

# A Population-Based Analysis of the Temporal Association of Screen Time and Aggressive Behaviors in Adolescents

Jasmina Wallace, PhD , Elroy Boers, PhD , Julien Ouellet, MSc , Patricia Conrod, PhD 

**Objective:** The recent widespread diffusion of screen-based devices among adolescents has raised questions about the effects of screen time on adolescent behavior, including aggressive behaviors. However, previous studies have been methodologically limited in their ability to distinguish between common vulnerability, concurrency, and lasting associations between screen time and aggression among adolescents, and findings are still inconsistent. To address this gap in the literature, time-varying direct and indirect associations between screen time and aggression were investigated.


**Method:** The sample included nearly 4,000 Canadian adolescents who participated in annual surveys for 5 consecutive years. Multilevel statistical models were applied to study between-person effects (common vulnerability), within-person effects (concurrency explaining a priming effect), and lagged-within-person effects (lasting effects explaining a learning process) of screen time (ie, social media use, television viewing, video game playing, computer use) on aggressive behaviors (ie, fighting, conduct problems, hostile thoughts). Screen time effects on aggression through hostility were further studied.

**Results:** Short-lived concurrent relations between different forms of screen time and aggressive behaviors suggested a priming effect. Social media use was further associated with longer lasting increases in conduct problems, suggesting a social learning process, while television viewing showed significant negative lagged-within-person association with hostility, showing a protective effect. Hostile thoughts mediated screen time and aggression associations mainly at between-person levels.

**Conclusion:** The results suggest that the nature of the relation between screen time and aggressive behaviors depends on the type of digital platform through which such content is presented and suggest the need for policies focusing on protecting young users of digital media.

**Clinical trial registration information:** Does Delaying Adolescent Substance Use Lead to Improved Cognitive Function and Reduce Risk for Addiction?; <https://www.clinicaltrials.gov/>: NCT01655615

**Key words:** conduct problems; fighting; hostility adolescence; screen time

JAACAP Open 2023;1(4):284-294. 

**N**owadays, almost all teens spend approximately 8 to 9 hours per day in front of a television, computer, and/or mobile device; these averages greatly surpass previously recommended and evolving public health guidelines for maximum hours per day spent on screens.<sup>1</sup> Given the popularity of screen devices, there are concerns about the impact screen time might have on teens' mental health and behavior.<sup>2,3</sup> One of these concerns is that exposure to extreme violent imagery in certain forms of digital media and video games potentially promotes aggressive thoughts and subsequent aggressive behaviors in youth who would not otherwise be exposed to such concepts. Violence is very common in the media, with high levels found in movies and television programs popular among adolescents<sup>4</sup> as well as in video games<sup>5</sup> and social

media.<sup>6</sup> For example, a content analysis showed that the majority of top-selling video games and children's favorite games contain violence, including often strong acts of violence.<sup>7</sup> Among the most widely played games by Canadian youth (ages 12-17 years), 5 of 6 of these games would be classified by the Entertainment Software Rating Board as containing violence or intense violence. Interestingly, a recent report by an independent demographic polling center, suggested that some of the most viewed videos by young people and searches on video streaming websites are in reference to video games, one in particular, that contain violent content.<sup>8</sup> Numerous longitudinal studies have examined the link between screen time and aggressive behaviors in adolescence. So far, these studies have produced inconsistent findings. Some studies have argued that screen

time increases aggression among adolescents,<sup>9–11</sup> including bullying<sup>12</sup> as forms of aggressive behaviors, and with no differences between boys and girls in the relation between video game playing and aggression,<sup>13</sup> whereas others have concluded that there is not such a link.<sup>14,15</sup> These inconsistencies have also been reported in a broader sense by contrasting results from meta-analytic reviews.<sup>16,17</sup> One reason for these inconsistent findings might be that studies to date, have been methodologically limited with respect to being able to distinguish properly between the potential short-term and long-term effects of screen time on aggression in adolescents. These studies have also been limited in how they have controlled for common vulnerability to aggressive behaviors and certain types of screen activities and in being able to confirm temporal associations of explanatory processes in the coevolution of both sets of behaviors. At the core of the most dominant explanatory theories of screen time effects on aggressive behaviors is the distinction between priming effects and learning.<sup>18,19</sup>

Priming is commonly defined as the immediate activation of already existing cognitive schema, such as thoughts and knowledge<sup>20</sup> about certain behavior and are considered short-lived effects, indicating that they disappear quickly after exposure and activation of cognitive schema. In the context of screen time and aggression, an example of a priming effect could be a short-lived and impulsive aggressive outburst because of exposure to violent media content. It has been argued that most theorists agree that short-lived effects of exposure to violent media content are, among others (arousal, immediate mimicking of behavior), predominantly the result of priming.<sup>21</sup> Moreover, priming effects have been linked to impulsive acts of aggressive behaviors,<sup>22</sup> and increased digital media use has been linked to increased levels of impulsivity.<sup>23–25</sup> On the other hand, repeated exposure to content can also contribute to a learning process that will maintain aggressive behaviors, independent of priming effects. Learning, defined as the psychological process that leads to change in behavior in response to experience,<sup>26</sup> would have more lasting effects relative to a priming effect.<sup>27,28</sup> Therefore, demonstrating that screen time is contributing to aggression through a learning process would predict that the effects of digital media on aggressive behaviors are longer lasting and potentially explained through the development of changes in attitudes or beliefs about the hostile intentions of others or social norms around displaying or using aggressive acts to resolve conflict. The environmental contribution to antisocial behavior is well documented, including the aspect of environment that is not shared within families and between siblings.<sup>29,30</sup> Furthermore, social psychological theories of antisociality suggest that repeated exposure to and reinforcement of aggressive acts within one's culture shape a

worldview that promotes or maintains antisocial behaviors and lifestyles.<sup>31</sup>

In this context, the current population-based study used an exceptional longitudinal cohort study and analytic strategy based on the principle of multilevel linear modeling (MLM) to investigate the link between screen time and aggressive behaviors repeatedly measured over the course of 5 years among adolescents. Such an analytic framework addresses methodological limitations of previous studies by modeling time-varying associations of screen time and aggressive behaviors. Thus, we investigated between-person effects (representing the common vulnerability), within-person effects (representing concurrent short-term effects and priming effect), and lagged-within-person effects (representing long-term effects and social learning process). In our model, we included different popular traditional modes of screen time among adolescents (ie, social media use, television viewing, video game playing, and computer use), while the variables related to aggressive behaviors were fighting, conduct problems, and hostility.

