Competence-Impeding Electronic Games and Players' Aggressive Feelings, Thoughts, and Behaviors

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Recent studies have examined whether electronic games foster aggression. At present, the extent to which games contribute to aggression and the mechanisms through which such links may exist are hotly debated points. In current research we tested a motivational hypothesis derived from self-determination theory—that gaming would be associated with indicators of human aggression to the degree that the interactive elements of games serve to impede players' fundamental psychological need for competence. Seven studies, using multiple methods to manipulate player competence and a range of approaches for evaluating aggression, indicated that competence-impeding play led to higher levels of aggressive feelings, easier access to aggressive thoughts, and a greater likelihood of enacting aggressive behavior. Results indicated that player perceived competence was positively related to gaming motivation, a factor that was, in turn, negatively associated with player aggression. Overall, this pattern of effects was found to be independent of the presence or absence of violent game contents. We discuss the results in respect to research focused on psychological need frustration and satisfaction and as they regard gaming-related aggression literature.

Keywords: motivation, competence, aggression, electronic games

Philosophers and researchers alike have sought the causes of human aggression, proposing a multitude of possibilities. Diverse factors such as genetic make-up (Ferguson, 2010), social learning (Bandura, 1977), goal frustration (Miller, 1941), and ambient air temperature (Anderson, Deuser, & DeNeve, 1995) have been evaluated as potential sources of aggressive thoughts, feelings, and behaviors. More recently however, popular interest has turned to electronic game entertainment as a source of aggression. Indeed, the great majority of social science research focusing on gaming environments examines concerns that some games—violent ones in particular—have the potential to foment aggression. Despite a growing body of research, there is no clear consensus regarding the effects of gaming on aggression: Some researchers report finding consistent links between some forms of gaming and measures of aggression (e.g., Anderson & Bushman, 2001), whereas others find unreliable or inconsequential links (e.g., Elson & Ferguson, in press). Our aim in the present research was to empirically explore gaming-related aggression through the motivational lens of self-determination theory (SDT; Ryan & Deci, 2000)—by systematically investigating psychological need thwarting in gaming as a source of aggressive feelings, thoughts, and behaviors.

Motivational Perspective

SDT theorizes that human aggression and interpersonal violence result from the threatened or actual thwarting of basic psychological needs (Deci & Ryan, 2012; Ryan & Deci, 2000). SDT posits three basic psychological needs that are sensitive to supports and susceptible to impedance from environmental circumstances: The needs for *competence* (i.e., the experience of efficacy), *autonomy* (i.e., the sense of choice and volition), and *relatedness* (i.e., the feeling of connection and belongingness with others). When supported, these three needs form the basis of psychological health and provide the necessary and sufficient conditions for effective self-regulation. SDT researchers have argued that people are more prone to aggression when any of these three basic needs is thwarted either proximally, by situational threats or deprivations, or distally, by chronic developmental conditions (Ryan, Deci, Grolnick, & La Guardia, 2006).

Several lines of research provide support for the idea that psychological need thwarting can contribute to increased aggres-

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sion. Early work by Ryan and Grolnick (1986) showed that children had higher levels of implicit aggressiveness when their basic need for autonomy was impeded. More recently, Roth, Kanat-Maymon, and Bibi (2011) reported that classroom environments that were autonomy-need thwarting were more likely to foster bullying as well as interpersonal aggression. Weinstein, Hodgins, and Ostvik-White (2011) also showed that the salience of autonomy-blocking led to increased accessibility of aggressive thoughts, which in turn resulted in people enjoying hostile forms of humor. Neighbors, Vietor, and Knee (2002) reported that need-thwarting motivation predicted experiencing pressure and ego-defensiveness while driving, a shift that in turn related to aggressive driving and road rage. Weinstein (2009) showed that those situations that undermined the need for relatedness served to increase interpersonal aggression, an effect that actually carried over from a prior environment to bias social behavior and introduce aggressive feelings into a new social context. Taken together, these studies provide preliminary support for the idea that psychological need thwarting can lead to aggressiveness. To date, the effects of competence-need deprivation have not been extensively explored from an SDT perspective. The present article builds upon the prior research by systematically examining aggression as an outcome of competence-need thwarting in a novel context.

Motivational Perspective and Electronic Gaming

Unlike many other pursuits, most people are not typically motivated to play electronic games for extrinsic rewards such as money or fame; instead such games are pursued because they provide inherent satisfactions. Indeed, according to SDT gaming is typically intrinsically motivated and provides individuals with rich opportunities for psychological need satisfactions (Ryan, Rigby, & Przybylski, 2006). In particular, many games provide ample competence need satisfactions—feelings of efficacy and skill growth, which are fundamental to intrinsic motivation (Deci & Ryan, 1985). For example, the graded challenges and detailed, unambiguous performance feedback in computer games can support satisfaction of the need for competence. Similarly, wide-ranging opportunities for exploration and action allow for satisfaction of the need for autonomy. Finally, the affordance of communication channels and group challenges emphasizing collaboration and competition can satisfy the need for relatedness. Supporting this idea, Ryan, Rigby, and Przybylski (2006) reported on a series of experiments demonstrating how in-game need satisfactions predicted both preferences for specific games, and game enjoyment. They also demonstrated that games that were need satisfying predicted positive short-term shifts in players' well-being. These relations were in evidence across a wide range of games, varying in content and genre.

Subsequent research by Przybylski, Ryan, and Rigby (2009) examined the motivational appeal of violent game content. They reported that opportunities for aggression in electronic games were not inherently motivating or necessarily more immersive. Instead, basic need supports, for competence and autonomy in particular, accounted for the lion's share of variability in violent game appeal and immersion. Like the earlier work of Ryan, Rigby, and Przybylski (2006), this research underscored the predictive utility of understanding games from a motivational vantage point. Przybylski et al. (2009) highlighted the extent to which games satisfied basic needs, a factor that was linked to how people engaged in games, independent of their particular contents or genres. That said, the motivation-focused approach based in SDT differs widely from how gaming-related aggression is typically studied.

The Gaming-Related Aggression Literature

The primary theoretical framework used to understand the links between electronic gaming and human aggression is the *general aggression model* (GAM; Anderson, Deuser, & DeNeve, 1995). The GAM is a social cognitive framework intended to model the paths by which exposure to violent media influences aggressive thoughts and feelings. Based on social learning theory (Bandura, 1977), the GAM argues that incidental exposure to media featuring violence is arousing and pleasurable and thus increases the future probability of intentional violent media exposure. Acute incidents of intentional self-exposure to violent media lead to chronic self-exposure. This kind of chronic exposure to violent media snowballs by increasing the accessibility of aggressive thoughts and cognitive schemas, heightening aggressive feelings, and resulting in aggressive behavior (for a comprehensive review, see Lindsay & Anderson, 2000). Originally, the GAM was designed to model the effects of violent content in traditional, passive forms of media such as comics, movies, and music. More recently however, the GAM has been used to study violence in computer games, which in contrast is an interactive domain.

Broadly speaking, GAM-based studies of gaming-related aggression have been conducted using one of three approaches: correlational studies, laboratory experiments, and longitudinal designs. A number of correlational and prospective studies have demonstrated small, yet consistent links from dispositional aggression, delinquency, and poor school performance to violent game engagement (e.g., Anderson, Gentile, & Buckley, 2007). These studies have used variants of the Violent Video Game Exposure (VVGE: Anderson & Dill, 2000) questionnaire to assess violent gaming levels, which has been somewhat controversial. Researchers have highlighted serious problems with the VVGE such as suspect validity because it does not accurately tap into everyday patterns of game play and may inflate effect-size estimates (Fikkers, Valkenburg, & Vossen, 2012). Further, an increasing number of recent prospective studies have indicated that the gaming-aggression link is not conclusive and is quite small when other factors are considered (Elson & Ferguson, in press). Demographic variability, parent–child relationship quality (Wallenius & Punamäki, 2008), peer deviance (Willoughby, Adachi, & Good, 2012), consistent measures of game content (Ferguson, 2011), and expert ratings of violent game exposure (e.g., von Salisch, Vogelgesang, Kristen, & Oppl, 2011) serve to moderate most observed relations between aggression and electronic gaming.

Because correlational and prospective studies leave open the causal direction of the relations—that is, whether violent play makes people somewhat more aggressive or dispositionally aggressive persons seek out violent games—an increasing number of studies have sought to address this issue of causality by examining the effects of violent gaming on players' aggressive feelings and behaviors postengagement in the laboratory. Like the cross-sectional (i.e., correlational) and prospective studies, a subset of these studies have shown increased postengagement aggression for those who played violent games (e.g., Anderson & Dill, 2000;

Anderson & Murphy, 2003), whereas others have not found these effects (e.g., Cicchirillo & Chory-Assad, 2005; Kirsh, 1998; McClure & Mears, 1986; Williams & Skoric, 2005).

Given this active debate, a number of dueling meta-analyses have recently been published on the growing number of contradicting experiments. Like the experiments themselves, these meta-analyses directly conflict in some cases (see Anderson et al., 2010, and Ferguson & Kilburn, 2010). That said, some findings from these summaries are relevant for a motivation-focused analysis of gaming-related aggression. For example, in reviewing a decade of experiments assessing links between aggression and computer games, Ferguson (2007) reported that some of the conflicting results in the gaming-related aggression area have emerged from intervening variables specific to interactive gaming contexts and unstandardized aggression measures. Similarly, Sherry's 2001 and 2007 meta-analyses reported evidence that a number of experimental factors present in the experimental literature, such as player arousal and the amount of experience, may differentially influence the relations between violent-game exposure and player aggression. Sherry's findings indicated that participants assigned to short periods of exposure showed the strongest link between gaming and aggression outcomes, whereas medium and longer-term periods of experimental exposure showed null and in some cases, reverse effects. Sherry speculated that the initial minutes of playing a video game may be highly stimulating—explaining larger effects for brief game exposure—but that this arousal might plateau and regress to the mean under conditions where play continues for longer time periods. Like Ferguson (2007), Sherry (2001, 2007) argued that the patterns of results demonstrated by their meta-analyses indicated the need to use new theoretical perspectives to study the gaming-aggression link.

