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RESEARCH PAPER

The Compensatory Association of Autonomy and Relatedness Satisfaction on Affect and Aggressive Feelings

Yuxin Liu[1] · Chen Chen[1,2] · Jianwei Zhang[3] · Yarong Guo[4] · Dirk van Dierendonck[2]

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Abstract
This article presents the results of an examination of self-determination theory; in this examination, the theory is extended through deeper insight into the compensatory association between autonomy and relatedness satisfaction. This study is designed to investigate whether the mutual influence of autonomy satisfaction and relatedness satisfaction on positive affect (PA), negative affect (NA), and aggressive feelings is best described as compensatory. The results of two laboratory studies verify a compensatory relationship and confirm a mediation by meaningful existence. The results verify the compensation effects of high relatedness satisfaction on NA and aggressive feelings when autonomy satisfaction is low. With role-playing and nonrole-playing digital game manipulation, the results are stronger when the participants were being themselves rather than playing a character.

Keywords Autonomy satisfaction · Relatedness satisfaction · Compensatory association · Positive affect · Negative affect · Aggressive feelings · Meaningful existence

1 Introduction

The importance of the relationship between autonomy and relatedness on individuals' psychological functioning is an essential element of Self-determination Theory (SDT) (Ryan and Deci 2000b, 2017), Autonomous-related Self Theory (Kağitçibaşi 2005; Kağitçibaşi and Yalin 2015) and cross-cultural relativism (Markus et al. 1996; Joshanloo 2014). SDT, especially its sixth mini-theory, i.e., Relationships Motivation Theory (RMT), describes the compensatory

✉ Yuxin Liu
Liuyuxin@uibe.edu.cn

[1] Department of Human Resource and Organizational Behavior, School of Business, University of International Business and Economics, Beijing, People's Republic of China

[2] Department of Organisation and Personnel Management, Rotterdam School of Management, Erasmus University, Rotterdam, The Netherlands

[3] Graduate School of Education, School of Humanities and Social Sciences, Beijing Institute of Technology, Beijing, People's Republic of China

[4] University College London, London, UK

positive relationship of autonomy and relatedness satisfaction on individuals' psychological growth and vulnerable underlying high-quality close relations (Deci and Ryan 2014; Ryan and Deci 2017). However, the intertwined nature of autonomy and relatedness satisfaction is still unclear. SDT has focused mainly on the independent benefits of the two need satisfactions for psychological wellness (e.g., Inguglia et al. 2018; Walker and Kono 2018; Van den Broeck et al. 2016). Some attention has been given to the negative consequences of the two needs being turned against with each other (e.g., Assor et al. 2004; Kanat-Maymon et al. 2016). However, the positive compensation benefit was largely ignored, although it is likely that when confronted with unmet needs, the compensatory association between autonomy and relatedness satisfaction may supplement individuals' active coping responses (Radel et al. 2011) by providing an adaptive, healthier alternative. That is, the fulfillment of one need may compensate for the deleterious effect of low satisfaction in not meeting another need.

To date, the compensatory association between autonomy and relatedness satisfaction has been hinted at in studies within close-relationship contexts (e.g., Bao and Lam 2008; Earl et al. 2019; Kluwer et al. 2020). In the broader and more general context, a few studies reported inconsistent conclusions (e.g., Dysvik et al. 2013; Sheldon and Filak 2008; Vansteenkiste et al. 2006) and the supportive findings (Dysvik et al. 2013; Vansteenkiste et al. 2006) resulted from cross-sectional self-report surveys, thereby raising issues around potential self-report artifacts and shared common method variance (Podsakoff et al. 2003). As such, preliminary support is relatively weak. These weaknesses can be overcome with an experimental method (Singleton et al. 1988) that allows for a stronger investigation of a possible causal link. Studies grounded in an experimental paradigm were specifically recommended to study the influence of the specific environmental conditions that support or undermine psychological needs, such as autonomy and relatedness (Ryan and Deci 2000a, 2017).

The two studies reported here are designed to further our understanding of the compensatory association between autonomy and relatedness satisfaction on psychological functioning by introducing the shared motivational mechanisms in terms of enhancing intrinsic motivation and the internalization of extrinsic motivation (Ryan and Deci 2000b, 2017; Ryan et al. 2016). Particularly, we verify that the interactive association between the two need satisfactions on individuals' positive affect (PA), negative affect (NA), and aggressive feelings with "tailored manipulations" (p. 281), as proposed by Sheldon and Filak (2008). Aggressive feelings, PA, and NA has been consistently proposed (Ryan and Deci 2000b, 2017) and rated as the typical outcomes in need satisfaction research (e.g., Yoon and Ham 2016; Van den Broeck et al. 2016); PA and NA signify two opposite and independent inward emotional states (Watson et al. 1988), while aggressive feelings supplement the inward character of the two affects because such feelings are an emotional state intended to harm others (Carnagey and Anderson 2005; Przybylski et al. 2014). To deepen our interpretation of the mediation process relating needs satisfaction to PA, NA, and aggressive feelings, we propose and investigate the mediating role of meaningful existence (for a similar research design, see Kluwer et al. 2020). Two laboratory experiments are conducted: a role-playing game manipulation (Uysal and Yildirim 2016) and a similar game manipulation without role-play.

2 Theory and Hypotheses

Autonomy satisfaction and relatedness satisfaction reflect the extent of embodied context facilitating or undermining autonomy and relatedness need, respectively (Ryan and Deci 2000b, 2017). Autonomy need reflects the sense of experiencing volition and

self-regulating ones' own actions. Relatedness need refers to the sense of feelings involved with and connected and attached to others. SDT maintains that just as sun, soil, and water are needed to grow plants, needs satisfaction provides the source of energy, nutriments, and drive that allow psychological well-being to develop (Ryan and Deci 2017). When an embodied context satisfies their needs, individuals develop inner resources that allow them to better flourish and cope with adversity in their psychological development. Individuals benefit from the fulfillment of need, even if they do not explicitly value or desire need satisfaction (Vansteenkiste et al. 2010).

2.1 Compensatory Association Between Autonomy and Relatedness Satisfaction

In accordance with the aforementioned research trend, the unique contribution of autonomy and relatedness satisfaction to psychological growth and vulnerabilities has been well acknowledged. In recent years, a few studies (e.g., Earl et al. 2019; Dysvik et al. 2013; Vansteenkiste et al. 2006) have proposed that, in addition to a direct effect, autonomy (relatedness) satisfaction can also compensate for lower levels of relatedness (autonomy) satisfaction in influencing psychological functioning. For example, in surveys, Chinese sojourners' autonomy satisfaction produces a more beneficial effect on vitality and better protects against depressive feelings when relatedness satisfaction is low (Vansteenkiste et al. 2006). RMT also provides theoretical support for this compensatory association. RMT particularly "addresses the intertwined nature of autonomy and relatedness needs and their synergistic influence for responsive, mutually satisfying relationships" (Ryan and Deci 2017, p. 21). RMT states that high-quality relations are promoted by having a close and enduring social contact with a partner and being autonomously motivated within and for that contact.

