Television Viewing and Symptoms of Inattention and Hyperactivity Across Time

The Importance of Research Questions

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The importance of well-specified research questions in the evaluation of early predictors of later inattention and hyperactivity is examined. In an analysis of a nationally representative sample of 2,717 children aged 4 to 10, latent growth trajectories for television viewing and inattention and hyperactivity are determined and the relationship of the two constructs examined. Analyses reveal a logistic latent growth model as the best description of the trajectory of television viewing across time, whereas a quadratic trend represents the best portrayal of the trajectory for symptoms of inattention and hyperactivity. Results do not support the presence of a meaningful relationship between television viewing and inattention and hyperactivity, which is inconsistent with previous findings from the same data set. The importance of the nature of well-specified research questions and the need to use contemporary longitudinal evaluation techniques to avoid misleading conclusions based on limited analyses and results are discussed.

Keywords: television; early childhood; longitudinal studies; attention and behavior problems

Inattention and hyperactivity has been associated with poor academic outcomes (e.g., Merrell & Tymms, 2001), social difficulties (e.g., Gresham, MacMillan, Bocian, Ward, & Forness, 1998), and problems ranging from oppositional behavior to depression (e.g., Hartung, Van Pelt, Armendariz, & Knight, 2006; Willcutt, Pennington, Chhabildas, Friedman, & Alexander, 1999). Understanding the predisposing and preexisting factors that have been related to the development of inattention and hyperactivity may be important for early intervention, as this knowledge might promote practical recommendations for those behavioral problems. One factor that has become pervasive in many American households is television viewing, which has been associated with health concerns, including obesity (e.g., Dietz & Gortmaker, 1985; Robinson, 1999), poor eating behavior (e.g.,
French, Story, & Jeffery, 2001), and smoking (e.g., Gidwani, Sobol, DeJong, Perrin, & Gortmaker, 2002; Hancox, Milne, & Poulton, 2004). Although some researchers have implicated television in the development of inattention and hyperactivity (e.g., Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Johnson, Cohen, Kasen, & Brook, 2007; Landhuis, Poulton, Welch, & Hancox, 2007), other investigators have questioned the importance of this relationship (e.g., Obel et al., 2004; Stevens & Mulsow, 2006).

To date, multiple regression and logistic regression techniques, which use composite independent variables when evaluating prediction, have been used by most researchers who study the relationship between television and attention problems (e.g., Christakis et al., 2004; Johnson et al., 2007; Landhuis et al., 2007). Considerable overlap appears to exist among many of the predictor variables used in previous television analyses. Therefore, researchers cannot be certain of the importance of the role of television beyond the other variables in the prediction of inattention and hyperactivity, especially when failing to partition variance to better understand the contributions of individual predictor variables (Zientek & Thompson, 2006).

Researchers have provided several explanations concerning differences in findings about television. Specifically, they have noted the possibility that television exposure is more detrimental to very young children (i.e., age 2) than it is to preschoolers (Landhuis et al., 2007) or that television viewing is especially problematic for children predisposed to an actual attention and behavior disorder (Stevens & Mulsow, 2006). However, these suggestions start from the premise that television is indeed harmful to children’s attention and behavior. We propose that the differential findings have resulted because investigators have asked different questions. Furthermore, these explanations should be considered with caution as they assume that the results from the aforementioned studies imply causality when correlational research does not determine cause and effect.

Statistical analyses depend on the research questions proposed; therefore, the possibility exists that research concerning the association between television and subsequent attention problems does not actually differ. Instead, researchers may have been addressing different questions regarding this relationship. In addition, interpretations of the results might have exceeded what is warranted by implying causal relationships from correlational studies.

