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CHILDREN'S TELEVISION VIEWING AND ADHD-RELATED BEHAVIORS: EVIDENCE FROM THE NETHERLANDS

Sanne W.C. Nikkelen, Helen G.M. Vossen and Patti M. Valkenburg

This study examined how ADHD-related behaviors are associated with children's overall amount of television viewing, specific content viewing (i.e. violent/scary and educational), and attention and arousal responses when viewing television. Additionally, it explored the moderating role of children's sex in these relationships. To address these aims, parents of 865 Dutch children (3–7 years) completed a survey measuring ADHD-related behaviors and kept four-day television diaries. We found that ADHD-related behaviors were not associated with overall viewing nor with violent/scary content viewing. These relationships, however, were moderated by sex. Further analyses of these moderations revealed a positive trend between ADHD-related behaviors and overall and violent/scary content viewing for boys only. ADHD-related behaviors were not related to educational content viewing. Furthermore, ADHD-related behaviors were related to more arousal when viewing television, regardless of content, and less attention to overall and educational television. We did not find sex differences in arousal and attention responses.

KEYWORDS ADHD; ADHD-related behaviors; television; content; arousal; attention

The past decades have witnessed an increased research interest in the potential relationship between television viewing and attention-deficit/hyperactivity disorder (ADHD). ADHD is a developmental disorder typified by a combination of inattention, hyperactivity, and impulsivity (The Diagnostic and Statistical Manual of Mental Disorders, 5th ed. [DSM-V], American Psychiatric Association, 2013). Although ADHD has traditionally been viewed as a categorical disorder, its behaviors are often considered as existing on a continuum (e.g. Larsson, Anckarsater, Råstam, Chang, & Lichtenstein, 2012), which is a perspective we adopt in this study. We will refer to this behavioral continuum as *ADHD-related behaviors*.

A recent meta-analysis yielded a small but positive relationship ($r = .12$) between television viewing and ADHD-related behaviors (Nikkelen, Valkenburg, Huizinga, & Bushman, 2014). However, although informative, this meta-analysis revealed several areas that need further research attention. First, the majority of existing studies have only investigated overall television use without distinguishing between different

content types. As a result, we still largely lack knowledge about the relationship between specific content viewing and ADHD-related behaviors. Second, most existing studies have been conducted among children in middle childhood or adolescence (e.g. Ferguson, 2011; Gentile, Swing, Lim, & Khoo, 2012). As such, little is known about the relationship between ADHD-related behaviors and television viewing in early childhood, the age period during which ADHD-related behaviors typically develop (Polanczyk et al., 2010).

Third, we lack knowledge about how ADHD-related behaviors are related to children's specific responses to television. For example, it is plausible to assume that ADHD-related behaviors are associated with less attention and more arousal during television viewing. Knowledge about these specific responses may help generate hypotheses about the underlying mechanisms of the television-ADHD relationship (Valkenburg & Peter, 2013). Fourth and finally, although previous research acknowledges the influence of children's sex on their television viewing preferences (Valkenburg & Cantor, 2000; Valkenburg & Janssen, 1999) and ADHD-related behaviors (Froehlich et al., 2007; Rajendran et al., 2013), the possible moderating effect of sex is largely ignored in empirical studies.

This study addresses the aforementioned issues by conducting a comprehensive survey and television diary study among children in early childhood (i.e. ages 3–7). The television diary enables us to closely examine what content children actually watch and how they respond to that content. Specifically, we aim to examine how ADHD-related behaviors are associated with children's overall amount of television viewing, viewing of different content (i.e. violent/scary and educational television), and their attention and arousal while watching television. In addition, we will explore the moderating role of children's sex in these relationships.

ADHD-related Behaviors and Television Use

It has been theorized that ADHD-related behaviors are associated with increased overall television viewing, for three reasons (Acevedo-Polakovich, Lorch, & Milich, 2007). First, children high in ADHD-related behaviors typically experience peer difficulties (Hoza, 2007) and may thus engage in more solitary play activities, such as watching television. Second, because ADHD-related behaviors are associated with parenting stress and parent-child conflict (Johnston & Mash, 2001), parents may be less restrictive in their children's television use to enjoy some stress- and conflict-free time. Third, because children with high ADHD-related behaviors often experience educational difficulties (e.g. getting low grades, Loe & Feldman, 2007), they may be less motivated to do homework or to engage in educational play activities and thus spend more time viewing television. We therefore expect that high ADHD-related behaviors will be related to more television viewing overall.