Theoretically, autonomy satisfaction and relatedness satisfaction share the same motivational mechanisms, namely, intrinsic motivation and internalization of extrinsic motivation (Ryan and Deci 2000b, 2017; Ryan et al. 2016). Intrinsic motivation is a self-motivating drive that encourages individuals to behave according to their internal interest, whereas extrinsic motivation is an external-motivating drive in which individuals behave to obtain instrumental benefits or avoid punishments. Internalization of extrinsic motivation is an active taking-in process confronting external requests, standards, or regulations. This internalization begins when individuals understand the value of these separable norms. Well-internalized extrinsic motivation occurs when individuals accept and identify these values and integrate them into their own.

Autonomy satisfaction facilitates the two motivational mechanisms with volitional support, while relatedness satisfaction promotes the two motivational mechanisms with relational support (Ryan and Deci 2000b, 2017). In particular, autonomy satisfaction is significant in promoting intrinsic motivation because the feelings of willingness, volition, and choice stimulates individuals to engage in interesting activities. Autonomy satisfaction also fosters internalization because more self-initiated feelings help individuals notice the value of noninteresting activities, reduce the difficulty of accepting them, and accelerate the taking-in process. Likewise, relatedness satisfaction enhances intrinsic motivation because personal connections and feeling of relational security increase individuals' curiosity and happiness. Relatedness satisfaction also significant in facilitating the internalization because social connectedness from significant others helps individuals select the "to-be accepted" norms and energize their internalization. A recent meta-analysis confirmed this significance by showing that, in an organizational setting, both autonomy and relatedness

satisfaction uniquely predict employees' intrinsic motivation, identified regulation and introjected regulation (Van den Broeck et al. 2016).

Some empirical studies also support shared underlying mechanisms. Concerning video games, Ryan et al. (2006) provided preliminary support with multiple experiments, where both autonomy and relatedness satisfaction uniquely predict in-game enjoyment. Additionally, with experiments, Bao and Lam (2008) showed that Chinese children's freedom of choice interacts with the mother–child relatedness to predict children's intrinsic motivation. Biological evidence also points toward a similar shared mechanism of both psychological needs on intrinsic motivation (e.g., Di Domenico and Ryan 2017; Lee and Reeve 2017; Meng and Ma 2015; Reeve and Lee 2019). Importantly, with 625 employees and a cross-sectional research design, Dysvik et al. (2013) verified that autonomy satisfaction interacted with relatedness satisfaction to predict intrinsic motivation. The relationship between relatedness satisfaction and intrinsic motivation was positive when employees experienced much autonomy satisfaction. Specifically, with multiple approaches to operationalizing SDT motivation (see Howard et al. 2017), several studies demonstrated that both autonomy and relatedness satisfaction independently predict lower negative affect and better positive affect and subjective wellbeing via the shared underlying mechanisms (e.g., Alcaraz et al. 2015; McDonough and Crocker 2007; Milyavskaya and Koestner 2011; Podlog et al. 2015).

2.2 Autonomy and Relatedness Satisfaction on PA and NA

An individual's dominant, independent affective states are represented by their PA and NA (Watson et al. 1988). The extent to which a person feels "enthusiastic, active, and alert" is reflected by their PA; individuals in a high PA state express "full energy, concentration, and pleasurable engagement," whereas individuals in a low PA state show "sadness and lethargy" (Watson et al. 1988, p. 1063). A variety of subjective aversive mood states are reflected by NA; a high NA refers to feelings of "anxiety and nervousness," for example, while a low NA refers to the feelings of "calmness and serenity" (Watson et al. 1988, p. 1063). Over the years, the robustness of direct positive links between autonomy satisfaction and relatedness satisfaction to PA have been well validated, as have negative direct links to NA (Van den Broeck et al. 2016).

The internalization of intrinsic motivation may cause autonomy satisfaction to compensate relatedness satisfaction in predicting PA and NA. Indeed, some studies, for example, Dysvik et al. (2013), found a confirmation specifically for these needs satisfaction, and Lin et al. (2019) found a confirmation for intrinsic motivation in general. Intrinsic motivation increases people's interest and enjoyment in a potential activity, thereby positively predicting PA and negatively predicting NA in diminishing individuals' unpleasant, unappealing, boring, aversive, or risky feelings. SDT's internalization process in terms of autonomous motivation and controlled motivation is highly correlated with PA and NA (e.g., Brunet et al. 2015; Gillet et al. 2013).

The compensation effect may exist—especially because the fulfillment of one need becomes more salient when another is lacking—to independently provide individuals with a stronger intrinsic motivation and accelerate the internalization process (Ryan and Deci 2017; Van den Broeck et al. 2016). Previous studies, indeed, concluded that in a low relatedness satisfaction condition, high autonomy satisfaction can help individuals experience more vitality and less depression (e.g., Vansteenkiste et al. 2006). Additionally, in a low

autonomy satisfaction condition, high relatedness satisfaction can help individuals have a more active voice response (Kluwer et al. 2020). Herein, we hypothesize the following:

H1a Autonomy satisfaction interacts with relatedness satisfaction to influence positive affect such that high relatedness satisfaction compensates for the effect of low autonomy satisfaction on positive affect.

H1b Autonomy satisfaction interacts with relatedness satisfaction to influence negative affect such that high relatedness satisfaction compensates for the effect of low autonomy satisfaction on negative affect.

2.3 Autonomy and Relatedness Satisfaction on Aggressive Feelings

Aggressive feelings refer to the emotional states intended to harm another individual (Carnagey and Anderson 2005; Przybylski et al. 2014). Aggressive feelings are well-acknowledged in the SDT as a typical maladaptive outcome of a lack of autonomy satisfaction or relatedness satisfaction (Vansteenkiste et al. 2010). Based on the shared mechanism of intrinsic motivation and internalization, autonomy satisfaction may compensate relatedness satisfaction to predict aggressive feelings. Indeed, several studies concluded that low levels of intrinsic motivation and internalized extrinsic motivation are linked to more aggressive feelings projections (Ryan and Grolnick 1986; Weinstein et al. 2011). Therefore, similar to PA and NA, we hypothesize the following:

H1c Autonomy satisfaction interacts with relatedness satisfaction to influence aggressive feeling such that high relatedness satisfaction compensates for the effect of low autonomy satisfaction on aggressive feelings.

