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Beyond the lab: Investigating early adolescents' cognitive, emotional, and arousal responses to violent games

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ABSTRACT

Cognitive, emotional, and arousal responses to violent games play a central role in theoretical explanations of how violent media may affect aggression. However, existing research has focused on a relatively narrow range of responses to violent games in experimental settings. This limits our understanding of whether and how violent game-induced responses relate to aggression in real life. To address these gaps, this study investigated how cognitive effort, emotional valence, and arousal in response to violent games relate to early adolescents' aggression, both cross-sectionally and over a period of one year. In addition, we investigated how a social context variable (i.e., family conflict) predicts these responses to violent games and subsequent aggression. A sample of 448 early adolescents (10–14 years) completed survey questions and media diaries that measured their responses to violent games. Results showed that, outside the lab, a positive cross-sectional relationship between violent game-induced arousal and aggression exists. In addition, arousal mediated the relationship between family conflict and aggression. Study findings justify increased research attention to media responses outside the lab and a need for further theoretical and methodological refinement.

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1. Introduction

The relationship between violent game play and young people's aggressive behavior has been studied for decades, with a number of studies finding a small positive relationship (e.g., Krahé, Busching, & Möller, 2012; Krcmar & Lachlan, 2009, but see e.g., Adachi & Willoughby, 2011; Ferguson et al., 2015). In order to better understand whether and how violent game play may affect aggressive behavior, researchers have studied the processes through which violent game play and aggression may be related (for a review, see Krahé, 2014). Most empirical work in this field has been informed by the General Aggression Model (GAM, Anderson & Bushman, 2002), which posits that a person's cognitive, emotional, and excitative (arousal) responses to violent games play a key role in how violent games may contribute to aggression. In the short term (i.e., immediately after violent game play), a player may experience increased aggressive thoughts, aggressive emotions, and physiological arousal, each of which is thought to increase the likelihood of aggressive behavior at that moment (Anderson & Bushman, 2002). After repeated experiences of such responses to violent games, more long-lasting effects may take place, such as the development of aggressive knowledge structures, disinhibition, and desensitization (Anderson & Bushman, 2002). These changes in a person are proposed to contribute to more long-lasting changes (increases) in aggression.

Although a large number of studies have investigated responses to violent games, there are two important limits to our knowledge that hinder a complete understanding of these processes. First, cognitive, emotional, and excitative responses to violent games have almost exclusively been studied in experimental settings (for a review, see Barlett, Anderson, & Swing, 2009). Such research is characterized by high control over the violent stimulus and measurement of subsequent responses (i.e., high internal validity), but also by typically smaller samples of (young) adults, short exposure to a preselected stimulus, and an aggression-inducing situation directly after exposure (i.e., lower external validity). Thus, the conclusions of this body of work are currently limited to relatively direct effects in very controlled settings, whereas parents and practitioners are often more concerned about potential "real-life" and longer-term effects on children and adolescents. In addition, little knowledge exists about how the social context in which an adolescent grows up may affect the strength of responses to violent

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games and consequently the extent to which youth may become aggressive (cf. Valkenburg & Peter, 2013). Testing such relationships in adolescents' home environment would not only help us understand whether and how violent game play may be related to aggressive behavior, but also for whom this holds in particular. Therefore, the first aim of this study was to explore the relationships between violent game-induced responses and adolescents' aggression (both cross-sectionally and longitudinally) outside the lab, as well as how such responses may be predicted by family conflict – a relevant social-context factor related to media violence and aggression.

A second limitation to our knowledge about responses to violent games is that most empirical studies, as guided by the GAM, have focused on a limited range of cognitive and emotional responses to violent games (while arousal is generally conceptualized similarly across studies). As a theory of human aggression, the processes explicated by the GAM are logically directed towards this particular outcome. Thus, cognitive responses are conceptualized as aggressive thoughts and emotional responses as anger or hostility – with experimental research following accordingly. From a media-entertainment perspective, however, this is a relatively narrow view of the scope of potential responses to violent games. For example, the Differential Susceptibility to Media-effects Model (DSMM, Valkenburg & Peter, 2013) offers a broader view of responses to media by conceptualizing cognitive responses as "the extent to which media users selectively attend to and invest cognitive effort to comprehend media content", and emotional responses as "all affectively valenced reactions to media content" (Valkenburg & Peter, 2013, p. 228). Taking such a broader view on responses to violent games may further advance our thinking and understanding of violent game processes and effects. Therefore, inspired by both the GAM and the DSMM, the second aim of this study was to investigate how media-relevant responses to violent games (cognitive effort, emotional valence, and arousal) are related to adolescents' aggressive behavior. This was done by combining media diaries that captured cognitive, emotional, and excitative responses to violent game play with longitudinal survey data that assessed adolescents' aggressive behavior and social context.