Aside from overall television viewing, it is often argued that ADHD-related behaviors are associated with a preference for arousing (e.g. violent or scary) content (e.g. Miller et al., 2007), because it induces physiological arousal (Fleming & Rickwood, 2001; Gilissen, Koolstra, van IJendoorn, Bakermans-Kranenburg, & van der Veer, 2007). ADHD has been linked to low baseline arousal levels (Lazzaro et al., 1999) and to subsequent stimulation-seeking behaviors as a way to increase arousal to an optimal level

(optimal stimulation theory, Zentall & Zentall, 1983). Children with high ADHD-related behaviors may therefore be more drawn to arousing television content. In this study, we specifically focus on violent and scary content because frequent exposure to such content has been linked with negative outcomes (e.g. Anderson et al., 2010; Valkenburg, Cantor, & Peeters, 2000). Indeed, the meta-analysis of Nikkelen, Valkenburg et al. (2014) showed a positive relationship between ADHD-related behaviors and violent media use. However, only two of the included studies measuring violent media use were conducted in young children (Knezevic, 2009; Zimmerman & Christakis, 2007), which were inconclusive about whether or not violent media use and ADHD-related behaviors are related in this age group. Because violent and scary content are both considered arousing, and because these types of content often overlap (Cantor & Nathanson, 1996), in this study, we conceptualize arousing content as content that is classified as violent and/or scary (referred to as violent/scary content). We expect that ADHD-related behaviors are positively associated with the amount of violent/scary television content viewing.

Furthermore, it is conceivable that ADHD-related behaviors are associated with less viewing of educational television content. Educational content tends to be slower paced (McCullum & Bryant, 2003), thereby inducing relatively little arousal. Therefore, educational content may be less appealing to children high in ADHD-related behaviors. This would be of concern because children with high ADHD-related behaviors often experience educational difficulties (Loe & Feldman, 2007) and could take advantage from any extra learning opportunities. Studies examining the association between ADHD-related behaviors and educational content viewing are inconclusive. Whereas one study found a negative relationship between the two (Hastings et al., 2009), other studies found no relationship (Mazurek & Engelhardt, 2013; Milich & Lorch, 1994; Tomopoulos et al., 2007; Zimmerman & Christakis, 2007). Therefore, in this study, we will explore whether ADHD-related behaviors are associated with educational content viewing in young children.

ADHD-related Behaviors, Arousal, and Attention to Television

Arousal. Due to differences in internal arousal functioning, children with high ADHD-related behaviors may show different arousal responses when viewing television than children with low ADHD-related behaviors. There are two opposing hypotheses concerning the arousal functioning of children with high ADHD-related behaviors. First, it is argued that these children typically show high arousing behavior (i.e. act excited, active, jittery) as a way to increase their low baseline arousal to a more pleasant level (e.g. White, 1999). Because exciting television content (i.e. violent/scary content) induces arousal (Fleming & Rickwood, 2001; Gilissen et al., 2007), these children may be less inclined to act excited when viewing such content. According to this hypothesis, high ADHD-related behaviors may be associated with less arousing behavior when viewing arousing (i.e. violent/scary) content. Instead, when viewing general and educational content, children with high ADHD-related behaviors may show more arousing behavior because the content induces little arousal itself. The opposing hypothesis states that ADHD-related behaviors are associated with a

“hypersensitivity” to exciting stimuli (Sikström & Söderlund, 2007). Accordingly, high ADHD-related behaviors may be related to more arousal when viewing violent/scary content compared to low ADHD-related behaviors, but not when viewing television in general or when viewing educational content. To investigate these two hypotheses, we will examine the relationship between ADHD-related behaviors and children’s arousal when viewing television in general and when viewing violent/scary or educational content.

Attention. Because children with high levels of ADHD-related behaviors have trouble sustaining their attention, it may be expected that they are also less able to focus on television. For example, research has shown that children with ADHD are more easily distracted when viewing television compared to typically developing children (e.g. Lorch et al., 2000). However, attention to television may differ by content. Violent/scary content is characterized by frequent use of salient formal features, such as character movements, action, and visual effects. Formal features like these continuously draw the viewer’s attention to the screen (e.g. Lang, Zhou, Schwartz, Bolls, & Potter, 2000). Children with high ADHD-related behaviors may therefore be just as attentive as children with less ADHD-related behaviors when viewing violent/scary content. Educational content makes specific use of formal features to promote learning, but these are generally less salient (McCollum & Bryant, 2003). Moreover, processing this content may be especially difficult for children with high ADHD-related behaviors, who have trouble sustaining their attention. Therefore, their initial attention response may quickly fade away and they may thus be less attentive to educational content compared to children with less ADHD-related behaviors. In this study, we will examine these relationships by investigating children’s attention levels when viewing television in general and when viewing specific content.

Moderating Influence of Children’s Sex

Typically, the effect sizes of the ADHD–media relationship reported in empirical studies are small, which might indicate that this relationship differs between children. One important moderator may be children’s sex. For example, Nikkelen, Valkenburg et al.’s (2014) meta-analysis on the relationship between ADHD-related behaviors and media use showed that the effect sizes of the included studies increased as the proportion of boys in the sample increased, indicating stronger relationships for boys. Differences may emerge especially in arousing content viewing. After all, boys in general are more drawn to television content that contains action and violence than girls (Valkenburg & Janssen, 1999). Boys with high levels of ADHD-related behaviors might therefore be more attracted to violent/scary television content than girls with high levels of ADHD-related behaviors. Differences between boys and girls may also occur in children’s television responses, due to temperamental differences. Boys are generally less attentive and have more difficulty inhibiting their behavior compared to girls (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006), which may strengthen the relationship between ADHD-related behaviors and arousal and attention responses for boys. The final aim of this study is therefore to examine sex differences in all of the aforementioned relationships.