2.4 Mediation of Meaningful Existence

Meaningful existence, or need for recognition, refers to a sense of "need to be recognized as existing" (Williams 2009, p. 280). Meaningful existence emphasizes the desire to be noticed and "make an impact on the world" (Gerber et al. 2017, p. 50). With high meaningful existence, individuals may be less likely to be concerned with being liked, fitting in, and craving recognition from others. Individuals experiencing little meaningful existence are more likely to experience uncertainty and doubts about themselves. A lack of meaningful existence has been shown to lead to more aggressive, provocative responses, reduced positive affect, and increased negative affect (Williams 2009).

Gerber et al. (2017) proposed that a meaningful existence can be captured by popularity, autonomy, and self-actualization. Popularity is functional due to the invisible feeling caused by interpersonal exclusion. Ample studies have demonstrated that interpersonal exclusion, presumably reflecting a lack of relatedness satisfaction (Sheldon and Filak 2008; Vansteenkiste et al. 2010), highly threaten the sense of meaningful existence (Kothgassner et al. 2017; Wyer and Schenke 2016). The direct negative correlation was so robust that it existed even for individuals confronting momentary, impersonal exclusion, such as during role-playing (Wyer and Schenke 2016), Cyberball, and face-to-face ball tossing (Zadro et al. 2004; Kothgassner et al. 2017).

Autonomy is functional because, as SDT suggests, individuals find meaning through it (Gerber et al. 2017). With low autonomy satisfaction, individuals cannot follow their volition and the process of self-regulation (Ryan and Deci 2000b). To achieve more meaning in life, these individuals are more likely to crave attention from others, have a higher desire for social recognition (Renger et al. 2017), and be more likely to voice their opinions and concerns (Radel et al. 2011).

Autonomy and relatedness satisfaction may interact to predict meaningful existence by stimulating self-actualization. In SDT, self-actualization signifies higher internalization of extrinsic motivation (Ryan and Deci 2017), representing the harmonious interplay of autonomy and relatedness satisfaction. Self-actualization facilitates meaningful existence by triggering the need to develop potential and a meaningful life (Gerber et al. 2017).

Taken together, we hypothesize the following:

H2 The interaction of autonomy satisfaction and relatedness satisfaction with (a) positive affect, (b) negative affect, and (c) aggressive feelings is mediated by meaningful existence.

3 Overview of the Studies

The abovementioned hypotheses were tested in two laboratory experimental studies. In the first study, a 2×2 design was employed to manipulate both needs satisfaction; the study measured meaningful existence as a potential mediator and PA, NA, and aggressive feelings as outcomes. Needs satisfaction factors were manipulated with a role-playing digital game called Catch Jerry, which involved a starving cat (Tom) catching a rat (Jerry). Study 2 replicated the findings in Study 1 through a nonrole-playing manipulation called Catch Jerry (II), a digital game adapted from Catch Jerry.

4 Study 1

Study 1 focused on the compensatory association between autonomy and relatedness satisfaction on PA, NA, and aggressive feelings. If an association was indicated, the study further investigated the compensation effects of high relatedness satisfaction on PA, NA, and aggressive feelings when autonomy satisfaction is low. Additionally, we investigated the mediating role of meaningful existence.

4.1 Method

4.1.1 Participants and Design

We recruited 191 Chinese undergraduates (55 males, 136 females, $M_{age} = 20.25$, $SD_{age} = 1.34$) to participate in the study for course credits.

We employed a 2 (autonomy satisfied: high versus low)×2 (relatedness satisfied: high versus low) between-subject design. A desk computer was used. Participants were randomly assigned to different conditions (cells ranging from 38 to 57). The participants started with a warm-up test, followed by the eight-round formal test, and concluded with

a paper questionnaire. Inspired by the Tom and Jerry task (Wielenga-Meijer et al. 2011, 2012), Catch Jerry is a self-developed puzzle task that manipulates the core elements of autonomy and relatedness satisfaction (Ryan and Deci 2017) according to the standards of manipulating basic psychological needs in digital games (Uysal and Yildirim 2016).

4.1.2 Autonomy Satisfaction Manipulation

First, a warm-up test helped the participants familiarize themselves with the game. The participants, playing as Tom, were informed that the game goal was to catch Jerry within 20 steps, using a traditional "game controller" with keystrokes (1–4) (Uysal and Yildirim 2016). Fewer keystrokes to catch Jerry represented better performance. The best performance was 14 keystrokes, which was the shortest route possible to catch Jerry. Participants also had to decipher the meaning of each keystroke (1–4) during the warm-up test. To enhance the game difficulty, each key (1–4) signified two different directions in the left and right part, which was separated by a hidden line, invisible to participants (Fig. 1). After catching Jerry, participants became familiar with the rules, received a "passing" feedback, and qualified for the formal test.

Subsequently, the eight-round formal test was conducted; in this test, the standard of choice (Uysal and Yildirim 2016) manipulated the level of autonomy satisfaction conditions. In high autonomy satisfaction conditions, participants had full discretion in using keystrokes (1–4) to move and explore any route. To encourage participants to explore more routes, the game screen randomly switched from Fig. 1a, b between rounds. In low autonomy satisfaction conditions, participants had no discretion regarding movement or route exploration. In each round, the route lengths (keystroke numbers), ranging from 14 to 36 were well prepared. Before each move, participants constantly received playing hints on how to catch Jerry. The participants had to follow the hints because all "wrong" keys were locked. Each hint was designed, enlarged, and flashed at the middle bottom of the screen, and the next hint would not appear until the participants obeyed the current hint.