Given the nature of the aggressive behavior variables investigated in this study, we expected that screen time effects for fighting would be predominantly demonstrated at the concurrent within-person level because fighting is an impulsive and short-lived form of aggression.<sup>22</sup> On the other hand, conduct problems involve a system of personality and behavioral tendencies toward rule breaking, violating the rights of others, irresponsibility, and aggression.<sup>32</sup> We expected that screen time could show significant associations with conduct problems not only at the concurrent within-person level, but also at the lagged-within-person level explained by a learning process, over and above a common vulnerability. Indeed, this pattern of deviant social and behavioral tendencies has been shown to be highly dependent on parenting styles, traumatic experiences, and social disadvantage conditions as well as biological conditions such as traumatic brain injury and genetic factors.<sup>33</sup> Many studies have shown that conduct problems and hostile attributional styles are exacerbated by family discord, parental conflict, and disadvantageous socioeconomic conditions<sup>34</sup> and that these thoughts and perceptions do not manifest over night, but rather occur over time and with repeated experiences.<sup>35</sup> Contextual factors can also shape antisocial behaviors, with an important role for peers.<sup>36</sup> Early studies suggest that conduct problems tend to grow in magnitude over the course of adolescence, mostly because of the influence of deviant peers and peer pressure.<sup>37,38</sup> Moreover, in a time in which digital screens dominate the lives of adolescents, it seems reasonable to assume that over and above childhood risk factors, peer influence and peer-pressure practices do not take place only within a physical social context, but also within a

digital social context. Since the advent of digital technology, social networking sites, such as Facebook and Instagram, have become a primary way for adolescents to acquire information about their peers.<sup>38</sup> In the present study, taking into account common vulnerability and the possibility of learning from the content presented on digital screens, we tested the extent to which digital experiences contribute to a learning process, related to antisocial attitudes and behavior, that takes place through observations of peers sharing information and content of acts of rule-breaking, violating the rights of others, irresponsibility, and aggressive behaviors. As social media is an environment in which adolescents are frequently exposed to attitudes, social norms, and peer behaviors, we posited that, relative to television viewing (which might censor out such behaviors), video game playing (which promotes such behaviors only in a virtual and obviously pretend world), or computer use, social media use would contribute more strongly to the development of conduct problems. Therefore, in the context of such effects, we assumed that social media use would conform to a social learning process with lasting effects.

Finally, hostile attributions and thoughts are considered as a system of beliefs that predispose an individual to interpret a situation as provocative and are associated with aggressive and antisocial behaviors.<sup>39,40</sup> It is worth noting that several previous studies have attributed a mediating role of hostility in the association of video game playing, violent movies, and aggression.<sup>41–43</sup> Specifically, it has been argued that, over time, hostile attributions that arise from high-risk experiences, including repeated exposure to graphic scenes of violence, will contribute to the development of an antisocial temperament and conduct problems. Thus, we also posited hostility to mediate the association of screen time, fighting, and conduct problems at between-, within-, and lagged-within-person levels.

## METHOD

### Participants

We used data from a population-based randomized controlled trial<sup>44</sup> investigating the effectiveness of a 5-year personality-targeted drug and alcohol prevention program. In September 2012, a large sample of 3,826 adolescents (1,798 girls [47%]; mean [SD] age = 12.7 [0.5] years) was recruited from 31 schools in Greater Montreal, Quebec, Canada. This sample of adolescents was studied annually from 7th grade through 11th grade and was epidemiologically representative of each of the school districts regarding average size and socioeconomic index. The sample of schools represented 15% of all schools across Greater Montreal. The study sampled, on average, 76% of all seventh-grade students in these schools, suggesting that

the cohort included 6.0% to 11.4% of the population of seventh-grade students of Greater Montreal. Only 2 exclusion criteria for schools were specified: the school had to agree to the study protocol, and the school could not have more than 50% of 7th-grade students with special educational needs. There were no exclusion criteria for students other than providing written informed assent and parental consent. All participants included in the study provided the written informed assent and parental consent. The main variables were measured through a confidential annual web-based survey. Ethical approval was obtained from the local Research Ethics Board. This study has been registered at ClinicalTrials.gov (<https://www.clinicaltrials.gov>; NCT01655615).

### Measures

**Screen Time.** Screen time was measured by asking participants how much time per day they spend playing video games (on a computer, cell phone, or game console), on social media (eg, Facebook, Instagram, Twitter, or other social networking sites), watching shows or movies on television, and using the computer to engage in another kind of activities. The amount of time spent was operationalized into 4 categories and coded from 0 to 4, respectively: 0 to 30 minutes, 30 minutes to 1 hour 30 minutes, 1 hour 30 minutes to 2 hours 30 minutes, 2 hours 30 minutes to 3 hours 30 minutes, and 3 hours 30 minutes or more. Our study did not require young people to report on whether their digital content was of a violent nature. Instead, we simply assessed the amounts of time spent engaging with various forms of digital media.

**Fighting.** Physical fighting was measured by asking participants how many times they were in a physical fight in the last 6 months. The amount of physical fighting was operationalized in 5 categories and coded from 0 to 4, respectively: none, 1 time, 2 times, 3 times, and 4 times or more.

**Hostility.** Hostility was measured using the hostility subscale of the Children's Automatic Thoughts Scale, a widely used, reliable, and valid self-report measure designed to assess a broad range of negative self-statements in children and adolescents.<sup>45</sup> Participants were asked to respond to the following: "Please read each thought carefully and decide how often, if at all, each thought popped into your head over the past 12 months." The thoughts were: "I have the right to take revenge on people if they deserve it." "Other kids are stupid." "Most people are against me." "I won't let anyone get away with picking on me." "If someone hurts me, I have the right to hurt them back." "Some people deserve what they get." "I always get blamed for things that are not my fault." "People always try to get me into trouble." "Some people are bad."

“Bad people deserve to get punished.” Responses to these thoughts were operationalized in 5 categories and coded from 0 to 4, respectively: not at all, sometimes, fairly often, often, and all the time. The total score corresponded to the sum of the responses of all items. Cronbach’s  $\alpha$  ranged from .872 to .884 at all 5 assessments.

**Conduct Problems.** Conduct problems were assessed using the Conduct Problems Scale of the Strengths and Difficulties Questionnaires (SDQ),<sup>46</sup> one of the most commonly used instruments for screening psychopathology in children and adolescents. Participants were asked to respond to the following statements and indicate whether this was not true (coded as 0), somewhat true (coded as 1), or certainly true (coded as 2): “I get very angry and often lose my temper.” “I usually do as I am told.” “I fight a lot. I can make others do what I want.” “I am often accused of lying or cheating.” “I take things that are not mine from home, school or elsewhere.” The total score corresponded to the sum of the responses for each item. Cronbach’s  $\alpha$  ranged from .604 to .648 at all 5 assessments.

**Covariates.** Each statistical model was controlled for baseline socioeconomic status (SES) and sex (0 = female, 1 = male). SES was assessed using the Family Affluence Scale for adolescents.<sup>47</sup>

### Statistical Modeling Approach

We employed an MLM analysis while distinguishing between the following: between-person effects (common vulnerability, measured as the average of variables over 5 years), within-person effects (time-limited relations between changes

in one set of behaviors within a given year and changes in the other set within the same year), and lagged-within-person effects (long-term effects of changes in one set of behaviors on the other set of the next year). Between-person, within-person, and lagged-within-person effects were included within the same statistical model (Figure 1). The analytic approach consisted of 2 steps. First, we assessed the temporal direct associations between the predictors and the outcomes. In doing so, different independent MLMs with Bayesian method assessed direct associations of screen time (ie, social media use, television viewing, video game playing, and computer use) and aggressive behavior variables (ie, fighting, conduct problems, and hostility), as well as the associations of hostility and other aggressive behaviors. Second, we performed a mediation MLM with Bayesian method to test the direct and indirect effects of the various types of screen time on aggressive behaviors through hostility (Figure 1).