The purpose of our study was to demonstrate the importance of research questions in the evaluation of early childhood predictors related to later inattention and hyperactivity. Because researchers have used regional community-based samples (e.g., Johnson et al., 2007), databases from other countries (e.g., Landhuis et al., 2007), and various national databases (e.g., Christakis et al., 2004; Stevens & Mulsow, 2006) as well as multiple measurement strategies, we focused on the variation of research questions specific to a database and measures related to Attention-Deficit/Hyperactivity Disorder (ADHD). Hence, we believe that our approach allows for a better comparison of outcomes related to different research questions. The relationship between television in early childhood and later inattention and hyperactivity has been evaluated using the National Longitudinal Survey of Youth (NLSY-79) 1986-2004. For example, Christakis et al. (2004) conducted a logistic regression analysis using the national database to address the question of whether a relationship existed and whether television exposure predicted the presence of attention and behavioral problems. We extended the analysis to capitalize on the longitudinal nature of
the database and posited different questions. We used latent growth curve modeling with parallel processes to address the following research questions:

1. What is the developmental trajectory of both television viewing and attention and hyperactivity for a sample of children from age 4 to 10? and
2. What is the relationship between trajectories of television viewing and attention and hyperactivity problems?

Because we analyzed the same data as Christakis et al. (2004), we had the opportunity to show how the same data set could yield different results based on the questions posited and when using varying statistical procedures.

Method

National Longitudinal Survey of Youth (NLSY-79) 1986-2004

We used a sample of 2,717 children aged 4 to 10 in the four most recent waves (i.e., 2000, 2002, 2004, and 2006) of the National Longitudinal Survey of Youth (NLSY-79) 1986-2004. We selected children if they were 4 years of age in the first wave of data collection and had data for each of the measures of interest across the remaining three waves of collection. The NLSY-79 included 12,686 men and women who were between the ages of 14 and 21 years in 1979. This weighted national sample is representative of similarly aged individuals living in the United States during this period (Center for Human Resource Research, 2006). The children included in the present sample were children born to the NLSY-79 sample of women. In applying weights, this sample of children represented some 11,555,144 children aged 4 to 10 across the United States from the year 2000 to 2004 who were born to NLSY-79 women.

Data collection occurred every 2 years. Mothers in the NLSY-79 sample completed study measures that assessed their children’s (a) cognitive ability, (b) temperament, (c) motor and social development, (d) behavior problems, (e) self-competence, and (f) home environment. The four most recent waves of data evaluated in the present study were collected via computer.

Boys comprised 51.67% (n = 1,404) of the sample whereas girls comprised 48.33% (n = 1,313) of the sample. The most frequently reported racial background of children in the sample was non-Black and non-Hispanic, consisting of approximately 56% (n = 1,536) of the sample. An additional 24.5% (n = 665) of mothers of children in the sample reported being Black and 19.0% (n = 516) identified themselves as being Hispanic.

Measures

All measures were retrieved from the four most recent waves of the NLSY 1986-2006. To measure children’s television exposure, parents self-reported the number of hours of television viewing per day and the numbers were summed to create a variable of hours of television per week. The average number of hours was 3.94 (SD = 4.01) per week and appeared to be positively skewed (z = 2.10) and have a high degree of kurtosis (z = 2.45).
The average obtained is similar to the value reported by Christakis et al. (2004) for 3-year-olds. The median number of hours of television viewing per week was 3.00, with a range of 0 to 48 hr a week. Our analyses indicated no significant differences in the number of hours of television viewing per week according to gender or ethnic background of children.

We used the inattention and hyperactivity subscale scores of the Behavior Problems Index (BPI) to measure inattention and hyperactivity. The BPI consists of items adapted from the Child Behavior Checklist (Achenbach & Edelbrock, 1981) by Peterson and Zill (1986). The BPI items assess problem behaviors within six subscales: (a) antisocial behavior, (b) anxiousness and depression, (c) headstrongness, (d) hyperactivity, (e) dependency, and (f) peer conflict and social withdrawal. The five-item inattention and hyperactivity subscale of the BPI measures the maternal-reported behaviors of inattention and hyperactivity, with total scores ranging from 0 indicating no inattentiveness and hyperactivity problems to a score of 5 indicating a high degree of inattention and hyperactivity difficulties. The dichotomously scored items assess both hyperactivity (“He/she is restless or overly active, cannot sit still”) and inattention (“He/she has difficulty concentrating, cannot pay attention for long”), although the subscale is typically referred to as hyperactivity. The average for the inattention and hyperactivity subscale was 1.52 ($SD = 1.54$) and ranged from 0 to 5 with a normal distribution. There were no significant differences in symptoms of inattention and hyperactivity according to ethnic background of children. Gender differences, however, did emerge in the inattention and hyperactivity subscale scores. Mothers reported male children ($M = 1.55$, $SD = 1.36$) as having more difficulties with inattention and hyperactivity than female children ($M = 1.20$, $SD = 1.30$). A Cohen’s $d$ was calculated as a measure of effect size for the inattention and hyperactivity differences between male and female children with a value of $d = .26$. This value indicates a small effect size (Cohen, 1988). Because of the existence of this small effect size with a relatively large sample size that can tend to reveal statistical significance (e.g., the law of large numbers and the underestimation of standard errors) we decided that gender did not warrant inclusion into the analyzed models.