A primary objective of the present research was to apply SDT to investigate gaming-related aggression through a motivation-based lens, extending this complex literature. As reviewed previously, SDT research examining acute and chronic impedance of the basic psychological needs for autonomy and relatedness showed that deprivation of these supports result in increased aggression. In contrast, the effects of competence need deprivation on aggressive thoughts, feelings, and behavior have not been as extensively explored from an SDT viewpoint. Computer gaming, a domain where human competence is of paramount importance, provides an excellent context for studying the effects of competence-thwarting experiences. Further, as past SDT-based gaming research indicates, competence is central to the interactive experiences that make games appealing. Competence thwarting would thus seem to serve as an ideal candidate for evaluation as a source of gaming-related aggression. Importantly, although SDT-based gaming research has focused on how virtual contexts can support needs and bolster well-being, no empirical work has examined the negative consequences of need thwarting in gaming.

Indeed, many of the positive motivational mechanisms that have been studied in terms of supporting experiences of competence also can be reviewed in terms of their potential to impede competence. For example, Ryan, Rigby, & Przybylski (2006) demonstrated that *mastery-of-controls*—the learned ability to effortlessly use a game's control interface to carry out actions in virtual environments—was essential to building an overall sense of competence in engaging in game play. Mastery-of-controls played an important role in game motivation as a necessary, but not sufficient, condition for achieving psychological need satisfying play. Electronic game developers aim to minimize the complexity of game controls in an attempt to hook players' interest and excitement but do not always succeed.

Despite the best efforts of game creators, the controls and rules of computer games are often quite elaborate and require significant trial and error learning and sustained effort on the players' part. Often this means that players require a number of gaming sessions to master the controls and understand the rules, and balance of challenges presented by a new game. This is especially the case with games intended for more experienced players because they provide more in-depth interactive experiences. Regarding balance, however, this investment eventually pays off in the players' favor. For example, complex games can offer more immersive experiences and provide players with important gratifications such as stress reduction (Reinecke, 2009) and opportunities to explore ideal self-aspects (Przybylski, Weinstein, Murayama, Lynch, & Ryan, 2012). Games succeed commercially when they strike the balance between complexity and competence support and fail when they do not strike this balance. Games that get this balance wrong are described by critics as providing "a steep learning curve."

Competence-impeding gaming experiences have the potential to aggravate and demotivate players. SDT-based research into gaming provides evidence that the skill-graded challenges of games are potential motivators because they can provide optimal challenges. However, challenges provided by computer-controlled algorithms can also be poorly scaled to a specific player's abilities, and they may present overly difficult challenges that result in repeated failures. This competence frustration anecdotally can lead to aggressive feelings and behaviors. For example, in multiplayer contexts where players vary widely in their skills, there is a phenomenon known to gamers as *rage-quitting* (Brook, 2009). Defined as the act of disconnecting gaming equipment, sometimes violently, rage-quitting is thought to result from sudden, high-intensity negative emotional experiences in response to feeling overwhelmed by competitors. Given these potential pitfalls, game designers strive to create games that attract and match players of similar skill levels and try to create algorithms that provide incremental challenges.

Game developers also make extensive use of demographic and behavioral market segmentation, targeting games primarily to one of two main audiences. The first category, known as *casual games*, tends to offer simple challenges that cater to desires of players seeking out spontaneous gaming sessions. *Hard-core games*, by contrast, provide much more difficult challenges tailored to the preferences and abilities of highly skilled and invested players. By dividing games in this way, game developers aim to create optimally engaging experiences that appeal to different kinds of game players. Given the different levels of skill necessary for different games, it is possible that players will at times encounter challenges beyond their capacities, so the present research examines the competence dimensions of gaming, focusing on its effects on postgame aggressive ideation and behaviors.

This approach, concerned with need thwarting, represents a shift away from focusing mainly on violent game content as a predictor of aggression. To date, the structural and motivational aspects of gaming have not been explored as a source of player aggression. Psychologically need satisfying play has been robustly linked to game

engagement, immersion, and positive short-term shifts in player well-being (Przybylski et al., 2009; Ryan, Rigby, & Przybylski, 2006). Given this, it is plausible that need-thwarting experiences in games have the opposite effect. Specifically, gaming contexts that impede the fundamental need for competence may undermine game appeal and well-being, as well as stoke postgame aggression. By empirically evaluating this idea, our aim is to bring a new perspective to the current literature and advance understanding about the motivational sources of aggressive feelings, thoughts, and behavior.

The Present Research

Seven studies were conducted to explore how competence-thwarting experiences of computer games influence indicators of aggression and gaming motivation. Given the active debate surrounding the links between violent content and aggression, the present work evaluated these need-thwarting hypotheses across a range of gaming contexts. We examined the effects of competence deprivation using specific designs that compared games varying in their violent content (Studies 1 and 7), that explicitly manipulated violent content (Studies 2 and 5), or that had nonviolent content (Studies 3, 4, and 6). Designing the studies in this way allowed us to disentangle game content from the motivational aspects of game structure.

In Study 1, we revisited a widely cited gaming related aggression study from a motivational perspective. The original work focused on how differences between the violent contents of two computer games related to player aggression. In this study, we explored how the varied motivational features of the games used in the experiment related to short-term shifts in aggressive feelings. In Study 2, we manipulated the violent content of a single game, holding the motivational features of the game constant. Our goal was to test how players' experiences of mastery related to aggressive feelings independent of the violent contents of the game.

In Studies 3 and 4, we shifted the focus to nonviolent gaming contexts to dig deeper into the factors that shape player experiences of competence as well as influence aggressive thoughts and feelings. In both experiments, we manipulated the complexity of a puzzle game's interface to test how this change influenced assessments of competence and aggression. First, we evaluated how complex game controls impacted the accessibility of aggressive thoughts and positivity of attitudes about the game. Second, we tested the idea that increases in aggression rooted in competence deprivation would undermine game enjoyment.

In Studies 5 and 6, we examined additional mechanisms through which games might influence player competence, aggressive feelings, and aggressive behavior. In Study 5, we investigated how different levels of player experience influenced aggressive feelings as mediated by players' felt competence, and in Study 6, we manipulated a puzzle game's level of challenge to evaluate how competence-impedance influences players' aggressive feelings and behavior.

Finally in Study 7, we shifted from experimental methods to a field study, recruiting self-selecting computer-game players. Our aim was to test the competence-impedance hypothesis in a community sample. We evaluated how variability in player competence as well as between-game variability in violent content related to postplay aggressive feelings and gaming enjoyment. Across the seven studies, our aim was to investigate a perspective that considers the interactivity of games as a factor in the gaming-related aggression area and to clarify how some aspects of gaming robustly contribute to players' aggressive thoughts, feelings, and behaviors. We did that by evaluating the need-thwarting hypothesis derived from SDT in the gaming domain, an area that is principally concerned with performance, interaction, and competence.

Study 1

Study 1 investigated how players' competent use of game interfaces related to gaming-related aggression. We adapted a widely cited experimental design focused on gaming and aggression (Anderson et al., 2004) that compared one violent game and one nonviolent game. Because the violent game had complex controls and the nonviolent exemplar had simpler controls, we tested the extent to which self-reported mastery-of-controls influenced short-term increases in aggressive feelings while controlling for the game content. We predicted that those playing the violent game (with a complex interface) would report lower levels of mastery-of-controls compared to those assigned to play the low-violence game, and we hypothesized that the players' mastery-of-controls would be negatively associated with aggressive affect.

Method

Procedure. Ninety-nine university undergraduates (41 males) received extra course credit for participating. Questionnaires were administered before and after a 20-min game engagement period. Following the completion of the first group of questionnaires, participants were randomly assigned to play one of two target games. Demographic information was collected on the initial set of questionnaires, aggressive feelings were assessed before and after game engagement, and the players' mastery-of-controls was measured following game engagement.

Target games. Participants were randomly assigned to play one of two target games identified by Anderson et al. (2004; Study 2) as representative of violent and nonviolent games. The nonviolent exemplar, *Glider Pro 4,* is a single-player game, designed for relatively short play, in which players use two keyboard keys to navigate a paper airplane through a two-dimensional image of a home interior. This skill can be readily mastered by gaming novices. The violent game used in this study, *Marathon 2,* is a game meant for dedicated computer game players. Designed for extended gaming sessions, players must use a mouse and 20 keyboard keys to navigate combat in a three-dimensional environment.

Measures. Survey measures were delivered in HTML format. All items, except for participant gender and age, used 7-point scales and utilized their scale as appropriate response anchors.

Aggressive affect. The 35-item State Hostility Scale was used to assess aggressive feelings (Anderson et al., 1995). Participants rated the extent to which they agreed with each hostile mood statement at that moment: "I feel irritated," "I feel like I am about to explode," and "I feel friendly" (reversed). Items were reversed appropriately and averaged, creating before-play ($M = 2.41$, $SD = 0.82$, $\alpha = .97$) and after-play aggressive affect scores ($M = 2.54$, $SD = 0.95$, $\alpha = .96$). Because we are interested in short-term shifts in aggressive feelings from pre- to postengagement, we

regressed postplay scores onto preplay scores and saved the standardized residual scores. This enabled us to quantify change in aggressive affect for each participant.

