesting by undergraduate students from the target audience. Several focus groups and interviews were conducted to collect feedback from these test players for game improvement (Peng et al., 2010; Winn, Peng, & Pfeiffer, 2011a, 2011b).

What distinguishes this game from other off-the-shelf exergames, such as *Dance Dance Revolution* and *Wii* games, is its narrative-driven gameplay and incorporation of both a dancepad and Wiimote. In this single-player fantasy role-playing game set in ancient Greece, players will rise through the citizenry by training in athletic events, honing their skills before they are sent to a mission to save their sister in the game by killing the Minotaur. When moving the characters, players need to literally walk or run on the dancepad in place. Players' walking and running speed correspond to their characters'. Players also need to physically jump to make the character jump, or use both their hands (moving the Wiimotes up and down) and feet (moving on the dancepad) to climb, shake spiders or other attacking creatures off their bodies by shaking the Wiimotes, and stomp the dance pad to kill them.

Autonomy-supportive game features

According to Przybylski, Rigby, and Ryan (2010), game features such as the mission choices offered to players, the skills the players require, and how their characters appear are all important choices in the game to motivate players to continue playing the video game. Three game features were manipulated to correspond to the concept of autonomy. First, character customization allowed players to personalize their characters in the game. In the autonomy-supportive features on condition, players were offered options to choose the character's gender and change the character's appearance such as skin tone, hair color, eye color, etc. In the autonomy-supportive features off condition, the players were just provided with a default character matching their biological sex and did not have the option to customize the appearance of the characters. Second, in the autonomy-supportive features on condition, players could choose how to donate treasure to different Gods at the altar in exchange for different types of rewards, including increase of strength, speed, or damage power for character development. Each time the players made a choice in which area they want to develop their characters, the internal game system would track the statistics and this would influence how much damage the their game characters could endure from the opponents (strength), how fast their game characters could navigate (speed), and how much damage their game characters could cast on their opponents (damage power). What skills the players chose to improve would be critical, as this provided skill boost to their future game play and future character performance would largely depends on this. In the autonomy-supportive features off condition, players did not have the choice over donations for character growth. When they found a treasure and picked it up, the game just automatically donated the treasure to increase speed, strength, and damage power in a sequential way. Third, players could also choose from a range of different answers when conversing with other non-player characters in the game if they were in the autonomy-supportive game features on condition. Otherwise, there was only one option in the dialog and thus giving no choice for the player.

Competence-supportive game features

Based on SDT and current literature, three features were designed in this game to support the need satisfaction of competence. First, in the competence-supportive features on condition, a dynamic difficulty mechanism would adjust along with players' performance in the game. For example, after a player successfully completed a challenge, he or she would be given a more difficult challenge. Conversely, if a player was struggling, then the subsequent challenges would be easier. In competence-supportive features off condition, there would be no dynamic difficulty mechanism. Therefore,

the difficulty level would remain the same, regardless of the players' performance. Second, a heroism meter was shown on the screen to reflect how well a player handled the game and its challenges. Players would receive heroism points when performing well in the game. Conversely, players in the competence-supportive features off condition would not be able to see the heroism meter. Third, the game also created various types of achievement badges for players. Players could earn and browse their achievements in the achievement menu of the game. Players in the competence-supportive features off condition were not able to earn achievements throughout the game.

Procedure

Qualified participants were invited to schedule their visit to the lab. Based on the screening questionnaire, we stratified the sample by gender and randomly assigned participants into one of the four conditions. Upon arrival to the lab, participants were introduced to the procedure of the experiment, and signed the consent form. The participants took time playing the game tutorial which included practice of all types of movements. They were then randomly assigned to one of the four conditions in this study: a 2 (autonomy-supportive game features on vs. off) × 2 (competence-supportive game features on vs. off) between subjects design. The actual game play lasted for 15 minutes for each player, followed by an online post-test questionnaire. A $10 online giftcard code was sent within two weeks as honorarium to each participant.