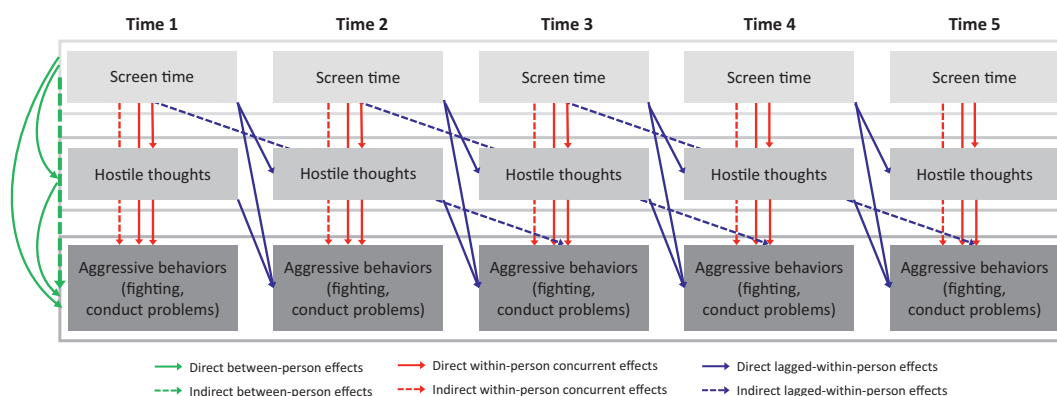
Each MLM was controlled for sex, SES, and time. All analyses were performed using Mplus software.<sup>48</sup> The time parameter (the survey waves) was coded from 1 to 5. Bonferroni correction was applied to adjust multiple comparisons.

## RESULTS

### Descriptive Statistics

Among the 3,826 adolescents included in the study, 3,779 participants completed the survey. Participants reported a mean (SD) SES score of 2.94 (1.08). The main variables measured at each year of assessment along the 5-year longitudinal study are shown in Table 1. Concerning screen time variables, social media use and television viewing

**FIGURE 1** Multilevel Linear Model Assessing Temporal Associations of Screen Time and Aggressive Behaviors and the Potential Mediating Role of Hostile Thoughts



**Note:** The between-person association corresponds to the average level of screen time over 5 years; the within-person association corresponds to the change in the level of screen time compared with a person's mean level over 5 years; the lagged-within-person association corresponds to the level of screen time 2 years before through the mediator and compared with a person's mean use within that year. Time corresponds to survey waves.

increased yearly. Video game playing slightly decreased, while computer use was stable during the study. Concerning aggressive behavior variables, hostile thoughts remained stable over the course of the study, while fighting decreased, and conduct problems slightly decreased.

### Associations of Screen Time and Aggressive Behaviors

All results indicating the associations of screen time and aggressive behaviors among adolescents are shown in Table 2. The results of the MLM analysis indicated significant between-person effects of social media, television viewing, and video game playing on fighting in adolescents. Over and above the significant between-person effects, the results also indicated significant within-person effects of social media use, television viewing, and computer use on fighting. No significant lagged-within-person effects were revealed for social media use, television viewing, and video game playing.

Regarding the association of screen time and conduct problems, results indicated significant between-person relations between social media use, television viewing, video game playing, and computer use and conduct problems in adolescents. The results also indicated significant within-person effects of social media use, television viewing, video game playing, and computer use on conduct problems. Finally, significant lagged-within-person effects were revealed for social media use. No such lagged-within-person effects were found for other types of screen time.

Finally, significant between-person effects of social media use, television viewing, video game playing, and computer use on hostility were revealed. Over and above the significant between-person effects, results also indicated significant within-person effects of social media use, video game playing, and computer use on hostility. No significant

within-person effect was found for television viewing. A significant negative lagged-within-person effect was found for television viewing. No lagged-within-person effect was found for other types of screen time.

### Associations of Hostility and Aggressive Behaviors

Regarding the multilevel associations of hostility and fighting, the results showed a significant between-person effect ( $\beta = .017$ , 95% credibility interval (CrI) = 0.013 to 0.022,  $p = .000$ ) and a significant within-person effect ( $\beta = .013$ , 95% CrI = 0.010 to 0.015,  $p = .000$ ), but no lagged effect ( $\beta = .001$ , 95% CrI =  $-0.001$  to 0.004,  $p = .190$ ). Similarly, results indicated a significant association of hostility and conduct problems with between-person level ( $\beta = .091$ , 95% CrI = 0.082 to 0.101,  $p = .000$ ), and within-person level ( $\beta = .041$ , 95% CrI = 0.036 to 0.046,  $p = .000$ ), but not with lagged-within-person level ( $\beta = .003$ , 95% CrI =  $-0.002$  to 0.008,  $p = .105$ ). All results indicating the associations of hostility, fighting frequency, and conduct problems are presented in Table S1, available online.

### Indirect Associations of Screen Time and Fighting Through Hostility

Results indicating the associations of screen time and fighting through hostility are shown in Table 3. The association of social media use and fighting was mediated by hostility at between-person level and within-person level, but not at lagged-within-person level. The association of television viewing and fighting was mediated by hostility at between-person level, but not at within-person level and lagged-within-person level. The within-person relation of video game playing to fighting was shown to be significantly mediated by between-person and within-person changes in

**TABLE 1** Age, Predictors, and Outcomes at Each Year of Assessment

	Year 1		Year 2		Year 3		Year 4		Year 5	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Age, y	12.80	(0.50)	13.80	(0.40)	14.70	(0.50)	15.80	(0.40)	16.80	(0.40)
Predictors										
Social media use	0.94	(1.25)	1.13	(1.30)	1.24	(1.27)	1.43	(1.25)	1.57	(1.24)
Television viewing	1.52	(1.16)	1.55	(1.20)	1.60	(1.20)	1.60	(1.23)	1.61	(1.23)
Video game playing	1.33	(1.30)	1.43	(1.38)	1.41	(1.40)	1.34	(1.43)	1.20	(1.40)
Computer use	0.60	(1.02)	0.59	(1.02)	0.57	(0.99)	0.61	(1.04)	0.62	(1.02)
Outcomes										
Hostility	15.10	(7.97)	15.29	(7.86)	15.25	(7.63)	14.99	(7.38)	15.19	(7.51)
Fighting	0.43	(0.92)	0.33	(0.79)	0.29	(0.76)	0.27	(0.75)	0.16	(0.54)
Conduct problems	2.12	(1.64)	2.09	(1.61)	2.16	(1.63)	2.08	(1.61)	1.95	(1.50)

Note: Year 1 assessment was in 7th grade and so on.