Mastery-of-controls. To assess participants' felt competence using game controls, we used an intuitive controls assessment used in previous motivation and gaming research (Ryan, Rigby, & Przybylski, 2006). Three items assessed how effortlessly participants found the control interface for carrying out their intentions in the game. Items included "The game controls are intuitive" and "When I wanted to do something in the game, it was easy to remember the corresponding control." The scale demonstrated acceptable reliability ($M = 4.59$, $SD = 1.59$, $\alpha = .72$).

Results

Demographics. Participants' age and gender were collected in all seven of the present studies. Where significant differences emerged, the relations were relatively small in magnitude (average $R^2 < .03$) or were not of interest in the present inquiry; for example, females tended to have less gaming experience and lower levels of competence during play than did males. We conducted all analyses presented in this article twice, once including participant demographics as control variables and once leaving them out. The direction, magnitude, and significance levels did not vary between these parallel analyses, so we did not report the analyses including demographics to conserve space.

Player competence. We hypothesized that poor mastery-of-controls would be associated with increased levels of aggressive feelings following game engagement when controlling for type of game and the interaction of game type and mastery-of-controls. To test this hypothesis, we regressed residualized change scores in aggressive feelings simultaneously on mastery-of-controls, $\beta(97) = -.33$, $p < .001$, $R^2 = .10$, and the target game type (nonviolent = −1, violent = +1), $\beta(97) = -.06$, $p = .55$. The data collected for Study 1 allowed us to evaluate the relation of players' felt competence (i.e., mastery-of-controls) to aggression when controlling for game content (violent vs. nonviolent). We evaluated a hierarchical moderation model to test the idea that game content moderated the relation between mastery-of-controls and aggressive feelings and found the interaction term was not significant, $\beta(95) = .07$, $p = .80$. We thus did not find evidence that player felt competence and game content interacted to account for additional variability in player aggression. Results from this provided initial support for the competence-impeding hypothesis: Struggling with feelings of incompetence at the game interface relates to increased levels of aggressive affect.

Target game differences. We predicted that the violent game used in this classic design would present a formidable challenge to mastery-of-controls, thus impeding participants' experiences of competence. Results obtained by regressing mastery-of-controls onto the game-condition code (nonviolent = −1, high violence = +1), $\beta(98) = -.20$, $p < .05$, $R^2 = .04$, showed the violent game presented a barrier to players' competence in using the controls. The present study also allowed us to test a conceptual replication of the aggression effects reported by Anderson et al. (2004; Study 2). Results derived by regressing change in aggressive affect onto game condition-code did not show higher aggression for those randomly assigned to play the violent game, $\beta(98) = .004$, $p = .97$.

We also examined the indirect effect that game content (violent vs. nonviolent) had on players' aggressive feelings by way of player competence. More specifically, we evaluated a mediation model in which we tested mastery-of-controls (the mediating variable in Figure 1) as an intervening factor linking game type (the independent variable) to short-term shifts in aggression (the outcome variable) following the bootstrapping approach outlined by Preacher and Hayes (2008). As noted previously, there was no total effect observed relating game type to change in aggressive feelings (path C), $\beta = -.08$, $p = .41$; mastery-of-controls was predicted by game type (path A), $\beta = -.25$, $p < .001$; and change in aggressive feelings was predicted by mastery-of-controls (path B), $\beta = -.32$, $p < .001$. Bootstrapping indicated a significant indirect effect (path A*B). The 95% confidence interval for the indirect path, based on 10,000 resamples, ranged from 0.02 to 0.33, and it accounted for 10.61% of the variability (R^2) in aggressive feelings. Given that the C and C′ paths were nonsignificant while the A*B path was significant, results indicated that being assigned to play the violent game had a positive influence on short-term shifts in aggressive feelings insofar as the more complex control interface impeded player competence.

Study 2

The aim of Study 2 was to conceptually replicate Study 1 in a more elegant way. Specifically in Study 2, we carefully manipulated only the graphics and narrative conceit of a single game to have a violent version and a nonviolent version of the same game. As in Study 1, we tested the hypothesis that players who felt incompetent using the game interface would report increased levels of aggressive feelings postengagement, over and above variability attributable to violent game content.

Method

Procedure. One hundred one undergraduates (36 males), mean age 19.6 years ($SD = 1.32$), received extra course credit in exchange for participating. Upon entering the lab, all participants engaged in a 20-min practice period with a version of the game created specifically for training purposes. Following this, demographic information and aggressive affect were assessed, and participants were randomly assigned to a high or low violence 20-min play period. These versions were created in order to present two levels of violence, holding constant other aspects of the game such as landscape, visual complexity, and gameplay mechanics.

Target game content. We created two additional gaming environments based on the popular and commercially available game *Half-Life 2* using a programmer tool kit. The first environ-

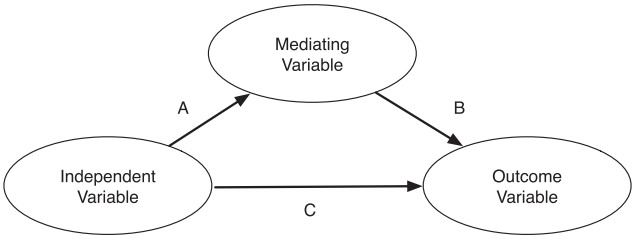

Figure 1. Conceptual mediation model.

ment was crafted to teach participants how to use the game-control interface to interact with the gaming environment. A friendly character programmed by the experimenter verbally supported participants, providing them with instructions, encouragement, and suggestions when they faltered. The other two environments (i.e., the original version and a version we created), which were used for the primary game play, were structurally identical but varied with respect to how the participant removed a competitor from play. In the low-violence condition, competitors (i.e., the computer) used a nonlethal "marker" to tag participants, and participants used a psychic-ball power that teleported competitors away. The power lifted and evaporated competitors to remove them. In the original high-violence condition, both the competitors (computer) and the participants used firearms to maim and dispatch the opponents, leaving them spewing blood and lying dead in the game world. Thus, the two game variants were motivationally fixed but varied in terms of level of violent content.

Measures. Participant age and gender were assessed before the challenge period, aggressive feelings were measured before ($M = 2.88$, $SD = 0.86$, $\alpha = .97$) and after the challenge period ($M = 2.53$, $SD = 0.82$, $\alpha = .93$), and mastery-of-controls ($M = 5.33$, $SD = 1.32$, $\alpha = .87$), was assessed after the challenge period. Table 1 presents zero-order correlations between observed variables.

Results

Manipulation check. To ensure that redesign influenced violent content and not game structure, we conducted two manipulation checks. To test whether the manipulation of content was successful, we assessed perceived threat using the single item: "I felt vulnerable during play." We regressed these scores onto game type (low violence = −1, high violence = +1), $\beta(100) = .27$, $p < .01$, $R^2 = .08$. This result showed the violent game was more threatening. To test if the design inadvertently manipulated player competence, we regressed mastery-of-controls scores onto game type, $\beta(100) = .08$, $p = .44$. The results showed that the violent content manipulation was successful (i.e., higher player threat) without influencing game structure (i.e., invariance in mastery-of-controls).

Player competence. We hypothesized that participants' poor mastery-of-controls, and thus their felt incompetence, would lead them to experience increased levels of aggression. To test this, we regressed residualized change scores in aggressive feelings simultaneously onto mastery-of-controls, $\beta(99) = -.22$, $p = .03$, and the target game type (nonviolent = −1, violent = +1), $\beta(99) = -.09$, $p = .32$. Results from this analysis conceptually replicated those derived from Study 1. Using a more rigorous method, we found that those who reported less mastery of the game interface also reported increased levels of aggressive feelings.

Table 1
Correlations Observed Between Variables in Study 2

Variable	1	2	3
1. Violent Content	—		
2. Threat (Content Manipulation Check)	.27**	—	
3. Mastery-of-Controls	.08	−.22*	—
4. Δ Aggressive Feelings	.08	.48***	−.31*

Note. $n = 101$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Player competence and target game differences. The experimental design allowed us to evaluate two additional relations: an overall effect for violent game content, in line with theory advanced by Anderson et al., 2004, and a potential interaction between player competence and content. Results derived by regressing change in aggressive affect onto game type, $\beta(99) = -.08$, $p = .41$ did not support a main effect for violent content. We evaluated a hierarchical moderation model to test if competence frustration and violent content interacted, and we found no significant interaction, $\beta(97) = .04$, $p = .65$.

Study 3

The central aim of Study 3 was to examine how competence-impeding gaming influences aggressive thoughts. The design used in Study 3 experimentally manipulated the control interface of a nonviolent puzzle game, making it either simple and intuitive or complex and highly challenging. Of interest was the effect that this competence-impeding interface might have on players' accessibility of aggressive thoughts and their evaluation of the game. We hypothesized that players randomly assigned to use the complex interface would report lower levels of mastery-of-controls, have faster access to aggressive thoughts, and hold less positive evaluations of the gaming experience.

Method

Participants and procedure. One hundred four undergraduates (30 males), mean age 19.92 years ($SD = 1.23$), participated in exchange for course credit. Participants were randomly assigned to 10 min of game play using either a simple or a complex control interface. Following game play, participants completed a lexical decision task assessing the accessibility of aggressive thoughts and a thought-listing task measuring the positivity of evaluations of the game.

Target game complexity. We used a variant of *Tetris*, a popular puzzle game, in Studies 3 and 4 because it provides straightforward challenges and unambiguous performance feedback that communicates an immediate sense of ability. Upon entering the lab, participants were randomly assigned to play by using either a simple button layout (see Figure 2A) or a complex layout requiring more effort to master (see Figure 2B).

Measures. After play, participants completed the lexical decision task to measures aggressive thoughts, a thought listing task to measure game attitude, and a self-report assessment of mastery-of-controls ($M = 3.01$, $SD = 1.30$, $\alpha = .93$). Table 2 presents zero-order correlations observed between study variables.

