

Social behavior in action video game players: the contribution of competitive personality

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Abstract

Background

Research on action video game play, which encompasses first- and third-person shooter games but is not limited to those, has focused more on the cognitive than the social behavioral profile of such gamers. In parallel, research on social behavior among video game players has predominantly focused on the impact of violent video game content on aggression. The present cross-sectional study characterizes aggressive and prosocial behaviors in action video game players (AVGPs) compared with non-video game players (NVGPs) and examines whether observed group differences may be partly related to competitive personality.

Methods

Adults who either frequently played action video games or seldom played video games ($N = 104$) completed the Competitive Reaction Time Task (CRTT), the Zurich Prosocial Game, the Money Burning Game, and the Dictator Game, together with questionnaires assessing aggressive, empathic, and competitive personality traits. Group comparisons and nested multiple regression analyses were conducted to examine the contribution of competitive personality to observed behavioral differences.

Results

Compared with NVGPs, AVGPs displayed greater retaliatory behavior during the CRTT and reported higher levels of competitive personality and trait aggression. By contrast, the groups did not differ in spiteful punishment, helping behavior, altruistic sharing, or empathic personality traits. Importantly, the group differences in retaliatory behavior and trait aggression were substantially attenuated after accounting for competitive personality.

Conclusions

Rather than supporting a generalized aggressive profile among AVGPs, these findings identify competitive personality as an important individual characteristic positively associated with retaliatory behavior and contributing substantially to behavioral differences that might otherwise be attributed to gaming status alone.

1 Background

Action video games (AVGs) are among the most extensively studied video game genres in psychology and neuroscience. Unlike classifications based on narrative content, AVGs are defined primarily by gameplay mechanics, including rapid decision making, flexible allocation of attention, and demanding

visuomotor coordination [1]. Initially restricted to first- and third-person shooter games, the AVG classification has since expanded to include action role-playing and adventure games, sports and driving games, and real-time strategy games, including multiplayer online battle arenas (MOBAs), based on shared gameplay characteristics [2]. These characteristics have made AVGs a useful model for studying perceptual, attentional, and cognitive performance. Cross-sectional studies consistently report differences between action video game players (AVGPs) and non-video game players (NVGPs) across these domains, although the extent to which these differences reflect gaming experience, pre-existing individual characteristics, or both, remains an active area of investigation [3–7].

Although AVGs have been extensively investigated in relation to perceptual and cognitive performance, considerably less is known about the broader social behavioral profile of their players. In particular, it remains unclear whether AVGPs differ from NVGPs in aggressive and prosocial behavior. This question is particularly relevant because AVGs frequently involve interpersonal competition, and early research on action gaming, which predominantly focused on shooter games, tended to conflate violent content with the gameplay mechanics that define the genre. More recent intervention studies using action games designed for children or clinical populations, and therefore devoid of violent content, indicate that cognitive benefits can be observed when action-game mechanics are retained in the absence of violent content [8–12]. By contrast, research examining social behavior has predominantly classified video games according to their violent content rather than their gameplay mechanics. Because not all violent video games are action video games, and not all action video games contain violent content, the two classifications overlap only partially. Consequently, research on AVGs and research on violent video games have largely evolved in parallel despite focusing on partially overlapping gaming populations. The present study addresses this gap by examining aggressive and prosocial behaviors and personality traits in habitual first- and third-person shooter players, selected using the Bavelier Lab's classification criteria to identify experienced action video game players rather than the broader category of action-like game players.

Meta-analyses have synthesized evidence from cross-sectional, longitudinal, and experimental studies examining associations between violent video game exposure and aggressive behavior. These reviews differ in their conclusions regarding the magnitude and practical significance of the reported associations, as well as in the study designs and analytical approaches used. Meta-analyses synthesizing primarily zero-order associations have generally reported small-to-moderate average effect sizes [13–15], whereas those synthesizing adjusted regression coefficients or partial correlations controlling for baseline aggression and other covariates have typically reported substantially attenuated estimates [15–19]. Accordingly, observed differences between gaming populations may reflect not only gaming experience itself but also pre-existing characteristics of the individuals who preferentially engage with particular game genres. These characteristics include personality traits associated with engagement in particular game genres, as well as broader psychological characteristics such as internalizing symptoms (e.g., anxiety and depression), both of which have been independently associated with prosocial [20] and aggressive behaviors [21, 22].

Among the pre-existing psychological characteristics that may contribute to these observed differences, competitive personality represents one particularly plausible candidate. Competition has traditionally been conceptualized in two complementary ways: as a characteristic of situations and as a stable individual disposition. Previous research has primarily examined the competitive characteristics of games or the effects of experimentally manipulated competitive situations [23–28]. Competitive gaming has been proposed to represent a stronger correlate of aggressive outcomes than violent content alone [29, 30]. By contrast, relatively little is known about whether competitive personality contributes to the broader social behavioral profile of AVGPs, including both aggressive and prosocial behaviors.

Competitive personality refers to a stable individual disposition characterized by the enjoyment of interpersonal competition and the motivation to outperform others in challenging situations [31]. Beyond the context of video games, competitive personality has long been associated with behavior across domains including sport, work, leisure, and interpersonal relationships [31–33]. Consistent with this broader literature, interpersonal competition is one of the primary motivations reported by players of shooter and strategy games [34–37], suggesting that individuals with a stronger competitive personality may be more likely to engage with highly competitive game genres.

Because competitive personality may contribute to engagement in highly competitive game genres, it may also contribute to behavior expressed in competitive laboratory contexts. The Competitive Reaction Time Task (CRTT), one of the most frequently used laboratory paradigms to assess retaliatory behavior, requires participants to compete directly against an opponent before delivering retaliatory responses. Accordingly, questions have been raised regarding its construct validity [38–41] as performance may reflect not only retaliatory behavior but also stable individual differences in competitiveness. The CRTT therefore provides an opportunity to examine whether individual differences in competitive personality contribute to the observed behavioral differences between AVGPs and NVGPs. Beyond determining whether AVGPs differ from NVGPs, the present study sought to determine whether any observed differences reflect a generalized social behavioral profile or are instead restricted to specific behavioral contexts.

Based on the reviewed literature, the present study pursued two complementary objectives. First, we sought to characterize the social behavioral profile of AVGPs by comparing aggressive and prosocial behaviors with NVGPs. Given the violent video game literature, we expected AVGPs to display greater retaliatory behavior, higher aggressive personality traits, and higher levels of competitive personality. Based on the limited available evidence, we tentatively expected lower helping behavior, altruistic sharing, and empathic personality traits. Because previous findings have been inconsistent, no directional hypothesis was formulated regarding symptoms of anxiety and depression. Second, we examined the extent to which individual differences in competitive personality could account for observed behavioral differences between AVGPs and NVGPs. In particular, we hypothesized that competitive personality would explain a significant proportion of the group differences in retaliatory behavior and would be positively associated with trait aggression.

2 Materials and Methods

2.1 Study design and participants

This observational cross-sectional study compared action video game players (AVGPs) and non-video game players (NVGPs) on laboratory measures of aggressive and prosocial behavior, together with self-report measures of personality and mental health. Participants completed two laboratory sessions separated by several weeks.