Method

Sample

Data were collected by a private Dutch research institute (TNS-NIPO) from September to December 2012. Families were recruited through the research institute's existing online panel (approximately 60,000 representative Dutch households). This study is part of a larger design in which the inclusion of sibling data was necessary. Hereto, the research institute recruited 521 families with at least two children between three and seven years old. Given that 10 of 11 children in the Netherlands grow up in multi-child families (CBS, 2003), this sample provided a sufficient representation of Dutch children. Two children from each family participated, resulting in a total of 1,042 children, of whom 934 had complete survey data. Of these 934 children, 69 were excluded due to incomplete television diary data, leading to our final sample of 865 children (52% female, 99% sibling pairs) with a mean age of 5.40 ($SD_{\text{age}} = 1.40$) and an even age distribution (20% 3 years; 21% 4 years; 20% 5 years; 21% 6 years; 18% 7 years). Our sample was well represented in terms of parent's educational level (<1% primary; 15% secondary; 33% vocational; 52% higher education).

Procedure

We collected data using television diaries and a survey, completed by one of the parents. Television diaries were completed online to measure children's television viewing and their arousal and attention responses. Parents have previously proven to be a reliable source when measuring children's television viewing using television diaries (Anderson, Field, Collins, Lorch, & Nathan, 1985). Surveys were administered on a laptop during a home visit by an interviewer to measure ADHD-related behaviors and demographics. Because the planning of the television diaries and home visits occurred separately, the order in which the diaries and the survey were filled out varied between respondents (i.e. survey first [2%], diary first [52%], or the survey in between diary days [46%]).

Television Diaries

For both children, parents filled out the television diary on four days: a Friday, Saturday, Sunday, and random weekday. These four days were spread across a one-month period without overlapping days between siblings. Parents were notified via email and text message a day prior to each diary day. The diary was filled out in the evening (after 8 pm) to document the children's television use during the previous 24 h. As a memory aid, parents received a shortened printed diary to keep notes of their children's television use. In total, parents of 785 respondents had completed all four diaries. As a trade-off between sample size and the reliability of the television measures, we included respondents with at least three completed diaries, resulting in our total sample of 865 respondents. There were no differences between included and excluded respondents concerning sex, $\chi^2(1, N = 934) = .08, p = .804$, age, $t(932) = .14, p = .888$, ADHD-related behaviors $t(75.20) = .41, p = .683$, or birth order, $t(932) = .40, p = .691$. Included participants had slightly higher SES ($t(932) = -4.49, p < .001$).

Each diary day was split into five time slots: (1) previous evening, from 8 pm to bedtime, (2) 6 am to noon, (3) noon to 3 pm, (4) 3 to 6 pm, and (5) 6 to 8 pm. For each time slot, parents reported whether their child had watched television programs or movies, including real-time viewing, on-demand viewing, and viewing through DVDs or on YouTube. If so, we asked parents to write down the program or movie title. If parents forgot the title, they could indicate on which broadcasting station it aired (this was the case for 8% of all titles), so we could look it up. Subsequently, we asked during which half-hour time blocks the title was viewed. Finally, we asked about the child's responses to each title (discussed below). Parents could fill out up to five television programs and five movies per time slot.

Overall television viewing. To calculate overall television viewing, we used a three-step approach. First, for each day separately, we summed all half-hour time intervals in which the child had viewed television programs or movies. Second, we averaged these daily measures—separately for weekdays and weekend days. Third, we multiplied average weekday viewing by five and average weekend day viewing by two and summed these measures to calculate overall viewing in hours per week ($M = 8.09$, $SD = 5.36$). This three-step approach was necessary because children typically watch more television during weekend days, and the number of completed diaries varied between children. Simply averaging the daily measures would therefore lead to an imprecise estimate.

Types of television content. Two trained coders coded whether the programs and movies listed in the television diaries contained violent/scary or educational content (see below for the coding process). Entries with unclear, ambiguous, or multiple titles were handled as missing data. On average, 82% of respondents' television viewing consisted of clear titles that could be coded. All diaries together resulted in a total of 1,112 unique titles to be coded, of which 25 percent were coded as violent/scary and seven percent were coded as educational. Twenty-five percent of the unique titles were double-coded to measure inter-rater reliability.

Coding of violent/scary content. Presence of violent/scary content was coded using the Dutch television and movie rating system, the "Kijkwijzer" (Valkenburg, Beentjes, Nikken, & Tan, 2008). The Kijkwijzer is based on a 60-item questionnaire that broadcasting companies and movie distributors complete to rate their productions. The specific questionnaire responses result in an age and content rating (e.g. whether or not the production contains violent, scary, and sexually explicit content). All programs and movies that have currently been rated by the industry are included in an online, publicly accessible database (kijkwijzer.nl). Coders coded the titles in the television diaries in two steps. First, coders searched for the title on the website of the Kijkwijzer. If ratings for the title were available from the website, coders coded the title for the presence of violent and/or scary content (0 = *absent*, 1 = *present*). Second, titles with no current rating in the online database (7% of all titles) were watched and rated by our coders using the 60-item Kijkwijzer questionnaire. To code television programs, coders watched two randomly chosen episodes of the most recently aired season. Movies were watched in their entirety. Inter-rater reliability was high, with a percentage of agreement of 96% and a kappa coefficient of .90 (Viera & Garrett, 2005).