Lexical decision task: Aggressive thoughts. A go/no-go lexical decision task was used to evaluate how readily accessible aggressive thoughts were following game engagement. The objective of this task was to evaluate how quickly participants could identify words linked to aggression relative to neutral words. In full, participants completed 110 trials, the first 10 of which were practice trials. Each trial began with participants focusing on a fixation point of "+" for 200 ms, which was

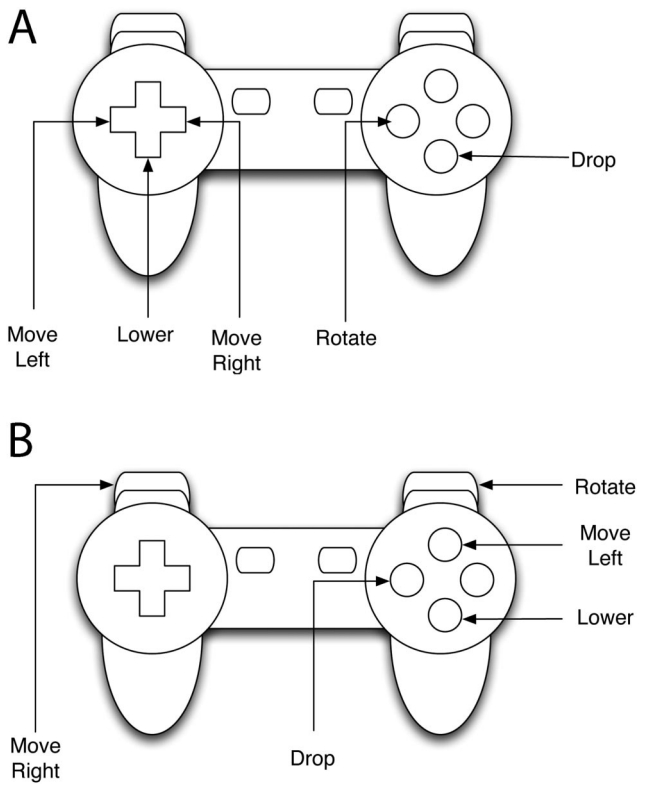

Figure 2. Simple (layout A) and complex (layout B) interfaces used in Studies 3 and 4.

replaced by a blank screen for 50 ms, and was in turn replaced by a string of letters that was either a legitimate or a plausible but illegitimate English word. Participants were instructed to strike the spacebar key as quickly as possible if the string was a legitimate English word and to wait until the next trial began if the string was a nonword (2,000 ms). Five practice trials presented neutral words, and five used text strings of plausible nonwords. The remaining trials presented 60 strings that were nonwords, 20 neutral words, and 20 that related to aggression (e.g., abuse, damage, injure, outrage). Reaction times to legitimate English words below 250 ms and above 1,500 ms were discarded as outliers, and these dropped cases comprised less than 4% of trials. There were no significant condition differences in word accuracy between conditions; reaction times were log transformed and aggressive thoughts scores were calculated for each participant by subtracting reaction times to aggression words from reaction times to neutral words. A technical problem resulted in response-time data not being recorded for the first eight participants. Where applicable, all analyses were done twice, once including these individuals and once excluding them. Because the effects did not differ, the second set of analyses is not reported.

Thought listing task: Game evaluation. A thought-listing task was used to tap into the participants' attitudes toward the game. Specifically, participants were instructed to rapidly jot down the first five thoughts that came to mind when thinking about the puzzle game. Participants then rated each thought on a 7-point scale in terms of how extremely positively (+3) versus extremely negatively (−3) it reflected on the game. Positivity of evaluations was calculated for each participant by averaging across all five ratings ($M = 0.05$, $SD = 1.43$, $\alpha = .73$).

Results

We hypothesized that players using the complex interface would report less mastery-of-controls, demonstrate faster access to aggressive thoughts, and report less positive attitudes toward the game compared to those who used the simple interface. To test these predictions, in three regression models, we regressed mastery of controls, $\beta(95) = -.76$, $p < .001$, $R^2 = .58$, aggressive thoughts, $\beta(95) = .23$, $p = .01$, $R^2 = .05$, and game evaluations, $\beta(95) = -.27$, $p < .01$, $R^2 = .07$, onto the condition codes for our manipulation of controls (simple = −1, complex = +1). These results provided support for the hypotheses.

We also hypothesized that players' mastery of game controls would be negatively related to aggressive thoughts and positively related to evaluations of the game. Results from two analyses, regressing aggressive thoughts, $\beta(95) = -.27$, $p < .01$, $R^2 = .07$, and game evaluations, $\beta(95) = .43$, $p < .001$, $R^2 = .19$, onto mastery-of-controls indicated that players who felt more mastery of the game's interface showed lower automatic access to aggressive thoughts and more positive attitudes about the game.

Study 4

Study 4, like its predecessor, manipulated the difficulty of game controls to gain a better understanding of how competence-impeding gaming related to player aggression. New to this study was a direct measure of players' competence-need satisfaction. We introduced this measure because we wanted to evaluate it as a mediating factor that linked both complexity (i.e., difficulty) of controls and reported mastery-of-controls to aggressive affect. In line with the competence-impedance hypothesis and previous SDT-based gaming research, we tested three hypotheses. First, we hypothesized that the difficult controls would be associated with increased aggressive feelings and decreased levels of gaming enjoyment. Second, we predicted that that mastery-of-controls would mediate the relation between complexity of the game interface and players' competence need satisfaction and also that players' competence need satisfaction would mediate the links between mastery-of-controls and aggressive feelings. Finally, we hypothesized that increased levels of aggressive feelings would be negatively associated with player enjoyment.

Table 2
Correlations Observed Between Variables in Study 3

Variable	1	2	3
1. Complexity of Controls	—		
2. Mastery-of-Controls	−.76***	—	
3. Aggressive Thoughts	.23*	−.27***	—
4. Positive Game Attitude	−.23*	.41***	−.13

Note. $n = 98$.
* $p < .05$. *** $p < .001$.

Method

Participants and procedure. One hundred forty-one undergraduates (52 males) participated in exchange for extra course credit. The procedures of this study closely followed those of Study 3 except that participants completed self-report measures in place of the lexical and thought-listing tasks used in the previous study.

Measures. In this study, we used a new measure of aggressive feelings to shorten the assessment from 35 items to six and to be able to disguise them more easily among filler items; before and after the play period, participants completed assessments of aggressive feelings (outlined below). Mastery-of-controls ($M = 3.56$, $SD = 1.88$, $\alpha = .90$), players' competence need satisfaction, and game enjoyment were assessed after game play. Table 3 presents zero-order correlations between variables.

Players' competence need satisfaction. Competence need satisfaction experienced during the game was assessed after the game using a three-item competence measure based on the widely used task competence subscale of the Intrinsic Motivation Inventory (IMI; Ryan, Mims, & Koestner, 1983), the items demonstrated good internal consistency ($M = 4.14$, $SD = 1.52$, $\alpha = .76$) in keeping with past research (Ryan, Rigby, & Przybylski, 2006; $\alpha = .82$). Item scores were averaged for each participant to compute players' competence need satisfaction scales.

Aggressive affect. State-level shifts in aggressive feelings were assessed using the hostile emotions subscale of the Positive and Negative Affect Schedule (PANAS-X; Watson & Clark, 1994). Participants rated the extent to which they felt aggressive by evaluating six adjectives (e.g., angry, hostile, scornful) before and after play based on how they felt at that moment. Before ($M = 2.50$, $SD = 0.78$, $\alpha = .90$) and after play ($M = 2.57$, $SD = 0.86$, $\alpha = .92$) state-level scores were computed for each participant, and change scores for aggression were calculated between these two scores using the method outlined in Study 1.

Game enjoyment. How much enjoyment and fun participants experienced during game play was assessed with four items adapted from the interest and enjoyment subscale of the IMI (Ryan et al., 1983). Sample items included "I enjoyed playing the game very much" and "I thought the game was boring" (reversed). Items were averaged to create total enjoyment scores ($M = 4.90$, $SD = 1.39$, $\alpha = .89$).

Results

Target game complexity. We hypothesized that participants assigned to use complex controls would experience lower levels of mastery-of-controls and feel a diminished sense of overall competence need satisfaction relative to those who played using the simple interface. Results derived from models regressing mastery-of-controls, $\beta(140) = -.65$, $p < .001$, $R^2 = .42$, and player competence need satisfaction, $\beta(140) = -.42$, $p < .001$, $R^2 = .19$, onto the target game interface (simple = −1, complex = +1) supported these expectations.

Player competence need satisfaction. We predicted that competence need satisfaction during gaming would serve to enhance game enjoyment, whereas diminished competence-need satisfaction would detract from enjoyment and foment aggression. Results derived by regressing change in aggressive feelings, $\beta(140) = -.39$, $p < .001$, $R^2 = .15$, and game enjoyment, $\beta(140) = .53$, $p < .001$, $R^2 = .28$, onto player competence-need satisfaction supported our expectations. Feeling competence-need satisfaction was associated with short-term decreases in aggressive affect and higher levels of player enjoyment.

Target game complexity and player competence need satisfaction. We hypothesized that the relation between interface complexity and players' overall competence-need satisfaction would be mediated by the players' mastery-of-controls. To test this expectation we regressed player competence simultaneously onto mastery-of-controls, $\beta(139) = .60$, $p < .001$, and complexity-of-controls $\beta(139) = -.04$, $p = .67$, and then we calculated the magnitude and significance of the indirect effect (path A*B) as outlined by Baron and Kenny (1986). Results demonstrated a significant indirect path linking complexity of controls to lower levels of player competence-need satisfaction by way of mastery-of-controls, $\beta = -.39$, $t(139) = -5.70$, $p < .001$.