Measures

Dependent variables

Game enjoyment was measured by adding one item to the 6-item Enjoyment Scale developed by Song, Peng, and Lee (2011) in an exergame study. Participants rated the game using a 7-point scale anchored by 1 (*describes the game poorly*) and 7 (*describes the game very well*) on the following adjectives: boring (reverse-coded), exciting, enjoyable, entertaining, fun, interesting, and pleasant ($\alpha = .94$).

Effort for gameplay was measured using the subscale of effort in the Intrinsic Motivation Inventory (McAuley, Duncan, & Tammen, 1987). Participants rated their perceived effort for the game using a 7-point scale anchored by 1 (*not at all true*), 4 (*somewhat true*), and 7 (*very true*) on five items. Sample items include "I put a lot of effort into this game" and "I tried very hard on this game" ($\alpha = .85$).

Motivation for future play included three items that were revised based on Ryan et al. (2006), including "Given the chance I would play this game in

my free time," "I would like to spend more time playing this game," and "I would like to continue playing this game." Participants rated the above three items on a 7-point scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*; $\alpha = .96$).

To measure self-efficacy for exercise using the game, the participants were asked to first imagine that they own a copy of the game. Then they were asked to indicate their willingness to exercise using the game (two or more times a week) in seven situations (e.g., "when I am feeling tired" and "during bad weather") using a 7-point scale anchored by 1 (*will not do*) and 7 (*certainly will do*; $\alpha = .87$). The 7-item scale was a revised version of the General Exercise Self-Efficacy Scale (Shin, Jang, & Pender, 2001) and was used in Song et al. (2011).

Another dependent variable assessed the likelihood that the participant would recommend the game to others (termed as game recommendation). Participants used a 7-point scale anchored by 1 (*extremely unlikely*) and 7 (*extremely likely*) to rate how likely it was that they would recommend this game to others. Finally, game rating was measured using a statement, "How would you rate this game?" Participants rated a 7-point scale anchored by 1 (*highly unsatisfactory*) and 7 (*highly satisfactory*).

Mediators

Two mediators were proposed in this study: need satisfaction of autonomy and need satisfaction of competence. Need satisfaction of autonomy contained two items from the Autonomy subscale in the Player Experience of Need Satisfaction (PENS; Ryan et al., 2006)—"This game provided me with interesting options," "I experience a lot of freedom in the game"—and four items created for this study by adapting the Basic Need Satisfaction At Work scale (Deci et al., 2001)—"I had a lot of choices in this game," "I felt like I was free to decide for myself how to proceed in this game," "I had many opportunities to choose how to grow my character," "I was able to play the game the way I wanted to play it." Cronbach's alpha was .90. Participants rated these statements on a 7-point scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*).

Need satisfaction of competence was measured using one item from the Competence Subscale in PENS (Ryan et al., 2006, "I felt competent at this game," and four modified items adapting the Basic Need Satisfaction At Work scale (e.g., "I felt a great sense of accomplishment playing this game," "I felt able to meet the challenge of performing well in this game," "I did not feel very capable when playing this game [reverse-code]," and "I felt that I was effective interacting in this game"). Cronbach's alpha was .85. Participants rated these statements on a 7-point scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*).

TABLE 1 *t* Test Results for Manipulation Check

Autonomy-supportive features	On ($n = 76^a$)	Off ($n = 78^a$)	$t(1, 75)$
Amount of customization	3.89 (1.97)	0.00 (.00)	17.23***
Frequency of player initiated donations	3.18 (1.43)	0.00 (.00)	19.41***
Frequency of player encountering dialogue choices	7.99 (1.10)	0.00 (.00)	63.22***
Competence-supportive features	**On ($n = 78^a$)**	**Off ($n = 76^a$)**	$t(1, 77)$
Total difficulty increases	0.09 (.33)	0.00 (.00)	2.40*
Total difficulty decreases	0.94 (.41)	0.00 (.00)	20.38***
Heroism gained	64.74 (22.38)	0.00 (.00)	25.56***
Achievements earned	6.49 (1.42)	0.00 (.00)	40.32***

*$p < .05$, ***$p < .001$.
[a]Several cases had missing data due to the technical error of logging the game play.