Participants were recruited between July 2014 and October 2015 from an existing laboratory database populated through responses to local advertisements. Because individuals meeting our predefined AVGP or NVGP inclusion criteria were relatively uncommon in the general population, some advertisements specifically targeted experienced and inexperienced video game players to facilitate recruitment at both extremes of gaming experience. Throughout the year, volunteers completed a standardized screening battery assessing demographic characteristics, cultural background, leisure activities (including sports, music, media habits, and video game use), and video game habits. Educational level was assessed using a seven-point scale adapted to the Swiss educational system: (1) less than mandatory schooling; (2) mandatory schooling; (3) vocational or special schools; (4) vocational high school; (5) high school diploma (A-level equivalent); (6) tertiary professional education and training; and (7) university degree. Participants meeting the inclusion criteria for the present study were identified from this database and subsequently contacted by an experimenter who was not involved in participant screening. To minimize demand characteristics, participants were informed that the study investigated cross-cultural differences in interpersonal behavior, and all experimenters remained blind to participants' gaming status throughout data collection.

A total of 104 male participants were recruited. Seven participants were excluded before data collection because they did not meet the predefined gaming criteria ($n = 3$), were an age outlier (45 years; $n = 1$), or failed to comply with task instructions ($n = 3$). The final sample for Session 1 therefore comprised 97 participants, including 47 AVGPs (mean age $\pm$ SD = 22.3 ± 4.3 years) and 50 NVGPs (24.2 ± 5.1 years). Session 1 lasted approximately 2 h 30 min and included three emotion perception tasks reported elsewhere [42], followed by the Zurich Prosocial Game (ZPG), the Competitive Reaction Time Task (CRTT), an auditory discomfort calibration procedure, and a battery of personality and mental health questionnaires. At the end of each social task, participants completed a debriefing in which they described their subjective impressions of the co-players. This procedure served to identify participants whose responses may have been influenced by awareness of the experimental deception. Participants expressing such suspicions were excluded from analyses involving the corresponding task. Thirteen participants (4 AVGPs and 9 NVGPs) expressed such suspicions and were excluded from analyses involving the CRTT and the ZPG, resulting in a final sample of 84 non-suspicious participants for session1 (43 AVGPs and 41 NVGPs).

Eighty-four participants returned for Session 2, including 38 AVGPs (22.3 ± 4.3 years) and 46 NVGPs (24.1 ± 5.3 years). Session 2 lasted approximately 2 h and included five additional emotion perception tasks reported elsewhere [42], followed by two economic games assessing prosocial (Dictator Game) and aggressive (Money Burning Game) social decision-making, as well as a second battery of personality questionnaires. The same debriefing procedure was conducted following each economic game. An additional ten participants (3 AVGPs and 7 NVGPs) expressed suspicion regarding the experimental deception and were excluded from analyses involving the Dictator Game and the competitive personality questionnaire, leaving a final sample of 74 non-suspicious participants for session2 (35 AVGPs and 39 NVGPs). Mean age is reported for descriptive purposes; age was included as a covariate in subsequent regression analyses.

All participants were male, of Caucasian descent, and between 18 and 35 years of age. The study was approved by the Ethics Committee of the University of Geneva and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before participation and received financial compensation.

2.2 Sample size justification

Sample size was determined *a priori* using G*Power 3 [43]. At the time the study was designed in 2014, the most comprehensive estimate of the association between violent video game play and aggressive behavior was provided by the meta-analysis of Anderson et al. [13], which reported a cross-sectional effect of $r = .26$ ($d \approx .54$) for the best-practice studies and a $r = .17$ ($d \approx .35$) after statistical adjustment for sex. A subsequent re-analysis by Hilgard et al. [44] yielded a comparable cross-sectional effect of approximately $r = .24$ ($d \approx .49$) under a random-effects model. Assuming a medium effect size, a significance level of $\alpha = .05$, and 80% statistical power, the required sample size was estimated at 36–55 participants per group. Recruitment continued until 50 participants per group had been enrolled.

2.3 Classification of action video game players and non-video game players

Participants were classified as action video game players (AVGPs) or non-video game players (NVGPs) using the same video game questionnaire and classification criteria previously developed in the Bavelier laboratory (<http://www.unige.ch/fapse/brainlearning/index.php/vgq>). Gaming status was coded as a binary variable (0 = NVGP, 1 = AVGP) based on AVG play during the previous year.

To be classified as an AVGP, participants were required to have played first- or third-person shooter games for at least 5 h per week during the previous year, while playing no more than 1–3 h per week of other video game genres (turn-based strategy, real-time strategy, fantasy/role-playing, action-sports, and music games). Participants reporting 3–5 h of weekly shooter game play during the previous year were also classified as AVGPs if they had played first- or third-person shooters for more than 5 h per week before that period, thereby ensuring stable long-term gaming habits.

To be classified as NVGPs, participants had to report no more than 1 h per week in each of these game genres and no more than 5 h of total video game play per week during both the previous year and the preceding year.

These criteria were designed to identify relatively genre-pure shooter game players, thereby minimizing potential influences of other gaming genres on perceptual, cognitive, and social outcomes [45]. The video game questionnaire and criteria used at the time of the study can be found in the following archive (<https://osf.io/ch73x/overview>).

Only male participants were included because recruitment of sufficiently large samples of female participants meeting the predefined AVGP criteria was not feasible at the time of the study.

2.4 Experimental measures

2.4.1 Aggressive behavior

Competitive Reaction Time Task (CRTT, retaliatory behavior)

Retaliatory behavior was assessed using the Competitive Reaction Time Task (CRTT), one of the most widely used laboratory paradigms for measuring retaliatory behavior [46]. We used the computerized version of the CRTT (version 3.4.2) from Whitaker & Bushman [47], in which participants were told that they were competing online against a same-sex participant from another European research institute, although the opponent was computer-controlled.

The CRTT consisted of 25 competitive reaction-time trials. On each trial, participants were instructed to respond as quickly as possible to a visual cue. Before each trial, participants selected both the intensity and duration of a noise blast that would ostensibly be delivered to the opponent if the opponent lost the trial. Unknown to participants, the sequence of wins and losses was predetermined and identical for all participants. The opponent's programmed responses were designed to provide repeated provocation throughout the task by varying the intensity and duration of the retaliatory noise blasts across trials while keeping the sequence identical for all participants. Noise-blast intensities ranged from 60 to 105 dB in 5-dB increments, whereas noise durations ranged from 0 to 5 s in 0.5-s increments. We also recorded reaction time to the go signal as a secondary task-performance measure. Noise-blast intensity was calibrated using a sound level meter (NTI XL2; impulse measure LAImax, temporal integration window = 35 ms) to ensure accurate delivery through the headphone system. Detailed task procedures are provided in Supplementary Methods S1.

Several scoring procedures have been used to quantify aggressive behavior in the CRTT, including separate and composite measures of noise-blast intensity and duration [48, 49]. To provide transparent reporting and facilitate comparison with previous studies, we report mean noise-blast intensity and duration separately across all 25 trials. The follow-up regression analyses were conducted using the aggregate CRTT score proposed by Chester and Lasko [38], which combines intensity and duration into a single measure of retaliatory behavior. This choice was supported by the high correlation between

intensity and duration in the present sample ($r = .90$). Results were qualitatively identical irrespective of whether mean intensity, mean duration, or the aggregate score was analyzed.