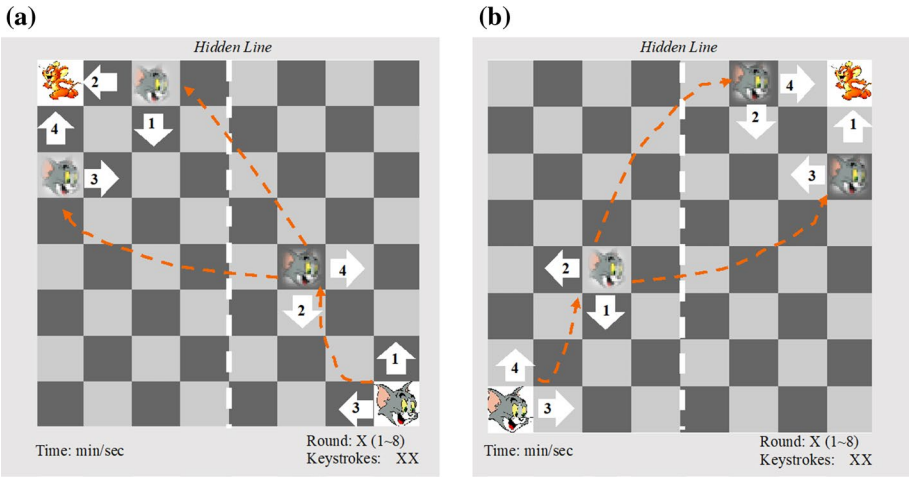

Fig. 1 The game interface

Participants received word feedback during and at the end of each round. During each round, participants' keystroke numbers, playing time, and round numbers were shown on the screen (see Fig. 1). At the end of round 1, participants received their actual entered keystrokes number as feedback. From rounds 2 to 7, feedback varied according to a performance comparison between the current and latest round. Subjects who performed better in the current round received a compliment. Those who performed worse received a warning. Otherwise, participants received the same feedback as they did in round 1. At the end of round 8, they received their average entered keystrokes number as the final feedback.

4.1.3 Relatedness Satisfaction Manipulation

To manipulate relatedness satisfaction, we developed "welcome" and "unwelcome" scenario instructions before the warm-up test and labeled them on the right side of the screen throughout the formal test. In high relatedness satisfaction conditions, participants were instructed that Tom was petted and welcomed by his owner and other animals. The word "welcome" flashed intermittently. In low relatedness satisfaction conditions, participants were told Tom was neither petted nor welcomed by his owner nor by other animals. The word "unwelcome" flashed intermittently.

4.2 Measures

All self-report variables were measured with a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Demographic data, such as gender, age, and grade, were collected at the end of the questionnaire.

4.2.1 Manipulation Check

As "Catch Jerry" was inspired by Wielenga-Meijer et al. (2011), we adopted five items used in the same article to confirm the effectiveness of autonomy satisfaction manipulation. The items are (1) "I had the freedom to choose how to catch Jerry," (2) "I had freedom to make each move…," (3) "…I had the feeling that I could decide what to do," (4) "…I had the feeling that restrictions were imposed on me" (reverse), and (5) "I could decide how to perform…"; $\alpha = 0.878$. We excluded the last item in Wielenga-Meijer et al. (2011) because it focuses on the meaning of "independence"; this meaning does not accord with the definition of autonomy satisfaction used in our research.

Following the definition of relatedness satisfaction in Ryan and Deci (2017), in digital games, "relatedness needs are satisfied when others recognize and support one's self and when the person feels able to connect with, feel significant with, and be helpful to others" (p. 516). Herein, we adapted the three items for the "belonging" measurement (Zadro et al. 2004) to confirm the effectiveness of relatedness satisfaction manipulation: (1) "…I felt as though I had made a 'connection' or bonded with one or more…," (2) "…I felt like an outsider," and (3) "…I felt poorly accepted by the others" (reverse); $\alpha = 0.741$.

4.2.2 Positive Affect and Negative Affect

We adopted the 20 adjectives of the PANAS scales used in Watson et al. (1988) to respectively measure PA and NA (see also, Hamama et al. 2013; Loh et al. 2014; Busseri 2018). Participants reported how much they felt about each of the 10 PA adjectives (e.g., "interested," "excited," and "proud") with $\alpha = 0.927$ and each of the 10 NA adjectives (e.g., "disinterested," "ashamed," and "irritable") with $\alpha = 0.876$.

4.2.3 Aggressive Feelings

Following the definition of aggressive feelings (Carnagey and Anderson 2005; Przybylski et al. 2014), we used the three-item subscale of the Effects of Drinking Questionnaire used in George et al. (1989): (1) "…I really felt like fighting Jerry," (2) "…I want to be angry with anyone else," and (3) "…I want to argue with anyone else"; $\alpha = 0.784$.

4.2.4 Meaningful Existence

To measure meaningful existence, we used the three-item scale used in Zadro et al. (2004) (see also, Gerber et al. 2017; Gerber and Wheeler 2014; Gratz et al. 2013): (1) "I felt that my performance had some effect on the direction of the game," (2) "I felt nonexistent during…" (reverse), and (3) "I felt as though my existence was meaningless during…" (reverse); $\alpha = 0.722$.

4.3 Results

For the manipulation check, participants in the high autonomy satisfaction condition reported greater perceived autonomy ($M = 4.42$, $SD = 1.40$) than those in the low autonomy satisfaction ($M = 2.50$, $SD = 1.23$, $t\,(189) = 10.06$, $p < 0.001$, $d = 1.45$) and those in the high

Table 1 Means, standard deviations of variables of autonomy and relatedness satisfaction in Study 1 and 2

Dependent Variables	Conditions							
	Autonomy high-satisfied		Autonomy low-satisfied		Relatedness high-satisfied		Relatedness low-satisfied	
	M	SD	M	SD	M	SD	M	SD
Study 1								
Positive affect	4.89	1.19	3.43	1.11	4.27	1.44	4.00	1.25
Negative affect	2.61	0.99	3.02	1.09	2.56	0.93	3.11	1.12
Aggressive feelings	2.45	1.39	3.89	1.54	2.91	1.48	3.50	1.75
Study 2								
Positive affect	4.95	1.05	3.72	1.40	4.64	1.19	3.78	1.49
Negative affect	2.67	1.04	3.54	1.18	2.75	1.04	3.66	1.10
Aggressive feelings	2.40	1.28	3.95	1.59	2.69	1.32	3.97	1.74

