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Paper presented at the Biennial Meeting of the Society for Research in Child Development,

Atlanta, GA

April 9, 2005

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4/9/05

Abstract

A great deal is known about how to teach effectively. We describe several of the "best practices" of learning and instruction, and show how violent video games use those practices. Three hypotheses are advanced and tested. First, curricula that teach the same underlying concepts across contexts and domains have the best likelihood of transfer. Second, learning is more likely to be long-term if practice is distributed across time, in contrast to massed practice. Third, systematic physiological and emotional responsiveness can improve learning, and may lead to what some call video game "addiction." Data with elementary school children, middle school children, and college students support each of these hypotheses. Finally, we describe what educators can learn from the successful instructional practices of video games.

"The great thing, then, in all education, is to *make our nervous system our ally instead of our enemy … we must make automatic and habitual, as early as possible, as many useful actions as we can*, and guard against the growing into ways that are likely to be disadvantageous to us, as we should guard against the plague."

William James (*The Principles of Psychology*, p 122)

Suppose you wanted to teach so that all of the following instructional goals were demonstrable:

- Steady progress in mastering the required knowledge and skills established for the curriculum at successive levels of difficulty.
- Multiple ways of solving problems were practiced to avoid the "one best way" mentality and thus increase the probability of transferring those acquired skills to different settings.
- Students who originally learn to a high standard and then voluntarily distribute their practice day after day, thus providing overlearning of the knowledge and skills to the point of automaticity.
- Instructional activities which provide an adrenaline rush that truly excites the learners, even to the point of seeming addicted to their studies.
- Students' rewards for achieving success at each level is the opportunity to use more advanced tools and higher-level skills to attempt even more difficult material in the curriculum.
- Popularity is gained by achieving success in the curriculum, with students proud to be seen as high achievers and/or aspire to be like the highest achieving models.
- Success is available to all--no child need be left behind-- because previous academic record, standardized test scores, or socio-economic status have been rendered of negligible importance.

"This is an educational system to die for," most teachers and parents might exclaim. And yet, it exists and few of us – educators or parents – have more than a cursory awareness of it. The educational system of which we speak is video games, particularly violent video games.

Yes, there is evidence for all of the above accomplishments of the violent video game curricula that modern societies have accepted as mainstream education/entertainment for their children. It is our purpose in this report to show two things: first, how these games use all the best-practice principles of learning and instruction to captivate our children in the above ways and, second, what we might learn from the successes of the video game curricula that might transfer to our official scholastic curricula.

Playing the Game

Consider the following first-person account of playing a state-of-the-art violent game, *Manhunt* (from the team who also created the top-selling *Grand Theft Auto* series). You have been captured by a demented film-maker who drops you into a gang-infested slum. While the gangs think they are hunting you, they don't know the real plot: that you are hunting them, while the director records each act of murder on film. Since you are outnumbered and could easily be mobbed, you cannot just jump in and fight everyone. Rather, you must be silent and patient, tracking your prey so that you can strike from behind. One reviewer's account continues (Grossman, 2003):

> *Manhunt* is an exceptionally violent game – garrote a villain with a sharp wire, and a finely-rendered mist of blood sprays from his severed carotid. Interestingly, the game's premise feels like an attempt to help you sidestep any twinges of conscience you may feel at your own sadism – hey it's that sick director guy who's making you do this! Not that this is any excuse, but if you can make your peace with the carnage, the game play is a bracing change from the usual button-mashing slugfests: *Manhunt*'s thrills aren't in the action; they're in the taut, panting breaks in between, the up slope of the roller coaster, the pause just before the kill. It's a game that rewards thought and patience – which is, of course, a virtue. You might mention that when you tell your kids it will be a while before they're old enough to play it. (p. 105)

Despite the final sentence caveat for parents, few can be so naive as to believe that such games are only being played by adults. (In addition, it is worth debating whether such games are healthy for adults, given that the evidence suggests adults are as affected as children, but that is an issue for discussion elsewhere.) Among elementary and middle-school populations, girls play video games for an average of about 5.5 hours/week and boys average 13 hours/week (Anderson, Gentile, & Buckley, under review; D. Gentile, Lynch, Linder, & Walsh, 2004). In a nationally representative sample of parents, D. Gentile & Walsh (2002) found that young children aged two to seven play an average of 43 minutes/day, and Woodard and Gridina (2000) reported that preschoolers aged two to five play an average of 28 minutes/day. Comparing these data with previous studies shows that the amount of time spent playing video games is increasing, but not at the expense of television viewing which has remained stable (D. Gentile & Anderson, 2003). Although most children play video games, the average age of video game players has steadily risen to age 29, demonstrating that many children continue playing into adulthood (Entertainment Software Association, 2004).

Data about children's amount of time spent playing video games are content-independent and, like the data on television watching, are correlated with many other risk factors for health such as obesity (Berkey et al., 2000; Subrahmanyam et al., 2000; Vandewater, Shim, & Caplovitz, 2004) as well for poorer academic performance (e.g., Anderson & Dill, 2000; Anderson et al., under review; D. Gentile et al., 2004; Harris & Williams, 1985). When video games play is analyzed for violent content, additional risk factors are observed for aggressive behavior and desensitization to violence (again in parallel with the data on viewing violent television; e.g., Anderson et al., 2003; Anderson et al., under review; D. Gentile, 2003; D. Gentile et al., 2004).

As the entertainment industry and reviewers regularly point out, viewer discretion and parental monitoring are advised. But if one examines the natural developmental progression of how people get hooked into video games, one can understand how parents who play games have habituated to the violence over time and may therefore not be able to make well-informed judgments. Moreover, most parents do not know that as many as 89% of video games include violent content (Children Now, 2001), with about half including violence against others culminating in serious injury or death (Children Now, 2001; Dietz, 1998; Dill, Gentile, Richter, & Dill, in press). By inventing educational and entertaining games for preschoolers and then slowly but surely including more and more need for "viewer discretion," the industry trains people to be ready – emotionally, cognitively, and behaviorally – for games like *Manhunt*. Most consumers are not conscious of the learning principles underlying this progression, but the developers and marketers probably are, if only by realizing that they need to keep creating games that outdo previous games in order to capture a larger share of the market.

Video Games as Exemplary Teachers

Although the research has become clearer that violent video games can cause people to have more aggressive thoughts, feelings, and behaviors (e.g., Anderson & Bushman, 2001; Anderson, 2004), our goal here is to praise video games for their effective use of psychological principles of learning, cognition, and instruction. Video games are excellent teachers along several dimensions.

First, the games have clear objectives, often set at multiple difficulty levels to adapt to the prior knowledge and skills of each learner. Second, and related to the first, the pace of the activities can be adjusted for faster or slower learners, novices or experts, to truly deliver differentiated instruction. Inventing ways of matching objectives and pace to the capabilities of learners is no small accomplishment, since it is central to most if not all models of instruction from Glaser's (1962) and Hunter's (1982) specification of objectives at the correct level of difficulty to Carroll's (1963; 1989) concept of aptitude as time needed to learn to an established standard of mastery. Moreover, there is empirical evidence for many memory tasks that the average learning rate of the top third of any class is at least three times faster than the bottom third, with the fastest and slowest learners in the same class differing by even larger multiples (e.g., J.R. Gentile & Lalley, 2003; J.R. Gentile, Voelkl, Mt. Pleasant, & Monaco, 1995).