Coding of educational content. Because the Kijkwijzer only informs about potential harmful content, we designed a coding scheme for educational content. Coders were instructed to look up each title online and primarily look for its official website. If no official website existed, coders searched other websites containing information about television and movie titles (i.e. mediasmarties.nl; commonsensemedia.org; imdb.com; and esrb.org). Using the information on these websites, coders coded each title for the presence of educational content (0 = *absent*, 1 = *present*). Educational content was defined as "content in which the primary goal is to enhance children's perceptual and cognitive skills and to prepare them for school: teaches counting, basic math, and reading." Titles were only coded as containing educational content if it consisted a major part of the title's regular formula. Inter-rater reliability was acceptable, with a high percentage of agreement of 95% and a moderate mean kappa of .57 (Viera & Garrett, 2005).

Calculation of content viewing. Viewing of violent/scary and educational content was calculated using the same three-step approach that was used for overall television viewing. This calculation resulted in average weekly viewing (in hours per week) of violent/scary ($M = 1.17$, $SD = 1.94$) and educational content ($M = 1.01$, $SD = 1.81$).

Arousal and attention. For each title, arousal was measured by asking: "How excited or active did your child feel when watching this television program [movie]?" Parents indicated their children's arousal using the 5-point Self-Assessment Manikin which we adapted to parent report. The self-report measure has been validated in previous research (SAM, Bradley & Lang, 1994). The SAM for arousal consists of a series of graphical figures that illustrate increasing arousal. The graphical pictures were combined with verbal anchors, ranging from 1 (*not at all excited or active*) to 5 (*very excited or active*). Attention was measured by asking for each title: "How much did your child pay attention to what happened in the television program [movie]?" Responses ranged from 1 (*very little*) to 5 (*a lot*). Per participant, we first averaged the scores for arousal and the scores for attention for all titles, over all diary days, to calculate overall arousal ($M = 1.91$, $SD = .75$) and overall attention ($M = 3.93$, $SD = .49$). In addition, we calculated separate arousal scores for violent/scary ($M = 2.06$, $SD = 1.04$) and educational content ($M = 1.93$, $SD = .94$), $t_{(154)} = 2.58$, $p = .011$. Finally, we calculated attention scores for violent/scary ($M = 3.89$, $SD = .80$) and educational content ($M = 3.95$, $SD = .71$), $t_{(154)} = .48$, $p = .631$.

Survey Measures

ADHD-related behaviors. We measured ADHD-related behaviors using the Dutch ADHD questionnaire (Scholte & Van der Ploeg, 2010). This questionnaire consists of 18 items, closely matching the ADHD criteria in the DSM-V (American Psychiatric Association, 2013). The ADHD questionnaire has shown good validity with the "attention problems" subscale in the Child Behavior Checklist (CBCL, Achenbach, 2009; Scholte & Van der Ploeg, 2010). Items were rated on a five-point scale with 0 = *never*, 1 = *sometimes*, 2 = *regularly*, 3 = *often*, 4 = *very often*. Summing all 18 items created the total ADHD score ($M = 17.49$, $SD = 12.03$, $\alpha = .93$).

Control variables. The analyses controlled for children's age (Valkenburg & Cantor, 2001), socioeconomic status (SES, Gorely, Marshall, & Biddle, 2004), and birth order (Nikkelen, Vossen et al., 2014). Age was measured in years and months. SES was calculated as a composite of parents' educational level and household income. Educational level referred to the highest educational level of the parent who completed the survey (1 = no education, 2 = primary education, 3 = pre-vocational education, 4 = lower secondary education, 5 = higher secondary education, 6 = bachelor's degree, 7 = master's degree). Household income referred to the net household income per month. Composite SES was calculated by averaging the standardized scores of educational level and household income. Birth order referred to the child's rank in age among his or her siblings, with 1 = first born, 2 = second born, etc.

Statistical Analyses

For overall television viewing and arousal and attention responses, we conducted linear regression analyses using robust clustering to correct for the clustered nature of our data (i.e. sibling data). For violent/scary and educational content viewing, we conducted Zero-Inflated Negative Binomial (ZINB) regression analysis using robust clustering. ZINB regression accounts for over dispersed outcome variables with excess zeros, which violate the normality assumption of OLS regression (Lambert, 1992). To illustrate, in our sample, 50.6% of children watched zero hours of violent/scary television. The Vuong test for excess zeros and the log-likelihood to test for over dispersion were significant for all ZINB analyses ($p < .01$). Because ZINB regression is performed on integer dependent variables, we first rounded respondent's scores for violent/scary and educational viewing to the nearest hour. Subsequently, high single scores that were relatively distant from the other scores, as indicated by a histogram of the data distribution, were recoded to the nearest value because singular high values greatly affect the model's parameter estimates (Osborne & Overbay, 2004). These averaged, rounded scores of violent/scary content viewing and educational content viewing were used as the dependent variables in the ZINB regression analyses. ZINB regression breaks down the analysis into two models: an "inflate" model examining the effect of predictors on the probability of scoring >0 on the outcome and a "count" model examining the effect of the predictors on the *magnitude* of the score. For the sake of clarity, and because we were only interested in the effect of predictors on the magnitude of respondents' scores on our outcome variables, we only present results for the count model. Because regression coefficients are interpreted differently in ZINB regression, we converted them to incidence rate ratios (IRR), which are interpreted as the percentage of change in the outcome associated with a 1-unit change in each predictor. For each outcome variable, we first examined the main effects of the control variables, sex, and ADHD-related behaviors (Step 1). Subsequently, we added the interaction between sex and ADHD-related behaviors (Step 2).