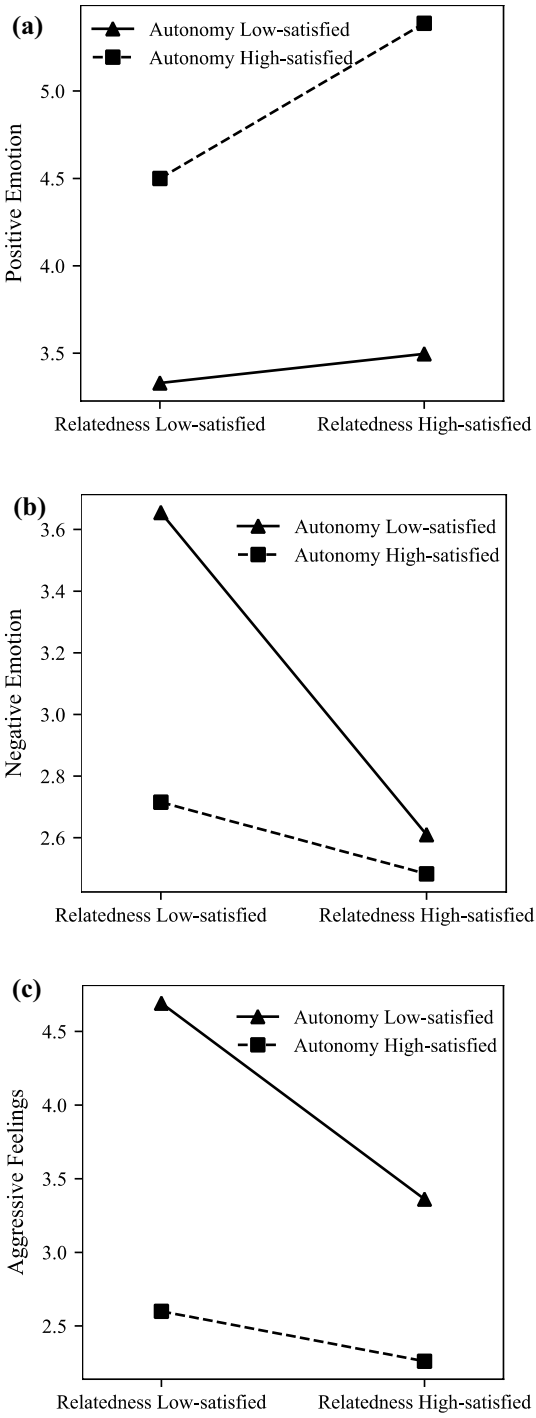

Fig. 2 The compensatory associations between autonomy and relatedness satisfaction on positive affect (**a**), negative affect (**b**) and aggressive feelings (**c**) in Study 1

($M = 4.25$, $SD = 1.25$) and low ($M = 3.41$, $SD = 1.19$) relatedness satisfaction condition ($t(189) = 4.688$, $p < 0.001$, $d = 1.17$), thus indicating that the manipulations were effective (Table 1).

As in Table 2 and Table 3, Two-way analysis of variance showed that autonomy satisfaction and relatedness satisfaction had a significant interaction effect on both PA [F (1, 187) = 4.891, $p = 0.028$, $\eta^2 = 0.25$ (Fig. 2a)], NA [F (1, 186) = 7.967, $p = 0.005$, $\eta^2 = 0.041$(Fig. 2b)], and aggressive feelings [F (1, 187) = 5.861, $p = 0.016$, $\eta^2 = 0.030$ (Fig. 2c)]. As in Aiken et al. (1991), we additionally performed simple effect analysis to test the between-needs compensation. The results showed that, the relationship between relatedness satisfaction and PA was positive only for participants in the high autonomy satisfaction condition, while the relationships between relatedness satisfaction and NA and between relatedness satisfaction and aggressive feelings were negative only for participants in the low autonomy satisfaction condition. In short, when autonomy satisfaction was low, participants in high relatedness satisfaction expressed lower NA and aggression but not higher PA.

The mediating role of meaningful existence was analyzed by the conditional process analysis (PROCESS Model 8, 95% CI, $n = 5000$), which is currently regarded as one of the most reliable ways to test mediating effects (Hayes and Little 2018). The conditional indirect effects of autonomy satisfaction and relatedness satisfaction on PA via meaningful existence were significant (CI [− 0.9608, − 0.2729], index = − 0.5827, $SE = 0.1748$), since its 95% CI did not contain zero. Similar results were found for the conditional indirect effects on NA (CI [0.1105, 0.5844], index = 0.3133, $SE = 0.1212$) and aggressive feelings (CI [0.2326, 0.9585], index = 0.5556, $SE = 0.1871$). Additionally, the conditional direct effect of autonomy satisfaction and relatedness satisfaction on PA was significant (CI [0.6900, 1.9167], $p < 0.001$), since its 95% CI did not contain zero. However, the conditional direct effects of autonomy satisfaction and relatedness satisfaction on NA (CI [− 0.0779, 1.0766], $p = 0.0895$) and aggressive feelings (CI [− 0.3689, 1.2411], $p = 0.2865$) were not significant, since its 95% CI did contain zero. Overall, we can conclude that meaningful existence is a partial mediator in the moderated relationship of relatedness satisfaction on PA; however, meaningful existence is a full mediator in the moderated relationship of relatedness satisfaction on NA and aggressive feelings.

4.4 Discussion

In Study 1, we found that Catch Jerry was quite efficient in manipulating autonomy and relatedness satisfaction. Two-way analysis of variance verified the compensatory association between autonomy and relatedness satisfaction on PA, NA, and aggressive feelings. Simple effect tests confirmed the compensation effects of high relatedness satisfaction on NA and aggressive feelings when autonomy satisfaction was low. The compensatory associations on PA was partially mediated by meaningful existence; the compensatory associations on NA and aggressive feelings were fully mediated by meaningful existence.

As for the disappointing compensation result of relatedness satisfaction on PA, current literature is surprisingly inconsistent on the effect of relatedness satisfaction on affect feelings. Several studies have concluded that more social exclusion, reflecting a lack of relatedness satisfaction (Sheldon and Filak 2008; Vansteenkiste et al. 2010), may motivate individuals to enter into an emotionally numb state rather than decrease positive affect (e.g., Twenge et al. 2003). The failed result may also be attributed to the role-playing nature of

the manipulation. Despite the claim by Uysal and Yildirim (2016) that role-playing games can generate "higher autonomy satisfaction as they provide a lot of freedom to the player" (p. 131), the statement still lacks direct evidence. Conversely, Allen and Anderson (2018) concluded that participants in virtual video games reported lower autonomy and relatedness satisfaction than did participants in the real world. Additionally, participants who were excluded by the virtual Cyberball game reported lower social exclusion and mood (measured by PA and NA) than did those who were excluded from real interpersonal relationships (Zadro et al. 2004). Without the role-playing element, the digital game may produce a better response on the two affects and aggressive feelings. Hence, in Study 2, we developed Catch Jerry (II) to verify the robustness of the results in Study 1 by removing the role-playing element.

5 Study 2

Study 2 replicated Study 1 through a nonrole-playing manipulation of autonomy satisfaction and relatedness satisfaction.

5.1 Method

5.1.1 Participants and Design

In this study, 232 Chinese undergraduates (58 males, 176 females, $M_{age} = 19.35$, $SD_{age} = 1.255$) volunteered to participate in the experiment in exchange for course credits.