Third, learning is active with practice, feedback, and more practice to the point of mastery. This is in contrast to much classroom learning in which teachers lecture on or demonstrate a concept or skill, then take questions, if any, and move on to cover other material. But as is well known in the development of skills such as sports or music, learners have questions only after attempting to *do* what was demonstrated. Feedback and corrections operate only then, which in classrooms often happens only much later (e.g., on a unit test) and thus is too late to be of much help. Practice to the point of mastery – that is, to a higher rather than lower standard of accuracy – is predictive of how much is remembered later, as well as how much savings will occur in relearning at a later date (Bahrick, 1984; Ebbinghaus, 1885; J. R. Gentile & Lalley, 2003; Semb & Ellis, 1994; Willingham, 2004).

Fourth, once mastered, the knowledge and skills are practiced further to provide *overlearning*. This helps the knowledge and skills become automatized and consolidated in memory, so that the learner can begin to focus consciously on comprehending or applying new information. In other words, the novice is beginning to process and organize new information with more expertise (Chase & Simon, 1973; Chi, Glaser, & Rees, 1982). Bloom (1986) illustrated this process for developing reading ability. Only after knowledge of letters and sounds are automatized can the budding reader recognize whole words. Only after achieving a number of "sight words" can the reader focus on the meaning of the sentences.

Fifth, mastery of an objective is reinforced both extrinsically (with points, totals, better weapons, more money, more health, etc.) and intrinsically (by advancement to higher levels of complexity and the self-esteem that accompanies increased competence). This last point is perhaps underappreciated by educators who have been told to praise often so as to increase children's self-esteem. But a wide range of theorists agree that perceived self-efficacy arises from competence or efficacy (Bandura, 1977), and lack of competence leads to learned helplessness (Seligman, 1975). Likewise, mastering the essential tasks of school results in solving the identity crisis of that age ("I am what I can do"), while nonmastery leads to feelings of inferiority (Erikson, 1963; 1968; 1980). Vygotsky (1962) also speaks of the "rupture," "turning point," or "struggle" that is involved in maturation and which is resolved by mastering society's developmental tasks. Finally, Piaget's central motivational construct is "cognitive conflict," which arises when there is a discrepancy between a child's perception of an event and disconfirming evidence (e.g., in the conservation of liquid's tasks; Piaget & Inhelder, 1941). This cognitive conflict establishes a tension (between assimilation and accommodation in the equilibrium mechanism), which produces the ultimate teachable moment. That is, the child recognizes what he or she does not understand and is now ready to learn it. Accomplishing this difficult task earns self-esteem, self-efficacy, and indeed a new identity (when, for example, a non-reader is now a reader).

Sixth, and related to the fifth, video games are well-sequenced in levels of increasing difficulty, complexity or pace, with success at subsequent levels contingent upon competencies mastered at previous levels. Consider the example of the popular first-person-shooter game[1] *Halo*. For the first hour of play, the game not only sets up the story (you are a warrior in a science fiction future, in which you are saving humans from attacking aliens), but also teaches you how to play. The game characters and spaceship computer teach you systematically which control buttons to use to look around, to walk, to crouch, to jump, to pick up weapons, to reload, etc. This is necessary partly because of the complexity of the game controller (13 buttons, joysticks, pads, and triggers). But after teaching a specific skill, the game immediately gives you a chance to practice it. The game then gives immediate feedback, including adapting to your specific skill using the controller. For example, the first author had difficulty

[1] A "first-person-shooter" game is one in which the action is seen from the point of view of the main character. Usually one sees as if one were "in" the game, so when you hold a gun in front of you, you see the barrel of the weapon and sometimes the hand holding it. The "shooter" part of the definition should be self-evident. This type of game can be distinguished from other violent games in which the action is seen from a distance (a third-person perspective). First-person-shooters have become so popular, they are now known by that title as a distinct genre of game.

with the joystick in looking up and down – it was more "natural" to pull back to look up and push forward to look down (as one would in an airplane). This was contrary to the default settings on the game. The game noticed this, and inverted the joystick controls to fit the author's predilection, and asked if this was better. Over the course of the first hour of play, a series of skills are taught systematically, with feedback and opportunities for practice, until one has learned several skills necessary for successful game play (such as how to use the information shown on the display, when to reload, and how to sneak up behind one's prey for silent kills).

This is the embodiment of the *spiral curriculum* (Bruner, 1960), in which each learning objective has identifiable prerequisites which, when mastered, facilitate transfer to the next level of difficulty. Thus, learners come to see mastery of an objective not as the completion of a learning objective, or "benchmark" in current educational lingo (as J.R. Gentile & Lalley quipped, "The easiest way to achieve benchmarks…is to sit too long on a bench;" 2003, p. 133). Rather, mastery is properly conceived as the beginning: you are now ready to use that knowledge or skill in some meaningful way on the road toward expertise.

Seventh, because video games are adaptable in level of difficulty and pace, they encourage a close-to-optimal combination of massed and distributed practice. Initial attempts at the game, no matter how abysmal, receive feedback or a score immediately and few can resist trying again and again until they begin to show progress. Such massed practice eventually begins to produce diminishing returns (when a plateau is reached or fatigue sets in). However, the repetition has begun to develop both physical and mental skills and habits (e.g., eye-hand coordination, knowledge of what is required, etc.) on parts of the task, but always in the context of the whole sequence. Each subsequent encounter with the game provides the memory benefits of distributed practice – namely, relearning anything that was forgotten; providing new cues for memory, interpreting new information or examples with what is already in memory and reorganizing the memory accordingly. This combination of massed practice to build sufficient initial mastery to play the game, followed by distributed practice over days or weeks to prevent forgetting is optimal for the development of automatized structures of knowledge, or schemas (e.g., Ellis & Hunt, 1993; J. R. Anderson, 1983; Glaser, 1984).

Eighth, knowledge or skills learned and practiced in multiple ways, on several problems, or in a variety of contexts are more likely to transfer than when practiced in only one way on a single kind of problem, or the same context. One reason for this, in Bransford, Brown, and Cocking's words, is that "with multiple contexts, students are more likely to abstract the relevant features of concepts and develop a more flexible representation of knowledge" (1999, p. 66). Multiple contexts also provide a variety of cues for recall rather than memory having to rely on availability of cues from the original context or problem situation, what Tulving and Thompson (1973) called the encoding specificity principle, and Brown, Collins, & Duguid (1989) called situated cognition.

Multiple ways of solving problems or performing skills also avoid the mental sets or rigidities that naturally arise from success with a particular method (e.g., Luchins, 1942). To avoid the aversion so many Americans have to the metric system, for example, students need to learn to measure in multiple ways – feet and meters, pounds and grams – and then practice using them in math, science, and social problems in school and in the rest of life. Learning multiple ways of representing division of fractions, rather than simply memorizing the "invert and multiply" algorithm is more likely to lead to greater comprehension than the same amount of time spent simply practicing the algorithm. Violent video games are set in many contexts. Some are set in historical times, some are modern, some are very realistic, some are cartoonish, some are futuristic, etc. Some portray hand-to-hand combat, some use small arms, some use military weapons, some use laser guns, and one popular game even uses a golf club as a lethal weapon. The common feature among all of these different games and contexts is that violence is the solution to whatever problem the gamer/student faces. This is exactly the best way to teach so that the student will be able to transfer the underlying concept to new situations.