We examined multivariate outliers using Mahalanobis distance. Cases were considered multivariate outliers when their distance score was particularly remote from other distance scores. Two individuals were identified as outliers for the combination of variables entered in Step 1, and one for the combination of variables entered in Step 2. Outliers were excluded from the analyses.¹

Results

Descriptive Statistics and Zero-order Correlations

Table 1 presents the zero-order correlations between the main variables in this study and the descriptive statistics for boys and girls separately. ADHD-related behaviors were not related to overall television viewing or specific content viewing. Concerning arousal responses, ADHD-related behaviors were positively related to arousal to overall, as well as violent/scary and educational television. In contrast, ADHD-related behaviors were negatively correlated with attention to overall and educational television. Compared to girls, boys displayed more ADHD-related behaviors and watched more violent/scary television.

Relationship between ADHD-related Behaviors and Television Viewing

The OLS regression analysis for overall viewing and the ZINB regression analysis for violent/scary content viewing showed no main effect of ADHD-related behaviors on both, but a significant interaction with sex, see Table 2. For overall television viewing, a simple slopes analysis using STATA's "margins" function showed a positive, marginally significant relationship between ADHD-related behaviors and overall television viewing for boys ($b = .04$, $SE = .02$, $z = 1.75$, $p = .081$, 95% CI $[-.00, .08]$) and a non-significant relationship for girls ($b = -.03$, $SE = .02$, $z = -1.37$, $p = .172$, 95% CI $[-.07, .01]$). A simple slopes analysis for violent/scary television viewing revealed a comparable image, with a marginally significant positive relationship for boys ($IRR = 1.02$, $SE = .01$, $z = 1.90$, $p = .058$, 95% CI $[-.00, .03]$) and no relationship for girls ($IRR = .99$, $SE = .01$, $z = -.20$, $p = .839$, 95% CI $[-.02, .01]$). The interactions are visualized in Figure 1 (overall television) and Figure 2 (violent/scary television viewing). The ZINB regression analysis for educational television viewing showed no main effect of ADHD-related behaviors and no interaction effect with sex (see Table 2).

Relationship between ADHD-related Behaviors and Arousal Responses

The OLS regression analyses for arousal to overall, violent/scary, and educational television showed significant positive relationships between ADHD-related behaviors and arousal responses, see Table 3. We found no interaction with sex for either of the three variables. The relationships between ADHD-related behaviors and arousal to overall, violent/scary, and educational television are visualized in Figure 3.

Relationship between ADHD-related Behaviors and Attention Responses

OLS regression analyses showed negative relationships between ADHD-related behaviors and attention to television overall and to educational content, see Table 3. There was no main effect of ADHD-related behaviors and attention to violent/scary television. Neither of the relationships were moderated by children's sex. The relationships between ADHD-related behaviors and attention to overall, violent/scary, and educational television are visualized in Figure 4.

TABLE 1
Bivariate correlations between main study variables and descriptive statistics separately for boys and girls

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|----------------------------------|-------------------------------|----------------|-----------------------------|----------------|---------------|----------------|---------------|---------------|---------------|---------------|
| 1. ADHD-related behaviors | | | | | | | | | | |
| 2. Overall TV | .01 | | | | | | | | | |
| 3. Violent/Scary TV ^a | .04 | .35*** | | | | | | | | |
| 4. Educational TV ^a | .03 | .39*** | -.05 | | | | | | | |
| 5. Arousal: Overall | .23*** | .07* | .05 | .14*** | | | | | | |
| 6. Arousal: Violent/scary | .23*** | .09 | .05 | .14** | .77*** | | | | | |
| 7. Arousal: Educational | .19*** | .03 | .03 | .17*** | .78*** | .46*** | | | | |
| 8. Attention: Overall | -.12*** | -.08* | .01 | -.00 | .08* | .08 | .04 | | | |
| 9. Attention: Violent/scary | -.04 | -.04 | .11* | -.13* | .06 | .11* | -.03 | .65*** | | |
| 10. Attention: Educational | -.13* | -.06 | -.09 | .06 | .03 | .07 | .01 | .65*** | .11 | |
| Age | -.01 | -.09* | .08* | -.27*** | .00 | -.01 | -.06 | .04 | .22*** | -.07 |
| SES | -.10** | -.03 | -.04 | -.03 | -.12*** | -.08 | -.11* | .00 | -.07 | -.06 |
| Birth order | -.04 | -.03 | .02 | -.03 | -.01 | -.06 | .01 | -.09** | -.19*** | .09 |
| Mean (SD) Boys | 18.91 ^b (11.84) | 8.08 (5.60) | 1.38 ^b (2.07) | .94 (1.67) | 1.96 (.73) | 2.15 (1.01) | 1.91 (.94) | 3.93 (.50) | 3.92 (.80) | 3.92 (.69) |
| Girls | 16.06 (11.62) | 8.10 (5.14) | 1.11 (1.82) | 1.10 (1.81) | 1.87 (.77) | 1.96 (1.07) | 1.94 (.94) | 3.93 (.47) | 3.85 (.80) | 3.98 (.72) |