Manipulation check

Numeric data extracted from the game log file provided the objective indicators whether our manipulation of the need satisfaction-supportive game features were successful. For autonomy-supportive game features, indicators included the amount of customization, frequency of player initiated donations of the treasures to gods, and frequency of player encountering dialogue choices. Indicators for competence-supportive game features included the total difficulty increases, total difficulty decreases, heroism gained, and achievements earned in the game.

RESULTS

Manipulation Check

Two sets of independent sample *t* tests were conducted to check the manipulation of the two independent variables—games features that support the two types of need satisfaction (Table 1). The results indicated that the manipulation was successful for both independent variables.

Main Effects of Game Features

A two-way analysis of covariance (ANCOVA) was conducted using autonomy-supportive game features (on vs. off) and competence-supportive game features (on vs. off) as the independent variables, controlling for gender and monthly gaming hours. Autonomy-supportive game features had significant main effects such that participants in conditions with autonomy-supportive features had greater need satisfaction of autonomy, enjoyment,

TABLE 2 ANCOVA Results Showing the Main Effects of Autonomy-Supportive Game Features

Dependent variables	Autonomy-supportive features: On (n = 80) M (SD)	Autonomy-supportive features: Off (n = 80) M (SD)	$F(1, 154)$	η^2
Need satisfaction of autonomy	3.64 (1.30)	3.20 (1.19)	4.3*	0.03
Game enjoyment	4.76 (1.11)	4.38 (1.32)	6.36*	0.04
Effort for gameplay	4.84 (1.10)	4.99 (1.16)	0.41	0.003
Motivation for future play	4.05 (1.73)	3.56 (1.80)	5.53*	0.04
Game recommendation	4.20 (1.59)	3.70 (1.65)	5.56*	0.04
Game rating	4.38 (1.21)	3.83 (1.26)	7.29**	0.05

*$p < .05$, **$p < .01$.

motivation for future play, game recommendation, and game rating than those in conditions without autonomy-supportive features (Table 2). The main effect of autonomy-supportive features on effort for gameplay was not statistically significant. Similarly, competence-supportive game features had significant main effects on all dependent variables except for effort for gameplay (Table 3). No interaction effects were found.

Mediation Analyses

Multiple tests were conducted to examine whether the proposed mediators had significant indirect effects on the hypothesized relationships after controlling monthly gaming hours and gender. Indirect effect was tested using the bootstrapping method (Hayes, 2009; MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008; Williams & MacKinnon, 2008). Bootstrapping method has been recommended for testing indirect effects

TABLE 3 ANCOVA Results Showing the Main Effects of Competence-Supportive Game Features

Dependent variables	Competence-supportive features: On (n = 80) M (SD)	Competence-supportive features: Off (n = 80) M (SD)	$F(1, 154)$	η^2
Need satisfaction of competence	4.79 (1.15)	4.42 (1.15)	4.17*	0.03
Game enjoyment	4.90 (1.00)	4.24 (1.37)	12.10**	0.07
Effort for gameplay	5.04 (1.22)	4.79 (1.04)	1.82	0.01
Motivation for future play	4.10 (1.67)	3.51 (1.84)	4.33*	0.03
Game recommendation	4.28 (1.50)	3.63 (1.70)	6.46**	0.04
Game rating	4.45 (1.08)	3.75 (1.34)	13.92***	0.08
Self-efficacy for exercise using the game	3.92 (1.28)	3.27 (1.29)	10.31**	0.06

*$p < .05$, **$p < .01$, ***$p < .001$.

on small to moderate samples (MacKinnon, Lockwod, Hoffman, West, & Sheets, 2002; MacKinnon et al., 2004; Preacher & Hayes, 2004) over the traditional Baron and Kenny (1986) method as the Baron and Kenny (1986) method suffers from low statistical power in most situations (MacKinnon et al., 2002). In addition, the bootstrapping test includes a significance test of the indirect effect.