1.1. Cognitive responses

Many theories that attempt to explain effects of media content rely on learning mechanisms (e.g., GAM, Anderson & Bushman, 2002; Social Cognitive Theory, Bandura, 2009), effectively placing cognitive responses to media at the heart of media effects. Numerous concepts have been studied under the umbrella of cognitive responses to media (Valkenburg & Peter, 2013). In media violence research, cognitive responses are generally conceptualized as the accessibility of aggressive thoughts through priming. The GAM posits that violent game play increases the accessibility of aggressive thoughts in memory, which may then increase the likelihood of aggressive behavior at that time (Anderson & Bushman, 2002). Experiments suggest that violent media use indeed temporarily makes aggressive thoughts more easily accessible (e.g., Barlett & Rodeheffer, 2009; Bushman, 1998). However, because priming effects tend to dissipate quickly (Roskos-Ewoldsen, Roskos-Ewoldsen, & Dillman Carpentier, 2009), this conceptualization of cognitive responses is applicable only to situations where aggression is tested immediately after violent game play (i.e., experimental settings). Because such situations are less common in real life, it is relevant to explore alternative cognitive responses that may be able to explain a potential relationship between violent game play and aggression outside the lab.

Research on mediated message processing and learning indicates that cognitive effort, or the amount of cognitive resources allocated to processing and comprehending a message (Fisch, 2000; Lang, 2000; Salomon, 1984), may be a key variable for the learning and development of aggressive cognitions during violent game play. This body of work suggests that higher cognitive effort while playing a violent game results in deeper processing and more elaboration on the game (Fisch, 2000; Lang, 2000; Salomon, 1984). This may result in a more thorough integration of the game content into a game player's associative networks, facilitating later retrieval and learning of the message (Fisch, 2000; Lang, 2000; Salomon, 1984). Unlike the temporarily enhanced accessibility of aggressive thoughts as a result of priming, the more thorough integration of aggressive content in memory as a result of higher cognitive effort can be expected to last beyond a specific game play situation. Thus, investigating cognitive effort as a cognitive response to violent games may explain how such responses can ultimately affect real-life aggressive behavior. Therefore, we pose the following hypothesis:

Hypothesis 1 (H1). Higher cognitive effort during violent game play is related to increased aggressive behavior both cross-sectionally (H1a) and longitudinally (H1b).

1.2. Emotional responses

In addition to cognitive responses, scholars argue that emotional responses to media content are important as well (Nabi, 2009). Although a wide array of emotional responses to media content have been studied in the broader media-effects literature, media violence research generally focuses on aggression-related emotions in response to violent games, such as anger and hostility. These emotional responses are proposed to increase aggressive behavior (Anderson & Bushman, 2002). However, this focus on negative emotions overlooks the fact that violent games are a popular form of entertainment and are designed to evoke positive emotional responses as well (Schneider, Lang, Shin, & Bradley, 2004). If violent games also evoke positive feelings, then it is important to understand whether and how such responses may relate to adolescents' aggressive behavior.

Although the GAM does not provide an explicit explanation for how positive responses to violent games may relate to aggression, other work by media violence researchers suggests that positive emotions experienced during violent game play may increase the likelihood of aggression by creating positive associations with such behavior (Carnagey, Anderson, & Bushman, 2007; Krahé et al., 2011; Lang, Bradley, Schneider, Kim, & Mayell, 2012). In general, people are believed to be inhibited from acting aggressively because they feel negative about such behavior (Crick & Dodge, 1994). However, when aggression is paired with positive emotions, people may be disinhibited from acting aggressively, that is, they may not have such reservations against aggression (Krahé et al., 2011; Lang et al., 2012). Violent games provide a context in which violent acts are often paired with positive emotions (Lang et al., 2012), which may thus contribute to creating positive associations with aggressive acts. As a result, "people who react less negatively to violent media scenes and experience more positive reactions to such scenes should be more aggression prone" (Krahé et al., 2011, p. 632). Although some studies have shown that violent media can evoke happy or positive feelings (e.g., Lang et al., 2012; Schneider et al., 2004), no research has investigated whether or how such responses are related to aggressive behavior. Based on the theoretical explanation for how positive feelings induced by violent games may increase the likelihood of aggression in real life, we pose the following hypothesis:

Hypothesis 2 (H2). A more positive emotional response to violent

games is related to increased aggressive behavior, both cross-sectionally (H2a) and longitudinally (H2b).