^aRounded and recoded variables.

^bSex difference is significant at $p < .05$.

* $p < .05$; ** $p < .01$; *** $p < .001$.

TABLE 2

Multiple regression results for the relationship between sex, ADHD-related behaviors, and television viewing

| | Overall TV ^a (N = 865) | | Violent/Scary TV ^b (N = 865) | | Educational TV ^b (N = 865) | |
|--|--------------------------------------|----------|--|----------|--|----------|
| | <i>b</i> (SE) | <i>t</i> | IRR (SE) | <i>z</i> | IRR (SE) | <i>z</i> |
| Age | -.46 (.16) | -2.90** | 1.13 (.07) | 1.97* | .71 (.06) | -3.93*** |
| SES | (Excluded) ^f | | .82 (.08) | -2.07* | .82 (.08) | -2.11* |
| Birth order | -.49 (.25) | -1.97* | 1.32 (.12) | 3.03** | .73 (.08) | -2.81** |
| Sex ^c | .00 (.35) | -.01 | .87 (.11) | -1.17 | 1.13 (.16) | .90 |
| ADHD | .04 (.02) | 1.75 | 1.02 (.01) | 2.27* | 1.03 (.16) | 1.42 |
| Sex*ADHD | -.07 (.03) | -2.22* | .97 (.01) | -2.70** | - | - |
| <i>R</i> ² /Pseudo <i>R</i> ² ^d | .02 | | .04 | | .15 | |
| <i>F</i> /Wald χ^2 ^e | 2.51* | | 34.97*** | | 25.59*** | |

^aResults from OLS regression.

^bResults from zero-inflated negative binomial regression, IRR = incidence rate ratio.

^c0 = boys, 1 = girls.

^dFor overall TV, *R*² is reported, for violent/scary and educational TV, the Cox and Snell's *R*² is reported.

^eFor overall TV, *F* is reported, for violent/scary and educational TV, the Wald χ^2 is reported.

^fBecause the overall model fit was not significant for the initial model, non-significant control variables were excluded.

p* < .05; *p* < .01; ****p* < .001.

Discussion

This study aimed to examine how ADHD-related behaviors are associated with specific television viewing patterns in young children and the moderating role of children's sex in these relationships. Our findings indeed indicate several content- and sex-specific differences in the television use and responses between children who display high ADHD-related behaviors and those with less ADHD-related behaviors.

Findings Concerning Television Exposure

In contrast to our expectations based on previous studies (e.g. Acevedo-Polakovich et al., 2007), we did not find a significant relationship between ADHD-related behaviors and overall television viewing. However, in line with a recent meta-analysis (Nikkelen, Valkenburg et al., 2014), we did find an interaction with child's sex, indicating significant differences between boys and girls in this relationship. Further analysis showed a positive trend between ADHD-related behaviors and overall television viewing for boys only. The same was true for the relationship between ADHD-related behaviors and amount of violent/scary content viewing, which was also moderated by sex, with a positive trend for boys only. This finding is consistent with a meta-analysis on the violent television-aggression relationship (Paik & Comstock, 1994). Thus, not only do boys display more ADHD-related behaviors and are they more attracted to violent and action-packed media content, they also show stronger relationships between these two factors. Finally, we found no relationship between ADHD-related behaviors and the

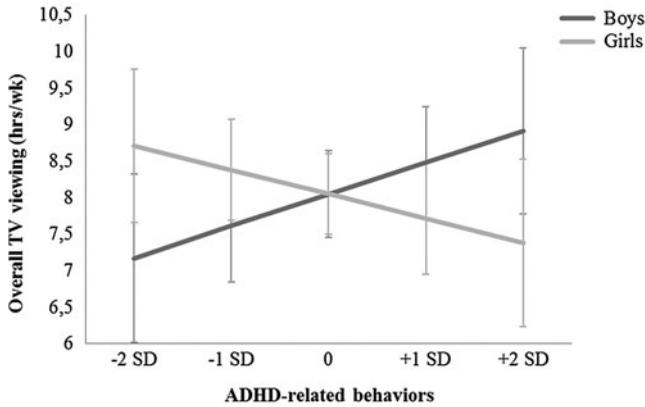


FIGURE 1 Relationship (+95% CI) between ADHD-related behaviors and overall television viewing, separately for boys and girls