Procedure

We performed statistical analyses with SPSS (v. 12.0) and MPlus (v. 4.20), and for missing data we used Bayesian estimation and the multiple imputation techniques recommended by Widaman (2006) for complex modeling with many parameters to be estimated. Widaman asserted that multiple imputation techniques should be used when there is a moderate or large amount of missing data because of longitudinal, overlapping cohort designs. It should be noted that Christakis et al. (2004) did not explicitly state how they managed missing or incomplete data.

As the NLSY is a complex longitudinal survey, we created custom weights for the four most recent waves of data collection using the Web investigator feature online (NLS User Services, 2007). Analyses were performed with and without applying these weights in MPlus (v.4.20) with statistically and conceptually similar results. For instance, in examining television viewing and hyperactivity concurrently, model fit statistics with weights applied indicated a comparative fit index (CFI) of .99, a Tucker-Lewis Index (TLI) of .99, and a root mean square error of approximation (RMSEA) of .02. However, without weights
being applied, these same model fit statistics indicated a CFI of .99, a TLI of .99, and an RMSEA of .02. Hence, we chose to report analyses with application of these weights.

Analyses

To examine the relationship between television viewing and inattention and hyperactivity across time, latent growth models for these two constructs were tested separately within subjects to determine the best-fitting trend or form of trajectory across time for each construct. Latent growth modeling allows for estimation of those parameters that represent growth as a function of a repeatedly measured variable (or variables) across time (Meredith & Tisak, 1990). This modeling technique permits the examination of “systematic inter-individual differences in intra-individual change” (Stoel, van den Wittenboer, & Hox, 2004, p. 1). As is customary with latent growth modeling, all paths from the outcome variable to the estimated intercept were set to 1.00 to control for differences in initial status across individuals (Meredith & Tisak, 1990). The path from the first time point to slope factor are then weighted at 0.00, whereas all respective paths are weighted or set to values according to the trend that is being tested. Linear, quadratic, and logistic function models were examined for possible fit to the data to determine the form of the rate of change across time for television viewing and inattention and hyperactivity. The best-fitting model was determined by evaluating Bayesian information criterion (BIC) and Akaike information criterion (AIC) results for each construct modeled across time. Both the BIC and AIC are measures of goodness of fit that penalize for model complexity according to the number of parameters and cases (D’Unger, Land, McCall, & Nagin, 1998; Nagin, 2005). Kass and Wasserman (1995) probability values were then calculated from BIC values, indicating the probability that a model is correct over another model. We understand that an infinite number of models could fit the data as well or better than the model selected as best-fitting (cf. MacCallum, 2003). In this sense, our fit is relative and should be considered in relation to extant literature. Next, we examined concurrently television and inattention and hyperactivity variables by regressing the rate of change in inattention and hyperactivity on the rate of change in television viewing (see Figure 1). Five statistics reflecting model fit are reported: (a) chi square ($\chi^2$) goodness of fit, (b) $\chi^2/df$ ratio, (c) RMSEA, (d) TLI, and (e) CFI.

Results

Television Viewing and Inattention and Hyperactivity Separately

First, the form of the trajectory in television viewing and inattention and hyperactivity across time were examined separately. Table 1 contains the BIC and AIC fits for the linear, quadratic, and log-curved models. Lower values of BIC and AIC suggest a better fit than do higher values. The chi-square goodness-of-fit statistic was not evaluated in making model comparisons as it has been demonstrated to be sensitive to sample size and model complexity (MacCallum, Browne, & Sugawara, 1996). In addition, the chi-square statistic may only be legitimately used when making model comparisons that are nested, such as a linear model being nested within a quadratic model as polynomial functions (Ghisletta &
Figure 1
Latent Growth Models of Inattention and Hyperactivity and TV Viewing