Mediating role of player competence need satisfaction. We next tested the hypotheses that the influence of both the complexity of the game's interface and the mastery-of-controls on both short-term shifts in aggressive feelings and player enjoyment would be mediated by the overall levels of player competence-need satisfaction.

Aggressive feelings. To determine the magnitude and significance of an indirect effect linking complexity of controls and self-reported mastery-of-controls to aggression, we regressed change in aggression simultaneously onto complexity, $\beta(138) = -.18$, $p < .05$, and player competence-need satisfaction, $\beta(138) = -.34$, $p < .001$, in one model, and mastery-of-controls, $\beta(138) = -.09$, $p > .10$, and player competence-need satisfaction, $\beta(138) = -.48$, $p < .001$ in a second model. Results demonstrated two significant indirect paths, $\beta = -.19$, $t(139) = -2.94$, $p < .001$, for complexity and $\beta = -.26$, $t(139) = -4.03$, $p < .001$, for mastery. This provided evidence that both control complexity and mastery-of-controls related to aggressive feelings in part because they influenced overall player competence-need satisfaction.

Game enjoyment. To test the pattern and significance of indirect effects linking complexity of controls and mastery-of-controls to gaming enjoyment, we regressed player enjoyment simultaneously onto complexity, $\beta(138) = .12$, $p > .10$, and player competence, $\beta(138) = .59$, $p < .001$, in one model, and mastery-of-controls, $\beta(138) = -.07$, $p > .30$, and player competence-need satisfaction, $\beta(138) = .58$, $p < .001$, in a second. Results demonstrated two significant indirect paths (A*B), $\beta = -.23$, $t(139) = -2.08$, $p < .05$, for complexity, and $\beta = .32$, $t(139) = 6.43$, $p < .001$, for mastery. The result indicated that the complexity of game controls and sense of mastery-of-controls related to the appeal of

Table 3
Correlations Observed Between Variables in Study 4

Variable	1	2	3	4	5
1. Complexity of Controls	—				
2. Mastery-of-Controls	−.66***	—			
3. Player Competence	−.45***	.61***	—		
4. Game Enjoyment	−.15	.28***	.53***	—	
5. Δ Aggressive Feelings	.34***	−.20*	−.42***	−.30***	—

Note. $n = 141$.
* $p < .05$. *** $p < .001$.

the game insofar as they influenced overall player competence satisfaction.

Gaming-related aggression and enjoyment. We expected and found that players who became increasingly aggressive as a consequence of engagement would experience less enjoyment of play by regressing the former onto the latter, $\beta(140) = -.28$, $p < .001$, $R^2 = .08$. This result indicated that shifts in aggressive feelings were negatively associated with game enjoyment.

Study 5

The aim of Study 5 was to conceptually replicate and further evaluate how experimental manipulations meant to thwart players' competence needs would predict short-term shifts in aggression and enjoyment. Study 5 expanded on Study 1 where two games that were used incidentally differed in the difficulty of controls, and on Studies 3 and 4 where the complexity of the game controls was designed to make the controls in one condition more difficult than in the other. In Study 5, we used a complex interface in both conditions and gave players in one condition the opportunity to develop experience with the game.

This manipulation was inspired by meta-analytic findings in the gaming-related aggression literature (Sherry, 2001, 2007), which revealed that players' length of exposure to and experience with games moderated the extent to which play was associated with indicators of aggression. In particular, results showed that very brief periods of video game play were most strongly associated with aggression. Viewed from the SDT perspective we are applying, this result suggested to us that insufficient experience with games might be a source of increased aggression because limited experience would thwart mastery-of-controls and competence-need satisfaction. In line with this idea we evaluated four hypotheses.

First, we hypothesized that opportunities to build experience with a game would foster greater mastery-of-controls, leading to lower player aggression and higher game motivation. Second, we predicted that amount of player experience would positively influence overall competence-need satisfaction insofar as it bolstered mastery-of-controls. Third, we expected that players' competence-need satisfaction would serve to mediate links from both levels of player experience and mastery-of-controls to both aggressive feelings and motivation. Finally, we predicted that increased aggressive feelings would be negatively related to players' game motivation.

Method

Participants and procedure. One hundred twelve undergraduates (33 males) received extra course credit for participating. Upon entering the laboratory, participants were randomly assigned to one of four conditions: (a) experience and low violence challenge, (b) experience and high violence challenge, (c) no experience and low violence challenge, or (d) no experience and high violence challenge. Participants assigned to one of the two experience conditions engaged in a 10-min training period, which was an abbreviated version of the practice that all participants had in Study 2. Participants in the no-experience condition activities spent the 10-min period by playing with the game used in Studies 3 and 4. Therefore, the time and activity of using some types of game controls was constant across groups, but those in the no experience condition had less exposure to the target game. Following the practice period and before the 10-min challenge period, all participants completed a questionnaire. Participants then played one of the two versions of the game used in Study 2, presaged by short films that framed play as either kill-or-be killed combat in the high-violence condition or a friendly game of tag in the low-violence condition. After this, participants completed a second questionnaire, and the experimenter provided them with a choice of either continuing with another 10-min period of play or browsing the Internet. A technical problem prevented data from three participants being recorded, and they were dropped from the study.

Measures. Measures, using 5-point scales, of aggressive feelings were assessed before ($M = 1.31$, $SD = 0.48$, $\alpha = .72$) and after play ($M = 1.40$, $SD = 0.51$, $\alpha = .81$), and measures of mastery-of-controls ($M = 3.07$, $SD = 1.07$, $\alpha = .83$), overall player competence-need satisfaction ($M = 2.77$, $SD = 1.11$, $\alpha = .89$), and player motivation ($M = 2.48$, $SD = 0.72$, $\alpha = .92$) were measured only after engagement. Table 4 presents zero-order correlations between variables.

Player motivation. A behavioral assessment was used as an additional method for evaluating game appeal. Following the second survey, the experimenter offered participants specific choices regarding how to spend the remaining 10 min of laboratory time: they could persist at playing the game or browse the Internet. The time participants played with the game was considered a measure of *game motivation* and was derived from the frequently used free-choice measure of intrinsic motivation (Deci, 1971). To create a parsimonious, overall measure of game appeal, the behavioral

Table 4
Correlations Observed Between Variables in Study 5

Variable	1	2	3	4	5	6
1. Violent Content	—					
2. Game Experience	.01	—				
3. Threat (Manipulation Check for Content)	−.29**	.04	—			
4. Mastery-of-Controls	−.05	.27**	−.02	—		
5. Player Competence	.02	.38***	.01	.63***	—	
6. Player Motivation	−.14	.21*	.04	.33***	.48***	—
7. Δ Aggressive Feelings	.03	−.20*	−.02	−.16	−.30***	−.23*

Note. $n = 109$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

measure of game motivation was combined with the self-report measure of game enjoyment ($r = .44$) after each was standardized.

Results

Manipulation check. To ensure that we successfully manipulated the violent content of the computer game without affecting the motivational aspects of play, we regressed perceived threat (same measure used in Study 2), $\beta(108) = -.29$, $p < .01$, $R^2 = .07$, and mastery-of-controls, $\beta(108) = -.05$, $p > .50$, onto the game condition coding (low violence = −1, high violence = +1). Results demonstrated that the manipulation of violent content was successful: participants facing high violence challenges felt more threatened, and the manipulation of content did not influence players' perceptions of mastery.

Player experience. To test the prediction that the amount of players' experience with the game would be associated with higher levels of mastery-of-controls, player competence-need satisfaction, and game motivation, as well as with lower levels of aggressive feelings, we evaluated three regression models. Results derived by regressing mastery-of-controls, $\beta(108) = .27$, $p < .01$, $R^2 = .07$, player competence, $\beta(108) = .38$, $p < .001$, $R^2 = .15$, change in aggression, $\beta(108) = -.20$, $p < .05$, $R^2 = .04$, and game motivation $\beta(108) = .21$, $p < .05$, $R^2 = .05$, onto the amount of player experience (coded: no = −1, yes = +1), provided support for the first hypothesis.

Player experience and competence-need satisfaction. To evaluate our hypothesis that mastery-of-controls would serve to mediate the relations between player experience and player competence-need satisfaction, we regressed player competence satisfaction simultaneously onto mastery-of-controls, $\beta(107) = .57$, $p < .001$, and player experience, $\beta(107) = .23$, $p = .01$. We then calculated the magnitude and significance of the indirect effect relating these factors. Results demonstrated a significant indirect path (A*B), linking amount of experience to player competence satisfaction through its effect on mastery-of-controls, $\beta = .17$, $t(108) = 2.59$, $p < .001$.

Player experience effects mediated by competence-need satisfaction. We next did a series of analyses to evaluate the links between overall player experience and both change in aggression and game motivation as mediated by competence-need satisfaction. First, in two regression models, we regressed change in aggressive feelings, $\beta(108) = -.30$, $p < .001$, $R^2 = .09$, and player game motivation, $\beta(108) = .57$, $p < .001$, $R^2 = .33$, onto player experience. To ensure that the competence-impedance by lack of experience was independent of violent game content, we tested two additional regression models. We regressed change in aggression scores simultaneously onto player experience, $\beta(107) = -.30$, $p < .001$, and the game content coding (low violence = −1, high violence = +1), $\beta(107) = .03$, $p = .74$. We also evaluated game content as a moderator of the link from player experience to aggression, but the interaction term was not significant, $\beta(106) = .06$, $p = .56$. Taken together, these sets of analyses indicated that player experience was associated with lower levels of aggressive feelings and higher levels of player motivation—a pattern of relations that was robust across different levels of violent game content.

We then proceeded to evaluate the prediction that competence-need satisfaction would mediate the relations from both amount of player experience and mastery-of-controls to levels of aggressive feelings and player motivation.