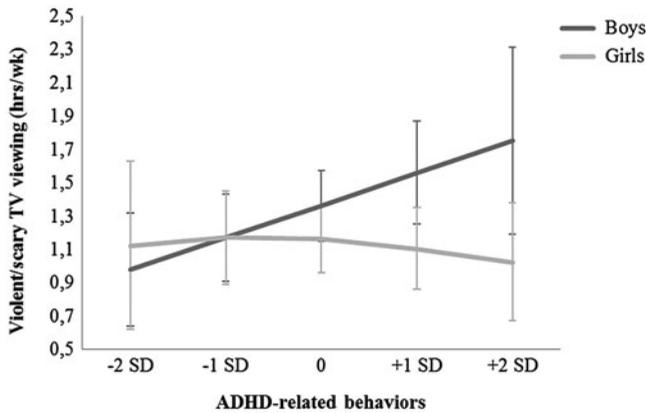


FIGURE 2 Relationship (+95% CI) between ADHD-related behaviors and violent/scary television viewing, separately for boys and girls

amount of viewing of educational television, and no moderation by sex. Despite its slower pace, educational content may appeal as much to children displaying more and those displaying less ADHD-related behaviors.

Findings Concerning Arousal and Attention Responses

Children who displayed more ADHD-related behaviors showed more arousal (e.g. excited, active, and jittery behavior) when viewing television in general and when viewing violent/scary or educational television. These results held for both boys and girls. One could argue that this heightened arousal merely reflects general hyperactivity of

TABLE 3
 OLS regression results for the relationship between sex, ADHD-related behaviors, and arousal and attention responses

| | Arousal responses | | | | Attention responses | | | | | | | |
|------------------|-------------------------|---------|-------------------------------|---------|-----------------------------|--------|-------------------------|---------|-------------------------------|--------|-----------------------------|--------|
| | Overall TV (N = 835) | | Violent/Scary TV (N = 386) | | Educational TV (N = 361) | | Overall TV (N = 835) | | Violent/Scary TV (N = 386) | | Educational TV (N = 361) | |
| | b (SE) | t | b (SE) | t | b (SE) | t | b (SE) | t | b (SE) | t | b (SE) | t |
| Age | -.00 (.02) | -.01 | -.03 (.04) | -.69 | -.04 (.05) | -.83 | -.00 (.01) | -.10 | .09 (.03) | 2.78** | (Excluded) ^b | |
| SES | -.11 (.05) | -2.42* | -.08 (.08) | -.92 | -.14 (.09) | -1.63 | -.01 (.03) | -.43 | -.09 (.07) | -1.30 | (Excluded) ^b | |
| Birth order | -.01 (.04) | -.12 | -.09 (.07) | -1.25 | -.01 (.09) | -1.17 | -.06 (.03) | -2.14* | -.13 (.06) | -2.13* | (Excluded) ^b | |
| Sex ^a | -.06 (.06) | -1.02 | -.15 (.11) | -1.39 | .07 (.10) | .71 | -.03 (.03) | -.84 | -.09 (.08) | -1.11 | .03 (.08) | .39 |
| ADHD | .01 (.00) | 5.60*** | .02 (.00) | 4.25*** | .02 (.00) | 3.14** | -.01 (.00) | -3.31** | -.00 (.00) | -1.16 | -.01 (.00) | -2.60* |
| Sex*ADHD | | | | | | | | | | | | |
| R ² | .06 | | .06 | | .05 | | .03 | | .07 | | .02 | |
| F | 8.27*** | | 5.00*** | | 2.61* | | 3.13** | | 5.82*** | | 3.53* | |

^a0 = boys, 1 = girls.

^bBecause the overall model fit was not significant for the initial model, non-significant control variables were excluded.

*p < .05; **p < .01; ***p < .001.

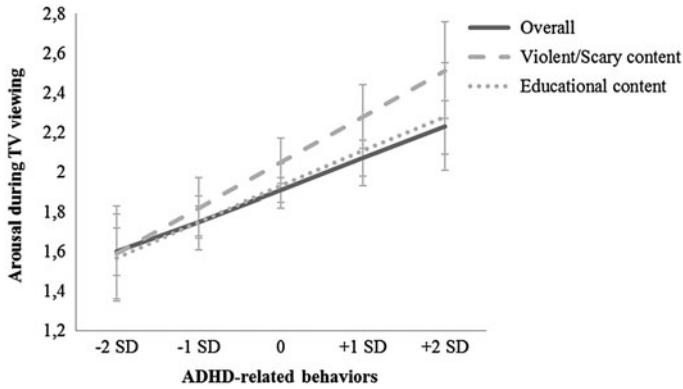


FIGURE 3 Relationship (+95% CI) between ADHD-related behaviors and arousal when viewing television, separately for overall, violent/scary, and educational television viewing