A 2×2 between-subject laboratory study was used. Participants were randomly assigned to (high/low) autonomy and (high/low) relatedness satisfaction condition (cells ranging from 40 to 65). Participants were asked to finish Catch Jerry (II) first; this experiment involved an online personality test, a virtual online-matching process, a digital game, and a subsequent questionnaire. Compared with Catch Jerry, Catch Jerry (II) replaced the role-playing element (playing Tom) with a virtual 48 multiplayer game scenario. The online multiplayer context, including a single player in a virtual multiplayer game (Uysal and Yildirim 2016), was functional in generating needs satisfaction, specifically relatedness satisfaction (e.g., Rigby and Ryan 2011). Participants were instructed to complete the game together with one partner but actually played the game alone. The other parts of Catch Jerry (II) were identical to parts of Catch Jerry.

5.1.2 Relatedness Satisfaction Manipulation

Compared with playing Tom in Study 1, participants were convinced that the result of being accepted or not was attributed only to their personality test results. An online personality test, a virtual online-matching process, and scenario instructions were used to form the virtual multiplayer competition context, corresponding to the statement that the design of need satisfaction manipulation should be more consistent with players' characters (Uysal and Yildirim 2016).

Ten items from the revised Eysenck Personality Questionnaire (Eysenck et al. 1985) were randomly adopted to measure participants' personalities.

All participants were randomly assigned to the experimental conditions with well-prepared scenario instructions, yet we informed participants that they were matched by an online-matching process based on their personality test results. In high relatedness satisfaction conditions, participants were received with a "welcome" comment and informed that some players wanted them to pair as a team after reading their personality test results. The players were also informed that the game center would randomly pick one partner from the alternatives to pair them with as a team. In addition, a label "players chose you as a partner: more than 16! …You are very welcome!" was shown on the right side of the screen. In low relatedness satisfaction conditions, participants were received by an "unwelcome" warning and informed that no one wanted them as a team partner. They were also informed the game center would randomly assign the one remaining player online for them to pair with as a team. The label "players chose you as a partner: 0! You are not welcome!" was shown.

5.1.3 Autonomy Satisfaction Manipulation

Autonomy satisfaction manipulation was largely replicated from Study 1, except we removed the role-playing set. Thus, participants were playing a game rather than being one character in the game. Participants were manipulated by their "log in" time. In high autonomy satisfaction conditions, regardless of "log in" time, participants' personal and final team performance depended on the better player. In low autonomy satisfaction conditions, participants had to follow their partner for their later "log in" time.

5.2 Measures

All variables were measured the same as they were in Study 1, including the manipulation check ($\alpha_{autonomy\ satisfaction}=0.919$; $\alpha_{relatedness\ satisfaction}=0.803$) and the measures of PA ($\alpha=0.936$), NA ($\alpha=0.896$), aggressive feelings ($\alpha=0.785$), and meaningful existence ($\alpha=0.748$).

5.3 Results

We performed two manipulation checks. Participants reported greater autonomy in the high autonomy satisfaction condition ($M=4.60$, $SD=1.31$) than in the low autonomy satisfaction condition ($M=2.34$, $SD=1.23$), $t\,(230)=13.46$, $p<0.001$, $d=1.77$); similarly, participants reported greater relatedness in the high relatedness satisfaction condition ($M=5.04$, $SD=1.14$) than in the low relatedness satisfaction condition ($M=3.19$, $SD=1.32$), $t\,(230)=11.456$, $p<0.001$, $d=1.50$, thus suggesting that the manipulations were effective.

Two-way analysis of variance showed that autonomy satisfaction and relatedness satisfaction had a significant interaction effect on PA [$F\,(1, 228)=13.812$, $p<0.001$, $\eta^2=0.057$ (Fig. 3a)], NA [$F\,(1, 228)=8.368$, $p=0.004$, $\eta^2=0.035$ (Fig. 3b)], and aggressive feelings [$F\,(1, 227)=9.872$, $p=0.002$, $\eta^2=0.042$ (Fig. 3c)]. Simple effect analysis results (see Table 3 and Fig. 3) revealed that, regardless of autonomy satisfaction, high relatedness satisfaction always led to lower NA and aggressive feelings. However, the relationship between high relatedness satisfaction and PA was only positive when participants were in the low autonomy satisfaction condition. In short, when autonomy satisfaction was low,

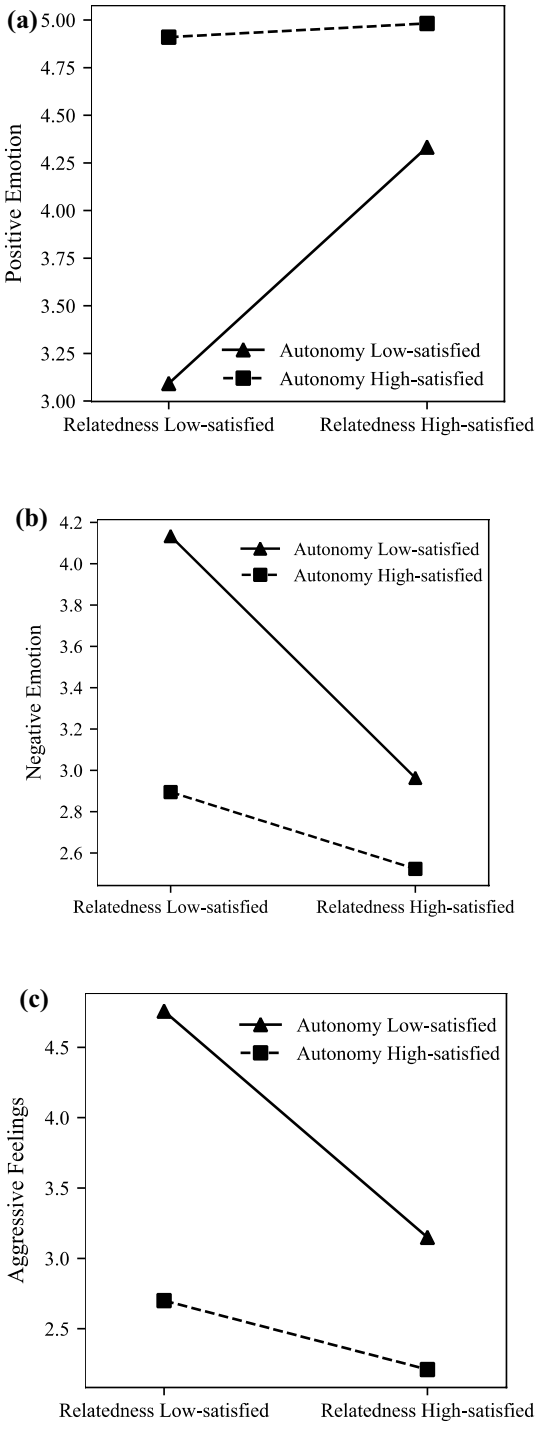

Fig. 3 The compensatory associations between autonomy and relatedness satisfaction on positive affect (**a**), negative affect (**b**) and aggressive feelings (**c**) in Study 2