Auditory discomfort threshold

Because individual tolerance to loud sounds may influence responses in the Competitive Reaction Time Task (CRTT) independently of retaliatory behavior, participants completed an auditory discomfort task before the CRTT. Participants repeatedly rated the loudness of the same noise stimulus used during the CRTT, and individual discomfort thresholds were estimated using an adaptive staircase procedure. These thresholds were included as a covariate in all regression analyses involving the CRTT to account for individual differences in auditory sensitivity. A detailed description of the adaptive procedure is provided in Supplementary Methods S2.

Skin conductance response during the CRTT

Skin conductance (SC) was recorded continuously throughout the CRTT at a sampling frequency of 1,000 Hz using a Biopac MP150 system (BIOPAC Systems, Inc.) and AcqKnowledge 4.2 software. Two electrodes were attached to the medial phalanges of the index and middle fingers of the non-dominant hand. The signal was band-pass filtered using a 0.005-Hz high-pass and a 1-Hz low-pass filter. Recording and processing procedures followed general recommendations for electrodermal measurements [50].

Each trial comprised a reaction-time phase initiated by the go signal, followed by a 3-s interval ending with feedback indicating whether the participant had won or lost the trial. On loss trials, feedback was accompanied by delivery of the noise blast ostensibly selected by the opponent (maximum duration: 5 s); on win trials, no noise blast was delivered. Because electrodermal responses occur with a delay relative to stimulus onset, responses to the trial outcome were quantified beginning 1 s after feedback/noise-blast onset over a 4-s analysis window. For each trial, response amplitude was calculated as the maximum minus the minimum conductance value within this window. Response amplitudes were then averaged separately across loss trials in which a noise blast was received (punishment) and win trials in which no noise blast was received (no punishment). The physiological outcome was the difference between these mean responses (punishment minus no punishment), providing an index of physiological reactivity to receiving the noise blast.

Money Burning Game

Spiteful punishment was assessed using a single-trial adaptation of the Money Burning Game, originally developed by Abbink and Herrmann [51] and subsequently adapted by Steinbeis et al. [52]. Whereas the CRTT measures retaliatory behavior following interpersonal provocation, the Money Burning Game provided a measure of costly aggressive behavior under strategic uncertainty, before participants know how the other player will behave. Participants were told that they would be paired online with another player from a partner European research institute, although the other player was computer-controlled. Both players simultaneously received an endowment of 100 points and independently decided how

many points (0–100) they wished to invest to reduce the other player's earnings. Each point invested reduced the participant's own earnings by one point while reducing the opponent's earnings by three points, thereby making punishment personally costly while producing a greater loss for the other player.

Participants were informed that, after both players had made their decisions, the computer would randomly remove an unknown number of points from each player's endowment. Consequently, participants knew that some points would always be lost regardless of their own decision but were never informed of either the amount invested by the other participant or the number of points removed by the computer. At the end of the game, participants were informed only of their final number of remaining points. The primary outcome measure was the number of points invested to reduce the other player's earnings, with higher values reflecting greater spiteful punishment.

2.4.2 Prosocial behavior

Zurich Prosocial Game (Helping behavior) : Helping behavior was assessed using the Zurich Prosocial Game (ZPG), an ecologically valid laboratory paradigm that repeatedly measures helping behavior in a cooperative game context [53]. Participants were told that they would be connected online with a different participant from a partner European research institute on each trial, although all co-players were computer-controlled. The goal of the game was to navigate a virtual character through a maze and reach a treasure within a limited time. During the game, participants could use a limited number of colored keys either to progress through their own maze or to help the co-player overcome obstacles. Participants were instructed to maximize their own score and were not informed that helping behavior constituted the primary outcome measure, thereby preserving the experimental deception. Participants first completed four training trials followed by 11 experimental trials. The primary outcome measure was the number of helping opportunities in which participants voluntarily used one of their own keys to assist the co-player across all experimental trials. Following the original paradigm [53], the experimental trials manipulated reciprocity (reciprocity vs. no reciprocity), helping cost (high vs. low), distress cues (present vs. absent), and fairness. To encourage participants to monitor the entire game environment, red stars appeared in five of the 11 experimental trials, awarding 20 additional points if collected within 3 s. Participants competed with the other player to collect these stars. In addition to the primary outcome of helping behavior, the task provided several secondary performance measures, including helping reaction time, time to reach the treasure, star collection reaction time, and star collection rate (proportion of stars collected among the five presented). Detailed task procedures are provided in Supplementary Methods S3.

Dictator Game (Altruistic sharing)

Altruistic sharing was assessed using a single-trial Dictator Game [54]. Participants were told that they would be paired online with another participant from a partner European research institute, although the other participant was computer-controlled. They were further informed that the role of decision maker would be randomly assigned between the two players. In reality, participants always assumed the role of the decision maker and received an endowment of 100 points, whereas the other participant initially

received no points. Participants decided how many points (0–100) to transfer to the other participant while retaining the remaining points for themselves. The primary outcome measure was the number of points voluntarily shared with the other participant, with higher values reflecting greater altruistic sharing.

2.4.3 Personality

Aggressive personality : Aggressive personality traits were assessed using the Buss–Perry Aggression Questionnaire (BPAQ) from Buss and Perry [55]. The BPAQ comprises 29 items assessing four dimensions of aggression: physical aggression (Cronbach's $\alpha = .83$), verbal aggression ($\alpha = .65$), anger ($\alpha = .73$), and hostility ($\alpha = .76$). Following Buss and Perry [55], the total score obtained by summing the four subscales was used as the primary outcome of trait aggression (range: 29–145), with higher scores indicating higher levels of trait aggression.

Empathic personality : Empathic personality traits were assessed using the Interpersonal Reactivity Index (IRI) from Davis [56]. The IRI comprises 28 items yielding four independent subscales: empathic concern (Cronbach's $\alpha = .78$), personal distress ($\alpha = .75$), perspective taking ($\alpha = .72$), and fantasy ($\alpha = .74$). Each subscale ranges from 0 to 28, with higher scores indicating higher levels of the corresponding empathic disposition. Because the IRI was designed to assess distinct components of empathy rather than a single underlying construct, the four subscales were analyzed separately.

Competitive personality : Competitive personality traits were assessed using the Enjoyment of Competition subscale of the Revised Competitiveness Index [33]. This 9-item subscale measures the extent to which individuals enjoy and seek interpersonal competition (range: 9–45), with higher scores indicating greater enjoyment of interpersonal competition (Cronbach's $\alpha = .92$). Only the Enjoyment of Competition subscale was administered because the Contentiousness subscale primarily measures attitudes toward interpersonal conflict rather than enjoyment of competition.

2.4.4 Mental health

Symptoms of depression were assessed using the Beck Depression Inventory [BDI-13; $\alpha = .81$ –.57]. Total scores range from 0 to 39, with higher scores indicating greater depressive symptom severity.