1.3. Excitative responses

Lastly, next to cognitive and emotional responses, violent games can also evoke excitative (arousal) responses (Anderson & Bushman, 2002; Valkenburg & Peter, 2013). Arousal is an energizer of behavior that is in itself not inherently positive or negative (Zillmann, 1991). High arousal evoked by violent games is proposed to increase aggressive behavior by energizing action tendencies immediately after game play (i.e., excitation transfer, Anderson & Bushman, 2002; Zillmann, 1991). Over time, repeated experience of arousal during violent game play is thought to result in *lower* arousal levels in response to violent imagery (i.e., desensitization, Carnagey et al., 2007). Such reduced arousal is hypothesized to be related to reduced sympathy for victims, less negative attitudes towards violence, less inhibition against acting aggressively, and ultimately, to increased aggression (Carnagey et al., 2007; Krahé et al., 2011). Thus, theory predicts a positive relationship between violent game-induced arousal and aggressive behavior immediately after game play, but a negative relationship in the long term.

However, neither of these perspectives sufficiently explains how arousal induced by violent games may be related to aggressive behavior outside the experimental context. Aggressing immediately after game play is unlikely to be very common in real life, and the theoretical explanations for long-term effects are remarkably unspecific, essentially only indicating that media violence exposure should be "repeated" and "long-term" for such patterns to occur (Carnagey et al., 2007). In addition, studies into violent game-induced arousal are exclusively short-term experimental studies (including those that investigate desensitization, e.g., Carnagey et al., 2007; Krahé et al., 2011), and only very few actually test whether such arousal is related to aggression. Because of a lack of non-experimental research and clear theoretical expectations, we do not yet fully grasp whether or how violent game-induced arousal and aggression are related in real life (also noted by Anderson et al., 2010; Grizzard et al., 2014). This study extends the experimental body of knowledge and takes a first step towards a better understanding of this relationship by exploring it outside the lab. To that end, we pose the following research question:

Research Question 1 (RQ1). What is the relationship between violent-game induced arousal and aggressive behavior, cross-sectionally (RQ1a) as well as longitudinally (RQ1b)?

1.4. Family conflict as predictor of responses to violent games

Most theoretical models used in media-effects research posit that media use elicits cognitive, emotional, and excitative responses that explain why effects of media may take place (e.g., Anderson & Bushman, 2002; Valkenburg & Peter, 2013). These models also propose that how people respond to media is not only the result of the type of content they are using (such as violent games), but also a result of individual characteristics such as their social context, personality, and developmental level. As such, if we want to better understand the role of media responses, we must not only look at their consequences, but also at their potential origins.

Although individual differences are often treated as moderators in media-effects theory and research, this study conceptualizes them as direct predictors of responses to violent games for two reasons. First, individual differences are theorized to moderate the relationship between *exposure* to violent games and subsequent *responses*, not the relationship between responses and subsequent outcomes such as aggression (Valkenburg & Peter, 2013). In other words, although some adolescents are expected to experience stronger cognitive, emotional, or arousal responses to violent games than others, the relationship between these responses and subsequent aggression is expected to be the same across all adolescents. Given that the current study focuses on this second step, treating individual differences as moderators would be conceptually inappropriate.

Second, this study focuses specifically on adolescents' responses *while playing* violent games. Although media-effects models often make a conceptual distinction between exposure and responses to media, in actuality one cannot experience responses to a violent game without being exposed to it. Thus, in this study on "violent game-induced responses", exposure to violent games is automatically implied and not a distinct preceding construct. As a consequence, although individual differences are theoretically seen as moderators of the *relationship* between exposure and responses, in this study we conceptualize them as direct predictors of the combined construct "violent game-induced responses". Specifically, this study explores whether and how responses to violent games and subsequent aggression are predicted by family conflict, a relevant social-context variable related to media violence and aggression (see Fig. 1).