In addition to the above well-known principles of educational instruction, video game producers also use time-honored "tricks" that have been well-known by the media and advertisers. For example, Kubey & Csikszentmihalyi (2002) describe how the "orienting response," first described by Ivan Pavlov, has been used to increase attention to television ads. Visual or auditory changes, such as edits that change the angle of camera view or sound effects, make us look at them. Increasing the frequency of edits has been shown to improve recognition memory (up to a point…there is an optimal level). Furthermore, provocative scenes of sex and violence not only capture one's attention, but also supply vivid visual images, which are known to create better memory than the same information provided verbally (e.g., Paivio & Begg, 1981). Active participation in aggressive or provocative scenes in video games increases physiological arousal (e.g., Ballard & Weist, 1996; Gwinup, Haw, & Elias, 1983; Lynch, 1994; Lynch, 1999; Murphy, Alpert, & Walker, 1992; Segal & Dietz, 1991). This physiological responding in the context of "playing fun games" is likely to condition one's emotions to such activities, not unlike other addictive "highs." Indeed, there is some research demonstrating that the brain releases dopamine in response to playing violent video games (Koepp et al., 1998). Dopaminergic neurotransmission may also be involved in learning, reinforcement of behavior, attention, and sensorimotor integration as well (Smith, McEvoy, & Gevins, 1999). Because the difficulty of the games, which varies as one progresses, guarantees that reinforcement will be intermittent, not continuous, they take full advantage of the addictive nature of intermittent reinforcement (e.g., slot machines). While research in this area is still young, there is evidence that video games may indeed be "addictive" for some people, perhaps as many as 15% to 20% of players (Griffiths & Hunt, 1998; Hauge & Gentile, 2003; Yee, 2001).

Finally, these games are marketed widely as something everyone must have, thus making skill in such games an important social currency for popularity among children (especially among boys).

The General Aggression Model and Research Hypotheses

Although the major thrust of the present article is to discuss how educational theory can be used to predict violent video game effects, it is important to note that the studies described below were designed under the theoretical framework of the General Aggression Model (GAM; see Anderson & Carnagey, 2004; Anderson, Gentile, & Buckley, under review; Anderson & Huesmann, 2003 for detailed descriptions). A brief description is necessary here to help understand the choice of variables measured.

Although the GAM has a single aggressive episode as its central focus, it also can be used to predict long-term learning of aggression. Figure 1 displays many of the personality variables believed to be influenced by an individual's ongoing bio-social interactions. What is learned across time depends on the experiences an individual has, including interactions with biological factors (such as biological predispositions to learn certain types of associations through rewards and punishments).

Violent video games may affect individuals by having influences on their aggressive beliefs, schemata, scripts, and by desensitizing them to aggression. One type of schema that has received a good amount of empirical support is called a hostile attribution bias (see Crick & Dodge, 1994, and Crick et al., 1999 for reviews). Having a hostile attribution bias is basically a filter in which a person perceives the outside world in aggressive terms. In response to an ambiguous situation (e.g., one gets bumped in the hallway), the person with a hostile attribution bias assumes that the bump had hostile intent instead of assuming it was accidental. Once children begin to have this bias, they are much more likely to begin to respond aggressively to perceived provocations (Crick, 1995; Crick et al., 1999). As children begin to see the world in aggressive terms and therefore begin to act more aggressively, their personality changes over time to become more aggressive and hostile. These changes will result in increased opportunities for aggressive behavior, because of both changes in the individual's personality variables and changes in the situations the individual is likely to get involved in as others react to the individual. Thus these experiences and changes over time act as distal processes and causes of later aggressive encounters. Once in a specific social situation where aggressive behaviors are a potential outcome, proximal influences such as the individual's affect, cognitions, and physiological arousal will be relevant factors partially determining whether the individual will react aggressively (see Anderson & Bushman, 2002 and Anderson & Huesmann, 2003 for further details).

Several testable hypotheses can be formed from the educational principles described above, three of which will be addressed here. First, curricula that teach the same underlying concepts across contexts and domains have the best likelihood of transfer. Therefore, students who play multiple violent video games are more likely to learn aggressive cognitions and behaviors than students who generally play fewer violent video games. Second, learning is more likely to be long-term if practice is distributed across time, in contrast to massed practice (our students know this as "cramming"). Therefore, students who play violent video games frequently across time are more likely to learn aggressive cognitions and behaviors than students who play less frequently even if they play for equal amounts of time. Third, students who become "addicted" to video games are also likely to be more affected by them, perhaps because of the enhanced learning created by conditioned emotional/physiological responding to them. Therefore, students who are addicted to video games are more likely to learn aggressive cognitions and behaviors than students who are not addicted to video games.

Methods

Three sets of data were collected, one with elementary school children in grades 3 to 5, one with young adolescents in grades 8 and 9, and one with late adolescents enrolled in a large Midwestern university. For the elementary school sample, 430 3rd (N = 119), 4th (N = 119), and 5th grade (N = 192) students participated in the study. Students were recruited from five Minnesota schools, including one suburban private school (N = 138), three suburban public schools (N = 265), and one rural public school (N = 27). The sample was almost evenly divided between boys and girls, with 49% of the children being female (51% male). Participants ranged in age from 7 to 11 years of age (*M* = 9.65; *SD* = 1.03). Eighty-six percent of the respondents classified their ethnic background as Caucasian (which is representative of the region).

For the young adolescent sample, 607 8th-grade (*N* = 496) and 9th-grade (*N* = 111) students participated in the study. Students were recruited from four schools, including one urban private school (*N* = 61), two suburban public schools (*N* = 350), and one rural public school (*N* = 196). Students were recruited from mandatory classes within their schools. The mean age of respondents was14 years (*SD* = 0.64). Fifty-two percent of respondents were male. Eighty-seven percent of the respondents classified themselves as Caucasian.

For the late adolescent college sample, 1,441 students participated in the study. Students voluntarily participated in mass testing sessions, and earned extra credit points for their introductory psychology classes. Forty-five percent of respondents were male. Eighty-nine percent of the respondents classified themselves as Caucasian, which is representative of the region and university populations.

Elementary Sample Procedure

Data were collected between November 2000 and June 2003. Consent levels were at least 70% for all classrooms, each of which was a mandatory class (i.e., not elective) to reduce the likelihood of selection bias.

Participants completed three confidential surveys, and teachers completed one survey for each participating child (described below). Each participant (including teachers) completed each of these surveys at two points in time during the school year. The first administration (Time 1) occurred between November and February of the academic year. The second administration (Time 2) occurred between April and May of the year. The time lag between the two administrations was therefore between two and six months. Additional details of the procedure and instruments are available in Anderson, Gentile, & Buckley (under review).

Assessment of Social Adjustment

Peer Assessment of Social Adjustment. A peer nomination instrument was used to assess children's social adjustment, and was adapted from a peer nomination instrument that has been used in several previous studies of children's social behavior (e.g. Crick, 1995; Crick & Grotpeter, 1995). Only the physical aggression scale (2 items) will be discussed here. Coefficient alpha was computed and was found to be satisfactory ($\alpha = .92$).