Anxiety was assessed using the State–Trait Anxiety Inventory [STAI Form Y₁; 58], comprising separate measures of state anxiety (STAI-YA; Cronbach's $\alpha = .93$) and trait anxiety (STAI-YB; $\alpha = .90$). Scores on each 20-item subscale range from 20 to 80, with higher scores indicating greater state or trait anxiety, respectively. Trait anxiety was completed online at least two days before Session 1 to avoid potential influences of the experimental protocol on this measure, whereas state anxiety was completed during Session 1. One participant had missing data for the state anxiety questionnaire.

2.5 Statistical analyses

Bivariate tests

Statistical analyses were performed using R 4.4.2 [59][60]. Demographic characteristics, behavioral outcomes, task-performance measures, personality traits, and mental health variables were first compared between AVGPs and NVGPs using independent-samples t-tests. Effect sizes are reported as Cohen's d. Pearson correlation coefficients were computed to examine bivariate associations among all study variables (Supplementary Table S1).

Nested multiple regression analyses

For the primary behavioral outcome showing a significant group difference (i.e., retaliatory behavior in the Competitive Reaction Time Task), we fitted a series of nested multiple regression models. Regression analyses were restricted to this outcome; all other behavioral measures were analyzed using bivariate group comparisons only.

Five nested models were specified according to the theoretical framework developed in the Introduction. Model 1 included gaming status (AVGP vs. NVGP) only. Model 2 additionally adjusted for age, educational level, and individual auditory discomfort thresholds. Model 3 further adjusted for aggressive personality traits. Aggressive personality was entered before competitive personality because previous studies have reported only weak associations between trait aggression and CRTT performance [38, 40], allowing us to evaluate whether competitive personality explained additional variance beyond aggressive disposition. Model 4 introduced competitive personality, the principal predictor of interest, to determine whether it explained additional variance beyond gaming status and aggressive personality. Model 5 additionally adjusted for depressive symptoms, state anxiety, and trait anxiety, which were considered potential confounders. Finally, an exploratory Model 6 additionally included interaction terms between gaming status and the continuous predictors that remained significant in the adjusted models to examine whether these associations differed between AVGPs and NVGPs.

Models were compared sequentially with their predecessor by examining changes in adjusted explained variance (Δ Adjusted R^2) and the corresponding F-tests for nested model comparisons. Each model was also compared with the intercept-only model using the overall model F-test. To ensure direct comparability, all regression models were fitted to the same dataset containing complete observations ($n = 74$). Continuous predictors were standardized (z-scores) before analysis, whereas gaming status remained coded as 0 (NVGP) and 1 (AVGP). Multicollinearity was assessed using the variance inflation factor (VIF), which ranged from 1.19 to 2.72, indicating no evidence of problematic multicollinearity.

For the descriptive analyses presented in Table 3 and Fig. 2, CRTT outcomes and trait aggression were residualized for competitive personality using linear regression models with competitive personality as the sole predictor, and the resulting residual scores were compared between AVGPs and NVGPs using independent-samples t-tests.

3. Results

3.1 Participant characteristics

Participant characteristics are presented in Table 1. The groups did not markedly differ in demographic characteristics, including age, participant education, and parental education. They also showed comparable auditory discomfort thresholds.

3.2 Group differences in social behavior and personality

Regarding retaliatory behavior, AVGPs selected significantly higher noise-blast intensities than NVGPs during the Competitive Reaction Time Task (CRTT; $d = 0.47$, Fig. 1a), whereas the group difference in noise-blast duration was not statistically significant (Fig. 1b). Accordingly, the aggregate CRTT score was marginally higher in AVGPs ($d = 0.43$). Because noise-blast intensity and duration were highly correlated ($r = .90, p < .001$; Supplementary Table S1), subsequent regression analyses were conducted using the aggregate CRTT score proposed by Chester and Lasko [38]. No group differences were observed for skin conductance responses elicited by the noise blasts during the CRTT or for spiteful punishment in the Money Burning Game (Table 1; Fig. 1d).

Regarding prosocial behavior, no group differences were observed in helping behavior in the Zurich Prosocial Game (ZPG) or altruistic sharing in the Dictator Game (Table 1; Fig. 1e-f). Nevertheless, AVGPs made helping decisions more rapidly than NVGPs ($d = 0.44$, Table 1) despite displaying comparable frequencies of helping behavior.

On task-performance measures, AVGPs reached the treasure more rapidly than NVGPs during the ZPG ($d = 0.84$, Table 1). No group differences were observed in reaction time to the CRTT go signal, star collection reaction time, or star collection rate, although the latter two measures were based on only five star presentations per participant.

Regarding personality and mental health, AVGPs reported substantially higher levels of competitive personality ($d = 0.76$), as well as higher levels of trait aggression ($d = 0.60$), compared with NVGPs (Table 1; Fig. 1c). No group differences were observed for the four dimensions of empathic personality, depressive symptoms, trait anxiety, or state anxiety.

3.3 Contribution of competitive personality to retaliatory behavior as measured by the CRTT

To determine whether competitive personality explained additional variance in retaliatory behavior beyond gaming status and other pre-existing psychological characteristics, we fitted a series of nested multiple regression models (Table 2).

Five nested models were specified based on the theoretical framework presented in the Introduction. The unadjusted model (M1) showed that AVGP status was associated with greater retaliatory behavior than NVGP status ($\beta = .49, p = .036$). This association remained virtually unchanged after adjustment for demographic characteristics and auditory discomfort threshold (M2, $\beta = .49, p = .041$), indicating that these variables did not account for the observed group difference.

Adding trait aggression in Model 3 did not significantly improve model fit ($\Delta\text{Adjusted } R^2 = .02$, $\Delta F = 2.31$, $p = .13$). Trait aggression was not independently associated with retaliatory behavior ($\beta = .20$, $p = .13$), and the association between gaming status and retaliatory behavior remained of similar magnitude ($\beta = .41$, $p = .09$).

In contrast, adding competitive personality in Model 4 significantly improved model fit ($\Delta\text{Adjusted } R^2 = .08$, $\Delta F = 7.26$, $p = .009$), accounting for an additional 8% of the adjusted variance in retaliatory behavior beyond gaming status, demographic characteristics, and individual differences in trait aggression. Competitive personality was independently associated with retaliatory behavior ($\beta = .32$, $p = .009$, Supplementary Figure S1a). Trait aggression remained unrelated to retaliatory behavior ($\beta = .18$, $p = .15$), whereas age emerged as a positive predictor, with older participants displaying greater retaliatory behavior ($\beta = .24$, $p = .047$). Importantly, the coefficient associated with AVGP status was substantially attenuated, from $\beta = .41$ in Model 3 to $\beta = .23$ ($p = .34$) in Model 4 after competitive personality was introduced. Additional adjustment for depressive symptoms and state and trait anxiety in Model 5 did not significantly improve model fit compared with Model 4 ($\Delta\text{Adjusted } R^2 = .03$, $\Delta F = 1.80$, $p = .16$). Competitive personality remained associated with retaliatory behavior ($\beta = .34$, $p = .005$). Older age ($\beta = .29$, $p = .017$) and higher trait anxiety ($\beta = .35$, $p = .030$) were also associated with greater retaliatory behavior. Neither depressive symptoms, state anxiety, nor trait aggression were independently associated with retaliatory behavior. Gaming status also remained non-significant ($\beta = .27$, $p = .27$).