Family conflict is defined as openly expressed anger, hostility, and aggression in the home (Moos & Moos, 1994). Several studies have shown that family conflict predicts both media violence exposure (Vandewater, Lee, & Shim, 2005) and aggression (Ribeaud & Eisner, 2010), and moderates the relationship between media violence exposure and aggression (Fikkers, Piotrowski, Weeda, Vossen, & Valkenburg, 2013). Theoretically, family conflict has been argued to contribute to aggressive behavior via social learning processes (Margolin & Gordis, 2000) and maladaptive processing of social information (Schultz & Shaw, 2003). In addition, repeated exposure to conflict in the home can result in chronic elevation of arousal in children (Davies & Cummings, 1994). Given this maladaptive responding to real-life situations as a consequence of conflict in the child's environment, it is reasonable to ask whether family conflict also affects how children respond to violent games. Media-effects theories propose that when a child's social environment converges with what he or she sees in the media, this may result in a stronger effect of media (called context-content convergence or resonance), potentially through stronger responses (Valkenburg & Peter, 2013). In other words, adolescents who experience higher levels of family conflict may also experience stronger responses when playing violent games, and increased aggression as a consequence. Given that there is no existing research on the relationship between family conflict, violent game-induced responses, and subsequent aggression, we pose the following research question:

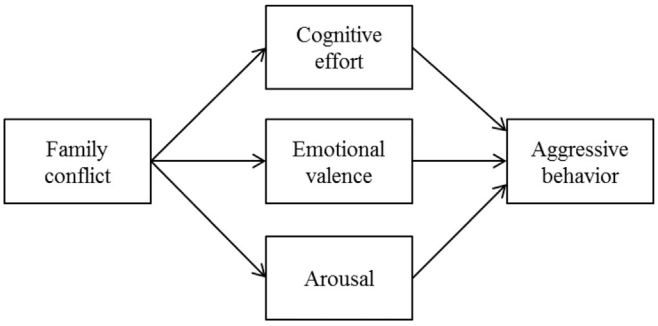

Fig. 1. Conceptual model of the relationship between family conflict, responses to violent games, and aggressive behavior.

Research Question 2 (RQ2). Does family conflict predict adolescents' cognitive, emotional, and excitative responses to violent games and subsequent aggressive behavior, cross-sectionally (RQ2a) and longitudinally (RQ2b)?

2. Method

2.1. Participants and procedure

After receiving approval from the sponsoring institution's Institutional Review Board, a large, private survey research institute in the Netherlands collected the data. Of the 1565 families with at least two children between 10 and 14 in the online panel, 516 families participated. Data collection consisted of two waves, and took place in the adolescents' homes where they completed the questionnaire on a laptop. The first wave of data collection was conducted between September and December 2012; the second wave between September and December 2013. In addition to the questionnaire, respondents completed media diaries that were used to measure responses to violent games.

A total of 1032 early adolescents participated in wave 1. To be included in this study, respondents had to have complete data on the relevant variables for this study in wave 1 and wave 2. In addition, respondents had to report playing at least one game that contained violent content in their media diaries. Out of the 707 respondents who reported playing at least one game in their media diaries, 448 respondents reported at least one *violent* game title. These 448 respondents made up the final sample (54.9% sibling pairs; 24.8% girls; mean age at wave 1 = 11.8 years, *SD* = 1.4 years). For 28 respondents, no wave 2 aggression data were available. These 28 respondents could therefore not be included in the longitudinal analyses, but were included in the cross-sectional analyses.

2.2. Responses to violent games

Media diaries were used to measure responses to violent games (for a detailed description of the set-up of the media diaries, see Fikkers, Piotrowski, and Valkenburg, 2015). Respondents were invited to complete online media diaries on up to four days, in which they reported all titles of games played (computer games, video games, casual games, etc.) on those days as well as how long they played. For each game, respondents reported their cognitive, emotional, and excitative responses, which were measured with one item each in order to keep the length of the media diary manageable. For cognitive effort, respondents reported how much effort they had put into understanding the game on a scale from (1) very little to (5) a lot (cf. Salomon, 1984). Emotional and excitative responses were operationalized as valence and arousal, and measured using Bradley and Lang's (1994) Self-Assessment Manikin (SAM). This scale uses a five-point pictorial response option paired with verbal anchors. For valence, adolescents indicated how they felt while playing the game on a scale from (1) "sad", with a picture of a sad manikin, to (5) "happy", with a picture of a happy manikin. Self-reported arousal during violent game play was measured on a scale from (1) not at all aroused, accompanied by a picture of a calm manikin, to (5) very aroused, which was accompanied by a picture of a very excited manikin.

In order to establish which responses in the diary were induced by *violent* games, all game titles were coded using the Pan European Game Information (PEGI) system, which informs gamers about whether or not a game contains violent content. Trained coders coded the game titles by looking up their violence ratings in the online PEGI database. All game titles that were not in the online database were played by the coders and coded following the official PEGI guidelines. For both of these steps, reliability was evaluated by double-coding at least 25% of the unique titles in the dataset. Coding reliability was high (Kappa's ranged from .74 to .96).