An SPSS macro developed by Preacher and Hayes (2008) was used and the bootstrapping resample was set to 1,000. Results of the mediation analysis testing need satisfaction of autonomy as a mediator are presented in Table 4 and results of the mediation analysis testing need satisfaction of competence as a mediator are presented in Table 5. In these tables, we included the effect of the independent variable on the mediator, the effect of the mediator on the dependent variable, the effect of the independent variable on the dependent variable (total effect), the partial effect of the independent variable on the dependent variable, with the mediator in the model (direct effect), and the difference between the total effect and the direct effect, which was the partial effect from the independent variable to the dependent variable through the mediator (indirect effect).

Two criteria were used to determine whether the mediation exists. First, the total effect should be statistically significant, and the direct effect should become statistically non-significant (full mediation) or remain significant but reduce in absolute size (partial mediation). Second, the indirect effect should be statistically significant in the direction predicted by the mediation hypothesis. For example, in the first analysis in Table 4, the total and direct effects (standardized coefficients) of autonomy-supportive game features on enjoyment were .20 (SE = .08), $p < .01$, and .10 (SE = .07), $p = .13$, respectively. The difference between the total and direct effect was the indirect effect through need satisfaction of autonomy, with a point estimate of .09 (SE = .04) and a 95% biased corrected bootstrap confidence interval of .10 and .20. These results indicated that the total effect of autonomy-supportive game features on enjoyment was significant. The direct effect became nonsignificant after including the mediator into the model. In addition, the indirect effect was significant, as the 95% biased corrected bootstrap confidence interval did not contain zero, which rejected the null hypothesis. The directions of the independent variable-mediator and mediator-dependent variable paths showed that autonomy-supportive game features led to greater perceived autonomy, which, in turn, led to greater enjoyment.

In summary, need satisfaction of autonomy fully mediated the effect of autonomy-supportive game features on game enjoyment, motivation for future play, game recommendation, and game rating. These indicated that autonomy-supportive features present in the game led to greater autonomy need satisfaction, which, in turn, led to greater enjoyment, motivation for future play, game recommendation, and game rating. Need satisfaction of

TABLE 4 Test of Indirect Effect of Autonomy-Supportive Game Features (IV) on Dependent Variables (DVS) Through Need Satisfaction of Autonomy (M)

DV (Game enjoyment)	*b**	*SE*	*p* value
IV to M	0.17	0.08	0.04
M to DV	0.55	0.07	0.00
Total effect of IV on DV	0.20	0.08	0.01
Direct effect of IV on DV	0.10	0.07	0.13
Indirect effects of IV on DV through M	0.09	0.04	
Biased corrected 95% CI: .01 − .20			
DV (Effort for gameplay)	*b**	*SE*	*p* value
IV to M	0.17	0.08	0.04
M to DV	0.18	0.08	0.02
Total effect of IV on DV	−0.05	0.08	0.54
Direct effect of IV on DV	−0.08	0.08	0.32
Indirect effects of IV on DV through M	0.03	0.02	
Biased corrected 95% CI: .005 − .09			
DV (Motivation for future play)	*b**	*SE*	*p* value
IV to M	0.17	0.08	0.04
M to DV	0.42	0.07	0.00
Total effect of IV on DV	0.19	0.08	0.02
Direct effect of IV on DV	0.11	0.07	0.12
Indirect effects of IV on DV through M	0.07	0.04	
Biased corrected 95% CI: .006 − .16			
DV (Game recommendation)	*b**	*SE*	*p* value
IV to M	0.17	0.08	0.04
M to DV	0.53	0.07	0.00
Total effect of IV on DV	0.19	0.08	0.02
Direct effect of IV on DV	0.10	0.07	0.16
Indirect effects of IV on DV through M	0.09	0.04	
Biased corrected 95% CI: .004 − .18			
DV (Game rating)	*b**	*SE*	*p* value
IV to M	0.17	0.08	0.04
M to DV	0.51	0.07	0.00
Total effect of IV on DV	0.21	0.08	0.01
Direct effect of IV on DV	0.12	0.07	0.08
Indirect effects of IV on DV through M	0.09	0.04	
Biased corrected 95% CI: .006 − .17			

Note. *b** = standardized regression coefficient, IV = autonomy-supportive game features, M = need satisfaction of autonomy, *SE* = standard error, CI = confidence interval.

competence fully mediated the effect of competence-supportive game features on motivation for future play and game recommendation. Competence need satisfaction also partially mediated the effect of competence-supportive game features on enjoyment, self-efficacy for exercise using the game, and game rating.