As a sensitivity analysis, we examined whether the incremental contribution of competitive personality was robust to predictor ordering by entering the mental health variables before competitive personality. When depressive symptoms, state anxiety, and trait anxiety were added to Model 3, the mental health block did not significantly improve model fit ($\Delta F(3, 64) = 1.39$, $p = .254$). In contrast, the subsequent addition of competitive personality significantly improved model fit ($\Delta\text{Adjusted } R^2 = .09$, $\Delta F(1, 63) = 8.27$, $p = .005$), accounting for an additional 9% of the adjusted variance in retaliatory behavior. Thus, the incremental contribution of competitive personality was robust to predictor ordering. Finally, as an exploratory analysis, Model 6 examined whether the associations of the significant continuous predictors in Model 5 with retaliatory behavior differed between AVGPs and NVGPs by adding gaming-status interactions with competitive personality, age, and trait anxiety. Adding these three interaction terms did not improve model fit relative to Model 5 ($\Delta\text{Adjusted } R^2 = -.01$, $\Delta F(3, 60) = 0.69$, $p = .565$). None of the individual interactions was statistically significant (gaming status $\times$ competitive personality: $\beta = -.23$, $p = .352$; gaming status $\times$ age: $\beta = .07$, $p = .798$; gaming status $\times$ trait anxiety: $\beta = -.27$, $p = .341$). Thus, we found no evidence that the associations of competitive personality, age, or trait anxiety with retaliatory behavior differed between AVGPs and NVGPs.

Altogether, these findings suggest that the association between action video game play and retaliatory behavior is largely accounted for by individual differences in competitive personality. After controlling for competitive personality, AVGP status was no longer associated with retaliatory behavior in the CRTT. In contrast, competitive personality remained independently associated with retaliatory behavior even after adjustment for demographic characteristics, trait aggression, and mental health variables. Importantly,

its incremental contribution was virtually unchanged when age was removed from the model, accounting for an additional 11% of adjusted variance in retaliatory behavior ($\Delta adjusted R^2 = .11, p = .005$).

Table 2. Nested regression models examining the incremental contribution of competitive personality to retaliatory behavior.

	M1		M2		M3		M4		M5	
Predictors	β	p	β	p	β	p	β	p	β	p
AVGP group (NVGPs: 0, AVGPs: 1)	.49*	.036	.49*	.041	.41	.09	.23	.34	.26	.27
Auditory discomfort threshold (dBA)			.20	.11	.17	.19	.11	.35	.15	.23
Age			.20	.12	.20	.10	.24*	.047	.29*	.017
Participant education			– .03	.83	.02	.89	.01	.96	– .02	.85
Parental education			.04	.75	.10	.45	.09	.43	.13	.29
Trait aggression					.20	.13	.18	.15	.08	.55
Competitive personality							.32**	.009	.34**	.005
Depression									.07	.68
Trait anxiety									.35*	.03
State anxiety									– .24	.19
Residual df		72		68		67		66		63
Adjusted R ²		.05		.05		.07		0.15		.18
Model F		4.59*		1.82		1.93		2.84*		2.6**
Model p		.04		.12		.09		0.012		.01
Δ Adjusted R ² (vs. previous model)				.01		.02		0.079		.03
Δ F (vs. previous model)				1.12		2.31		7.26**		1.80

Note. AVGP group was coded as 0 = NVGP and 1 = AVGP. Continuous predictors were standardized (z-scores) before analysis. β values represent standardized regression coefficients. Δ Adjusted R² represents the increase in adjusted explained variance relative to the preceding model. Model F and Δ F represent the overall and incremental model comparisons, respectively. $p < .05^*$, $p < .01^{**}$.

Table 2. Nested regression models examining the incremental contribution of competitive personality to retaliatory behavior.					
	M1	M2	M3	M4	M5
Δp (vs. previous model)		.36	.13	.009	.16
Note. AVGP group was coded as 0 = NVGP and 1 = AVGP. Continuous predictors were standardized (z-scores) before analysis. β values represent standardized regression coefficients. Δ Adjusted R^2 represents the increase in adjusted explained variance relative to the preceding model. Model F and ΔF represent the overall and incremental model comparisons, respectively. $p < .05^*$, $p < .01^{**}$.					

To visualize the impact of competitive personality on the observed group differences, we compared unadjusted and competitive-personality-adjusted CRTT scores in the same subset of 74 participants used in regression analyses with complete data and available competitive personality data (35 AVGPs and 39 NVGPs). Using the same participants for both comparisons ensured that changes in group differences reflected adjustment for competitive personality rather than differences in sample composition. Consistent with the nested regression models, group differences in retaliatory behavior were substantially attenuated and no longer significant after adjustment for competitive personality. For the aggregate CRTT score, the standardized group difference decreased from $d = 0.50$ to $d = 0.25$ (before adjustment: $t(72) = 2.14$, $p = .036$; after adjustment: $t(72) = 1.07$, $p = .290$; Supplementary Figure S1b; Table 3). Similarly, the group difference in noise-blast intensity decreased from $d = 0.51$ to $d = 0.27$ (before adjustment: $t(72) = 2.21$, $p = .031$; after adjustment: $t(72) = 1.14$, $p = .257$; Fig. 2b; Table 3), whereas the difference in noise-blast duration decreased from $d = 0.46$ to $d = 0.22$ (before adjustment: $t(72) = 1.97$, $p = .053$; after adjustment: $t(72) = 0.93$, $p = .357$; Fig. 2c; Table 3).

Table 3

Group differences in CRTT retaliatory behavior before and after adjustment for competitive personality.

CRTT outcome	Before adjustment	After adjustment
Retaliatory behavior – Aggregate score	$d \approx .50$, $t(72) = 2.14$, $p = .036$	$d = .25$, $t(72) = 1.07$, $p = .290$
Retaliatory behavior – Noise intensity	$d = .51$, $t(72) = 2.21$, $p = .031$	$d = .27$, $t(72) = 1.14$, $p = .257$
Retaliatory behavior – Noise duration	$d = .46$, $t(72) = 1.97$, $p = .053$	$d = .22$, $t(72) = 0.93$, $p = .357$

Finally, to examine whether this attenuation reflected a general reduction of group differences in performance or was specific to retaliatory behavior, an analogous analysis was performed for time to reach the treasure in the Zurich Prosocial Game. In contrast to the CRTT, the group difference remained statistically significant after adjustment for competitive personality ($t(72) = -3.11$, $p = .003$, $d = 0.72$), indicating that the influence of competitive personality was specific to retaliatory behavior rather than to task performance more generally.

4 Discussion

Three main findings emerged. First, AVGPs displayed greater retaliatory behavior in the Competitive Reaction Time Task (CRTT), together with higher levels of trait aggression and competitive personality, but did not differ from NVGPs in spiteful punishment, helping behavior, altruistic sharing, empathic traits, or mental health. Second, competitive personality accounted for a substantial proportion of the observed group difference in retaliatory behavior, with the coefficient associated with AVGP status markedly attenuated after competitive personality was introduced into the model. Third, competitive personality did not account for the group difference in Zurich Prosocial Game task performance, suggesting that its contribution was not a generalized explanation of all observed group differences in laboratory performance. Together, these findings suggest that AVGPs do not exhibit a generalized alteration of social behavior.