† I₁ and I₂ refer to the intercepts or initial status while S₁, S₂, and Q refer to the estimated growth factors across time.
‡* .05 level of significance
‡** .01 level of significance
McArdle, 2001). Logistic function models however are not nested within these polynomial functions. Both BIC and AIC have been viewed as being robust in making model comparisons (Huang, Martinez, Mateu, & Montes, 2007; Nagin, 2005). Kass and Wasserman (1995) have recommended that the probability of a model being the correct one from a set of models be calculated from the BIC scores of the different models under consideration. Table 1 presents the probability that the model tested is the correct model in relation to the other models tested as calculated from the BIC.

In estimating children’s television viewing across time, a logistic latent growth model appeared to fit the data best, indicating that television viewing among children increased exponentially and then leveled off to increase more gradually during ages 4 to 10, $\chi^2(5) = 5.48$, $p = .36$, CFI = .99, TLI = .99, RMSEA = .01. With respect to inattention and hyperactivity, a quadratic growth model appears to fit the data best such that inattention and hyperactivity seem to peak between ages 6 and 8 and then begin to decline, $\chi^2(1) = 0.76$, $p = .38$, CFI = .99, TLI = .99, RMSEA = .003.

### Television Viewing and Hyperactivity Concurrently

In examining the association between television viewing and inattention and hyperactivity across time, the growth factors of dual latent growth models were regressed onto one another as shown in Figure 1. Statistics reflecting model fit indicated a good fit to the data. Although the chi-square goodness-of-fit statistic was significant, suggesting that the model may not fit the data, $\chi^2(18) = 29.44$, $p = .04$, the chi-square statistic has been indicated as being sensitive to sample size and thus an adjunct discrepancy-based fit index may be used as the ratio of chi-square to degrees of freedom ($\chi^2/df$). A $\chi^2/df$ ratio value less than 5 has been suggested as indicating an acceptable fit between the hypothesized model and the sample data (MacCallum et al., 1996). From the analyses, a $\chi^2/df$ ratio value of 1.64 was obtained, demonstrating that the proposed model was an acceptable fit. In addition, the RMSEA as compensating for the effects of model complexity was .02. According to Browne and Cudek (1993), who noted that an acceptable fit of the model will be indicated by a value less than .05, our obtained value is congruent with their recommended value.

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### Table 1

Summary of Latent Growth Models for TV Viewing and Inattention and Hyperactivity

<table>
<thead>
<tr>
<th></th>
<th>Linear</th>
<th>Quadratic</th>
<th>Log</th>
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<tr>
<td><strong>Television viewing</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BIC</td>
<td>61,120.269</td>
<td>61,140.285</td>
<td>61,114.003</td>
</tr>
<tr>
<td>AIC</td>
<td>61,067.103</td>
<td>61,114.003</td>
<td>61,063.490</td>
</tr>
<tr>
<td>Kass and Wasserman probability</td>
<td>.001</td>
<td>$3.846 \times 10^{-12}$</td>
<td>.998</td>
</tr>
<tr>
<td><strong>Inattention and hyperactivity symptoms</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIC</td>
<td>36,457.202</td>
<td>36,443.807</td>
<td>36,453.247</td>
</tr>
<tr>
<td>AIC</td>
<td>36,414.074</td>
<td>36,403.213</td>
<td>36,405.194</td>
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<tr>
<td>Kass and Wasserman probability</td>
<td>$2.893 \times 10^{-9}$</td>
<td>.999</td>
<td>.007</td>
</tr>
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</table>

Note: BIC = Bayesian information criterion; AIC = Akaike information criterion.
The value of the TLI, also known as the nonnormed fit index (NNFI), was .99 and the value of the CFI was .99. Hu and Bentler (1999) noted that fit index values of .95 or better are indicative of good fit. Thus, the model overall appears to fit the data well as seen in Figure 1. Table 2 contains the values for the standardized path coefficients from the latent variables to the observed dependent variables of inattention and hyperactivity and numbers of hours viewing television per week.