**TABLE 2** Estimated Parameters for Multilevel Models Assessing the Association Between Screen Time and Aggressive Behaviors

Predictors	Outcomes											
	Fighting				Conduct problems				Hostility			
	Estimate	SE	Pr(> t )	95% CrI	Estimate	SE	Pr(> t )	95% CrI	Estimate	SE	Pr(> t )	95% CrI
Social media use												
Intercept	0.884	0.043	.000	0.793 to 0.975	2.654	0.091	.000	2.472 to 2.822	10.776	0.413	.000	22.474 to 25.556
Time	−0.060	0.005	.000	−0.068 to −0.050	−0.031	0.008	.000	−0.045 to −0.017	−0.065	0.036	.030	−0.138 to 0.001
Sex	−0.386	0.020	.000	−0.429 to −0.356	−0.535	0.048	.000	−0.630 to −0.450	2.854	0.193	.000	2.496 to 3.246
SES	0.012	0.006	.015	0.001 to 0.024	−0.016	0.011	.125	−0.036 to 0.007	−0.179	0.053	.000	−0.285 to −0.087
Between-person	0.129	0.013	.000	0.102 to 0.152	0.465	0.027	.000	0.413 to 0.525	1.242	0.134	.000	0.999 to 1.524
Within-person	0.040	0.007	.000	0.027 to 0.054	0.140	0.012	.000	0.114 to 0.160	0.661	0.064	.000	0.536 to 0.794
Lagged-within-person	0.006	0.008	.285	−0.010 to 0.019	0.058	0.014	.000	0.033 to 0.086	0.082	0.074	.100	−0.062 to 0.231
Television viewing												
Intercept	0.746	0.046	.000	0.917 to 1.178	2.049	0.101	.000	1.855 to 2.223	9.513	0.455	.000	8.548 to 10.302
Time	−0.054	0.005	.000	−0.062 to −0.044	−0.005	0.008	.267	−0.018 to 0.012	0.044	0.033	.085	−0.025 to 0.105
Sex	−0.316	0.019	.000	−0.359 to −0.288	−0.292	0.048	.000	−0.394 to −0.205	3.510	0.185	.000	3.157 to 3.865
SES	0.021	0.006	.000	0.009 to 0.033	0.019	0.011	.040	−0.002 to 0.043	−0.100	0.054	.030	−0.208 to 0.004
Between-person	0.059	0.015	.000	0.029 to 0.088	0.291	0.034	.000	0.228 to 0.369	0.593	0.146	.000	0.336 to 0.894
Within-person	0.022	0.007	.000	0.009 to 0.038	0.055	0.12	.000	0.032 to 0.077	0.035	0.062	.295	−0.079 to 0.164
Lagged-within-person	0.007	0.008	.255	−0.012 to 0.020	−0.011	0.014	.227	−0.037 to 0.016	−0.259	0.072	.000	−0.426 to −0.104
Video game playing												
Intercept	0.0742	0.053	.000	0.635 to 0.847	1.765	0.121	.000	1.507 to 1.968	8.015	0.547	.000	6.828 to 8.995
Time	−0.052	0.004	.000	−0.061 to −0.043	−0.001	0.007	.455	−0.014 to 0.011	0.050	0.033	.075	−0.012 to 0.113
Sex	−0.280	0.021	.000	−0.324 to −0.242	−0.039	0.050	.225	−0.138 to 0.057	4.308	0.215	.000	3.889 to 4.781
SES	0.021	0.006	.000	0.009 to 0.032	0.016	0.011	.060	−0.004 to 0.038	−0.099	0.054	.035	−0.212 to 0.003
Between-person	0.028	0.013	.015	0.002 to 0.051	0.253	0.027	.000	0.199 to 0.305	0.822	0.136	.000	0.533 to 1.074
Within-person	0.013	0.006	.025	0.000 to 0.025	0.058	0.011	.000	0.034 to 0.077	0.237	0.058	.000	0.126 to 0.363
Lagged-within-person	−0.006	0.007	.195	−0.022 to 0.007	0.018	0.012	.065	−0.005 to 0.043	−0.002	0.064	.480	−0.159 to 0.134
Computer use												
Intercept	0.774	0.046	.000	0.683 to 0.862	2.177	0.103	.000	1.942 to 2.347	8.574	0.491	.000	7.643 to 9.530
Time	−0.051	0.004	.000	−0.059 to −0.043	−0.007	0.007	.155	−0.020 to 0.005	0.041	0.041	.120	−0.033 to 0.123
Sex	−0.294	0.019	.000	−0.329 to −0.258	−0.181	0.042	.000	−0.276 to −0.111	3.934	0.207	.000	3.506 to 4.314
SES	0.021	0.005	.000	0.01 to 0.031	0.021	0.012	.050	−0.005 to 0.048	−0.053	0.062	.185	−0.191 to 0.065
Between-person	0.035	0.023	.050	−0.012 to 0.077	0.263	0.055	.000	0.163 to 0.371	1.581	0.237	.000	1.146 to 2.041
Within-person	0.034	0.008	.000	0.019 to 0.050	0.056	0.014	.000	0.027 to 0.083	0.190	0.069	.005	0.049 to 0.311
Lagged-within-person	−0.020	0.011	.055	−0.041 to 0.003	0.008	0.015	.325	−0.021 to 0.034	−0.120	0.085	.080	−0.326 to 0.027

**Note:** While controlling for sex and SES, the multilevel linear models (Bayesian method) allowed the study of average associations of screen time and aggressive behaviors over 5 years (between-person effect) as well as the study of concurrent associations (within-person effect) and lagged associations from one year to the other (lagged-within-person effect) between screen time and aggressive behaviors within the same assessment. Sex was coded as 0 (female) and 1 (male). The time parameter was coded from 1 to 5 corresponding to the survey waves. Boldface indicates significant effects. Bonferroni correction was applied to adjust multiple comparisons, and p-values < .017 were considered significant. CrI = credibility interval; SES = socioeconomic status.



**TABLE 3** Estimated Parameters for Multilevel Models Assessing Hostility as Mediator of the Temporal Association of Screen Time and Fighting Frequency

	<b>Estimate</b>	<b>SE</b>	<b>Pr(&gt; t )</b>	<b>95% CrI</b>
Social media use predicting fighting through hostility				
Intercept (fighting)	0.738	0.048	.000	0.646 to 0.845
Intercept (hostility)	10.588	0.437	.000	9.694 to 11.481
Between-person	0.017	0.004	.000	0.010 to 0.024
Within-person	0.008	0.001	.000	0.006 to 0.011
Lagged-within-person	0.000	0.000	.263	0.000 to 0.001
Television viewing predicting fighting through hostility				
Intercept (fighting)	0.601	0.048	.000	0.498 to 0.696
Intercept (hostility)	9.343	0.459	.000	8.345 to 10.220
Between-person	0.010	0.003	.000	0.005 to 0.017
Within-person	0.001	0.001	.257	−0.001 to 0.002
Lagged-within-person	0.000	0.000	.157	−0.001 to 0.000
Video game playing predicting fighting through hostility				
Intercept (fighting)	0.608	0.056	.000	0.494 to 0.711
Intercept (hostility)	7.865	0.560	.000	6.703 to 8.931
Between-person	0.014	0.004	.000	0.008 to 0.022
Within-person	0.003	0.001	.000	0.001 to 0.004
Lagged-within-person	0.000	0.000	.467	0.000 to 0.000
Computer use predicting fighting through hostility				
Intercept (fighting)	0.643	0.055	.000	0.519 to 0.756
Intercept (hostility)	8.426	0.510	.000	7.369 to 9.255
Between-person	0.027	0.006	.000	0.016 to 0.040
Within-person	0.002	0.001	.005	0.001 to 0.004
Lagged-within-person	0.000	0.000	.240	−0.001 to 0.000

**Note:** While controlling for covariates, the mediation multilevel linear model (Bayesian method) allowed the study of indirect average associations of screen time and fighting over 5 years (between-person effect) as well as the study of indirect concurrent associations (within-person effect) and indirect lagged associations from one year to the other (lagged-within-person effect) between screen time and fighting within the same assessment. Boldface indicates significant effects. Bonferroni correction was applied to adjust multiple comparisons, and p-values < .025 were considered significant. CrI = credibility interval.

hostility, but not by lagged-within-person changes in hostility. Finally, the association of computer use and fighting was significantly mediated by hostility at between-person and within-person levels, but not at lagged-within-person level.