The observation that AVGPs reported higher levels of competitive personality is consistent with previous work identifying interpersonal competition as one of the principal motivations underlying engagement with video games, particularly shooters and real-time strategy games [34, 36, 37, 61]. More importantly, accounting for competitive personality substantially attenuated the association between AVGP status and retaliatory behavior in the CRTT, whereas trait aggression did not explain comparable incremental variance. This pattern suggests that competitive personality may be more closely related to retaliatory behavior in the CRTT than self-reported aggressive disposition. Although the present findings are necessarily limited by our cross-sectional design, they are consistent with the possibility that competitive personality represents a pre-existing individual characteristic contributing both to engagement in highly competitive game genres and to retaliatory behavior in competitive laboratory contexts. However, the reverse pathway cannot be excluded: repeated engagement in highly competitive games may also strengthen competitive personality over time. These possibilities are not mutually exclusive and cannot be distinguished within the present cross-sectional design. Accordingly, our analyses focused on showing that adding competitive personality as a predictor reduced the association between AVGP status and retaliatory behavior while increasing the variance explained by the model. Establishing whether competitive personality constitutes an intermediate mechanism would require longitudinal data capable of testing the temporal ordering and indirect relationships among these variables. Importantly, these findings should not be interpreted as indicating that competitive personality is inherently maladaptive. Rather, they suggest that this motivational disposition becomes particularly relevant in situations involving direct interpersonal competition.

The hypothesis that competitive personality represents a pre-existing characteristic is also compatible with developmental research suggesting that individual differences in social competitiveness emerge early in life and show relative trait-like stability [62]. Individual differences in social competitiveness have been documented in preschool children (36–71 months of age), where greater competitiveness is associated with higher levels of aggressive traits and more frequent aggressive play [63, 64]. The view of competitive personality as a pre-existing characteristic is also consistent with the proposal that individuals actively seek out action opportunities in line with their temperament, personality, and intrinsic

motivational system [65]. Although these observations do not establish that competitive personality precedes engagement in action video games, they support its plausibility as a pre-existing characteristic that may contribute to engagement in highly competitive gaming activities.

Competitive gaming itself may also contribute to changes in aggressive dispositions and social behavior. Experimental studies indicate that competitive game play can increase subsequent aggressive behavior independently of violent content. Adachi and Willoughby [23] found greater aggressive behavior following competitive rather than less competitive game play, while Hawk and Ridge [66] found that experimentally manipulated competition increased subsequent aggressive behavior independently of violent content, game difficulty, competition outcome, and individual differences in trait competitiveness. Longitudinal studies further indicate that the frequency of competitive gaming is linked with subsequent increases in self-reported aggression, whereas non-competitive gaming is not [29, 30]. Similarly, Lobel et al. [67] reported that high levels of competitive gaming in children (> 8 hours per week) were associated with subsequent declines in prosocial behavior among frequent gamers, despite the absence of comparable longitudinal associations for violent game exposure alone. Importantly, these possibilities are not mutually exclusive: stronger competitive personality may be associated with greater engagement in competitive games, while competitive gaming may also prospectively relate to aggressive behavior and, potentially, competitive personality. Longitudinal studies jointly measuring competitive personality, gaming habits, and social behavior will be required to examine the temporal and potentially reciprocal nature of these associations.

These findings have methodological implications for the interpretation of the Competitive Reaction Time Task (CRTT). Although the CRTT remains one of the most widely used laboratory paradigms for assessing retaliatory behavior, concerns have repeatedly been raised regarding its standardization, construct validity, and the possibility that performance reflects multiple psychological processes beyond aggression alone [40, 41, 48, 68]. Whether the CRTT provides a valid proxy for real-world aggressive behavior remains debated [38, 40]. Within this context, our findings show that competitive personality accounted for a substantial proportion of the observed AVGP–NVGP difference in retaliatory behavior, even after adjustment for trait aggression, anxiety and depression. Importantly, this pattern was observed irrespective of the CRTT operationalization: adjustment for competitive personality similarly attenuated the group differences in noise-blast intensity, noise-blast duration, and the aggregate CRTT score (Fig. 2b–c; Supplementary Figure S1b). This consistency across outcome measures suggests that our findings are unlikely to depend on a particular CRTT scoring approach. Moreover, competitive personality did not similarly attenuate the AVGP–NVGP difference in time to reach the treasure in the Zurich Prosocial Game, arguing against a generalized attenuation of group differences in laboratory task performance. Rather than questioning the utility of the CRTT, our findings suggest that competitive personality should be considered as a potential confounding individual characteristic when interpreting group differences obtained with this paradigm, particularly in populations that differ in their propensity to engage in competitive activities. More broadly, these findings illustrate the importance of accounting for theoretically relevant personality characteristics when interpreting cross-sectional group differences in laboratory measures of social behavior.

Contrary to our initial hypothesis, AVGPs did not differ from NVGPs in helping behavior, altruistic sharing, empathic traits, or mental health. This pattern differs from cross-sectional studies [69] and meta-analyses reporting small negative associations (approximately $r \approx .10$) between violent video game exposure and prosocial traits or behaviors [13, 14], but is consistent with experimental studies reporting little or no effect of violent video game play on empathy and prosocial behavior [70–74]. Given that the meta-analytic associations reported for prosocial outcomes are generally smaller than those reported for aggression, the present study may have been underpowered to detect subtle group differences. Nevertheless, the convergence across multiple laboratory paradigms and self-report measures argues against a generalized alteration of social behavior in AVGPs. Although individual economic games capture only specific aspects of prosocial or antisocial decision-making, convergent findings across several complementary behavioral paradigms provide stronger evidence than any single task considered in isolation [75, 76]. AVGPs also did not differ from NVGPs in skin conductance responses to the aversive noise blasts delivered during the CRTT. Although the present study was not designed to test the hypothesis that violent video game exposure leads to physiological desensitization to real-life violence [77], the absence of reduced physiological reactivity to aversive noise blasts in AVGPs provides no evidence for generalized physiological blunting to aggression-related aversive stimulation. Overall, group differences were most pronounced in competitive personality, trait aggression, and retaliatory behavior in the CRTT, whereas no comparable differences were observed in helping behavior, altruistic sharing, or empathic traits.

The pattern observed across aggressive behavior tasks may also reflect their distinct psychological demands. Whereas the CRTT assesses retaliatory behavior within a repeated competitive and provocative interaction, the Money Burning Game requires a single costly decision to reduce another person's payoff under strategic uncertainty, without prior provocation. Although the group difference in spiteful punishment did not reach statistical significance, its effect size was not negligible ($d = 0.35$), and the present findings therefore do not allow us to conclude that group differences in aggressive behavior are specific to retaliatory contexts. Larger studies using complementary aggression paradigms will be needed to determine whether group differences depend on the competitive, provocative, or retaliatory characteristics of the interaction.