To create variables for cognitive effort, valence, and arousal, we extracted all game titles that received a violent content rating and their accompanying responses from the media diaries. For respondents with more than one violent game title, we calculated the average cognitive effort, valence, and arousal over the violent game titles. Means and standard deviations for each response are reported in Table 1.

2.3. Aggressive behavior

Adolescents' direct aggression was measured using eight items from the Direct and Indirect Aggression Scale (Björkqvist, Lagerspetz, & Kaukiainen, 1992). For example, adolescents were asked how often they hit, swear at, or fight with another adolescent. Response options ranged from (1) never, to (5) very often. Items formed a reliable scale (Cronbach's alpha = .93/.92 at wave 1/2). We summed the eight aggression items and recoded the variable so that it started at zero (recoded range: 0–32). Mean and standard deviation of this variable is reported in Table 1.

2.4. Family conflict

Family conflict was measured using five items from the conflict subscale of the Family Environment Scale (Moos & Moos, 1994). For example, respondents reported how often family members hit each other or become so angry they start throwing things. Response categories ranged from (1) never, to (4) often. Scores were averaged to create scales (Cronbach's alpha = .73), with higher scores indicating greater family conflict. The mean and standard deviation are reported in Table 1.

2.5. Control variables

2.5.1. Time spent playing violent games

Respondents indicated in their media diaries how long they had played a particular game by selecting 30-min time intervals (e.g., 6:00–6:30 pm, 6:30–7:00 pm, etc.) during which that game had been played. We summed all 30-min time intervals reported for violent game play, resulting in a number of hours playing violent games over the course of a minimum of one, and a maximum of four diary days. The mean and standard deviation are reported in Table 1. Time spent playing violent games was included as control variable in all models to ensure that any relationships found are a result of *responses* to these games, and not of the time spent playing them.

2.5.2. Gender

Gender was included in all models, coded as girls = 0 and boys = 1.

2.6. Analytic approach

Aggressive behavior was positively skewed in our sample, with many adolescents (22.3%) reporting no aggression. For all cross-sectional analyses, comparison of Zero-Inflated Poisson regression models with ordinary least squares regression showed that model fit was consistently better for OLS regression than for ZIP regression. We therefore report the results based on parametric OLS analyses. For all longitudinal analyses, we addressed skewness of aggression by creating a change score by subtracting the time 1 sumscore from the time 2 sumscore for each respondent. Using a

Table 1
Means, standard deviations, and zero-order correlations.

Variable	Mean (SD)	Observed range	Zero-order correlations[a]							
			1	2	3	4	5	6	7	8
1. Family conflict	2.19 (.56)	1–4	–							
2. Cognitive effort	2.42 (1.11)	1–5	.15*	–						
3. Valence	4.34 (.65)	2–5	−.06	−.12*	–					
4. Arousal	2.76 (1.07)	1–5	.15*	.21*	.09†	–				
5. Aggression T1	6.37 (6.26)	0–32	.30*	−.03	−.11*	.19*	–			
6. Aggression T2	6.38 (6.14)	0–30	.21*	−.01	−.06	.13*	.62*	–		
7. Change in aggression (T2 − T1)	.16 (5.36)	−23–19	−.09†	.04	.01	−.04	−.39*	.46*	–	
8. Time spent playing violent games[b]	4.03 (4.06)	.5–30.5	.01	−.02	−.10†	.07	.18*	.10†	−.08	–
9. Gender[c]	–	0–1	−.01	−.02	−.03	.07†	.26*	.23*	−.02	.27*

Note. n = 448 for all T1 variables; n = 420 for T2 variables.
*$p < .05$; †$p < .10$.
[a] Pearson's *r* correlations, converted from Kendall's tau-a correlations using Greiner's relation in Stata 12 (Newson, 2002).
[b] Measured in hours.
[c] Girls = 0; boys = 1.

change score is statistically equivalent to using aggression at wave 2 as the dependent variable while controlling for aggression at wave 1. The change score was normally distributed, meaning that we could proceed with parametric analyses for all longitudinal hypotheses and research questions.

Stata 12 was used to address H1, H2, and RQ1. To evaluate RQ2, we ran structural equation models in Mplus (version 7.11, Muthén & Muthén, 2014). We evaluated model fit by using the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). We preferred these measures over the Chi-square statistic, given that this index is often unreliable with large samples. A good model fit is indicated by a CFI larger than .95 and an RMSEA smaller than .05. A CFI between .90 and .95 and an RMSEA between .05 and .08 indicate acceptable model fit (Kline, 2010). All analyses controlled for gender and time spent playing violent games. Because 54.9% of the sample consisted of sibling pairs, standard errors were adjusted for clustering in all analyses.