As represented in Figure 1, the logistic rate of change in the number of hours of viewing television did not appear to be significantly related to inattention and hyperactivity across time (i.e., the path from $S_2$ to $Q$). The logistically increasing number of hours of television per week was not significantly associated with inattention and hyperactivity from age 4 to 10 for the sample of children studied. In addition, initial inattention and hyperactivity ($I_1$) appeared to be weakly associated with the rate of change in the number of hours of television viewing per week ($S_2$). The weak association indicates that initial symptoms of inattention and hyperactivity do not appear to have a relationship with subsequent television viewing across time. As expected, the initial status of inattention and hyperactivity did not appear to be significantly associated with initial status of television viewing hours ($I_1$ correlated with $I_1$). Post hoc power analyses indicate sufficient statistical power ($1 – \beta = .996$) to reveal any significant relationships at the .05 level or better (Preacher & Coffman, 2006).

### Discussion

The present findings contribute to the discussion of the relationship between television and inattention and hyperactivity as the results reveal longitudinal analyses of not only each variable but of their association as well. Results describing the trajectory of television viewing indicated that children’s exposure increased exponentially to a point where it became fairly level. Perhaps children at age 4 and after have more independence and

<table>
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<th>Path</th>
<th>Standard Coefficient</th>
<th>Path</th>
<th>Standard Coefficient</th>
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<tr>
<td>$I_1 \rightarrow 4$-year-olds, inattention and hyperactivity</td>
<td>.754</td>
<td>$I_1 \rightarrow 4$-year-olds, TV viewing</td>
<td>.616</td>
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<td>$I_1 \rightarrow 6$-year-olds, inattention and hyperactivity</td>
<td>.679</td>
<td>$I_1 \rightarrow 6$-year-olds, TV viewing</td>
<td>.697</td>
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<td>$I_1 \rightarrow 8$-year-olds, inattention and hyperactivity</td>
<td>.659</td>
<td>$I_1 \rightarrow 8$-year-olds, TV viewing</td>
<td>.670</td>
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<td>.626</td>
<td>$I_1 \rightarrow 10$-year-olds, TV viewing</td>
<td>.620</td>
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<tr>
<td>$S_1 \rightarrow 4$-year-olds, inattention and hyperactivity</td>
<td>.000</td>
<td>$S_2 \rightarrow 4$-year-olds, TV viewing</td>
<td>.000</td>
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<td>$S_1 \rightarrow 6$-year-olds, inattention and hyperactivity</td>
<td>.393</td>
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<td>.058</td>
<td>$Q \rightarrow 10$-year-olds, inattention and hyperactivity</td>
<td>.484</td>
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autonomy in their hours of viewing television as they mature. Nevertheless, we believe that young children’s independence or autonomy may have an upper limit that is parentally determined. In addition, children may experience saturation in television viewing such that once the threshold is crossed any observed influences are minimized because of the decrease in interest or program appeal (Lehmann, 1971; Robinson, 1969). The quadratic trend in inattention and hyperactive behaviors are also supported by extant literature indicating an age-dependent decline of the symptoms of ADHD that peak during middle childhood (ages 6 to 9; Biederman, Mick, & Faraone, 2000; Faraone, Biederman, & Mick, 2006; Willoughby, 2003).

Television viewing across time was not significantly associated with symptoms of inattention and hyperactivity. The initial study conducted by Christakis et al. (2004) evaluated two time points, television viewing at the age of 1 or 3 and attention and behavioral problems at the age of 7. We evaluated the variables across the ages of 4 to 10, which allowed us to better investigate the nature of the relationship across time. This may be important, as longitudinal evaluation that includes multiple time points is more likely to avoid limitations related to restriction of ranges of measurement. For example, the results revealed that a logistic latent growth trend best described the amount of television viewing across time, but a quadratic trend best described the amount of inattention and hyperactivity across the same period. The two variables initially increased at a similar rate; however, television viewing eventually leveled off, whereas inattention and hyperactivity began to decline between the ages of 6 and 8. If one looks at only one or two of the first time points, a positive relationship between television viewing and inattention and hyperactivity might be observed, but if one evaluates the relationship at later time points, the two variables may appear weak and possibly negatively related.