Teacher Ratings of Aggressive Behavior. Teachers completed a survey assessing children's aggression and prosocial behavior (D. Gentile et al., 2004). For the purposes of this study, only the subscales reflecting physical aggression were used in subsequent analyses. Coefficient alpha was computed and found to be satisfactory ($\alpha = .92$).

Self-Report of Fights. One item asked how many physical fights the participants had been in during the school year.

Assessment of Media Habits

Violent video game exposure. Similar to Anderson and Dill's (2000) approach, participants were asked to name their three favorite video or computer games. For each named video game, participants were asked to rate how frequently they played on a 5-point scale (1 = "Almost never," 5 = "Almost every day"). Participants were also asked to rate how violent they consider each media product to be on a 4-point scale (1 = "Not at all violent," 4 = "Very violent"). Data were also collected regarding TV and movies, which will not be reported here.

Weekly amount of video game play. Participants reported the amount of time they spent playing video games during different time periods on weekdays and weekends. Weekly amounts were calculated from these responses.

Assessment of hostile attribution bias/social information processing.

The final survey was an adapted version of a hostile attribution survey that has been reliably used in past research (e.g., Crick, 1995; Nelson & Crick, 1999). This instrument is composed of stories, each describing an instance of provocation in which the intent of the provocateur is ambiguous. Participants answer two questions following each story. The first presents four possible reasons for the peer's behavior, two of which indicate hostile intent and two reflect benign intent. The second question asks whether the provocateur(s) intended to be mean or not. This survey assesses the participant's perception of hostility from the outside world. Based on procedures delineated by Fitzgerald and Asher (1987), the children's responses to the attribution assessments were summed within and across the stories for each provocation type. Coefficient alpha was computed and found to be satisfactory ($\alpha = .85$).

Composite measures. A composite measure of physical aggression was created because we had multiple informants. Peer ratings of physical aggression, teacher ratings of physical aggression, and self-reports of physical fights were standardized and averaged to create a physical aggression composite. Coefficient alpha was computed and found to be satisfactory at both points in time (Time 1 $\alpha = .87$, Time 2 $\alpha = .89$).

Young Adolescent Sample Procedure

Data were collected in schools between 4 April and 2 May 2000. Consent levels were greater than 90% for all classrooms, each of which was a mandatory class. Each participant completed an anonymous survey that gathered descriptive data about students' habits, attitudes, and knowledge about video games, as well as school performance, demographic data, and a measure of trait hostility. Additional details of the procedure and instruments are available in D. Gentile et al. (2004).

Variables

Violent video game exposure. Similar to the approach described for elementary school students, participants were asked to name their three favorite video games. For each named game, participants were asked to rate how frequently they played the game on a 7-point Likert scale (1=''rarely'', 7=''often''). Participants were also asked to rate how violent each game is on a 7-point Likert scale (1=''little or no violence'', 7=''extremely violent'').

Participants were also asked to indicate how much violence they prefer to have in their video games on a 10-point scale (1=''no violence'', 10=''extreme violence''), and how much violence they prefer to have in their video games compared to 2–3 years ago on a 5-point scale (1=''a lot less'', 5=''a lot more'').

Amount of video game play. Participants were asked the amount of time they spent playing games during different time periods on weekdays and weekends. Weekly amount of game playing was calculated from these responses.

Trait hostility. Hostility was measured using the Cook & Medley Hostility Scale (Cook & Medley, 1954), a commonly used reliable instrument. Because the items for the Cook & Medley are taken from the MMPI, some were inappropriate for young adolescents. The instrument was modified by deleting seven items and changing the wording of some items to make them easier for 8th graders to understand. These modifications were based on those made by Matthews and colleagues (e.g., Woodall & Matthews, 1993).

Physical fights. Participants were asked if they had been in a physical fight in the last year. This question yielded a dichotomous response (yes/no).

Video game addiction. Participants were asked seven items assessing video game addiction. These items were modifications of the DSM-IV criteria for pathological gambling (similar to those used by Fisher, 1994 and Griffiths & Hunt, 1998). Similar to the DSM criteria, participants were considered to be "addicted" if they answered yes to at least four of the items.

Late Adolescent Sample Procedure

Data were collected in Fall 2003. Each participant completed an anonymous survey that gathered descriptive data about students' video game habits, demographic data, self-reported aggressive behaviors, and the Buss-Perry measure of aggression.

Variables

Violent video game exposure. Identical to the approach described for young adolescents.

Amount of video game play. Participants were asked the amount of time they spent playing games during different time periods on weekdays and weekends. Weekly amount of game playing was calculated from these responses.

Trait anger, trait hostility, and overall physical aggression. Students completed the Buss-Perry Aggression Questionnaire (Buss & Perry, 1992), a commonly used reliable instrument. Three subscales are reported here: the trait anger, trait hostility, and overall physical aggression subscales (reliability coefficients, $\alpha = .80, .84,$ & .84, respectively).

Video game addiction. Similar to the approach described for young adolescents, except participants were only able to answer "yes" and "no;" "sometimes" was removed to make the scale more similar to the DSM gambling addiction items. A subset of 463 students received the addiction items.

Proactive and reactive physical aggression. Students completed the Social Interaction Survey (Linder, Crick, & Collins, 2002), which measures self-reported use of physical aggression on a 7-point Likert scale (verbally-anchored "not at all true" to "very true"). It measures both proactive use of aggression (e.g., "I have threatened to physically harm other people in order to control them," $\alpha = .68$) and reactive aggression (e.g., "When someone has angered or provoked me in some way, I have reacted by hitting that person," $\alpha = .80$).

Results

Because multiple datasets are discussed here, the results are organized by hypothesis.

Hypothesis 1: Playing multiple violent video games will transfer better to aggressive cognitions and behaviors than playing fewer.

In two samples, participants reported their three favorite video games, how often they played each, and how violent each is. Under the logic of Hypothesis 1, if students play multiple violent games (which have different contexts, but share the underlying lesson that violence is an optimal solution to challenges), then those students should show more aggressive cognitions and behaviors, regardless of how much they play. The sample was restricted to only those participants who named three games so that amount of violence would not be confounded with the number of different games played. Because participants rated each game on the amount of violent content, the three violence ratings were averaged; thus, participants who play three violent games would have higher means than participants who play non-violent games or a mix of violent and non-violent games. Table 1 shows the raw correlations between the average violence scores and several measures of aggressive cognitions, personality, and behavior. The pattern of correlations show that students who play several violent games are more likely than students who play no violent games or a mix of violent and non-violent games (1) to have a hostile attribution bias, (2) to have a hostile personality, and (3) to be physically aggressive.

Because of the multicollinearity among hostility, sex, video game violence exposure, and aggressive behavior, simple correlations are not the best statistics to test this hypothesis. In order to provide a stricter test, logistic regressions were conducted on physical fights in which several variables were controlled. For the $8^{th}/9^{th}$ graders, logistic regressions were conducted in which sex, race, age, hostile attribution bias, and total weekly amount of time playing video games were statistically controlled. Even controlling for each of those variables, the amount of rated violence in the games explained a significant amount of variance in physical fights (B = .229, Wald = 7.7, $df = 1$, $p = .006$). This is important because it separates the *content* of the games played from the *amount* of games played. Similar results were found with college students. Controlling for sex, race, and total amount of time playing games, the amount of violence in the games played explained a significant amount of variance in overall physical aggression ($\beta = .094$, $t = 2.5$ $p = .012$).

