Results

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March 20, 2016

## Manipulation Check

*Game manipulation.* Participant ratings on the post-questionnaires were submitted to 2 (Violence) × 2 (Difficulty) ANOVA. The manipulation was highly effective: participants indicated that the violent game (*M* = 5.3 (1.6)) was much more violent than the nonviolent game (*M* = 2.2 (1.3); *d* = 2.1, [1.8, 2.4]). Similarly, participants rated the difficult game as being more challenging than the easy game, *t*(243) = 6.15, *p* < .001, *d* = 0.74, [0.50, 0.99]. The difficult game was not seen as more violent, nor the violent game seen as more difficult.

Players generally did not perceive themselves to have behaved aggressively during the game (*M* = 3.6, *SD* = 1.78 in the violent game, *M* = 2.76, *SD* = 1.55 in the less-violent game, where 4 represents “Neither agree nor disagree”). Ratings of one’s own aggressive behavior were significantly influenced by the game’s violent content (*t*(245) = 3.96, *p* < .001, *d* = 0.48 [0.24, 0.72]), but not by the game’s difficulty (*t*(245) = -0.49, *p* = .627, *d* = -0.06 [-0.3, 0.18]). An interaction was observed such that the difference between violent and non-violent games was larger when the game was easy, *t*(245) = -2.09, *p* = .038, *d* = -0.26 [-0.51, -0.01].

*Provocation.* Mean evaluations of the participants’ interactions with the partner were also assessed. Participants generally indicated that they were irritated (*M* = 5, *SD* = 1.7), angered (*M* = 4.2, *SD* = 1.8), and annoyed (*M* = 4.9, *SD* = 1.8) by their partner. Furthermore, they were neither happy (*M* = 2.4, *SD* = 1.4) nor pleased (*M* = 2.2, *SD* = 1.4) with their partner and found the feedback unhelpful (*M* = 1.7, *SD* = 1.3).

To determine whether the cold pressor dependent variable was a sensitive measure of aggression, we tested whether these participants more provoked by the feedback gave higher cold pressor assignments. Parallel analysis suggested a two-factor solution for participants’ ratings of their interaction with their partner. Factors were extracted using oblimin rotation. The first factor accounted for 52% of the variance and had loadings indicating provocation: .77, .76, and .67 for irritation, anger, and annoyance and -.25, .02, and .02 for happiness, helpfulness, and pleasure. This provocation factor was then used as a linear predictor of cold pressor assignment. The relationship was moderately strong, *t*(249) = 5.73, *p* < .001, *r* = .33 [.22, .43], suggesting that the cold pressor measure was indeed influenced by participants’ intent to aggress. A scatterplot and loess regression line are provided in Figure 1.

If violent games increase hostile appraisals, one might expect participants in the violent-game condition to rate their interaction more negatively. A 2 (Violence) × 2 (Difficulty) ANOVA was conducted to determine whether the game played influenced participants’ ratings of the interaction. Effects were small and not statistically significant (violence, *t*(247) = -0.28, *p* = .777, *d* = -0.03 [-0.27, 0.2]; difficulty, *t*(247) = -0.17, *p* = .867, *d* = -0.02 [-0.26, 0.22]; Violence × Difficulty, *t*(247) = -0.86, *p* = .392, *d* = -0.1 [-0.34, 0.13]), suggesting that the game played had a minimal influence on participants’ reaction to the feedback.

### Conventional General Linear Models.

General linear models were used to look for main effects and interactions of game difficulty, game violence, and 2D:4D ratio. These tests were preregistered. Two models were used to look for effects of left and right 2D:4D ratio separately. Factors were contrast-coded and 2D:4D ratios were standardized to preserve orthogonality of parameter estimates. Cell means and SDs are provided in Table 1.

Neither model found any significant effects. Neither game violence (*t*(265) = 0.9, *p* = .371, *d* = 0.11 [-0.13, 0.35]), game difficulty (*t*(265) = 0.85, *p* = .395, *d* = 0.1 [-0.13, 0.34]), nor their interaction (*t*(265) = -1.52, *p* = .129, *d* = -0.18 [-0.42, 0.05]) significantly predicted aggression. Additionally, neither left-hand 2D:4D (*t*(265) = -1.11, *p* = .266, *r* = -.07 [-.18, .05]) nor right-hand 2D:4D (*t*(266) = 0.52, *p* = .602, *r* = .03 [-.09, .15]) had a significant main effect on aggressive behavior. No higher-order interactions involving 2D:4D ratio of either hand were statistically significant. Full model output is summarized in Tables 2 and 3.

The earlier manipulation and sensitivity check indicated that much of the variance in aggression could be predicted by experienced provocation. Because this provocation was generally independent of the experimental condition, it was appropriate to try it as a covariate to increase statistical power. However, adding provocation as a covariate did not reveal significant effects. The effect of violence was *t*(246) = 0.78, *p* = .434, *d* = 0.09 [-0.14, 0.33], the effect of difficulty was *t*(246) = 1.08, *p* = .283, *d* = 0.13 [-0.11, 0.37], and their interaction was *t*(246) = -1, *p* = .318, *d* = -0.12 [-0.36, 0.12]. Effects of left-hand and right-hand 2D:4D remained nonsignificant (*t*(246) = -1.86, *p* = .065, *r* = -.12 [-.24, .01] and *t*(248) = -0.31, *p* = .755, *r* = -.02 [-.14, .11], respectively).