TABLE 5 Test of Indirect Effect of Competence-Supportive Game Features (iv) on Dependent Variables (Dvs) Through Need Satisfaction of Competence (M)

DV (Game enjoyment)	*b**	*SE*	*p* value
IV to M	0.15	0.07	0.04
M to DV	0.57	0.07	0.00
Total effect of IV on DV	0.26	0.08	0.001
Direct effect of IV on DV	0.18	0.07	0.007
Indirect effects of IV on DV through M	0.09	0.05	
Biased corrected 95% CI: .005 − .18			
DV (Effort for gameplay)	***b****	***SE***	***p* value**
IV to M	0.15	0.07	0.04
M to DV	0.25	0.08	0.002
Total effect of IV on DV	0.11	0.08	0.18
Direct effect of IV on DV	0.07	0.08	0.39
Indirect effects of IV on DV through M	0.05	0.03	
Biased corrected 95% CI: .004 − .09			
DV (Motivation for future play)	***b****	***SE***	***p* value**
IV to M	0.15	0.07	0.04
M to DV	0.43	0.08	0.00
Total effect of IV on DV	0.16	0.08	0.04
Direct effect of IV on DV	0.09	0.07	0.19
Indirect effects of IV on DV through M	0.07	0.03	
Biased corrected 95% CI: .005 − .15			
DV (Game recommendation)	***b****	***SE***	***p* value**
IV to M	0.15	0.07	0.04
M to DV	0.48	0.07	0.00
Total effect of IV on DV	0.20	0.08	0.01
Direct effect of IV on DV	0.12	0.07	0.08
Indirect effects of IV on DV through M	0.07	0.04	
Biased corrected 95% CI: .004 − .16			
DV (Game rating)	***b****	***SE***	***p* value**
IV to M	0.15	0.07	0.04
Direct effects of M on game rating	0.40	0.08	0.00
Total effect of IV on game rating	0.28	0.08	0.00
Direct effect of IV on game rating	0.22	0.07	0.002
Indirect effects of IV on game rating through M	0.06	0.04	
Biased corrected 95% CI: .002 − .14			
DV (Self-efficacy for exercise using the game)	***b****	***SE***	***p* value**
IV to M	0.15	0.07	0.04
M to DV	0.46	0.07	0.00
Total effect of IV on DV	0.25	0.08	0.00
Direct effect of IV on DV	0.18	0.07	0.01
Indirect effects of IV on DV through M	0.07	0.04	
Biased corrected 95% CI: .009 − .16			

Note. *b** = standardized regression coefficient, IV = competence-supportive game features, M = need satisfaction of competence, *SE* = standard error, CI = confidence interval.

DISCUSSION

How game features influence basic need satisfaction is not well studied. The present study adds empirical evidence to current research by experimentally manipulating several game features and examining how these game features influence basic need satisfaction. The results confirmed that several choices available in the game supported players' need satisfaction of autonomy: choice of avatar customization, choice of how to grow strength of avatars, and selection of how to respond to non-player characters and advance the game narrative by making choices in the dialogue branching. Additionally, the game's ability to dynamically adjusted difficulty levels based on players' performance and indicators for the players to see their achievements (e.g., heroism meter, achievement badges) better satisfied players' need of competence than games without those features.

The present study also provided additional empirical evidence that the need satisfaction-supportive features in a video game have positive effects on motivation and engagement-related outcomes as asserted in previous seminal literature (Przybylski et al., 2010; Ryan et al., 2006). Specifically, those autonomy-supportive game features led to greater game enjoyment, greater motivation for future play, greater likelihood of game recommendation, and greater game rating. Similarly, those competence-supportive game features led to greater game enjoyment, greater motivation for future play, greater self-efficacy for exercise using the game, greater likelihood of game recommendation, and greater game rating. However, we did not find any effect of the need satisfaction-supportive game features on players' self reported effort exerted in gameplay.

