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Screen media use and ADHD-related behaviors: Four decades of research

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The diagnosis of attention-deficit/hyperactivity disorder (ADHD) among children and adolescents has increased considerably over the past decades. Scholars and health professionals alike have expressed concern about the role of screen media in the rise in ADHD diagnosis. However, the extent to which screen media use and ADHD are linked remains a point of debate. To understand the current state of the field and, ultimately, move the field forward, we provide a systematic review of the literature on the relationship between children and adolescents' screen media use and ADHD-related behaviors (i.e., attention problems, hyperactivity, and impulsivity). Using the Differential Susceptibility to Media effects Model as a theoretical lens, we systematically organize the existing literature, identify potential shortcomings in this literature, and provide directions for future research. The available evidence suggests a statistically small relationship between media and ADHD-related behaviors. Evidence also suggests that individual child differences, such as gender and trait aggression, may moderate this relationship. There is a clear need for future research that investigates causality, underlying mechanisms, and differential susceptibility to the effects of screen media use on ADHD-related behaviors. It is only through a richer empirical body that we will be able to fully understand the media–ADHD relationship.

media effects | individual differences | media theory | ADHD | attention problems

Over the past four decades, there has been a significant increase in the diagnosis of attention-deficit/hyperactivity disorder (ADHD) during childhood and adolescence (1–3). Commonly defined as a clinically based diagnostic category, ADHD is now generally viewed as a continuum of ADHD-related behaviors (i.e., attention problems, hyperactivity, and impulsivity) (4, 5). Although the increase in the diagnosis of ADHD-related behaviors may reflect either an underdiagnosis in the past or an overdiagnosis at present (6, 7), scholars and health-care professionals alike have repeatedly attributed the increase in diagnoses to the violent, arousing, and fast-paced nature of contemporary screen media entertainment (8, 9).

While the literature on the relationship between children's media use and ADHD-related behaviors is continuing to grow, one of the challenges of this body of work is that it is scattered across a multitude of disciplines (e.g., communication science, developmental psychology, and pediatric medicine), which are all trying to understand the nature of this relationship from their own theoretical and analytical perspectives. With so many different perspectives, it is challenging to obtain a comprehensive view on the literature. However, such a view is crucial if we hope to separate what is known from what is yet to be known, and in doing so, identify a clear research agenda for the field moving forward. In this review, we therefore start with a comparison of the results of two recent meta-analyses on media use and ADHD-related behaviors (10, 11). Then, on the basis of the Differential Susceptibility to Media effects Model (DSMM) (12), we discuss important shortcomings in the existing literature and outline promising avenues for future research.

Screen Media Use and ADHD-Related Behaviors: Is There a Link?

The first empirical studies that addressed the question as to whether media use might lead to ADHD-related behaviors in children and adolescents date from the late 1970s (e.g., refs. 13 and 14). Since then, nearly 50 empirical studies have been conducted, of which the far majority have appeared in the past decade. These studies have recently been integrated into two meta-analyses, one by Nikkelen et al. (10) and one by Ferguson (11). Both meta-analyses have yielded statistically small but significant pooled zero-order correlations between screen media use and ADHD-related behaviors [Nikkelen et al. (10): $r+ = 0.12$; Ferguson (11): $r+ = 0.10$]. These pooled correlations are comparable to other meta-analyses of media effects, which have typically yielded effect sizes between $r+ = 0.10$ and $r+ = 0.20$ (with some deviations in both directions; see ref. 15 for a discussion). For example, meta-analyses on the influence of violent video games on aggression have also reported correlations of $r+ = 0.08$ (16), $r+ = 0.15$ (17), and $r+ = 0.19$ (18, 19).

Although the meta-analyses of Ferguson (11) and Nikkelen et al. (10) cover in part the same body of empirical work, there are some noticeable differences between the two. For example, the meta-analysis of Ferguson (11) focused only on video games (violent and nonviolent), whereas Nikkelen et al. (10) included both television viewing and video game playing (violent and nonviolent). As a result, the pooled correlation of Ferguson (11) is based on nine empirical studies, whereas that of Nikkelen et al. (10) is based on 38 studies on the effects of television and 17 on the effects of video games. Most importantly, however, is the difference in conceptual approach of the two meta-analyses. Whereas Ferguson (11) incorporated background variables (e.g., age and sex) as controls in his meta-analysis (which reduced the pooled correlation from $r+ = 0.10$ to $r+ = 0.03$), Nikkelen et al. (10) conceptualized such background variables as moderators. They found, for example, that boys are more susceptible to the effects of media use on ADHD-related behaviors than girls.

The validity of the meta-analytic approaches by Ferguson (11) and Nikkelen et al. (10) has been discussed elsewhere (see refs. 11, 20, and 21). It has been argued that treating background variables as controls instead of moderators, such as in Ferguson's meta-analysis, may unjustly wash away true media effects for certain subgroups of children (20, 21). As argued by Nathanson (22), children and families differ, and by routinely controlling for background factors, studies may easily disregard children's differential susceptibility to the effects of media. Indeed, most meta-analyses of media effects

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typically focus on main effects or large group-level moderator effects. As a result, they are often not able to highlight subtler yet potent individual differences in susceptibility to media effects (15). Investigating the moderating role of background variables, such as age, gender, and family environment, rather than controlling for them may help both academics and practitioners to better understand which children are vulnerable to media effects as a cause of ADHD-like behavior and, equally important, which children are not.