### Bayesian ANOVA.

Models were compared using the BayesFactor package for R (Morey & Rouder, 2014). The scale of the effect size under the alternative hypothesis was specified as *d* ~ Cauchy(.4), consistent with the effect size reported in meta-analysis (Anderson et al., 2010). Models were generated to represent all possible combinations of main effects and/or interactions. Models including interactions were required to include all lower-order interactions and main effects. All models were compared to a null-hypothesis model including no effects.

Of all the models, the null-hypothesis model was best supported by the data. Models of main effects of Violence, Difficulty, left-hand 2D:4D, or right-hand 2D:4D were each outperformed by the null model (Bayes factors = 3.61, 3.81, 4.4, and 6.53 in favor of the null, respectively). Higher-order interactions were not supported by the data, either. Evidence was ambiguous regarding a Violence × Difficulty interaction (BF = 1.6 favoring the null). Neither violence nor difficulty interacted with 2D:4D of the left hand (BF01 = 3.88, 4.58, respectively) or 2D:4D of the right hand (BF01 = 5.3, 4.58). The Violence × Difficulty × 2D:4D interaction was not supported (left-hand BF01 = 3.39, right-hand BF01 = 3.28).

Experienced provocation was added to the model as a predictor. An effect of provocation was strongly supported by the evidence (BF10 = 1.04325210^{6}). However, addition of this covariate did not improve the strength of evidence for main effects of violence (BF01 = 4.95), difficulty (BF01 = 3.72), or 2D:4D (left hand, BF01 = 1.26; right hand, BF01 = 6.13). Taken together, these results indicate that aggression could be predicted by experienced provocation but not by game condition.

### Non-local Bayesian prior.

In the Bayesian hypothesis tests provided above, we use a non-directional, non-specific alternative hypothesis scaled roughly to the magnitude of the expected effect. While this is a useful hypothesis to test, it would also be useful to compare the obtained results against a more specific alternative hypothesis representing the effect as estimated from previous meta-analysis, δ = .43 (.35, .52) (Anderson et al., 2010).

The main effect of Violence was *d* = 0.11 [-0.13, 0.35]. An online Bayes factor calculator [CITATION NEEDED] was used to compare the evidence for H0: *δ* = 0 relative to H1: *δ* = .43 [.35, .52]. The obtained Bayes factor substantially preferred the null, B01 = 14.2.

Proponents have suggested that the Anderson et al. (2010) estimate may be an overestimate due to publication bias, but that after adjustment for publication bias the effect is still approximately *d* = .30. The Bayes factor calculator was used to compare the evidence for H0: *δ* = 0 relative to H2: *δ* = .30 [.20, .40]. The obtained Bayes factor still preferred the null, but less so relative to this more modest estimate, B02 = 2.0.

### Supplementary methods

Cold pressor assignments were found to be non-normally distributed. To address this non-normality, the data were tested in two additional models to attempt to deal with the spike at 9. Censored regression was used to attempt to model responses greater than 9, and logistic regression was used to model the probability of a 9 response vs. all other responses. These methods did not yield substantively different conclusions (i.e., no parameters were significant). See the supplement for details.

### Exploratory analyses

A number of exploratory analyses were conducted. These examined whether aggression was predicted by participants’ experience of difficulty during the game, participants’ self-reported history of video games, and participants’ in-game behaviors. Exploratory factor analyses used parallel analysis to determine the number of factors, followed by an oblimin rotation.

Questions about the players’ experience of the game had a four-factor structure, with factors representing enjoyment, challenge, difficulty with the game controls, and experience of violent content. Of these, only enjoyment was significantly related to aggression, *t*(245) = 2.66, *p* = .008, *r* = .17 [.04, .29]. Experienced challenge was not related to aggression, contrary to our hypotheses regarding mental fatigue and aggression (*t*(245) = 0.75, *p* = .452, *r* = .05 [-.08, .17]). Discomfort with the game controls was also not related to aggression, *t*(245) = 0.17, *p* = .866, *r* = .01 [-.12, .14], contrary to previous findings by Przybylski et al [CITE].

History of game use was found to have a two-factor structure, with the first factor reflecting experience with video games in general and the second factor reflecting experience with first-person shooters in specific. One of the six items, “I’ve often played games like the one I played today,” had to be discarded to prevent a Heywood case. Neither factor significantly predicted aggression (general experience, *t*(245) = -0.09, *p* = .93, *r* = -.01 [-.13, .12]; FPS experience, *t*(245) = 0.58, *p* = .566, *r* = .04 [-.09, .16]). These results are not consistent with reports of cross-sectional associations between use of violent video games and aggression.

In-game behaviors did not behave well in factor analysis and created Heywood cases. We explored the correlation table directly. Participants who defeated more monsters and fired more bullets were slightly less aggressive (monsters defeated, *t*(272) = -2.51, *p* = .013, *r* = -.15 [-.26, -.03]; bullets fired, *t*(272) = -2.51, *p* = .013, *r* = -.15 [-.26, -.03]), but this finding should be regarded with caution given this test’s exploratory nature and modest *p*-value.