Table 2 The F-value of the main effects and interaction effects of autonomy and relatedness satisfaction in Study 1 and 2

Dependent variables	The main effects						The interaction effects		
	Autonomy satisfaction			Relatedness satisfaction					
	F	df	η^2	F	df	η^2	F	df	η^2
Study 1									
Positive affect	88.280***	1, 187	0.321	10.48**	1, 187	0.053	4.891*	1, 187	0.25
Negative affect	13.739***	1, 186	0.069	19.692***	1, 186[1]	0.096	7.967**	1, 186	0.04
Aggressive feelings	60.754***	1, 187	0.245	16.615***	1, 187	0.030	5.861*	1, 187	0.03
Study 2									
Positive affect	61.475***	1, 228	0.212	17.423***	1, 228	0.071	13.812***	1, 228	0.06
Negative affect	37.05***	1, 228	0.236	31.242***	1, 228	0.121	8.368**	1, 228	0.04
Aggressive feelings	70.744***	1, 227	0.238	34.707***	1, 227	0.133	9.872**	1, 227	0.04

[1]Degrees of freedom slightly vary in the analyses here and others because of the occasional missing data

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3 Simple effect analysis results in Study 1 and 2

	Within high autonomy satisfaction		Within low autonomy satisfaction	
	F	df	F	df
Study 1				
Positive affect	6.36*	1, 188	< 1	
Negative affect	< 1		20.09***	1, 187
Aggressive feelings	< 1		9.51**	1, 188
Study 2				
Positive affect	1.92	1, 229	28.63***	1, 229
Negative affect	6.64*	1, 229	36.27***	1, 229
Aggressive feelings	7.74**	1, 228	36.64***	1, 228

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

participants with high relatedness satisfaction expressed higher PA and lower NA and aggressive feelings.

Conditional process analysis shows that the conditional indirect effects of autonomy satisfaction and relatedness satisfaction on PA via meaningful existence was significant (CI [− 1.2594, − 0.4554], index = 0.2040, $SE = 0.8228$), as with these effects on NA (CI [0.0216, 0.5209], index = 0.25800221, $SE = 0.1262$) and aggressive feelings (CI [0.0267, 0.8156], index = 0.3808, $SE = 0.2010$). In addition, the conditional direct effects of autonomy satisfaction and relatedness satisfaction on PA were not significant (CI [− 0.9887, 0.2609], $p = 0.2523$), as with these effects on NA (CI [− 0.0128, 1.1669], $p = 0.0551$) and aggressive feelings (CI [− 0.0201, 1.5019], $p = 0.0563$). Herein, meaningful existence in Study 2, indeed, was a full mediator.

5.4 Discussion

In Study 2, we found that Catch Jerry (II) was also efficient in manipulating autonomy satisfaction and relatedness satisfaction. Consistent with the results in Allen and Anderson (2018), participants who played as themselves reported higher autonomy and relatedness satisfaction than those playing as a character. Two-way analysis of variance verified autonomy satisfaction and relatedness satisfaction not only compensated one another but also better predicted PA, NA, and aggressive feelings (with lower p value) than in Study 1 (see Table 2), thereby indicating that Catch Jerry (II) was a better way to manipulate autonomy and relatedness satisfaction. Simple effect analysis verified all compensation effects of relatedness satisfaction on PA, NA, and aggressive feelings when autonomy satisfaction is low (Table 3). Particularly, relatedness satisfaction compensated for the low PA caused by autonomy threat; we did not find obtain this finding in Study 1. Thus, the inconsistency that exists in the current literature regarding affect following relatedness satisfaction that exists in the current literature was mirrored in our two studies. Finally, we also replicated the full mediating role of meaningful existence in explaining the compensatory association of the two need satisfactions on NA and aggressive feelings. Additionally, the partial mediating role of meaningful existence in explaining the compensatory association and PA was updated to the role of a full mediator.

6 General Discussion

With two laboratory studies, we found compensatory associations and a mediating mechanism that helped us more deeply understand the associations between autonomy satisfaction and relatedness satisfaction on PA, NA, and aggressive feelings. We found that high relatedness satisfaction compensated for the side effect of low autonomy satisfaction on NA and aggressive feelings. Furthermore, the results were strongest for the nonrole-playing digital game manipulation.

6.1 Implications

First, the study answered the call in Sheldon and Filak (2008) for more reliable experimental explorations of the compensatory association between autonomy and relatedness satisfaction and identified meaningful existence as a functional mechanism in explaining how the compensatory association influenced PA, NA, and aggressive feelings, thereby providing to the SDT literature an incremental contribution grounded in theory and verified by experimental evidence. As shown in Table 2, besides their interactive effects, we also provided robust main effects of autonomy and relatedness satisfaction on PA, NA and aggressive feelings. In accord with many other studies (e.g., Earl et al. 2019; Dysvik et al. 2013; Ryan et al. 2006; Van den Broeck et al. 2016), our results further confirmed the importance of the two need satisfactions on PA, NA and aggressive feeling with more experimental evidence. The interactive effects results are also consistent with previous findings in more general contexts with surveys (e.g., Dysvik et al. 2013; Vansteenkiste et al. 2006) and with a cluster-analytical approach (Earl et al. 2019). Therefore, building on the description of a potential compensatory (synergistic) relation between the two need satisfactions in RMT, our results provide deeper insight into the compensatory (synergistic) relation in a general context. As similarly posited in RMT, satisfying relatedness is an important need for

psychological wellness but not the only need. In particular, the synergy between autonomy and relatedness predicts better psychological functioning. We thus provide more evidence for a core proposition of SDT. That is, the most integrated individuals experience a synthesis of autonomy and relatedness. These individuals act in their own benefit and do so with others in mind.