These results offer some explanation for the differences observed between the work of Stevens and Mulsow (2006) and that of Christakis et al. (2004), as the former studied television viewing in kindergarten-age children whereas the latter evaluated the television viewing of 1- and 3-year-old children. Stevens and Mulsow observed the relationship between television and inattention and hyperactivity when inattention and hyperactivity were starting their decline, and Christakis et al. reported the relationship as it was increasing. Thus, Christakis et al. were more likely to find a relationship as television was also increasing at the same time. Although the possibility exists that the association between television and inattention and hyperactivity is only present in early childhood and is meaningful, the current results do not support this interpretation as these variables were measured across time in our study.

The present model tested indicated that the logistically increasing number of hours of television viewing per week was not associated with inattention and hyperactivity from ages 4 to 10. If early television exposure was significantly related to inattention and hyperactivity, one might expect at least some association to be present later in childhood even if the strength of the relationship was diminishing. Instead, the parameter estimate representing this association was close to zero, which was similar to the results reported by Stevens and Mulsow (2006). To explain the apparent discrepancy between the Christakis et al. (2004) results and theirs, Stevens and Mulsow suggested that parents are more likely to place children with inattention and hyperactivity in front of the television to gain relief from their children’s challenging behavior; however, we found no support for this explanation. In
the present study, initial symptoms of inattention and hyperactivity appeared to be only weakly associated with the rate of change in television viewing, and this relationship was statistically nonsignificant.

Logistic regression allows for the study of the discrete outcome of disease–no disease (Tabachnick & Fidell, 2001) and was used by both Christakis et al. (2004) and Landhuis et al. (2007). Therefore, these researchers were interested in predicting the development of inattention and hyperactivity or in predicting the likelihood of a later disorder, which is in actuality a dichotomous question. Either a disorder or condition exists or it does not. Thus, the concern is more likely centered on providing information to avoid a disorder rather than how the relationship develops over time or how each predictor contributes independently to the prediction. Our study better addressed issues related to development that included questions related to the natural course of each variable over time as well as the form of the relationship between the variables over time. Thus, differences in findings, especially between the Christakis et al. study and the current study, which used the same database, could be related to the research questions asked by the authors.

The apparent interest that clinical researchers have in inattention and hyperactivity is that in the extreme they may indicate the presence of a disorder, ADHD. Christakis et al. (2004) and Landhuis et al. (2007) make this point obvious in their use of a cut point to create a dichotomous inattention and/or hyperactivity score that separated the most extreme children from the remainder of the sample. However, inattention and hyperactivity occur on a continuum and there is a change in the rate in response to developmental and contextual issues, such as the enrollment into formal educational settings that occurs in childhood and the formation of identity that is an important issue in adolescence. Although rating instruments used in the research of the relationship between television and inattention and hyperactivity reveal those children with extreme attention and behavioral issues, these children do not necessarily have ADHD. Thus, the use of a clinical paradigm that seeks the presence or absence of a disorder may be inappropriate when the data do not include a diagnosis and instead contain variables assessing individual differences over time.

Although we agree that television viewing, especially that which is not carefully selected for content, might be associated with negative developmental outcomes, the present analyses using simple measures of ADHD symptoms and television viewing do not support that a robust and meaningful relationship exists between television viewing and subsequent inattention and hyperactivity. Furthermore, our analyses indicate that the study of only limited measurement points, especially in early childhood, might reveal spurious results. Certainly, we do not endorse television viewing as a healthy activity for children of any age; however, we believe that implicating television as a predictor of ADHD is well beyond the interpretation of any of the correlational studies used to investigate this relationship.

Children with ADHD might respond differently to television viewing (e.g., Landau, Lorch, & Milich, 1992), and researchers should investigate relevant hypotheses with appropriate data sets and analytic techniques that include children actually diagnosed with ADHD. In addition, the measurement of relevant variables, including television viewing, needs improvement in future work to allow for underestimation and the amount of time that children are involved with similar activities. For example, parents might fail to report time spent watching videos online, at school, and during transportation.
The study of the development of inattention and hyperactivity is certainly relevant to child development and potentially effective interventions to attenuate behavioral problems. However, we believe that the research questions asked with the intent to provide clinicians with practical implications to distribute to parents and educators should not be dichotomous in nature. Instead, we think research questions should lead to analyses that better represent not only the presence of relationships but also the degree and nature of their association.

References