### Indirect Associations of Screen Time and Conduct Problems Through Hostility

Results obtained assessing the associations of screen time and conduct problems through hostility are presented Table 4. The association of social media use and conduct problems was mediated by hostility at the between-person level and within-person level, but not at the lagged-within-person level. Furthermore, it was found that the association of television viewing and conduct problems was mediated by hostility at the between-person level, but not at the within-person level and lagged-within-person level. It was revealed that the association of video game playing and conduct problems was mediated by hostility at the between-

person level and within-person level, but not at the lagged-within-person level. Finally, the association of computer use and conduct problems was significantly mediated by hostile thoughts at between-person and within-person levels, but not at lagged-within-person level.

## DISCUSSION

To our knowledge, this is the first study using a large population-based sample of nearly 4,000 Canadian adolescents analyzing short-term and long-term associations between screen time (ie, social media use, television viewing, video game playing, and computer use) and the development of aggressive behaviors (ie, fighting, hostility, and conduct problems) over the course of 5 years. Our statistical modeling approach, which distinguished between common vulnerability (between-person effect) and time-varying effects of screen time (within-person and lagged-within-person effects), while controlling for sex and SES at

**TABLE 4** Estimated Parameters for Multilevel Models Assessing Hostility as Mediator of Temporal Association of Screen Time and Conduct Problems

	<b>Estimate</b>	<b>SE</b>	<b>Pr(&gt; t )</b>	<b>95% CrI</b>
Social media use predicting conduct problems through hostility				
Intercept (conduct problems)	1.820	0.099	.000	1.598 to 2.018
Intercept (hostility)	10.656	0.413	.000	9.858 to 11.437
Between-person	0.095	0.013	.000	0.071 to 0.123
Within-person	0.024	0.003	.000	0.019 to 0.030
Lagged-within-person	0.000	0.000	.265	0.000 to 0.002
Television viewing predicting conduct problems through hostility				
Intercept (conduct problems)	1.306	0.106	.000	0.928 to 1.213
Intercept (hostility)	9.398	0.440	.000	8.567 to 10.251
Between-person	0.048	0.015	.000	0.021 to 0.079
Within-person	0.001	0.003	.360	−0.004 to 0.006
Lagged-within-person	−0.001	0.001	.125	−0.003 to 0.000
Video game playing predicting conduct problems through hostility				
Intercept (conduct problems)	1.147	0.122	.000	0.886 to 1.377
Intercept (hostility)	7.950	0.556	.000	6.856 to 9.088
Between-person	0.071	0.013	.000	0.041 to 0.098
Within-person	0.009	0.003	.000	0.004 to 0.014
Lagged-within-person	0.000	0.000	.340	−0.001 to 0.001
Computer use predicting conduct problems through hostility				
Intercept (conduct problems)	1.098	0.035	.000	1.035 to 1.168
Intercept (hostility)	24.139	0.911	.000	22.206 to 25.986
Between-person	0.138	0.020	.000	0.098 to 0.177
Within-person	0.007	0.003	.005	0.001 to 0.012
Lagged-within-person	0.000	0.000	.393	−0.001 to 0.000

**Note:** While controlling for covariates, the mediation multilevel linear model (Bayesian method) allowed the study of indirect average associations of screen time and conduct problems over 5 years (between-person effect) as well as the study of indirect concurrent associations (within-person effect) and indirect lagged associations from one year to the other (lagged-within-person effect) between screen time and conduct problems within the same assessment. Boldface indicates significant effects. Bonferroni correction was applied to adjust multiple comparisons, and p-values < .025 were considered significant. CrI = credibility interval.

baseline, allowed us test 2 concepts: priming and learning. Applying a mediation MLM analysis, we also tested the association of the exposure to digital screens with aggression behaviors through hostility. Several important conclusions can be drawn.

We found social media use to be significantly associated with fighting and hostility at between-person and within-person levels and to be significantly associated with conduct problems at between-person, within-person, and lagged-within-person levels. Based on the concept of priming, the significant association of social media use and fighting implies that exposure to certain social media content (eg, violent content) might be related to short-lived and impulsive aggressive outbursts. The latter is in accordance with previous research linking priming effects to impulsive acts of aggressive behavior<sup>22</sup> and increased screen time to increased levels of impulsivity.<sup>23–25,49</sup> Furthermore, in line with our expectations based on

learning, we found significant lagged-within-person associations of social media use and conduct problems. Thus, it appears that adolescents learn and develop aggressive attitudes over time due to social media use, which is then associated with increases in their general tendency toward breaking rules and violating the rights of others, both through aggressive and non-aggressive acts. Learning effects are the strongest when behavior is learned from relevant others, such as peers.<sup>38</sup> Some social media platforms, including Facebook and Instagram, are specifically designed to promote exposure to peer-generated content, which might explain why social media use was the digital screen mode that was the most strongly linked to the development of conduct problems, showing also a long-lasting effect.

There was evidence of a common vulnerability to high level of television viewing and aggressive behaviors (between-person effects), which is consistent with several



previous cross-sectional studies.<sup>50–52</sup> However, beyond this significant association, in contrast to our expectations, we found a negative association of television viewing and hostility at the lagged-within-person level, indicating that increased levels of television viewing resulted in a decrease in hostile attributions over time. This could be related to the fact that regular television content is subjected to editorial review and censorship, in contrast to social media. Furthermore, significant lagged-within-person associations of television viewing and conduct problems were absent. Globally, these results suggest that whatever violent content that teens are exposed to on television and in movies, it is not shaping hostile attributions toward others and does not appear to be contributing to the development of conduct problems over time, perhaps because edited content often includes both prosocial and antisocial messages and characters.

Video game playing was found to be significantly associated with fighting at the between-person level and with conduct problems and hostility at the within-person level in line with the concept of priming. The absence of lagged-within-person associations of video game playing and aggressive behaviors suggests that a learning process does not apply to video game playing. The latter might potentially be explained by the fact that, relative to social media use, video games do not distribute peer-generated content, and the content is depicted in a manner that is not realistic. In line with findings related to video game playing and aggressive behaviors, computer use showed a significant association with aggression explained by concurrent common vulnerability and concurrent longitudinal effect. Overall, these results suggest a general priming effect by all forms of digital media.