Second, for situations where people need to confront an unmet need, we added a positive alternative to the toolbox of coping responses, i.e., the compensation effects between need satisfactions. Over the years, studies in SDT, including RMT, focused mostly on the downward spiral when the environment turns autonomy and relatedness needs against each other (Ryan and Deci 2017). Particularly, studies examined the negative effect of low autonomy satisfaction in specific close relationships. However, our focus is the positive compensation effect of the high relatedness satisfaction when autonomy satisfaction is low in a more general context. Here, compared to an environment where satisfaction of both autonomy and relatedness is low, a positive compensation effect emerged. Although a few studies reported significant compensation effects between the two need satisfactions on intrinsic motivation, vitality, and depression (Dysvik et al. 2013; Vansteenkiste et al. 2006), this is the first study to explicitly propose this compensation effect as a coping response. Previous literature proposed a two-stage active coping response confronting unmet need; this response consisted of early need-restoration and subsequent maladaptive need compensation (Radel et al. 2011). Need restoration, an immediate, cognitive level "early alarm response," aims at restoring the unmet need itself. Need compensation aims at fleeting or short-lived satisfaction, including need substitutes and rigid behavior patterns (Radel et al. 2011; Vansteenkiste and Ryan 2013). Compared with need restoration, the compensation effects between needs satisfaction may provide another but more practical recovery alternative because need restoration stays mostly in the early, cognitive stage. Although a variety of compensatory processes provide fleeting satisfaction to individuals, these processes would ultimately fail to satisfy basic needs (Vansteenkiste et al. 2010). However, compensation effects between needs satisfaction may overcome the shortcomings of the short-lived benefits through an adaptive process toward functional recovery due to the shared positive motivational mechanisms.

Third, by applying an experimental design, we verified the robustness of the importance of the two need satisfactions in Eastern cultures specifically for Chinese participants. Traditionally, SDT sees relatedness as functionally important across both East and West (Ryan and Deci 2017). For autonomy, some scholars argue that it is highly valued and important to wellness in Western individualist cultures but is considered less valued in Eastern collectivist cultures. Our findings concluded the opposite; our results are actually consistent with the recent findings in SDT that autonomy satisfaction is also valuable in Eastern collectivist cultures (Koole et al. 2019), such as China (Chen et al. 2014; Vansteenkiste et al. 2006; Wu et al. 2014), India (Rathi and Lee 2017; Inguglia et al. 2018) and Japan (Church et al. 2013).

We also provided experimental evidence that the compensatory association between autonomy and relatedness satisfaction on individuals' psychological functioning is not culturally bound (for surveys showing similar results in Western culture, see Dysvik et al. 2013; Kluwer et al. 2020; Vansteenkiste et al. 2006). Although a number of cultural scholars have suggested that the value of autonomy is antithetical to values of relatedness (e.g., Markus et al. 1996; Joshanloo 2014), SDT insists that the satisfaction of autonomy and relatedness need positively relates to one another across domains and situations (Ryan and Deci 2017). Therefore, our findings are consistent with the main proposition that the experience of autonomy and relatedness are posited to be mutually compensatory. Importantly,

we verified that the positive compensation effect will occur when the two need satisfactions are turned against each other.

6.2 Limitations and Future Directions

As the study provides evidence for two of the three potential compensatory associations in SDT, future works may continue to explore the compensatory associations between needs satisfaction by incorporating competence satisfaction. Within SDT, it has long been proposed that all three needs, i.e., autonomy, relatedness, and competence, are distinct while essential in individuals' psychological wellness (Ryan and Deci 2000a, 2000b). Competence satisfaction refers to the degree of embodied context to satisfy individuals' need for competence, i.e., the confident, effective, and capable feelings in engaging activities. The importance of competence satisfaction becomes increasingly evident because a balanced amount of the satisfaction of each need received increasing attention (e.g., Milyavskaya et al. 2009; Tóth-Király et al. 2018). That is, all three needs should be equally satisfied to produce optimal psychological functioning. The current literature provides theoretical, empirical, and experimental implications for the proposition. Theoretically, competence satisfaction is significant in promoting intrinsic motivation and internalizing the value of external requirements, even those beyond individuals' understanding or capacities (Ryan and Deci 2017). Empirically, scarce direct evidence has shown the compensatory effect of autonomy and competence satisfaction on intrinsic motivation (Dysvik et al. 2013; Hagger et al. 2015), vitality (Vansteenkiste et al. 2006), and the restoration of autonomy need (Radel et al. 2013). Experimentally, investigators have shown the opportunities for manipulating the three needs satisfaction in one digital game (see Uysal and Yildirim 2016). Furthermore, based on shared motivational mechanisms, the compensation effects among the three needs satisfaction may also occur. Previous studies have reported high perceived competence accelerated the restoration process of autonomy (Radel et al. 2013). When competence satisfaction is low, high autonomy satisfaction promotes intrinsic motivation (Dysvik et al. 2013) and vitality (Vansteenkiste et al. 2006).

In addition, the shared mechanisms, while being consistently used in SDT (e.g., Ryan et al. 2016; Ryan and Deci 2017), have not been empirically evaluated. Future works may statistically evaluate the importance of intrinsic motivation and the internalization process of the compensatory association between needs satisfaction and psychological functioning. Hopefully, Dysvik et al. (2013) provided preliminary evidence regarding a shared mechanism of intrinsic motivation between need satisfactions. Some evidence also showed the empirical potential of the process of internalization as the shared mechanism between needs satisfaction (e.g., Alcaraz et al. 2015; Milyavskaya and Koestner 2011; Van den Broeck et al. 2016).

Finally, although we claimed to investigate the compensatory associations between autonomy and relatedness satisfaction on PA, NA, and aggressive feelings in the general context, the validity of the findings was indeed limited to the virtual world. In SDT, digital games provided myriad possibilities for satisfying basic psychological needs, thereby often influencing participants as strongly as interactions in the real world (Ryan and Deci 2017). However, need satisfactions were built with unparalleled immediacy, consistency and density in digital games compared with most other contexts (Rigby and Ryan 2011), thus causing individuals' feelings in virtual world to be distinct from those in our concrete world. Therefore, moving beyond digital games, future work may

continue investigating the robustness of our findings in other settings and investigating the implications of contrasting our findings in virtual realities with findings in everyday realities. For example, in RMT, autonomy has been regarded to be extremely important in interpreting high-quality close relations (Ryan and Deci 2017), while studies have focused mostly on low autonomy satisfaction detriments for the effect of high relatedness satisfaction on good-quality close relations. Thus, we call for more research focusing on the possibility of the compensation effect as proposed in our study.

In conclusion, with two laboratory experiments, we found that, autonomy satisfaction compensates relatedness satisfaction in influencing PA, NA, and aggressive feelings within SDT. The compensatory associations are mediated by meaningful existence. Additionally, the findings confirmed the compensation effects of high relatedness satisfaction on NA and aggressive feelings when autonomy satisfaction was low.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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