The third contribution of the current study is to add to the limited literature regarding the mechanisms that underlie the effects of video game playing. Although some studies validated that need satisfaction of autonomy and competence predict positive outcomes such as game enjoyment, motivation for future play, and game recommendation (Przybylski et al., 2009; Ryan et al., 2006), few studies directly tested basic needs satisfaction as the mediators for the relationships between the games features and the positive outcomes. By experimentally manipulating need satisfaction-supportive game features in the present study, we found important empirical evidence that adds to the limited existing research of the underlying mechanism (Sheldon & Filak, 2008; Tamborini et al., 2010). The findings explain how the game features impact the player's engagement and motivation of game use—through need satisfaction of autonomy and need satisfaction of competence.

In sum, results from this study have some implications for basic research in the domains of media enjoyment and motivation. Vorderer et al. (2004) posit that media characteristics are important antecedents of media enjoyment. The current study provided empirical evidence to support the

proposition and validated two groups of game features that contribute to enjoyment. More importantly, the mediation models shown in this study demonstrated the underlying processes explaining the effects of such game features on media enjoyment and other motivation outcomes, through need satisfaction. These results, overall, provided empirical evidence for the basic hypotheses outlined by Ryan et al. (2006) regarding various game features corresponding to the needs satisfaction of autonomy and competence. Finally, the study adds additional evidence to support the model proposed by Tamborini et al. (2010) explaining the role of enjoyment in media psychology from the SDT perspective.

Another important contribution of the present study is the practical implications for game design and game-based health and education interventions. Although all of the autonomy-supportive and competence-supportive features we manipulated have been adopted in many successful video games by designers and developers intuitively, our findings suggest that well-established theories can prescribe a systematic guideline for design choices, which goes beyond the intuitive seat-of-the-pants reasoning. This is especially important for researchers who plan to harness the motivating power of video games for health and education interventions. In fact, the exergame used in the experiment was designed to increase motivation to engage in physical activity as well as actual physical activity. Since playing the exergame itself is a form of physical activity, we count on the gameplay to be enjoyable and motivating so that the players will continue playing the exergame and at the same time engaging in physical activity. Our findings demonstrate that theory-prescribed game features contribute to enjoyment, motivation and engagement through need satisfaction. Although the game used in the study was an exergame, the results suggest that future intervention effort that intends to capitalize on the motivational pull of video games should purposely include game features that have the potential to increase need satisfaction.

The main limitation of the present study is that although we manipulated game features for need satisfaction of autonomy and competence respectively, a group of game features rather than one game feature was manipulated for each of the need satisfaction constructs. We are not able to identify specifically the contribution of each game feature to need satisfaction. As many of the features are not specific for a particular game, but common mechanics that have been widely used in various types of games, future empirical studies can focus on specific game features to provide evidence for future game designers and researchers of game-based interventions. The second limitation is that the sample in this study focused on insufficiently active young adults who play video games—the target player of the exergame used. Therefore, the results may not be generalizable to other populations. Future studies should replicate the study in different populations to have more robust results. The third limitation is that the current study did not

include another important construct in SDT—relatedness—due to limitation of resources. If we were to manipulate game features for relatedness, we could test the multiplayer feature because it provides an arena for players to connect to other players socially. Future research could manipulate this feature and compare the effects of multiplayer versus single player modes on need satisfaction and other psychological variables. Finally, our results are only based on self-reported outcomes at short term. As most of the health and education interventions are primarily concerned with long-term effects, longitudinal studies with objective indicators for motivation and engagement are needed. Specifically, studying the relatedness supportive features in longitudinal studies can shed light on the impact of such features on players' game enjoyment and motivation of continuing exergame play.

In conclusion, this study provides additional support to explain the motivational pull of video games from the perspective of need satisfaction. The empirical evidence validates game features that support the satisfaction of these needs. The results suggest that future research that intends to harness the power of video games needs to incorporate game features that support need satisfaction to increase enjoyment, motivation and engagement outcomes.

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