Interestingly, an exploratory post hoc analysis showed that adjustment for competitive personality substantially attenuated the between-group difference in trait aggression (Cohen's d from 0.60 to 0.36; $t(72) = 1.57$, $p = .12$; Fig. 2d). Although exploratory, this finding raises the possibility that competitive personality may also contribute to the association between action video game play and self-reported aggressive personality traits. This hypothesis requires confirmation in independent samples.

An important implication of the present findings concerns the interpretation of the cognitive differences previously reported between AVGPs and NVGPs. Beyond the social domain, research on achievement motivation has linked competitive and performance-approach orientations to greater persistence, effort, and performance, particularly in challenging situations [78–81]. Consistent with this literature, Murayama and Elliot [82] proposed that competition facilitates performance by promoting performance-

approach goals. Although the extension of these findings to competitive personality remains speculative, the present results raise the possibility that competitive personality may contribute not only to behavioral differences in competitive laboratory contexts but also to some of the cognitive differences consistently reported between AVGPs and NVGPs. Future studies should therefore examine whether competitive personality accounts for part of the cognitive differences typically attributed to action video game play.

Although AVGPs and NVGPs did not differ in symptoms of anxiety or depression, trait anxiety emerged as an independent predictor of retaliatory behavior in the fully adjusted model. Internalizing symptoms have previously been associated with aggressive and prosocial behaviors, as well as with problematic gaming [20, 21, 83], highlighting the importance of controlling for mental health variables when examining associations between video game play and social behavior [21, 84]. Notably, accounting for trait anxiety and depressive symptoms did not diminish the contribution of competitive personality to retaliatory behavior, suggesting that these variables capture distinct sources of variance. Together, these findings indicate that competitive personality represents an additional psychological characteristic that should be considered alongside mental health when interpreting cross-sectional differences between AVGPs and NVGPs.

Age was not associated with retaliatory behavior in the bivariate analyses but showed a positive association in the adjusted models, reaching statistical significance after the inclusion of competitive personality. Importantly, the direction of this association argues against age accounting for the higher retaliatory behavior observed in AVGPs: AVGPs were slightly younger than NVGPs, whereas older age was associated with greater retaliatory behavior once competitive personality was accounted for. Because age was negatively associated with competitive personality ($r = -.24, p < .05$), with older participants reporting lower levels of competitiveness, the emergence of the positive association with retaliatory behavior after adjustment for competitive personality may reflect the multivariate structure of the predictors rather than a straightforward age-related increase in retaliatory behavior. One possibility is that, after accounting for competitive personality, older participants were more inclined to punish the opponent's provocative behavior. However, because the CRTT does not distinguish punitive motives from aggressive retaliation, this interpretation remains speculative. This secondary finding should therefore be interpreted cautiously and warrants replication.

The present study has several strengths, including the combination of complementary laboratory paradigms and personality measures to characterize aggressive and prosocial behavior, and stringent classification criteria to recruit relatively genre-pure AVGPs. Nevertheless, several limitations should be acknowledged. First, the cross-sectional design precludes causal inference and therefore cannot determine whether competitive personality represents a pre-existing characteristic that influences engagement in action video games, a consequence of prolonged gaming experience, or both. Second, although the reduced heterogeneity in gaming experience allowed us to characterize a well-defined population of action video game players, it may limit generalizability to more heterogeneous gaming populations. The restriction of the sample to young adult males further limits generalizability to female players and other age groups. Third, the sample size limited precision for some secondary behavioral

outcomes, particularly spiteful punishment in the Money Burning Game. Finally, the post hoc analysis examining the contribution of competitive personality to trait aggression was exploratory and requires independent replication.

5 Conclusions

Taken together, the present findings do not provide evidence for a generalized aggressive or antisocial profile in AVGPs. Rather, AVGPs displayed higher retaliatory behavior in a competitive laboratory context and higher self-reported trait aggression, both of which were substantially attenuated after accounting for competitive personality. By contrast, no group differences were observed in helping behavior, altruistic sharing, empathic traits, or mental health, while the non-significant group difference in spiteful punishment was associated with a non-negligible effect-size estimate and therefore remains inconclusive. These findings highlight competitive personality as an important individual characteristic associated with behavioral differences between gaming populations that might otherwise be attributed to gaming status alone.

Abbreviations

- AVG
Action video game
- AVGP
Action video game player
- BDI
Beck Depression Inventory
- BPAQ
Buss–Perry Aggression Questionnaire
- CRTT
Competitive Reaction Time Task
- IRI
Interpersonal Reactivity Index
- NVGP
Non-video game player
- SCR
Skin conductance response
- STAI
State–Trait Anxiety Inventory
- ZPG
Zurich Prosocial Game

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the University of Geneva and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before participation.

Consent for publication

Not applicable.

Availability of data and materials

The individual-level datasets analyzed during the current study are not publicly available because explicit consent for public data sharing was not obtained at the time of data collection. De-identified data and R code are available from the corresponding author upon reasonable request.

Competing interests

Daphne Bavelier is a member of the scientific advisory board of Akili Interactive, Boston, and acts as a scientific advisor to Red Bull, Los Angeles. Swann Pichon is a founding member and scientific advisor of Celeste Technology, Paris. The other authors declare no competing interests.

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Authors' contributions

SP conceived the study, secured funding, analysed the data, and wrote the manuscript. LA collected the data and reviewed the manuscript. DB and TS provided initial feedback on the study design. JC contributed to the critical evaluation of the statistical analyses. All authors critically reviewed and approved the final manuscript.

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Table 1

Table 1 is available in the Supplementary Files section.