Finally, this study showed that social media use, video game playing, and computer use were associated with current increases in levels of hostility in adolescents and in turn increases in their tendency to engage in fighting, rule-breaking, and conduct problem behaviors (significant mediation at between- and within-person levels). However, increase in screen time during 1 year was not associated with increase of aggressive behaviors over the longer term (mediation at lagged-within-person level). In particular, for social media use and television viewing, which showed a significant lagged-within-person association with conduct problems and hostility, respectively, it was not revealed that hostile thoughts were mediating the development of conduct problems over the longer term. It is noteworthy that our lagged-mediation model considered the association between 2 sets of behaviors with a 2-year interval. Globally these results are in line with previous cross-sectional studies, which highlighted a mediating role of

hostility in the association of video game playing and viewing violent movies with aggression.<sup>41–43</sup> However, our findings suggested that an additional unmeasured learning or behavioral process might mediate the relation between social media use and the maintenance of conduct disorder symptoms. Potential mediators to investigate further might be changes in social norms regarding rule-breaking that are independent of hostile attributions or interference with the development of prosocial interpersonal skills and coping strategies.<sup>53</sup> For example, social norms can influence behaviors via social learning by observing behaviors of peers<sup>54</sup>; a significant mediation role of alcohol-related social norms in the association of social media use and alcohol consumption among adolescents has been previously shown.<sup>55</sup>

Overall, in using a longitudinal research design in a sample of nearly 4,000 adolescents and a rigorous and conservative data analytic approach, the present study is in line with previous studies supporting the link between screen time and aggression among both Canadian and North American adolescents<sup>10,12,13</sup> and adolescents in other countries<sup>9,11</sup> and contrasts previous works concluding there is not such a link.<sup>14,15</sup> Our findings showed that the relation between various forms of screen time and fighting behavior were transitory, but still consistent with a causal hypothesis. They suggest that increasing levels of screen time might lead to youth being more physically reactive. Our findings also highlighted a long-lasting protective role of television programs in relation to hostile thought process among adolescents, while social media use appeared to have a long-lasting impact on conduct problems, potentially through a learning process based on peer-generated content. Indeed, peer-generated aggressive content observation could stimulate the development of aggressive attributional biases, which promote longer-term tendencies to engage in antisocial behaviors that go beyond fighting and involve rule-breaking across a number of life domains.

The interesting findings revealed by this study need to be interpreted in light of several limitations. First, although we found several time-varying associations between screen time and aggressive behaviors in adolescents, it remains unclear which modes and types of content of screen time are in fact associated with these aggressive behaviors. Indeed, as violent content was not measured in this study, our results could not directly inform hypotheses on the relation between content exposure and the attitudes and behaviors of adolescents. Therefore, instead of only between screen time modes, we recommend that future research distinguish within screen time modes and that these within screen time modes examine what kind of

content is associated with aggressive behaviors and attitudes in adolescents. Second, as the digital screen measurement used in this study is limited to 3 hours 30 minutes or more of a particular type of screen activity, we most likely were not able to capture adolescents demonstrating more excessive forms of screen time (eg, playing video games for more than 8 hours per day). Third, we used self-reports to measure screen time and aggression. These self-reported measures may have caused some bias because of participants' difficulty in recalling exact fluctuations in regular and habitual behaviors, such as time spent in front of a digital screen. Nevertheless, self-reported screen time has been shown to correlate with objective measures of sedentary behavior, indicating some validity of self-reported measures.<sup>56</sup> Fourth, we controlled each MLM model for sex and SES as covariates. However, it is possible that there are still confounding time-invariant covariates at the between-person level (eg, personality) and confounding time-varying covariates at the within-person and lagged-within-person levels (eg, internalizing symptoms) that were not taken into account.

Overall, and notwithstanding these limitations, the main strength of our study is the temporal assessment of the association of various types of screen time with aggressive behaviors mediated by hostility using a large population-based sample of adolescents, while distinguishing between the time-varying factors. In addition, this longitudinal Canadian study collected data between 2012 and 2018. In this way, even though we did not cover the period characterized by the COVID-19 pandemic<sup>57</sup> or the arrival of new social media applications, such as TikTok,<sup>58</sup> we were able to study the effects of screen time on adolescent behavior at a unique time when technological advances and the increasing availability of mobile digital technologies have become increasingly accessible to youth. In conclusion, our results stress the need to regulate screen time to reduce and prevent

aggressive behaviors such as fighting, conduct problems, and hostility over the course of adolescence.

This article is part of a special series devoted to addressing aggressive behavior as a focus of psychiatric attention and how its manifestations and treatment needs may vary across psychiatric disorders. The series is edited by Guest Editor Joseph Blader, PhD, Deputy Editor Robert Findling, MD, MBA, and Editor Manpreet K. Singh, MD, MS.

Accepted August 17, 2023.

Drs. Wallace and Boers, Mr. Ouellet, and Prof. Conrod are with the Research Center of Sainte-Justine University Hospital Center in Montreal, Québec, Canada, and the University of Montreal, Québec, Canada.

Dr. Wallace was supported by a postdoctoral fellowship from the CFREF-IVADO Grant (PRF2020). Dr. Boers was supported by a postdoctoral fellowship from ERA-NET NEURON (JCT-2018). Mr. Ouellet was supported by a master fellowship from the CFREF-IVADO Grant (PRF2020). Prof. Conrod has received funding from the Canadian Institutes of Health Research (Grant FRN114887), the Canada Research Chair in Preventive Mental Health and Addiction, and the Dr. Julien/Marcelle and Jean Coutu Foundation Research Chair in Community Social Pediatrics.

Prof. Conrod served as the statistical expert for this research.

#### Author Contributions

*Conceptualization:* Wallace, Boers, Conrod

*Data curation:* Wallace, Boers, Conrod

*Formal analysis:* Wallace, Boers, Ouellet

*Funding acquisition:* Conrod

*Investigation:* Wallace, Boers, Conrod

*Methodology:* Wallace, Boers, Conrod

*Project administration:* Conrod

*Supervision:* Conrod

*Validation:* Conrod

*Visualization:* Wallace

*Writing – original draft:* Wallace, Boers

*Writing – review and editing:* Wallace, Ouellet, Conrod

**Disclosure:** Drs. Wallace and Boers, Prof. Conrod, and Mr. Ouellet have reported no biomedical financial interests or potential conflicts of interest.