3. Results

3.1. Descriptives

Table 1 presents the means, standard deviations, and intercorrelations among study variables. Recall that higher scores for the response variables mean more self-reported effort invested in understanding the violent game, happier feelings, and higher arousal in response to violent game play. Aggression at time 1 correlated with emotional valence and arousal (valence: $r = -.11$, $p = .027$; arousal: $r = .19$, $p < .001$), but not with cognitive effort ($r = -.03$, $p = .473$). Aggression at time 2 correlated with arousal ($r = .13$, $p = .008$), but not with cognitive effort ($r = -.01$, $p = .888$) or valence ($r = -.06$, $p = .196$). Change in aggression did not correlate with any of the three responses. Lastly, family conflict correlated significantly with cognitive effort ($r = .15$, $p = .002$) and arousal ($r = .15$, $p = .004$) while playing violent games.

3.2. Violent game-induced responses and aggressive behavior (H1, H2, RQ1)

H1 predicted that higher cognitive effort during violent game play is related to increased aggression; H2 predicted that more positive valence in response to violent games is related to increased aggression; and RQ1 asked how violent game-induced arousal and aggression are related. Analyses controlled for gender and time spent playing violent games and adjusted for clustering.

3.2.1. Cross-sectional analysis (H1a; H2a; RQ1a)

In the cross-sectional model, cognitive effort invested in violent games was negatively related to aggressive behavior ($b = -.49$, $SE = .24$, $p = .038$, $b^* = -.09$), thus rejecting H1a. Valence in response to violent games was not significantly related to aggression ($b = -.67$, $SE = .42$, $p = .115$, $b^* = -.07$), thus rejecting H2a. In response to RQ1a, we found that violent game-induced arousal was positively related to aggression ($b = .99$, $SE = .27$, $p < .001$, $b^* = .17$).

3.2.2. Longitudinal analysis (H1b; H2b; RQ1b)

In the longitudinal model, none of the responses predicted change in aggressive behavior over time. Thus, H1b and H2b were rejected, and we did not find any significant longitudinal relationship between arousal and aggression in response to RQ1b.

3.3. Family conflict as predictor of violent game-induced responses and aggression (RQ2)

RQ2 asked whether family conflict predicts responses to violent games and subsequent aggression, and was tested as a mediation model using SEM. The model controlled for gender and time spent playing violent games and adjusted for clustering.

3.3.1. Cross-sectional analysis (RQ2a)

Model fit was good, as indicated by a CFI of 1.00 and an RMSEA of .00. Table 2 presents the results for the cross-sectional models. Family conflict predicted increased cognitive effort ($b = .22$, $SE = .09$, $p = .015$, $b^* = .11$) and increased arousal in response to violent game play ($b = .29$, $SE = .09$, $p = .002$, $b^* = .15$), but was not significantly related to valence ($b = -.078$, $SE = .06$, $p = .174$, $b^* = -.07$). The indirect path from family conflict to aggression via cognitive effort did not reach traditional levels of significance ($b = -.15$, $SE = .080$, $p = .069$, $b^* = -.01$). The indirect path via arousal was significant ($b = .20$, $SE = .10$, $p = .041$, $b^* = .018$). Overall, in response to RQ2a, the results provide support for a path between family conflict and aggression via violent game-induced arousal.

3.3.2. Longitudinal analysis (RQ2b)

To evaluate the longitudinal relationships between family conflict, responses to violent games, and aggression, our structural equation model was re-run with change in aggression as the outcome variable. Model fit was good, as indicated by a CFI of 1.00 and an RMSEA of .00. Neither family conflict nor the three responses were significantly related to change in aggression. Therefore, in response to RQ2b, there is no evidence for a longitudinal

Table 2
Cross-sectional mediation analyses (RQ2a).

Violent game-induced response (mediator)	Family conflict → response			Response → aggression			Indirect effect		
	b	*SE*	b^*	*b*	*SE*	b^*	*b*	*SE*	b^*
Cognitive effort	.22*	.09	.11	−.65*	.22	−.12	−.15†	.08	−.01
Valence	−.08	.06	−.07	−.39	.39	−.04	.03	.04	.00
Arousal	.29*	.09	.15	.70*	.26	.12	.20*	.10	.02

Note. Controlling for gender and time spent playing violent games.
*$p < .05$; †$p < .10$.

path from family conflict to increased aggression via violent game-induced responses.