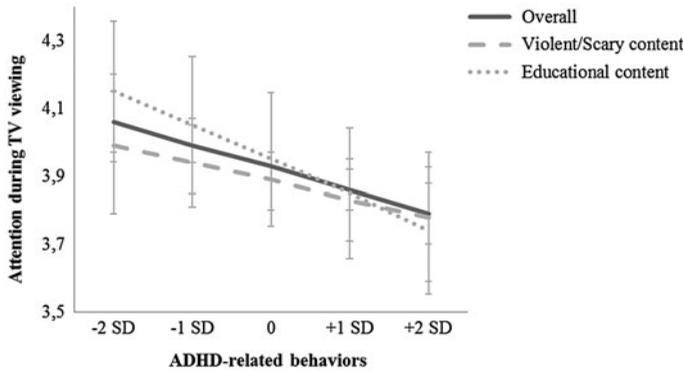


FIGURE 4 Relationship (+95% CI) between ADHD-related behaviors and attention when viewing television, separately for overall, violent/scary, and educational television viewing

these children. However, in general, children’s arousal to educational content was lower than their arousal to violent/scary content, which indicates that our arousal measure actually measured children’s arousal response to the specific content viewed, and not just children’s overall hyperactivity. Our findings are in line with the hypersensitivity hypothesis, which states that children high in ADHD-related behaviors show more arousal when exposed to exciting stimuli. We found this to be true not only for violent/scary content, but also for overall and educational television. Given that arousal is frequently hypothesized to play a role in the relationship between ADHD-related behaviors and media use, our study may inspire future studies to specifically test the underlying role of arousal in the media-ADHD relationship.

ADHD-related behaviors were negatively associated with attention to television viewing in general and educational content, but not to violent/scary content. There

were no sex differences in these relationships. These results are in line with our expectation that when television content contains less salient formal features, as is generally true for educational content, children who display more ADHD-related behaviors pay less attention to this content. This finding suggests that these children may not benefit from the positive effects that educational content potentially has on their cognitive skills (e.g. Wright et al., 2001). This implication is worrisome given that children with high levels of ADHD-related behaviors often face educational difficulties (Loe & Feldman, 2007) and may thus have a greater need for activities that potentially enhance their cognitive skills compared to children with less ADHD-related behaviors. In recent years, educational media for children has become a multimillion industry. Much research and money is dedicated to making quality media products that specifically draw and hold the attention of children. Our results suggest that more research is needed to examine how children high in ADHD-related behaviors view educational programs and how educational programs can keep the attention of these children.

Limitations and Directions for Future Research

The findings of our study should be considered in light of three limitations. First, our sample size was too small for some of our analyses. For example, arousal and attention responses to specific media content were only measured if the child actually used that specific media content. A considerable part of our sample did not watch any violent/scary or educational content. As such, the sample sizes for the analyses of arousal and attention to violent/scary and educational were smaller ($N = 386$ for violent/scary and $N = 361$ for educational content) than the sample sizes for the analyses regarding exposure ($N = 865$). This may partially explain why we found sex differences with the exposure measures and not for the response measures. Future studies using larger sample sizes might have more statistical power to reveal possible sex differences.

A second limitation concerns our use of parent report measures of attention and arousal. Parent reports may be biased because of the personal involvement of the parent with the child. Moreover, parents may keep sex-stereotypical behavior in mind when reporting on their children's arousal and attention responses (e.g. boys are generally more active, thus heightened arousal may not have been reported as such). This may explain why we found no sex differences for these measures. However, using parent reports, we were able to specifically match television exposure with children's responses and are therefore considered a first step. Still, our study should be seen as a first step in discovering the role of attention and arousal in the relationship between ADHD-related behaviors and television use. Future observational and experimental studies are needed to validate these measures and confirm our findings.

Finally, due to the cross-sectional nature of our data, we cannot draw conclusions about the direction of our results. Although television use may be a function of ADHD-related behaviors, there are also hypotheses stating that television viewing, particularly exciting content, increases ADHD-related behaviors (e.g. Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Levine & Waite, 2000). In addition, the effect may work in both directions, indicating a reinforcing spiral effect (Slater, 2007). To our knowledge, only one study considered both relationships in a sample of children in early childhood (Stevens, Barnard-Brak, & To, 2009). Although this study found no relationship between

television viewing and ADHD-related behaviors over time, the authors did not examine the moderating influence of sex and focused only on overall amount of television viewing. Research further exploring the bidirectional relationships between ADHD-related behaviors and television viewing is therefore urgently needed.

Conclusion

The findings of this study suggest that ADHD-related behaviors are associated with differences in both television viewing and responses to television content. These findings form an important first step toward the conceptualization and investigation of more nuanced models on the relationship between media use and ADHD-related behaviors. Future research should not only distinguish between different types of content that children are exposed to, but also more systematically conceptualize and model mediating (e.g. attention, arousal) and moderating (e.g. sex, age, temperament) factors. Only by investigating such indirect and conditional effects models are we able to arrive at a true understanding of the relationship between media use and ADHD-related behaviors.

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NOTE

1. We have checked whether results were different when outliers were excluded or included, and found that this was only the case for exposure to educational television content. This relationship was significant with inclusion of outliers, but non-significant upon exclusion of the outliers. Because the initial result (for the full sample, including outliers) was not robust and influenced by only a few cases, we only describe the findings excluding the outliers.

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