For the 3^{rd} – 5^{th} graders, logistic regressions were conducted in which sex, race, age, amount of lag between the two measurements, weekly amount of time playing video games, hostile attribution bias, and Time 1 physical fights. Again, controlling for each of those variables, the amount of violence in video games explained a significant amount of variance in physical fights (B = .594, Wald = 7.6, $df = 1$, $p = .006$). This result is particularly significant, because it shows that students who played several violent video games *changed* to become more aggressive across a school year, even controlling for several relevant variables.

Similar results are obtained when looking across time at changes in hostile attribution bias: controlling for sex, race, age, lag, weekly amount of video game play, and Time 1 hostile attribution bias, Time 1 amount of violence explains a significant amount of variance in Time 2 hostile attribution bias ($\beta = .156$, $p = .003$). Again, similar results are obtained looking at changes in overall aggressive behavior (self-reported, peer-nominated, and teacher-nominated). Figure 2 displays a path analysis testing a model of causality (the model also includes race, age, and school lag as exogenous variables). It is hypothesized that children who play multiple violent video games are more likely to learn the underlying concepts of aggression as normative, and will therefore begin to see the world more in aggressive terms (hostile attribution bias), which will then result in more aggressive behaviors. As can be seen in Figure 2, both prior aggression and playing multiple violent games at Time 1 predict hostile attribution bias (here shown as a mean of Time 1 and Time 2), which in turn predicts aggressive behavior at Time 2. In addition to this mediated pathway, both prior aggression and playing multiple violent games *directly* influence Time 2 aggressive behavior (and being a boy marginally increases the risk for Time 2 aggressive behavior).

Hypothesis 2: More regular and distributed practice with violent video games will increase learning of aggressive cognitions and behaviors.

In the 8th/9th grade and the college samples, participants reported how often they play video games on a scale ranging from "less than once a month" to "almost every day." Participants also reported for how many years they had been playing video games. A distributed practice variable was created by multiplying the frequency of play by the number of years of play. Under the logic of Hypothesis 2, if students play violent games (but not non-violent games) repeatedly over long periods of time, then those students should show more aggressive cognitions and behaviors. Again, the sample was restricted to only those participants who named three games, and the sample was split at the violence exposure scale midpoint (forming a low violence gaming group and a high violence gaming group). It was expected that students who played games more regularly for more years would have more aggressive cognitions and behaviors, but only for the high violence gaming group.

For the young adolescent sample, multiple regressions were conducted on hostile attribution bias, trait hostility, arguments with teachers, and physical fights. Distributed practice significantly predicted hostile attribution bias for the high violence gaming group, but not for the low violence gaming group, even controlling for sex, grade, and race (see Table 2). Distributed practice also significantly predicted arguments with teachers for both the high and low violence gaming groups, after controlling for sex, grade, and race. There were trends toward distributed practice predicting trait hostility and physical fights for the high violence gaming group, but they were non-significant.

For the college sample, multiple regressions were conducted on self-reported proactive and reactive physical aggression, and the anger, hostility, and physical aggression subscales of the Buss-Perry Hostility Inventory. Distributed practice significantly predicted trait anger, proactive physical aggression, reactive physical aggression, and general physical aggression for the high violence gaming group, but not for the low violence gaming group, even controlling for sex and race (see Table 3). There was a trend toward distributed practice predicting trait hostility ($\beta = .14$, $p = .12$) for the high violence gaming group, but it was non-significant.

Hypothesis 3: "Addiction" to video games will lead to greater learning of aggressive cognitions and behaviors.

In the 8th/9th grade and college samples, participants responded to the video game addiction items. Fifteen percent of the young adolescent sample and five percent of the college sample answered "yes" to four or more of the addiction items, and were classified as "addicted." A clearly non-addicted group was also created by selecting participants who responded "no" to at least six of the items and "sometimes" to a maximum of one item ($N = 265$). For the purposes of these analyses, all other participants were excluded. Under the logic of Hypothesis 3, if students are addicted to games (and hence are likely to have been physiologically and/or emotionally conditioned by them), then those students should show more aggressive cognitions and behaviors.[2]

A series of *t*-tests were run, comparing addicted and non-addicted students. As can be seen in Tables 4 and 5, addicted students spent more time playing video games ($M = 21.6$ & 18.4 hours/week for 8th/9th grade and college students, respectively) than non-addicted students ($M = 4.5$ & 5.6, respectively). Hypothesis 3 rests on the assumption that being "addicted" would mean that students are more physiologically and emotionally responsive to video games. To our knowledge, this assumption has never previously been tested. The young adolescent sample was given a list of emotional adjectives, and asked whether they usually feel each of them after playing video games. As shown in Table 3, addicted students were more likely than non-addicted students to feel excited, energized, frustrated, cheerful, positive or negative, and less likely than non-addicted students to feel bored. Addicted students also were more likely to say they prefer more violence in their video games ($M = 7.5$ on a 10-point scale, where 10 was verbally anchored as "extreme violence," compared to $M = 4.6$ for the non-addicted students). In addition, when asked whether they like more or less violence in their video games compared to 2 or 3 years ago, addicted students were most likely to say they like a "lot more" violence compared to 2 or 3 years ago (whereas non-addicted students were most likely to say "same amount").

As predicted, addicted 8th/9th grade students were more likely to have a hostile attribution bias and to score higher on trait hostility (Table 4). Addicted students also were more likely to get into arguments with teachers, as well as to be involved in physical fights.

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[2] Although the mechanisms of a hypothesized addiction pathway (physiological, emotional, or behavioral) have not yet been well described or tested, we assume that if video game "addiction" can be said to occur, it is not specific to playing only violent games.

As predicted, addicted college students were more likely to be physically aggressive overall, as well as to use physical aggression both proactively and reactively (Table 5). Addicted students also were more likely to have high anger and hostility scores, although both of these tests were only marginally significant.

Although not germane to this particular set of analyses, it is interesting to note that addicted $8^{th}/9^{th}$ grade students were more likely than non-addicted students to be male (86% male and 40% male, respectively; $\chi^2 = 42.9$, $df = 1$, $p < .001$), and also reported receiving poorer grades in school (*M* = B- and B+, respectively; $t = .5.0$, $df = 337$, $p < .001$, $d = .639$).

Discussion

When considered in the light of what is known to be the "best practices" of education, violent video games appear to be exemplary teachers. Each of our hypotheses was supported. Playing multiple violent video games, even after controlling for total amount of time playing all video games, appears to lead to better transfer of aggressive cognitions and behaviors than playing a mix of violent and non-violent games (or obviously playing only non-violent games). Because we had longitudinal data, we were able to show that students who play multiple violent games actually changed to have a greater hostile attribution bias, which also increased their aggressive behaviors over prior levels (Figure 2). Playing multiple violent games also increased aggressive behaviors directly, in addition to the mediated pathway through hostile attribution bias.