Aggressive feelings. To determine the magnitude and significance of the indirect effect linking experience and mastery-of-controls to aggressive feelings, we regressed change in aggression simultaneously onto player experience, $\beta(107) = -.10$, $p > .30$, and player competence satisfaction, $\beta(107) = -.26$, $p < .01$, in one model, and mastery-of-controls, $\beta(107) = .06$, $p > .50$, and player competence satisfaction, $\beta(107) = -.34$, $p < .001$, in a second model. Results demonstrated two significant indirect paths (A*B), $\beta = -.11$, $t(108) = -3.05$, $p < .01$, for experience, and $\beta = -.19$, $t(108) = -0.43$, $p < .001$, for mastery; linking these factors to shifts in aggressive feelings by way of their influence on player competence-need satisfaction.

Player motivation. To test the pattern and significance of the indirect effect linking player experience and mastery-of-controls to player motivation, we regressed the composite motivation measure simultaneously onto player experience, $\beta(107) = .03$, $p > .50$, and player competence satisfaction, $\beta(107) = .46$, $p < .001$, in one model, and mastery-of-controls, $\beta(107) = .05$, $p > .50$, and player competence satisfaction, $\beta(107) = .45$, $p < .001$, in a second. Results demonstrated two significant indirect paths, $\beta = .17$, $t(108) = 3.31$, $p < .001$, for experience, and $\beta = .28$, $t(108) = 5.18$, $p < .001$, for mastery, linking these factors to game motivation by their effect on player competence-need satisfaction.

Gaming-related aggression and player motivation. The final hypothesis was that increased levels of aggressive feelings would be related to less game motivation. Results derived from regressing player motivation, $\beta(108) = -.22$, $p < .01$, $R^2 = .05$, onto change in aggression supported this prediction. We also tested for a direct effect, linking violent game content to players' aggressive feelings but did not find a significant effect, $\beta(108) = .03$, $p > .70$, thus replicating findings in previous studies.

Study 6

Study 6 was designed to further evaluate the robustness of the need-thwarting hypothesis by advancing the present research in two ways. First, we implemented an alternative manipulation to thwart players' felt competence in which we altered the algorithms that shaped the players' degree of challenge, making it overly difficult in one of the two conditions. This supplements the manipulation of different games (Study 1), different control interfaces (Studies 3 and 4), and different levels of experience (Study 5). Second, in Study 6, we utilized a behavioral assessment as the primary outcome, measuring the assignment of physical pain to another participant as an index of aggression. In this study we evaluated a single hypothesis: that high game difficulty intended to thwart competence would relate to higher levels of aggressive behavior as well as increased levels of aggressive feelings.

Method

Participants and procedure. Forty-seven undergraduates (21 males, $M_{age} = 20.31$ years, $SD = 3.92$) received £3.00 compensation in exchange for participating in this 0.5-hr experiment. Participants were informed that the purpose of the study was to understand how physiological experiences relate to computer game engagement and emotion. Participants (a) filled out a demo-

graphic survey, (b) completed a chilled water task described in detail below, (c) completed a very brief packet of self-report assessments, (d) played a computer game for 10 min, and then (e) filled out a second short collection of self-report measures.

Behavioral aggression task. After completing a demographic survey, participants were informed that they were going to undergo a physiological stressor—placing their hand in a bath of chilled water before playing a computer game. Participants were told that the length of time they were to hold their hand in the chilled water was selected for them by the preceding participant. In truth, this time period was fixed for all participants at 25 s. The bath was maintained at 4° Celsius, and the temperature was verified for each participant using an infrared thermometer (±1°). To ensure all participants considered this task aversive, participants completed a single item measure of discomfort; it asked them to rate how their hand felt immersed in chilled water using a 10-point scale ranging from 1 "no pain at all" to 10 "in extreme pain." This assessment showed participants considered immersing their hand in the chilled water as moderately painful ($M = 5.43$, $SD = 2.51$).

Target game manipulation. In this study, we employed a custom variant of the popular puzzle game *Tetris*. Participants were randomly assigned to one of two versions of the game, using either the game's standard algorithm (i.e., optimally challenging) or an adjusted algorithm (i.e., overly challenging, intended to be competence-impeding). In its standard form, the puzzle game's algorithm provides the player one of seven pieces at random in each round. By normally distributing these seven pieces, the game provides a level of challenge well suited to the abilities of most players. In contrast, the adjusted challenge system used in this study utilized the Bastet 0.41 algorithm (Poloni, 2006). Instead of providing pieces at random, the algorithm uses an evaluation function that calculates and ranks the relative utility of all possible pieces for each round of the game. The algorithm selects a set of four suboptimal pieces using these values. From these four pieces, the algorithm then provides the worst possible piece in 75% of rounds, second worst in 17%, third worst in 6%, and forth worst in 2% of rounds. By distributing the pieces using this method, the game can be understood to be overly difficult, actively undermining player effectiveness.

To ensure that our manipulation of the game's algorithms would succeed in thwarting player competence, we conducted a pilot study. Participants ($n = 54$) were randomly assigned to play the game for 10 min using the optimally challenging algorithm (coded: −1) or the overly challenging algorithm (coded: +1). We regressed self-reports of player competence need satisfaction ($\alpha = .92$), $\beta(53) = -.56$, $p < .001$, $R^2 = .31$, onto the condition code. This result indicated the manipulation of game structure succeeded in influencing player felt competence-need satisfaction; those playing with the standard algorithm reported higher levels of competence ($M = 3.65$, $SD = 1.09$) compared to those using the modified algorithm ($M = 2.29$, $SD = 0.95$).

Measures. To accommodate the constraints of a 30-min design, only a handful of self-report assessments were collected. Besides demographics, aggressive feelings were assessed before ($M = 1.39$, $SD = 0.51$, $\alpha = .73$), and after ($M = 1.22$, $SD = 0.37$, $\alpha = .72$) play using the same measure as Studies 4 and 5. Change scores for aggressive affect were computed using the same method used in previous studies.

Aggressive behavior. The amount of time participants assigned for the next participant to endure the aversive physiological task was used as a behavioral measure of aggression. After 10 min of puzzle play, participants were provided with a single item measure that asked: "Based on your experience in the experiment thus far, how long do you believe the next participant should be instructed to put his or her hand in the chilled water?" Overall, participants assigned the next participant approximately the same amount of time they themselves endured ($M_{sec} = 25.98$, $SD = 11.10$). In other words, participants tended to pass on roughly the same dose of discomfort as they experienced. In the present study, we interpreted deviations from this moderate baseline as the participants' willingness to inflict more or less pain on another human being, reflecting aggression.

Results

Player competence and aggressive feelings. We hypothesized that short term shifts in aggressive feelings would be predicted by the challenge level of the game. We evaluated this prediction by regressing change in aggressive feelings, $\beta(45) = .37$, $p = .009$, $R^2 = .14$, onto the condition code (optimal challenge algorithm coded: −1, overly challenging algorithm coded: +1). This result showed that increased aggressive affect related directly to level of challenge, with those assigned to play the highly challenging (i.e., competence-impeding) algorithm showing increased aggressive feelings.

Player competence and aggressive behavior. We further hypothesized that behavioral aggression—how long participants would assign a moderately painful experience to another person—would be predicted by the very-highly challenging game play. We evaluated this prediction by regressing behavioral aggression scores, $\beta(46) = .35$, $p = .017$, $R^2 = .12$, onto the condition code. This outcome indicates players who played the optimal puzzle algorithm tended to assign subsequent participants to nearly 3 s less of the chilled water task than they experienced themselves ($M_{sec} = 22.25$), whereas those who played using the competence-thwarting algorithm assigned over seven more seconds of physical pain ($M_{sec} = 29.87$).

Study 7

Study 7 was conducted to evaluate the generalizability of the competence-impedance hypothesis across everyday gaming contexts. In this study, we recruited a sample of self-selecting computer game players to examine the extent to which avid players' experiences of competence-need satisfaction related to aggressive feelings postengagement as well as game enjoyment. We hypothesized that the competence-need satisfaction of self-selecting players would be negatively linked to aggressive feelings postplay and positively related to game enjoyment. Moreover, we expected that player competence would be related to postplay aggression independent of violent game content. Finally, we predicted postplay aggressive feelings would be negatively related to player enjoyment.

Method

Participants and procedure. Three hundred eight regular videogame players (258 males), mean age = 23.5 years ($SD = 4.5$)

participated in exchange for entry into a raffle for an electronic game of their choice, worth approximately $50 to $75. This sample was drawn from members of a popular web-based community that provides online forums for discussions about electronic games and Internet culture. Because avid gamers typically play more than one computer game at a time, they were requested to provide data on the three games they had played most frequently in the past month. After data collection was completed, the levels of violent content present in games were coded in two ways.

Target games coding.

ESRB rating. The Entertainment Software Rating Board (ESRB) is a nonprofit group largely funded through the electronic games industry that assigns titles one of five ratings: E (Everyone), E10+ (Everyone 10 or older), T (Teen), M (Mature), or AO (Adults Only), which we coded from 1 to 5, respectively. Because ESRB categories have changed slightly over time, we used the most up to date ratings for each game. In this sample no game mentioned by the participants was an AO game, effectively creating a 1–4 scale.

Content rating. In addition to using the ESRB ratings, four raters blind to the purpose of the study, coded all the target games utilizing a more stringent method used in past research to quantify the intensity of computer game content (Przybylski et al., 2009). A rating of 1 was assigned to games with no violent content whatsoever (e.g., *SimCity 4*), a 2 was assigned to games with abstract violence (e.g., *Super Mario Bros. Wii*), a 3 was assigned to games with impersonal violence (e.g., *Civilization 4*), a 4 was assigned to games with fantasy violence (e.g., *World of Warcraft*), and a 5 was assigned to games with realistic violence (e.g., *Grand Theft Auto 4*). To verify reliability, 50 game titles were selected at random, and scores generated by the four raters were examined for consistency. Reliability was good ($k = .94$). These raters coded all remaining titles, and violent content scores were calculated for games by averaging their scores.