4. Discussion

This study investigated the relationships between cognitive, emotional, and excitative responses to violent games and adolescents' aggressive behavior outside the lab. In addition, we explored whether these responses are predicted by family conflict, a relevant social-context variable related to media violence exposure and aggression. In the cross-sectional analyses, higher cognitive effort during violent game play was related to decreased aggression while higher arousal was related to increased aggression. No significant relationship was found between emotional valence during violent game play and aggression, nor was there support for longitudinal relationships between responses to violent games and change in aggression one year later. Looking at a potential predictor of violent game-induced responses and subsequent aggression, we found support for a cross-sectional indirect relationship between family conflict and aggression via increased arousal, although the indirect effect was small ($b^* = .02$). Family conflict also predicted increased cognitive effort, but the indirect effect on aggression was not significant. No longitudinal mediation effects on aggressive behavior one year later were found.

In all, the most consistent support was found for a positive cross-sectional relationship between violent game-induced arousal and aggression. The direction of this relationship is consistent with the idea of excitation transfer, which expects a positive relationship between these variables immediately after violent game play (Zillmann, 1991). Our study suggests that such a relationship may also exist beyond the game play situation. One explanation for how arousal during violent games may affect aggressive behavior at a later time is by affecting cognitive processes such as the speed of processing and memory of the violent game content (Ravaja, 2004), which may then translate into aggressive behavior after game play. Contrary to expectations, increased cognitive effort was related to *decreased* aggression in this study. Perhaps higher cognitive effort during a violent game reflects a more critical stance towards the game (Scharrer, 2006) rather than enhanced learning of aggression. A relevant follow-up to our study would be to more closely study cognitive processes in response to violent media, as well as to investigate how arousal affects such cognitive processes and subsequent aggressive behavior outside the lab.

A viable alternative explanation for the cross-sectional findings in this study is that already aggressive adolescents experience more arousal and less cognitive effort during violent game play. The absence of a longitudinal effect of violent game-induced responses on aggression one year later may be seen to suggest this. Yet, it is equally likely that any effects of such responses are simply not *that* long-lasting (Anderson et al., 2010). In either case, the cross-sectional relationships found in this study indicate that it is relevant to investigate how responses to violent games and aggression are related outside an experimental setting. To better understand the direction of this relationship in real life, future research might rely on longitudinal set-ups with shorter intervals and cross-lagged relationships between response measurement and aggressive behavior.

Regarding the role of social context, we found that family conflict was cross-sectionally related to higher cognitive effort and higher arousal in response to violent games. In addition, a small but significant mediation path from family conflict to aggression via arousal was found. This is the first study to show that adolescents' social environment can affect the strength of their responses to violent games. Importantly, heightened responding to violent games as a result of the social environment may provide an explanatory mechanism for resonance or context-content convergence effects (Valkenburg & Peter, 2013). For example, a previous study found that that *exposure* to media violence was related to increased aggressive behavior among those adolescents who were growing up in a high conflict family (Fikkers et al., 2013). The results found in this study suggest that such a resonance effect may take place because those adolescents experience more *arousal* during violent game play. Future research that further looks into why and how adolescents in particular social contexts may respond more strongly to violent games would further enhance our understanding of resonance effects.

4.1. Theoretical implications

This study is a first attempt to understand how cognitive, emotional, and excitative responses to violent games relate to aggression outside an experimental setting. Next to providing empirical insight into these relationships and identifying relevant next questions for future research, an important take-away of this study is that there is a need for more theoretical specificity about the role of media responses in affecting real-life outcomes. Although several theories stress the central role of responses to media in media effects (Anderson & Bushman, 2002; Valkenburg & Peter, 2013), we lack clear explanations about *how* such responses may ultimately contribute to behavioral outcomes such as aggression. This may be a consequence of the interdisciplinary nature of communication science, in which researchers often employ theories from other disciplines (e.g., psychology) in their work. While this interdisciplinary approach is a strength of the field, it can be problematic in that the main focus of such theories is often not on the media use process. For example, many media violence studies rely on the General Aggression Model (Anderson & Bushman, 2002). However, as a theory that focuses on an *outcome* of media violence exposure, the GAM can help guide empirical studies into aggression, but is not sufficiently specific in its expectations to guide studies into the media violence process. It is important that media psychologists and communication scientists extend such theories and develop clear hypotheses about how particular media content results in particular processes *and* subsequent outcomes. As a starting point, we provide two questions that should be further explicated in order to understand whether and how responses to media violence may affect aggression.