**Correspondence** to Patricia Conrod, PhD, Research Center of Sainte-Justine University Hospital Center, 3175 Chemin de la Côte-Sainte-Catherine, Montreal, QC H3T 1C5, Canada; e-mail: patricia.conrod@umontreal.ca

2949-7329/Crown Copyright © 2023 Published by Elsevier Inc. on behalf of American Academy of Child & Adolescent Psychiatry. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jaacop.2023.08.002>

## REFERENCES

1. Radesky JS, Christakis DA. Increased screen time: implications for early childhood development and behavior. *Pediatr Clin North Am*. 2016;63(5):827-839. <https://doi.org/10.1016/j.pcl.2016.06.006>
2. Twenge JM, Joiner TE, Rogers ML, Martin GN. Increases in depressive symptoms, suicide-related outcomes, and suicide rates among U.S. adolescents after 2010 and links to increased new media screen time. *Clin Psychol Sci*. 2018;6(1):3-17. <https://doi.org/10.1177/2167702617723376>
3. Santos RMS, Mendes CG, Sen Bressani GY, *et al*. The associations between screen time and mental health in adolescents: a systematic review. *BMC Psychol*. 2023;11(1):127. <https://doi.org/10.1186/s40359-023-01166-7>
4. Bleakley A, Jamieson PE, Romer D. Trends of sexual and violent content by gender in top-grossing US films, 1950–2006. *J Adolesc Health*. 2012;51(1):73-79. <https://doi.org/10.1016/j.jadohealth.2012.02.006>
5. Anderson CA, Gentile DA. Violent video game effects on aggressive thoughts, feelings, physiology, and behavior. In: Gentile DA, ed. *Media Violence and Children: A Complete Guide for Parents and Professionals*. 2nd ed. Santa Barbara, CA: Praeger/ABC-CLIO; 2014:229-270.
6. Patton DU, Hong JS, Ranney M, *et al*. Social media as a vector for youth violence: A review of the literature. *Comput Human Behav*. 2014;35:548-553. <https://doi.org/10.1016/j.chb.2014.02.043>
7. Dill KE, Gentile DA, Richter WA, Dill JC. Violence, sex, race, and age in popular video games: a content analysis. In: Cole E, Daniel JH, eds. *Featuring Females: Feminist Analyses of Media*. Washington, DC: American Psychological Association; 2005: 115-130.
8. Van Kessel P, Toor S, Smith A. A week in the life of popular YouTube channels. Pew Research Center; 2019. Accessed July 25, 2019. <https://www.pewresearch.org/internet/2019/07/25/a-week-in-the-life-of-popular-youtube-channels/>
9. Krahé B, Busching R, Möller I. Media violence use and aggression among German adolescents: associations and trajectories of change in a three-wave longitudinal study. *Psychol Pop Media Cult*. 2012;1(3):152. <https://doi.org/10.1037/a0028663>
10. Slater MD, Henry KL, Swaim RC, Anderson LL. Violent media content and aggressiveness in adolescents: a downward spiral model. *Commun Res*. 2003;30(6):713-736. <https://doi.org/10.1177/0093650203258281>