Measures. Participants were asked to reflect on the past 4 weeks of their computer gaming and select the three games they had played most in that time. They also provided reports of competence-need satisfaction ($M = 3.66$, $SD = 0.89$, $\alpha = .88$), enjoyment ($M = 4.08$, $SD = 0.80$, $\alpha = .79$), and aggressive feelings postplay ($M = 1.48$, $SD = 0.78$, $\alpha = .82$) for three favored games using 5-point response scales. To this end, participants completed abbreviated versions of game enjoyment (two items) and aggressive feelings (two items) scales to reduce burden. Because measures had to be completed three times by each participant, we only collected reports of postplay aggressive feelings. Despite these limitations, the measures showed good internal consistency.

Results

Analytic strategy. Given the nested nature of the data—each participant provided reports for three games—we evaluated the hypotheses using hierarchical linear modeling (HLM; Bryk & Raudenbush, 1992). This approach allowed us to test our predictions and make the best use of the hierarchical arrangement of data without inflating model estimates.

Player competence. To test the hypothesis that players' experiences of competence satisfaction in favored games would be related to their levels of enjoyment and postplay aggressive feelings, we evaluated the following Level 1 model:

$$Y = P_0 + P_1 + E$$

where Y is the outcome variable, P_0 reflects the intercept value of the outcome, P_1 represents player competence satisfaction, and E represents error at Level 1. We evaluated separate models for each outcome variable. Results indicated that player competence satisfaction was negatively associated with aggressive feelings, $b = -.11$, $t(919) = -3.27$, $p < .01$, and positively related to player enjoyment, $b = .38$, $t(919) = 11.01$, $p < .001$.

To test the hypothesis that player competence-need satisfaction was negatively related to postplay aggressive feelings independent of variability in violent content, we tested the following Level 1 model twice:

$$Y = P_0 + P_1 + P_2 + E$$

where Y is the outcome of postplay aggression, P_1 represents player competence satisfaction, P_2 represents violent game content, and E is error at Level 1. Results from separate models evaluating P_2 using ESRB ratings, $b = -.01$, $t(918) = 0.65$, *ns*, and P_2 using our violent content coding, $b = -.01$, $t(918) = 0.75$, *ns*, indicated that neither was significantly linked to postplay aggressive feelings. In both cases however, the link between player competence satisfaction and postplay aggressive feelings remained unchanged, $b = -.11$, $t(918) = -3.22$, $p < .05$.

Aggressive feelings. We hypothesized that high levels of aggressive feelings postplay would be negatively related to player enjoyment. The following Level 1 model examined enjoyment (Y), as a function of postplay aggressive feelings (P_1), and error at Level 1 (E).

$$Y = P_0 + P_1 + E$$

Results showed that aggressive feelings postplay were negatively related to player enjoyment, $b = -.13$, $t(919) = -2.87$, $p < .01$, as predicted.

General Discussion

The sources of human aggression are likely rooted in a diverse array of factors. Among these, popular interest and concerns about the effects of electronic gaming on aggression have gained the attention of numerous scientists, and the ways and extent to which gaming may be linked to aggression has become a hotly debated topic. The present research applies self-determination theory to bring a new perspective to this complex and increasingly nuanced literature. In seven studies, we focused on the ties between gaming and aggression through the lens of this motivational theory to evaluate a competence-impedance hypothesis. Our approach was built on recent SDT-based research that investigates the interactive and structural aspects of games and highlights the importance of need satisfaction for understanding the psychological experience of play (Przybylski et al., 2009; Ryan, Rigby, & Przybylski, 2006). In the present research, our core interest concerned the relations between the basic psychological need for competence and human aggression. We evaluated the prediction that games that undermined players' feelings of competence would lead to increases in players' aggressive thoughts, feelings, and behavior. Importantly,

we predicted and evaluated the idea that such relations would remain in evidence independent of violent game content, a factor oft studied in the gaming-related aggression literature.

Broadly speaking, the findings we derived across seven studies supported the competence-impedance hypothesis. We evaluated how manipulations of a range of gaming circumstances can serve to support or to undermine player competence through different of kinds of games (Study 1), complexity of game interfaces (Studies 3 and 4), levels of player experience with the game (Study 5), and the underlying algorithms that shape gaming challenges (Study 6), as well as differences in people's experience of competence at the same games (Studies 2 and 7). The present research thus married diverse manipulations intended to impact felt competence and participants' self-reports of felt competence with varied operationalizations of human aggression: short-term shifts in aggressive feelings (Studies 1, 2, 4, 5, and 6), the accessibility of aggressive thoughts (Study 3), aggressive behavior (Study 6), and evaluations within and between person variability in aggressive postplay feelings among self-selecting players (Study 7). Moreover, we controlled for baseline levels of aggression in the experimental studies and evaluated links between competence need satisfaction and aggression under conditions where violent game content was experimentally manipulated (Studies 1, 2, and 5), entirely absent (Studies 3, 4, and 6), and varied by player preference (Study 7). Across these operationalizations of competence supports versus thwarts and assessments of aggression, we found consistent support for the need-thwarting hypothesis across a spectrum of gaming content. Gaming that undermined the basic human need for competence was associated with short-term shifts in aggressive feelings, accessibility of aggressive thoughts, and aggressive behaviors, independent of the degree of violence contained within the games. What follows is a more detailed synopsis of the findings.

Studies 1 and 2 provided preliminary tests of the need-thwarting hypothesis, evaluating gaming contexts that featured varied levels of violent content. In the first study we revisited a widely discussed experiment (Anderson et al., 2004), comparing the effects of two different games, and in the second study we manipulated the violent content of a single game. Findings from Study 1 indicated that the exemplar games used in the classic design varied in motivational terms, suggesting that the use of different games to compare game contents can serve as unintended manipulations of competence-thwarting. In particular, our analysis showed that playing the violent game had an indirect effect on aggression insofar as its complex interface thwarted player competence. Study 2 provided a more a rigorous replication of Study 1, and results from both indicated that game engagement was associated with pre- to postplay shifts in aggressive affect for those players who felt little mastery of the game controls. Hence, the competence-impedance hypothesis received initial support in both of these studies.

Studies 3 and 4 directly manipulated player competence by modifying the complexity of the controls for a simple puzzle game. We found that the motivational thwarts influenced aggressive thoughts and feelings in a nonviolent gaming context. In Study 3, we tapped into the cognitive aspects of aggression. Using a lexical decision task, we found that competence-thwarting game interfaces led to increased accessibility of aggressive thoughts as well as less positive evaluations of the game. This is not to say that competence impedance contributed to aggressive intentions, but only faster recognition of aggression-related words. Study 4 focused on the motivational mechanisms linking game interface and aggressive feelings. Mediation analyses highlighted the key role of players' competence-need satisfaction in linking complex control interfaces and undermined mastery-of-controls to increased levels of aggressive affect. Results from Study 4 also showed that the enjoyment of games related positively to player competence and negatively to player aggression.

Inspired by meta-analyses (Sherry, 2001, 2007), Study 5 evaluated how different levels of player experience related to shifts in aggressive feelings and reintroduced an experimental manipulation of violent content to test the robustness of the competence-impedance hypothesis. Findings indicated that experience with a game had a direct effect on player competence-need satisfaction and consequently predicted less aggression. This pattern of relations conceptually replicated and extended those reported in meta-analyses by Sherry (2001, 2007), namely that past studies of aggression in gaming have tended to find the largest effects where participants were exposed to games for very short periods of time. Results from Study 5 showed that player experience fostered mastery over the game's interface as well as an overall sense of competence. By contrast, those who lacked experience with the game reported competence thwarting as well as increased levels of aggressive feelings. Further, these results highlighted the importance of player competence to motivation. Players high in competence were more likely to return to play during a free-choice period, whereas those experiencing less competence were less motivated.

Study 6 conceptually replicated and bolstered Studies 1–5 by actively manipulating player competence. We altered the underlying algorithms that shaped the game's challenges to create a version of play that continuously undermined player competence. In this study, we employed a behavioral measure of aggression, and results showed that gaming that thwarted the players' competence satisfaction increased aggressive feelings and also increased participant willingness to inflict an aversive physical experience on others.

Study 7 addressed the generalizability of the competence-impedance hypothesis, moving from the laboratory setting to a sample of self-selecting players. Results from this study indicated that player competence in everyday gaming settings was negatively associated with aggressive feelings postengagement—a finding that was robust controlling for variability in violent game content. Similarly, competence-need satisfaction related positively to player enjoyment, which was in turn negatively associated with postplay aggression. In sum, these findings supported our motivation-based approach and underscored the importance of considering, evaluating, and manipulating the motivational elements of gaming contexts when studying the influences that these environments have on aggressive thoughts, feelings, and behaviors.

Links With Prior Theories of Aggression

It is interesting to consider the current studies in relations to prior goal theories. For example, Dollard and colleagues (Dollard, Miller, Doob, Mowrer, & Sears; Miller, 1941) offered the *frustration-aggression hypothesis*, which proposes that interruption of goal pursuits is a necessary determinant of aggression. Our

SDT-based approach implies a more specific hypothesis, namely that the critical blockage is the thwarting of basic psychological need satisfactions. For example, in a classic study, Buss (1963) had college students experience one of three types of frustration: failure to win money, failure to earn a better grade, or failure on a task. All three groups showed more subsequent aggression than a control group that was not frustrated. For us, all these represented examples of thwarting of the need for competence. SDT research focused on thwarts to the needs for autonomy (Roth, Kanat-Maymon, & Bibi, 2011) and relatedness (Weinstein, 2009) have shown a conceptually similar pattern of findings.