First, one way to provide more specific explanations about

responses to violent media is to integrate ideas from mediated message processing theories into current aggression models. Several theories explain in rich detail how specific media characteristics may influence processing of a message and subsequent cognitive outcomes (e.g., Fisch's [2000] capacity model; Lang's [2000] LC4MP). Media violence researchers can use this body of knowledge to posit and test expectations about which types of processing are evoked by which characteristics of violent messages, and whether and how this may trickle through to aggressive behavior. The recently proposed Theory of Vivid Media Violence (Riddle, 2014) is a good example of using media processing theories to explain how vivid media violence can affect attention, presence, emotional reactions, and cognitive elaborations of such content, and how that may relate to subsequent cognitive effects. More work that explicates *and* formally tests how responses to violent media may increase, decrease, or not affect aggressive behavior would result in improved understanding of this relationship.

Second, to fully understand how responses to violent media affect aggression outside the lab, we need more specific explanations about *when* violent media-induced responses are expected to relate to behavioral outcomes such as aggression, and when they are not. Right now, explanations about the role of media responses focus on either the immediate media use situation, or on the long term. This leaves unanswered several questions about the effects of responses in single versus repeated exposure as well as all time lags in between "immediate" and "long term". For example, studies have shown that arousal in response to a violent game diminishes when people play longer (Krcmar & Lachlan, 2009) or repeatedly over the course of four days (Grizzard et al., 2014). Does this mean that aggressive behavior as a result of such arousal diminishes as well? Or do we expect that the *effect* of such arousal diminishes, but that other potential aggression-enhancing mechanisms take over? These are valid questions that may also be asked for cognitive and emotional responses to violent media. Taking on these questions by developing clear expectations about the time frame of effects of media responses will help refine and advance media violence research.

4.2. Methodological implications

Next to further theoretical specification, methodological innovation is necessary in order to answer questions about responses to media in the best possible way. In our study, we used media diaries to measure responses to violent games, and surveys to measure aggression and individual differences. This approach offers several advantages, such as the possibility to survey a large sample, an ecologically valid measurement of violent game-induced responses, and the possibility to test longitudinal relationships. In addition, the self-report measures of responses to games were less intrusive compared to physiological measures, which is an important issue to take into account with younger respondents.

At the same time, no method is free from weaknesses, and our study gives rise to two suggestions for future research. First, our response measurement relied on recalled and self-reported answers rather than directly observed responses. Physiological response measurement gives researchers more control over the exposure situation and response measurement, which enhances internal reliability, but also generally means smaller sample sizes and shorter duration of exposure. Ultimately, we need both methods in order to understand how media exposure, responses, and behavior are related to each other both in and outside the lab (Ravaja, 2004). Relevant future studies that combine "lab" and "real world" data could move beyond the limitations of either method (see e.g., Krahé et al., 2011). Furthermore, it is relevant for future work to consider naturalistic response measurement that relies less on recall, such as experience sampling (Kubey & Larson, 1990) or ambulatory measurement (Myrtek, Scharff, Brugner, & Muller, 1996).

Second, using more fine-grained analyses will generate more complete knowledge about media responses. In this study, we used aggregated scores for the cognitive, emotional, and excitative responses. However, responses can differ between and even within games, as shown by several studies who studied moment-to-moment physiological responses combined with an event-related analysis of violent games (Lang et al., 2012; Weber, Behr, Tamborini, Ritterfeld, & Mathiak, 2009). This fits with the idea of media use as a dynamic process in which responses and media content reciprocally and dynamically influence each other (Wang, 2014). In addition, it is worthwhile to take into account that other characteristics of a violent game than simple presence or absence of violence can affect responses to games. For example, recent new work has shown that more difficult games (Engelhardt, Hilgard, & Bartholow, 2015) and games that impede players' feelings of competence (Przybylski, Deci, Rigby & Ryan, 2014) can also give rise to aggressive responses and aggressive behavior independent of how violent the game content was. Future research should measure and analyze in much more detail the processes during violent game exposure, how these differ within and between games (as well as within and between respondents), and how they relate to aggression.

4.3. Conclusion

This study aimed to step outside the lab and explore how cognitive, emotional, and excitative responses to violent games relate to adolescents' aggressive behavior, as well as how these responses may originate from a social-context variable such as family conflict. Our findings show that more attention to *responses* to violent media is justified and necessary for understanding the relationship between media violence and aggression in adolescents' lives. However, if we want to study responses to violent media, their consequences, and their origins in a meaningful way, the field must develop more specific theoretical explanations for these relationships as well as think about the best way to measure and test them. Shifting the focus from outcome variables such as aggression to the "black box" of responses to violent media use will be a crucial steppingstone towards understanding the process of media effects.

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