11. Zhu X, Griffiths H, Xiao Z, *et al.* Trajectories of screen time across adolescence and their associations with adulthood mental health and behavioral outcomes. *J Youth Adolesc.* 2023;52(7):1433-1447. <https://doi.org/10.1007/s10964-023-01782-x>
12. Katapally TR, Thorisdottir AS, Laxer R, Leatherdale ST. The association of school connectedness and bullying involvement with multiple screen-time behaviours among youth in two Canadian provinces: a COMPASS study. *Health Promot Chronic Dis Prev Can.* 2018;38(10):368-379. <https://doi.org/10.24095/hpcdp.38.10.03>
13. Pagani LS, Jalbert M, Derevensky JL. From one year to the next: Video gaming life-style predicts subsequent psychosocial risk in adolescent boys and girls. *J Paediatr Child Health.* 2022;58(9):1554-1560. <https://doi.org/10.1111/jpc.16032>
14. Ferguson CJ, Wang JC. Aggressive video games are not a risk factor for future aggression in youth: A longitudinal study. *J Youth Adolesc.* 2019;48:1439-1451. <https://doi.org/10.1007/s10964-019-01069-0>
15. Orben A, Przybylski AK. The association between adolescent well-being and digital technology use. *Nat Hum Behav.* 2019;3(2):173-182. <https://doi.org/10.1038/s41562-018-0506-1>
16. Ferguson CJ, Kilburn J. The public health risks of media violence: a meta-analytic review. *J Pediatr.* 2009;154(5):759-763. <https://doi.org/10.1016/j.jpeds.2008.11.033>
17. Bushman BJ. Violent media and hostile appraisals: a meta-analytic review. *Aggress Behav.* 2016;42(6):605-613. <https://doi.org/10.1002/ab.21655>
18. Buckley KE, Anderson CA. A theoretical model of the effects and consequences of playing video games. In: Vorderer P, Bryant J, eds. *Playing Video Games: Motives, Responses, and Consequences.* Mahwah, NJ: Lawrence Erlbaum Associates; 2006: 363-378.
19. Bushman BJ. Priming effects of media violence on the accessibility of aggressive constructs in memory. *Pers Soc Psychol Bull.* 1998;24(5):537-545. <https://doi.org/10.1177/0146167298245009>
20. Fiske ST, Taylor SE. *Social Cognition.* 2nd ed. New York: McGraw-Hill; 1991.
21. Bushman BJ, Huesmann LR. Short-term and long-term effects of violent media on aggression in children and adults. *Arch Pediatr Adolesc Med.* 2006;160(4):348-352. <https://doi.org/10.1001/archpedi.160.4.348>
22. Kemp E, Sadeh N, Baskin-Sommers A. A latent profile analysis of affective triggers for risky and impulsive behavior. *Front Psychol.* 2019;9:2651. <https://doi.org/10.3389/fpsyg.2018.02651>
23. Cao F, Su L, Liu T, Gao X. The relationship between impulsivity and Internet addiction in a sample of Chinese adolescents. *Eur Psychiatry.* 2007;22(7):466-471. <https://doi.org/10.1016/j.eurpsy.2007.05.004>
24. Gentile DA, Swing EL, Lim CG, Khoo A. Video game playing, attention problems, and impulsiveness: evidence of bidirectional causality. *Psychol Pop Media Cult.* 2012;1(1): 62. <https://doi.org/10.1037/a0026969>
25. Weiss M, Baer S, Allan B, Saran K, Schibuk H. The screens culture: impact on ADHD. *Atten Defic Hyperact Disord.* 2011;3(4):327-334. <https://doi.org/10.1007/s12402-011-0065-z>
26. Lachman SJ. Learning is a process: Toward an improved definition of learning. *J Psychol.* 1997;131(5):477-480. <https://doi.org/10.1080/00223989709603535>
27. De Houwer J, Barnes-Holmes D, Moors A. What is learning? On the nature and merits of a functional definition of learning. *Psychon Bull Rev.* 2013;20(4):631-642. <https://doi.org/10.3758/s13423-013-0386-3>
28. Domjan M. *The Principles of Learning and Behavior.* 6th ed. Boston: Cengage Learning; 2010.
29. Silberg JL, Rutter M, Tracy K, Maes HH, Eaves L. Etiological heterogeneity in the development of antisocial behavior: the Virginia Twin Study of Adolescent Behavioral Development and the Young Adult Follow-Up. *Psychol Med.* 2007;37(8):1193-1202. <https://doi.org/10.1017/S0033291707000293>
30. Wesseldijk LW, Bartels M, Vink JM, *et al.* Genetic and environmental influences on conduct and antisocial personality problems in childhood, adolescence, and adulthood. *Eur Child Adolesc Psychiatry.* 2018;27(9):1123-1132. <https://doi.org/10.1007/s00787-017-1014-y>
31. Snyder J, Reid J, Patterson G. A social learning model of child and adolescent antisocial behavior. In: Lahey BB, Moffitt TE, Caspi E, eds. *Causes of Conduct Disorder and Juvenile Delinquency.* New York: Guilford Press; 2003:27-48.
32. Hill J. Biological, psychological and social processes in the conduct disorders. *J Child Psychol Psychiatry.* 2002;43(1):133-164. <https://doi.org/10.1111/1469-7610.00007>
33. Hoeve M, Dubas JS, Eichelsheim VI, Van der Laan PH, Smeenk W, Gerris JR. The relationship between parenting and delinquency: A meta-analysis. *J Abnorm Child Psychol.* 2009;37(6):749-775. <https://doi.org/10.1007/s10802-009-9310-8>
34. Dodge KA, Pettit GS. A biopsychosocial model of the development of chronic conduct problems in adolescence. *Dev Psychol.* 2003;39(2):349. <https://doi.org/10.1037/0012-1649.39.2.349>
35. Miles DR, Carey G. Genetic and environmental architecture on human aggression. *J Pers Soc Psychol.* 1997;72(1):207. <https://doi.org/10.1037/0022-3514.72.1.207>
36. Moffitt TE. Adolescence-limited and life-course-persistent antisocial behavior: a developmental taxonomy. *Psychol Rev.* 1993;100:674-701. <https://doi.org/10.1037/0033-295X.100.4.674>
37. Patterson GR. Developmental changes in antisocial behavior. In: Peters RD, McMahon RJ, Quinsey VL, eds. *Aggression and Violence Throughout the Life Span.* Newbury Park, CA: Sage; 1992:52-82.
38. Spies Shapiro LA, Margolin G. Growing up wired: social networking sites and adolescent psychosocial development. *Clin Child Fam Psychol Rev.* 2014;17(1):1-18. <https://doi.org/10.1007/s10567-013-0135-1>
39. Blackburn R. Psychopathy and the contribution of personality to violence. In: Millon T, Simonsen E, Birket-Smith M, Davis RD, eds. *Psychopathy: Antisocial, Criminal, and Violent Behavior.* New York: Guilford Press; 1998:50-68.
40. Orobio de Castro B, Slot NW, Bosch JD, Koops W, Veerman JW. Negative feelings exacerbate hostile attributions of intent in highly aggressive boys. *J Clin Child Adolesc Psychol.* 2003;32(1):56-65.
41. Anderson CA. Effects of violent movies and trait hostility on hostile feelings and aggressive thoughts. *Aggress Behav.* 1997;23(3):161-178. [https://doi.org/10.1002/\(SICI\)1098-2337\(1997\)23:3<161::AID-AB2>3.0.CO;2-P](https://doi.org/10.1002/(SICI)1098-2337(1997)23:3<161::AID-AB2>3.0.CO;2-P)
42. Bartholow BD, Sestir MA, Davis EB. Correlates and consequences of exposure to video game violence: hostile personality, empathy, and aggressive behavior. *Pers Soc Psychol Bull.* 2005;31(11):1573-1586. <https://doi.org/10.1177/0146167205277205>
43. Gentile DA, Lynch PJ, Linder JR, Walsh DA. The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *J Adolesc.* 2004;27(1):5-22. <https://doi.org/10.1016/j.adolescence.2003.10.002>
44. O'Leary-Barrett M, Mäse B, Pihl RO, Stewart SH, Séguin JR, Conrod PJ. A cluster-randomized controlled trial evaluating the effects of delaying onset of adolescent substance abuse on cognitive development and addiction following a selective, personality-targeted intervention programme: the Co-Venture trial. *Addiction.* 2017;112(10):1871-1881. <https://doi.org/10.1111/add.13876>
45. Schniering CA, Rapee RM. The relationship between automatic thoughts and negative emotions in children and adolescents: a test of the cognitive content-specificity hypothesis. *J Abnorm Psycho.* 2004;113(3):464. <https://doi.org/10.1037/0021-843X.113.3.464>
46. Goodman R. The Strengths and Difficulties Questionnaire: a research note. *J Child Psychol Psychiatry.* 1997;38(5):581-586. <https://doi.org/10.1111/j.1469-7610.1997.tb01545.x>
47. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med.* 2008;66(6):1429-1436. <https://doi.org/10.1016/j.socscimed.2007.11.024>
48. Muthén LK, Muthén BO. *Mplus User's Guide.* 8th ed. Los Angeles, CA: Muthén & Muthén; 1998-2017.
49. Loh KK, Kanai R. Higher media multi-tasking activity is associated with smaller gray-matter density in the anterior cingulate cortex. *PLoS One.* 2014;9(9):e106698. <https://doi.org/10.1371/journal.pone.0106698>
50. Johnson JG, Cohen P, Smailes EM, Kasen S, Brook JS. Television viewing and aggressive behavior during adolescence and adulthood. *Science.* 2002;295(5564):2468-2471. <https://doi.org/10.1126/science.1062929>
51. Martins N, Wilson BJ. Social aggression on television and its relationship to children's aggression in the classroom. *Hum Commun Res.* 2012;38(1):48-71. <https://doi.org/10.1111/j.1468-2958.2011.01417.x>
52. Keikha M, Qorbani M, Kazemi Tabaei MS, Djalalinia S, Kelishadi R. Screen time activities and aggressive behaviors among children and adolescents: a systematic review. *Int J Prev Med.* 2020;11:59. [https://doi.org/10.4103/ijpvm.IJPVM\\_71\\_20](https://doi.org/10.4103/ijpvm.IJPVM_71_20)
53. Guerrero MD, Barnes JD, Chaput JP, Tremblay MS. Screen time and problem behaviors in children: exploring the mediating role of sleep duration. *Int J Behav Nutr Phys Act.* 2019;16(1):105. <https://doi.org/10.1186/s12966-019-0862-x>
54. Heffernan CJ. Social foundations of thought and action: a social cognitive theory. *Behav Change.* 1988;5(1):37-38.
55. Boers E, Afzali MH, Conrod P. A longitudinal study on the relationship between screen time and adolescent alcohol use: the mediating role of social norms. *Prev Med.* 2020;132: 105992. <https://doi.org/10.1016/j.ypmed.2020.105992>
56. LeBlanc AG, Broyles ST, Chaput J-P, *et al.* Correlates of objectively measured sedentary time and self-reported screen time in Canadian children. *Int J Behav Nutr Phys Act.* 2015;12:38. <https://doi.org/10.1186/s12966-015-0197-1>
57. Pandya A, Lodha P. Social connectedness, excessive screen time during COVID-19 and mental health: a review of current evidence. *Front Hum Dyn.* 2021;3:684137. <https://doi.org/10.3389/fhumd.2021.684137>
58. Chao M, Lei J, He R, Jiang Y, Yang H. TikTok use and psychosocial factors among adolescents: comparisons of non-users, moderate users, and addictive users. *Psychiatry Res.* 2023;325:115247. <https://doi.org/10.1016/j.psychres.2023.115247>