The second hypothesis, that distributed practice over time playing violent video games will lead to greater aggressive cognitions and behaviors was largely supported. Controlling for the amount of violence in video games played by $8^{th}/9^{th}$ graders, playing more frequently during a given week over multiple years was correlated with greater hostile attribution bias and arguments with teachers. This held true after controlling for sex, race, and grade. There were trends in the hypothesized direction for hostile personality and physical fights, but these were non-significant. Among the college sample, after controlling for sex, race, and the amount of violence in video games played, distributed practice significantly predicted trait anger, proactive physical aggression, reactive physical aggression, and general physical aggression (Table 3). There was also a non-significant trend toward distributed practice predicting trait hostility.

It is likely that there is a great deal of measurement error when attempting to retroactively measure distributed practice. Furthermore, the analyses conducted here also assume that the current levels of violent video game exposure has also remained constant over time, which is likely to be an incorrect assumption. Given that both of these measurement problems would serve to make it unlikely to find any significant effects, it is perhaps surprising that significant effects were found for both aggressive cognition variables and antisocial/aggressive behavior variables.

The third hypothesis, that the potential emotional and physiological conditioning that may come with video game addiction would be related to increased aggressive cognitions and behaviors, was also supported. When video game "addiction" is defined similarly to the DSM-IV criteria for gambling addiction, approximately 15% of young adolescent players can be defined as addicted, and that addiction is significantly related to emotional responses to video games, hostile attribution bias, trait hostility, arguments with teachers, and physical fights. Although a smaller percentage of college students were defined as addicted (5%), such classification was significantly related to preferences for violent games, and the use of proactive and reactive physical aggression.

It is important to remember that the data presented here are correlational, and we cannot conclude that playing violent video games *caused* the changes in aggressive cognition and behavior. However, because we also have longitudinal data, it is clear that our data are not solely showing that aggressive kids play violent video games. Even controlling for prior aggressive cognition and behavior, playing multiple violent video games adds a significant amount of predictive power to predicting which children will become *more* aggressive (e.g., Figure 2). Violent video games appear to be excellent teachers.

How Can Schools Compete with That?

The simple answer is that schools cannot. It is difficult to imagine a lesson on multiplication of fractions being so vivid or arousing to create an addiction to math or be a means to widespread popularity. If math induces conditioned emotions, they are more likely to be anxiety or learned helplessness than euphoria (Dweck & Licht, 1980; J.R. Gentile & Monaco, 1986). Moreover, it is socially acceptable to admit or feign incompetence in math ("I was never good with math" or "I hate math"), while their opposites ("I love math") have little currency for popularity. In contrast, saying "I love this song" or "I am good at this video game" is likely to increase one's popularity, while admitting incompetence or dislike for pop songs or video games may carry a social penalty (e.g., Christenson & Roberts, 1999). To the extent that this is true, it indicts our society for a value system out of balance, but few teachers need to be reminded of that.

Given that the schools cannot – and should not – adopt all of the titillating tactics of the popular media, what can educators learn from the successful *instructional* practices of violent video games? The answer is: (1) Teach fewer concepts, but require that students master and then overlearn them; (2) connect those concepts (via a spiral curriculum) to past and future learnings via continual review and practice, as well as reminders of the connections; (3) reinforce (extrinsically with grades and intrinsically with perceived self-efficacy) increasing levels of competence or automaticity, depth of understanding, and analytic or creative applications of these concepts; and (4) use technology where appropriate to provide practice toward automaticity in a game-like atmosphere, including points for increasing levels of competence.

Most teachers feel that they have too little time to cover too much material. The movement toward higher standards, ironically, only exacerbates the problem by list after list of mostly unrelated objectives. Mastery of an objective – that is, achieving a benchmark – means you are done with that objective when it should instead be considered the beginning (J. R. Gentile & Lalley, 2003). Initial learnings, after all, will be forgotten even when a high standard of 80% to 100% correct is required if for no other reason than interference from previous and subsequent learning objectives (Hulse, Egeth, & Deese, 1980). Lower passing standards assure even less recall. Therefore, what is necessary is an instructional plan to require that knowledge and skills initially mastered will be overlearned, optimally in a variety of new applications and while adding new skills or knowledge incrementally (J. R. Gentile & Lalley, 2003; Willingham, 2004). There are many successful ways to do this, of course, but "covering the curriculum" to survey all of the concepts, historical periods, or formulas in a standard curriculum is not one of them.

As implied above, students must be encouraged – indeed, required – to find connections between previous and current concepts. This must be explicit because teaching for understanding and transfer requires that such connections be made (via a spiral curriculum or scaffolding; e.g., Bruner, 1960 or Glaser, 1984, respectively). It is also necessary because our current practices do not engender trust. Consider that when students ask us "Why do we have to learn this stuff?" we usually answer because you'll need it for something coming later. But when later comes, we often say, "Well, forget what you learned before; we don't do it that way here." J.R. Gentile and Lalley (2003) give the example of addition and subtraction of fractions, which is almost universally illustrated using pies and cakes. When it comes to multiplication and division of fractions, and students ask how dividing Joe's three-quarters of a pie by Mary's fifth of a pie leads to more pie, most teachers give a "Well, forget about pies" answer. The teachers say this because they don't know how to use pies to demonstrate the solution, but notice the message about trust that the students are receiving. Of course, our favorite example is teachers themselves, who upon taking their first job hear from their new colleagues, "Forget all that stuff they taught you in that ivory tower – we do it differently here in the real world of schools."

As much as the current zeitgeist rails against behaviorists and the evils of extrinsic motivation, schools are almost all about extrinsic reinforcers and punishers. Consider the gushy praise that many elementary students receive for mediocre work or for finally paying attention (after much inattention), or the points that are docked for work that is correct but a day late. What the students learn is that they can get by with little effort and that schedules are more important than competence. These are violations of behaviorist principles (e.g., reinforcement contingencies) that the designers of video games do not make. As noted earlier, self-esteem or self-efficacy is something that students must earn by increasing competence on a task that is perceived by them as important and that is just beyond their previous level of competence. Giving points for such skill, then, helps the learner self-monitor and does not undermine intrinsic motivation. Rather, the extrinsic reinforcer (points) is used in service of intrinsic motivation (competence and perceived self-efficacy). Indeed, recently a computer game designed to classically condition positive feedback has been shown to increase implicit self-esteem and lower aggression (Baccus, Baldwin, & Packer, 2004).

For all of the talk about technology in schools, we have not begun to tap its potential broadly and systematically. Eventually, some hope, we will have smart technology which "thinks" along with the student, adapting instruction to each student's current skills, mistakes, etc. Whether such a vision would be a dream or a nightmare, we now have the technology to use personal computers to provide knowledge and skill building: original learning to a high level, distributed practice with feedback, overlearning to automaticity. And yet, too many educators use the pejorative label "training" for such skill-building, which they distinguish from "educating" or "reflective practice." But skills and reflections are not mutually exclusive; moreover, if one were necessary for the other, it is a good bet that for most human endeavors basic knowledge and skills are primary. If our educational software is not yet sufficient to teach and reinforce the knowledge and skills we want our curricula to impart, then perhaps we need to hire some violent video game makers to develop such software.