Figures

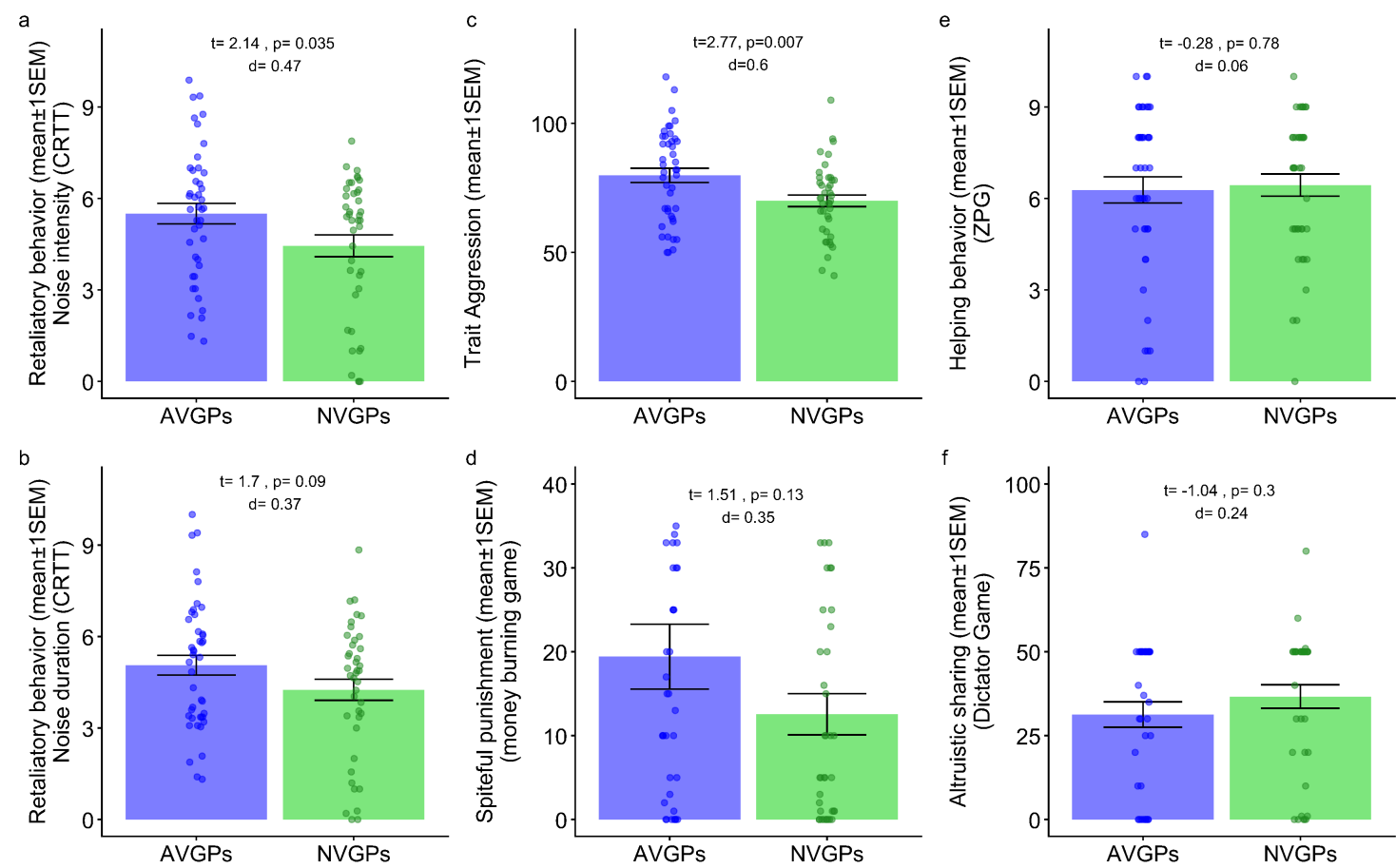


Figure 1

Group comparisons between action video game players (AVGPs) and non-video game players (NVGPs). AVGPs exhibited greater retaliatory behavior in the Competitive Reaction Time Task (CRTT), as reflected by higher noise-blast intensity (a) and marginally higher noise-blast duration (b). AVGPs also reported higher levels of trait aggression (c). No group differences were observed for skin conductance responses (not shown), spiteful punishment in the Money Burning Game (d), helping behavior in the Zurich Prosocial Game (ZPG) (e), or altruistic sharing in the Dictator Game (f). Bars represent group means, error bars indicate ± 1 standard error of the mean (SEM), and dots represent individual participants.

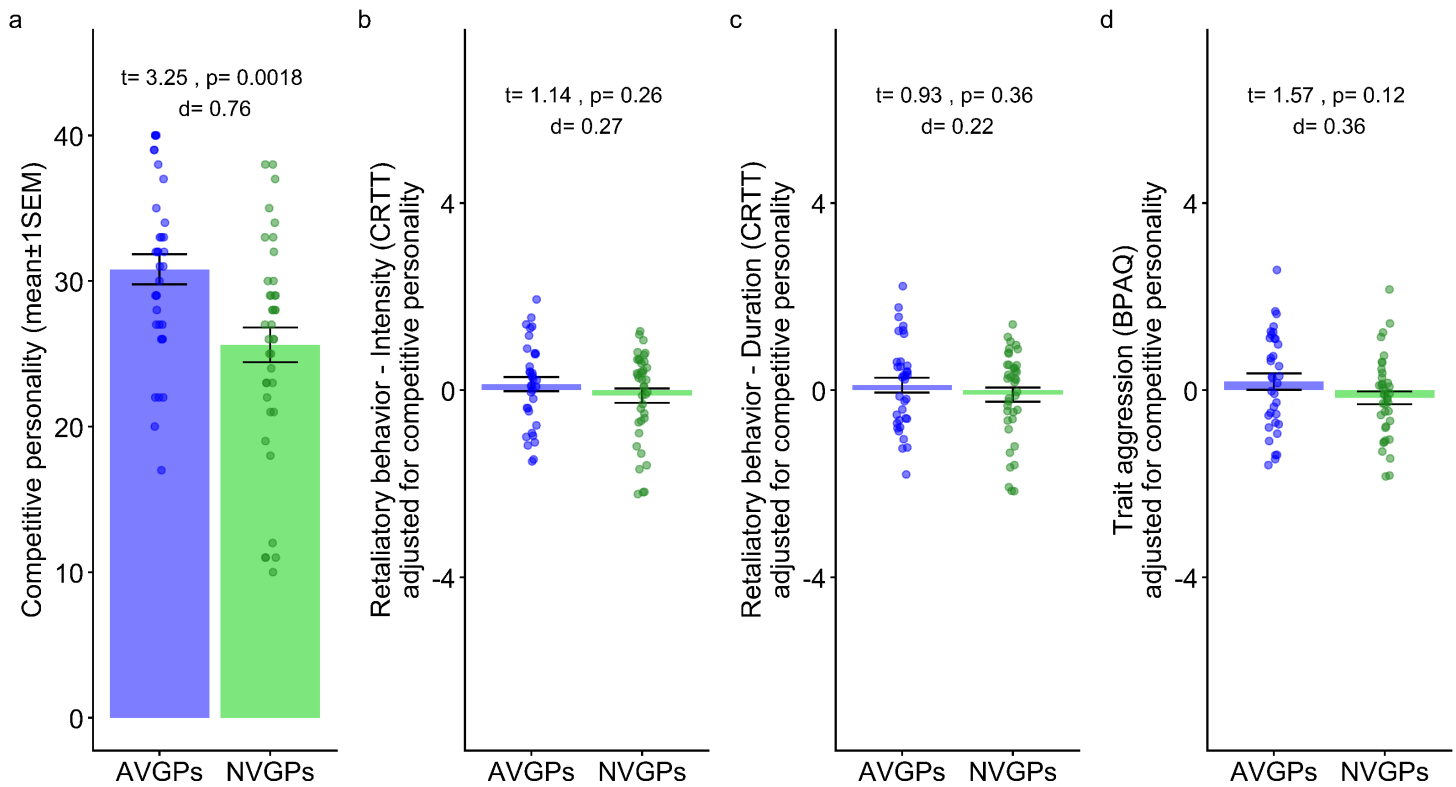


Figure 2

Contribution of competitive personality to group differences in retaliatory behavior and trait aggression. AVGPs reported higher competitive personality than NVGPs (a). After adjustment for individual differences in competitive personality, the AVGP–NVGP differences in noise-blast intensity (b) and duration (c) in the CRTC were substantially attenuated. An exploratory analysis similarly showed an attenuated group difference in self-reported trait aggression after adjustment for competitive personality (d). Bars and horizontal lines represent group means in panel a and competitive-personality-adjusted values in panels b–d; error bars indicate ± 1 SEM, and dots represent individual participants.

Supplementary Files

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- [7.PichonetalSupplementarycorrelationtable1.xlsx](#)
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