Miller (1941) noted that frustration may instigate aggression, but this is not the only type of emotional or motivational perturbation it may produce. Operating from a motivational perspective, we agree with this position for two reasons. First, competence-impedance prompts a number of changes, including some we observed in the present research. For example, in Studies 4–7, we found competence thwarting was also linked (negatively) to player enjoyment and motivation. Second, links from need-thwarting leads to aggression will no doubt be subject to a number of moderators. In line with Miller, SDT-based work had indicated that the degree to which a person autonomously regulates aggressive thoughts and feelings will impact on observable aggressive behavior (see Legault, Green-Demers, Grant, & Chung, 2007).

The present studies also interface with a more contemporary formulation of the frustration-aggression hypothesis. Berkowitz (1989) highlighted aggression-facilitating cues as necessary conditions for goal frustrations to result in observable shifts in aggression. Although we did not specifically hypothesize interactions between violent cues or imagery and frustrated competence based on motivational theorizing, we did test for them in Studies 1, 2, and 5. In these studies, we did not find empirical support for the idea that violent gaming stimuli would amplify the intensity of links between undermined competence (i.e., frustration) and short-term shifts in aggressive feelings. These findings are not sufficient to disprove Berkowitz's (1989) reformulated frustration-aggression hypothesis, but in three experiments we found competence-impeding gaming provided the necessary and sufficient conditions for our measures of aggression, without amplification of the aggression by violent cues.

Links With Content-Oriented Theories of Aggression

The results we derived in the course of evaluating the competence-impedance hypothesis also speak to the lively debate surrounding violent gaming content as a source of human aggression. Specifically, the present research highlights how critical it is to experimentally disentangle interactive aspects of games when evaluating postengagement experiences. In Study 1, we found evidence suggesting that the widely used practice of using different games as prototypes of high versus low violence play is problematic from a motivational perspective. In this instance, the violent game provided a very complex interface, which impeded players developing mastery over the game's control interface. Mediation analysis provided evidence that this thwarting of competence led to aggressive feelings. Findings across all of the experiments highlighted the fact that games are inherently interactive and require careful consideration in motivational terms. The interactive aspects of games that drive their mass appeal also affect how they influence motivation and aggression. In line with Sherry (2007), the present work supports the idea that gaming is clearly delineated from passive forms of media such as television, films, and music. Whereas observing violence in passive activities such as watching television tends to enhance aggression in the viewers, that did not occur for the interactive activities of game playing in the current studies. The present findings specifically underline the importance of considering how game structure and player skill can and do systematically influence aggression.

The present research also speaks to the wider controversy surrounding the existence and magnitude of effects linking violent game content exposure to player aggression. The central aim of the present work was to investigate the robustness of the link between competence-impedance and aggression in gaming contexts. To this end, many of our studies included exposure to different levels of violent game content to evaluate the empirical rigor of our hypothesis. Our designs explicitly manipulated violent game content in Studies 1, 2, and 5 and observed variation in game violence in Study 7. It was both notable and unexpected to our research team that we were unable to replicate any violent content effects that the general aggression model would predict across these studies. Further, in testing the aggressive-cues corollary of the frustration-aggression hypothesis, we did not find any evidence for interactions between player (in)competence and violent content on aggression. Viewed together, the present findings do not provide support the GAM framing of gaming-related aggression. Instead, they suggest there is a more nuanced picture yet to be painted that describes the fuller nature of the gaming-aggression relations.

The present findings are more in line with some of the more recent studies of gaming-related aggression. A recently published longitudinal study by Willoughby et al. (2012) showed that the effects of violent game content exposure and behavioral correlates of aggression were quite small when important covariates such as peer deviance and family relationships were considered. The principal contribution of this study from a motivational perspective was the consideration given to game structure. Willoughby et al. 2012 identified the competitive aspect of some games, not violent contents per se, as a factor that accounted for part of the gaming-aggression link. If indeed there is a dark side to electronic gaming, it could be in the alienating potential of some forms of direct player competition. Indeed, from an SDT-based perspective, the way that competitive play is framed—in terms of narrative and motivational affordances—may be key to understanding the potential of competitive gaming scenarios to foster social isolation, player alienation, and possibly aggression (e.g., Adachi & Willoughby, 2011).

Avenues for Future Research

The present research features a number of limitations that suggest fruitful avenues for future work. First, the present studies had a narrow theoretical scope. Although competence is a key psychological need postulated by SDT, one that is especially salient in computer games, the present research can say little about features and experiences of games that thwart the other two basic psychological needs of relatedness and autonomy. The present work focused on the competence need because it has received the least attention in terms of the need-thwarting hypothesis in SDT research to date. That said, there is good reason to think that

deprivations of the need for relatedness, that is, for feeling a sense of belonging (Assor, Roth, & Deci, 2004), or the need for autonomy, that is, for feeling a sense of volition and choice (Ryan & Grolnick, 1986), could also prompt increased gaming-related aggression. For example, research focused on ostracism (e.g., Legate, Dehaan, Weinstein, & Ryan, 2013; Zadro, Williams, & Richardson, 2004) speaks to this idea, suggesting that even simple virtual contexts can thwart a sense of belonging or relatedness and foment negative feelings when they communicate rejection to users. Since there are many features of games that could represent impedances of relatedness and autonomy, such elements within gaming contexts will be the focus of future studies.

A second aspect that can be expanded upon was the present studies' brief temporal focus. The experimental studies focused either on short-term shifts in aggressive feelings or postengagement standing on aggression measures. Although nearly all research in the gaming-related aggression literature is similarly limited, we can say little about how much of a lasting effect undermined competence has on aggression or whether such aggression might endure across contexts. Said differently, the present work looked only at the short-term effects of need thwarting play, so examining the temporal and contextual carry-over effects from gaming remain open questions. Previous SDT-based work indicates that chronic need thwarting might dispose some to be especially aggressive under psychosocial acute stresses (i.e., a diathesis stress model), but empirical studies are still at a formative stage.

Third, the present research drew on a relatively narrow demographic band of participants. Although the sample was representative of the primary demographic that encompasses the majority of passionate players, we did not focus on other groups of key concern from popular and criminological perspectives. Future work examining these effects in vulnerable populations such as children and individuals with temperamental or persistent psychosocial stressors has not been investigated and constitutes a necessary next step for the field (e.g., Elson & Ferguson, in press; Ferguson, 2011).

Finally, our approach for operationalizing human aggression merits note and highlights wider issues in the gaming-related aggression literature. In most of our studies, we measured the affective dimensions of aggression, assessing either changes in aggressive feelings (Studies 1, 2, and 4–6) or postplay levels of aggressive feelings (Study 7). We bolstered the value of these self-report instruments by utilizing residualized change scores, values that controlled for variability in preengagement differences in aggressive feelings. This provided a clearer perspective of how gaming influenced aggression because it controlled for how participants felt before play and was thus an improvement on most work in the gaming-related aggression literature that depends almost entirely on postplay assessments. Studies 3 and 6 presented important exceptions to our use of self-reports. In Study 3, we used a lexical decision task to tap into the cognitive aspects of aggression, and in Study 6 we measured aggression using a behavioral procedure. Although the ecological and internal validity of many laboratory-based behavioral tasks such as noise blasts and hot sauce are suspect (Ferguson, 2007), our approach did aim to give participants a fair dose of the aversive experience they were given the opportunity to pass on to another person. Compared to other lab-based aggression measures that can be computed in multiple ways (e.g., Breuer, Elson, Mohseni, & Sharkow, 2012), our approach was straightforward and psychologically valid. Insofar as these methods tapped into different aspects of human aggression in laboratory contexts, we believe they present a consistent effort to measure the emotional, cognitive, and behavioral facets of aggression. However, at present all laboratory-based behavioral measures of human aggression critically require external validation. Research linking standardized lab-based behavioral measures of aggression to real-world aggression measures are needed to contextualize the clinical and policy significance of findings.

Closing Remarks

The possibility that electronic games and player aggression are causally linked continues to be intensely debated amongst researchers (Anderson et al., 2007; Ferguson & Dyck, 2012). To date, most scientific interest in this gaming-related aggression literature has focused on the passive aspects of games, whether the violent contents of some games desensitize or aggravate players. The present studies investigated a different pathway through which games and aggression may be linked. We examined gaming as an interactive activity entailing motivational experiences that can support or undermine the psychological need for competence. Our findings indicated that impedances of player competence satisfactions increase cognitive, affective, and behavioral aspects of aggression. These effects were wholly independent of violent game contents.

These findings hold significance for the future study of both electronic games and other contexts. Psychological need-thwarting is something that can and does happen in myriad ways across most life domains, including parenting, sports, work, and education. Exploring how this happens and how to ameliorate these effects leads to extremely important questions for future motivation research. Herein we presented a step toward this goal, demonstrating how need thwarting can occur within computer games—a domain wherein, it is often thought, feelings of aggression arise. In so doing, we highlighted the robust role that need impedance can have as a proximal source of aggressiveness.

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See page 499 for a correction to this article.

Correction to Przybylski, Deci, Rigby, and Ryan (2013)

In the article "Competence-Impeding Electronic Games and Players' Aggressive Feelings, Thoughts, and Behaviors" by Andrew K. Przybylski, Edward Deci, C. Scott Rigby, and Richard M. Ryan (*Journal of Personality and Social Psychology*, Advance online publication. December 30, 2013. doi:10.1037/a0034820), the name of author Edward Deci was missing his middle name initial and should have read as Edward L. Deci. In addition, an incorrect version of figure 1 was published.

All versions of this article have been corrected.

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