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Table 1

Correlations between mean violence of 3 favorite games and aggressive cognitions, personality, and behavior

Violence	3rd – 5th Graders Average Violence of Games at Time 1	8th – 9th Graders Average Violence of Games	College Students Average of Games
Hostile Attribution Bias	.13*	.11*	...
Trait Hostility	...	.17***	.12**
Arguments with Teachers	...	.14*	...
Physical Fights (Time 1)	.21***	.28***	...
Physical Fights (Time 2)	.29***	...	...
Time 1 Peer-Nominated Physical Aggression	.27***	...	...
Time 2 Peer-Nominated Physical Aggression	.33***	...	...
Time 1 Teacher-Nominated Physical Aggression	.29***	...	...
Time 2 Teacher-Nominated Physical Aggression	.36***	...	...
Time 1 Overall Physical Aggression Index	.33***	...	...
Time 2 Overall Physical Aggression Index	.41***	...	...
Buss-Perry Trait Anger	...	...	.10**
Buss-Perry Overall Physical Aggression	...	...	.26***
Proactive Physical Aggression	...	...	.16***
Reactive Physical Aggression	...	...	.24***

Note 1: * $p < .05$, ** $p < .01$, *** $p < .001$,
Note 2: … = Not measured in this population

Table 2: Regression Coefficients Predicting Hostile Attribution Bias and Arguments with Teachers (8th/9th Grade)

Violence Group	Variable	Beta	t	Significance
Low Violence Gaming Group: Predicting Hostile Attribution Bias				
	Sex	-.041	-.586	.559
	Grade	.059	.884	.378
	Race	-.012	-.182	.855
	Distributed Practice	.016	.227	.821
High Violence Gaming Group: Predicting Hostile Attribution Bias				
	Sex	.025	.376	.708
	Grade	-.031	-.459	.647
	Race	.032	.479	.632
	Distributed Practice	.176	2.566	.011
Low Violence Gaming Group: Predicting Arguments with Teachers				
	Sex	-.124	-1.527	.129
	Grade	.075	.983	.327
	Race	-.038	-.502	.617
	Distributed Practice	.237	2.928	.004
High Violence Gaming Group: Predicting Arguments with Teachers				
	Sex	.014	.198	.843
	Grade	.178	2.489	.014
	Race	.175	2.451	.015
	Distributed Practice	.239	3.299	.001

Table 3: Regression Coefficients Predicting Anger and Physical Aggression (College Students)

Violence Group	Variable	Beta	t	Significance
Low Violence Gaming Group: Predicting Trait Anger				
	Sex	.069	1.511	.132
	Race	-.104	-1.905	.057
	Distributed Practice	.098	1.794	.073
High Violence Gaming Group: Predicting Trait Anger				
	Sex	.069	.865	.389
	Race	-.016	-.190	.850
	Distributed Practice	.255	2.985	.003
Low Violence Gaming Group: Predicting Proactive Physical Aggression				
	Sex	.074	1.638	.102
	Race	-.226	-4.149	.000
	Distributed Practice	.023	.426	.670
High Violence Gaming Group: Predicting Proactive Physical Aggression				
	Sex	-.015	-.183	.855
	Race	-.010	-.119	.906
	Distributed Practice	.269	3.160	.002
Low Violence Gaming Group: Predicting Reactive Physical Aggression				
	Sex	.102	2.283	.023
	Race	-.264	-4.954	.000
	Distributed Practice	.074	1.392	.165
High Violence Gaming Group: Predicting Reactive Physical Aggression				
	Sex	.034	.424	.672
	Race	-.130	-1.535	.127
	Distributed Practice	.225	2.650	.009
Low Violence Gaming Group: Predicting Overall Physical Aggression				
	Sex	.139	3.335	.001
	Race	-.372	-7.483	.000
	Distributed Practice	.081	1.636	.103
High Violence Gaming Group: Predicting Overall Physical Aggression				
	Sex	-.022	-.274	.784
	Race	-.162	-1.905	.059
	Distributed Practice	.184	2.163	.032

Table 4: *t*-tests comparing "addicted" and "non-addicted" students ($8^{th}/9^{th}$ graders)

Variable		***t***	***df***	***p value***	***Cohen's d***
	Weekly amount of video game play	-13.2	341	.000	-1.681
Post-play emotional response					
	I usually feel EXCITED after playing video games	-5.6	348	.000	-0.694
	I usually feel BORED after playing video games	2.6	348	.010	0.324
	I usually feel ENERGIZED after playing video games	-4.2	348	.000	-0.521
	I usually feel RELAXED after playing video games	-1.0	348	.301	-0.129
	I usually feel FRUSTRATED after playing video games	-2.0	348	.048	-0.248
	I usually feel CHEERFUL after playing video games	-3.7	348	.000	-0.459
	I usually feel POSITIVE after playing video games	-2.2	348	.031	-0.270
	I usually feel NEGATIVE after playing video games	-3.0	348	.003	-0.376
Preference for violent games					
	How much violence do you like to have in your VGs	-9.1	344	.000	-1.138
	Compared to 2 to 3 years ago, how much violence do you like to have in your VGs	-5.3	257	.000	-0.728
Aggressive cognitions					
	Hostile Attribution Bias	-4.1	347	.000	-0.516
	Trait Hostility	-7.3	340	.000	-0.926
Anti-social/aggressive behaviors					
	Arguments with teachers	-3.4	257	.001	-0.466
	Physical fights	-4.4	340	.000	-0.554

Table 5: *t*-tests comparing "addicted" and "non-addicted" students (college students)

Variable		***t***	***df***	***p value***	***Cohen's d***
	Weekly amount of video game play	-4.9	198	.001	-1.464
Preference for violent games					
	How much violence do you like to have in your VGs	-2.0	195	.042	-0.609
	Compared to 2 to 3 years ago, how much violence do you like to have in your VGs	-2.2	197	.032	-0.531
Aggressive cognitions					
	Trait Anger	-1.7	198	.093	-0.503
	Trait Hostility	-1.7	198	.085	-0.515
Aggressive behaviors					
	Proactive physical aggression	-3.1	197	.003	-0.934
	Reactive physical aggression	-3.0	197	.002	-0.900
	Overall physical aggression	-2.2	198	.026	-0.668

Figure 1. The General Aggression Model: Developmental Processes

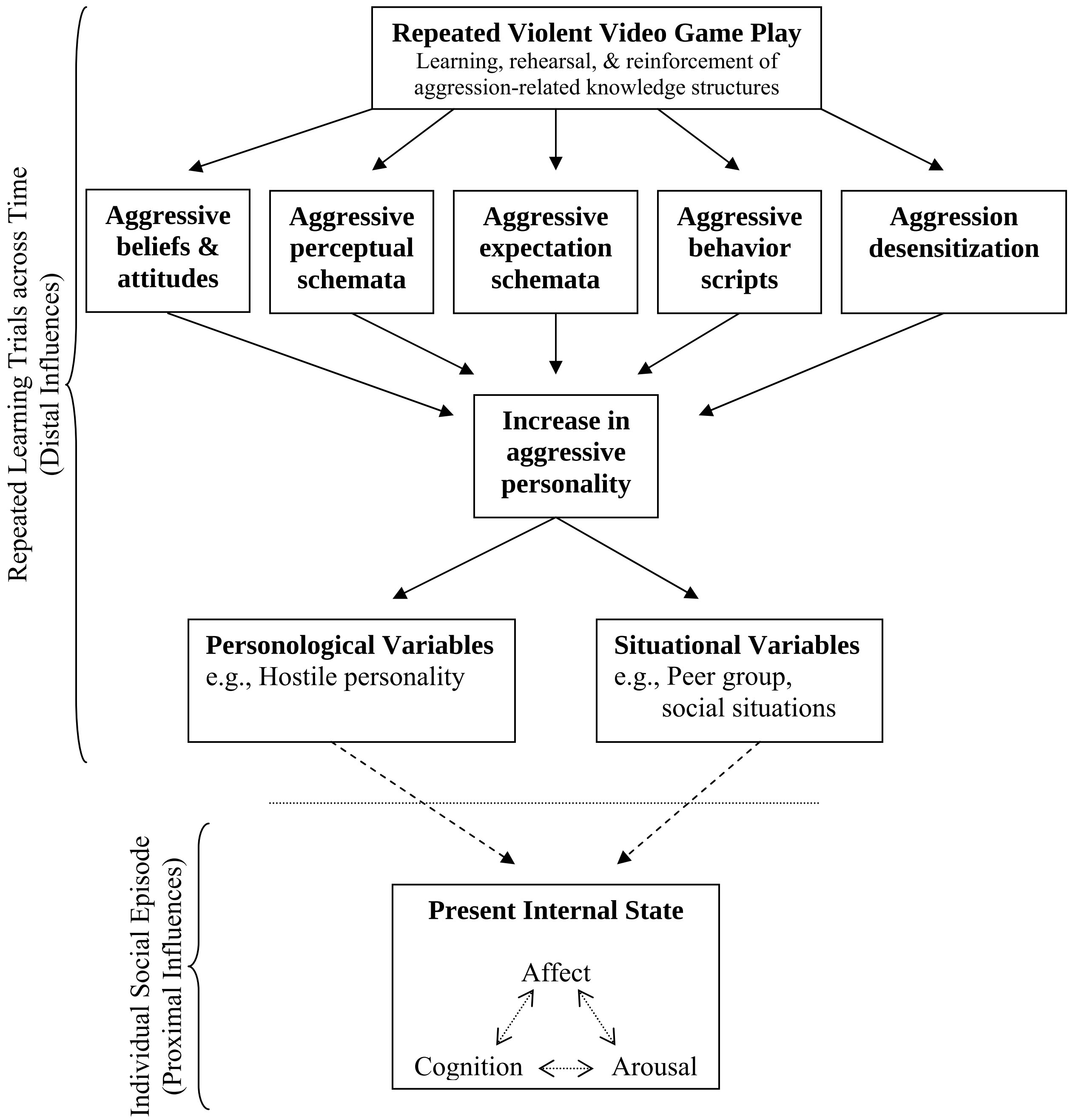
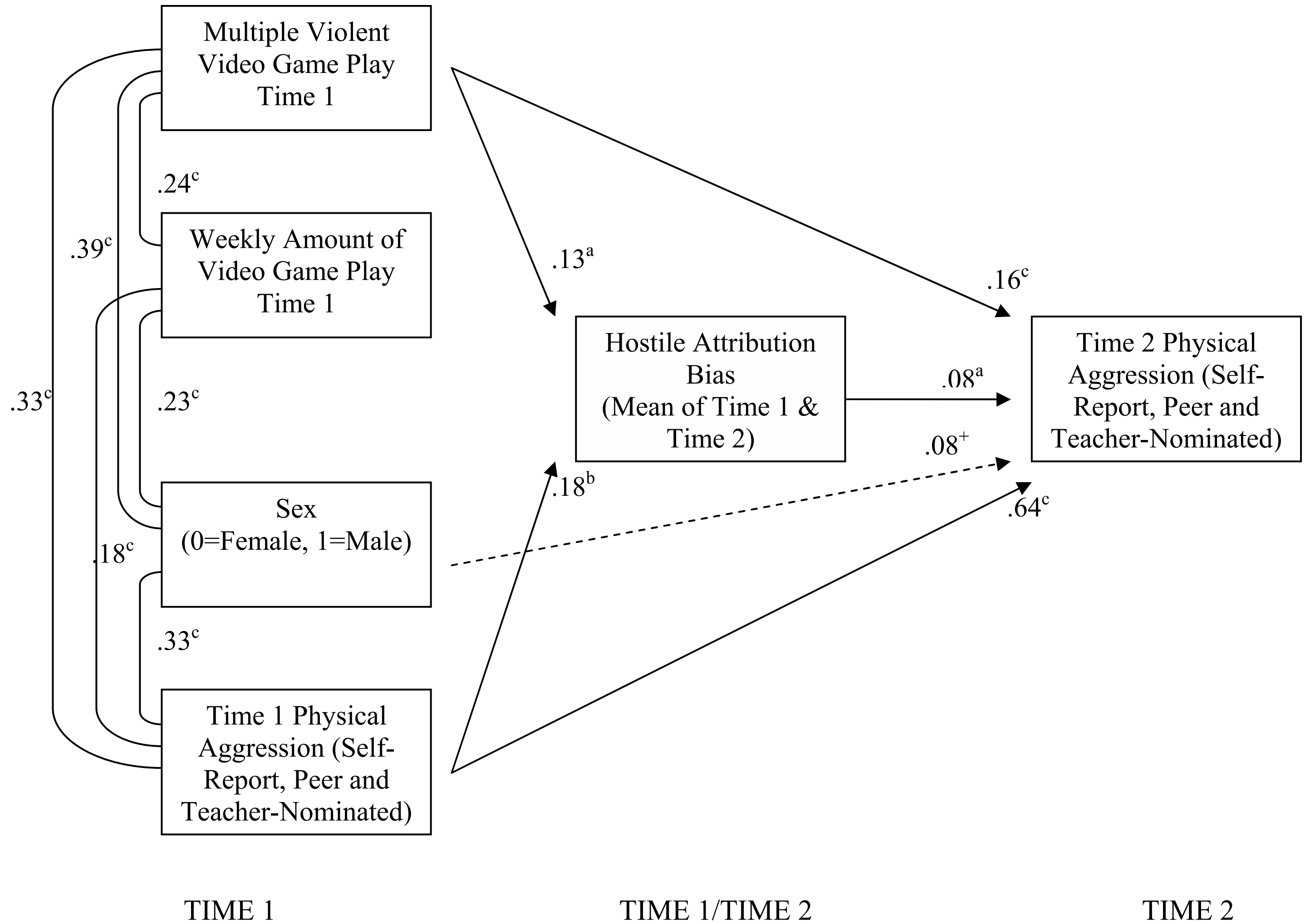


Figure 2. Longitudinal Path Analysis Demonstrating that Playing Multiple Violent Games Leads to Greater Physically Aggressive Behavior, Controlling for Prior Aggressive Behavior, Sex, and Total Amount of Game Play (3rd-5th graders)



$^{+}p < .10$, $^{a}p < .05$, $^{b}p < .01$, $^{c}p < .001$