Recently, the DSMM (12) has tried to more clearly specify why overall effect sizes in meta-analyses of media effects are typically small and why media effects may be small or even nonexistent for the majority of children but large for some particular children. Specifically, the DSMM puts forward three propositions that may be relevant to better understanding the process of media effects. In the remainder of this review, we use these propositions as a guiding lens to systematically organize the literature on the relationship between media and ADHD-related behaviors. In our literature review, we include some newer studies, which appeared after the meta-analyses of Nikkelen et al. (10) and Ferguson (11), and which were designed to investigate subtler individual differences in susceptibility to the effects of screen media on ADHD-related behaviors.

Indirect Media Effects: Which Mechanisms Explain the Media–ADHD Relationship?

A first proposition of the DSMM that specifies the boundary conditions of media effects on ADHD-related behaviors involves the underlying mechanisms of such effects (12). The DSMM posits that media effects can be explained by a combination of three types of response states that occur during or just after exposure to media: cognitive (i.e., the attention to and processing of certain media content), emotional (i.e., affective reactions, such as fear and joy while or after watching or playing), and excitative (i.e., physiological arousal while or just after watching or playing) response states (12). These response states are conceptualized as intervening (or mediating) variables between screen media use and ADHD-related behaviors.

Consistent with the DSMM (12), most explanatory hypotheses that have been forwarded in the literature conceptualize certain response states as the underlying mechanisms in the screen media–ADHD relationship. These hypotheses are based on the assumption that either the fast pace or the violent nature of contemporary media entertainment affect children's media-induced response states, which in turn increase the likelihood of ADHD-related behaviors. As for the fast pace of screen media, two hypotheses have been suggested. The fast-pace arousal-habituation hypothesis (10) builds on the role of cognitive and excitative response states. It posits that fast-paced media forces children to repeatedly shift their attention and renew their orienting responses, which increases arousal (23). With frequent exposure, children may become habituated to this fast pace and produce less arousal. As a result, children's baseline arousal levels may decrease, which may ultimately lead to ADHD-related behaviors (1, 24). A second hypothesis, the scan-and-shift hypothesis (10), builds on the role of cognitive response states and argues that the fast pacing of media prevents children from developing attentional focusing skills (25, 26) and forces them to constantly shift their attention, such that they acquire an attentional style of scanning and shifting (27). These deficits in attentional skills hinder children's capacities to engage in activities that require effortful attention.

As for the violent nature of screen media, two hypotheses have also been proposed. The violence-induced script hypothesis (10) builds on the role of cognitive response states and posits that through exposure to violent media content, children may acquire aggressive cognitive scripts (28, 29). These scripts may lead to the performance of aggressive behavior, which is characterized by impulsivity and poor inhibitory control, which, ultimately, may lead to ADHD-related behaviors (30). A second hypothesis, the violence-induced arousal-habituation hypothesis (10), attributes the effect of violent media on ADHD-related behaviors to arousal. Frequent exposure to violent media may increase children's arousal level (31, 32), which may habituate children to violent-induced arousal and create a desensitization effect, such that children's baseline arousal level declines (33). This state of underarousal may ultimately lead to ADHD-related behaviors (1, 24).

Effects of Program Pacing. The effects of program pacing on ADHD-related behaviors have mainly been investigated in experimental studies, with mixed results (10). It is no surprise, therefore, that the meta-analysis of Nikkelen et al. (10) was unable to discern an effect size for program pacing. Investigations of the role of program pacing began nearly four decades ago. In this early study, researchers compared the immediate effects of fast- and slow-paced episodes of *Sesame Street* on preschoolers' impulsivity and found that program pacing had no effect (13). However, because the pacing of *Sesame Street* is relatively slow compared with other child-directed media content (34), fast-paced episodes of *Sesame Street* might still be relatively slow and, as such, studies that used *Sesame Street* episodes as stimuli might underestimate the effect of pacing (35, 36).

Arguing that today's media pace is far faster than that of four decades ago (8), three recent studies have reinvestigated the program pacing–ADHD relationship, again with mixed results. Cooper et al. (37) recently investigated the short-term impact of pacing on children's attention problems and impulsivity. Surprisingly, they found that fast-paced television content was related with fewer (rather than more) attentional problems. However, the stimuli used in their study (i.e., a video clip of an adult reading a children's story, only 3.5 min in length) were highly unusual for a television study. In contrast, a study by Lillard and Peterson (25) found that children who viewed a fast-paced program had more attentional problems after viewing the program compared with children who viewed a slow-paced program and children who watched no television but engaged in drawing.

However, as proposed by Lillard and Peterson (25), the attentional problems of children in their study could be due to the fantastical content rather than the pace of the program. And indeed, in a follow-up study, Lillard et al. (36) found evidence for their hypothesis that it is not fast pacing but fantastic content that is problematic. However, Lillard et al. (36) relied on a sample of 4-y-olds, who are not yet able to distinguish fantasy and realistic media content, and thus still lack the skills to process fantastical media content in the way older children would do. In fact, some of the stimuli used in the study might have been too complex for children in their sample, thus leaving open the question as to whether the increase in attention problems can be attributed to the fantastical content or the complexity or the comprehensibility of their stimulus material.

In all, it seems that the role of pacing is not yet clearly understood and that more studies are needed to obtain a clear understanding. The inconsistent results may be due to three factors. First, because children's exposure to fast paced content cannot be validly assessed through questionnaires, researchers are forced to employ experimental designs in which groups of children are typically exposed to either fast-paced or slow-paced stimuli. However, in popular children's programs, a fast pace is often inextricably tied to action and/or violence (38). Although researchers may try to remove the action and violence from fast-paced stimulus materials, their materials may become too dull and artificial to ensure the ecological validity of their experiments. Second, the inconsistencies may be due to ethical constraints, which reduce the ecological validity of studies. For ethical reasons, it is impossible to expose children to programs that contain violence or otherwise age-inappropriate content. And because, as discussed, rapidly paced programs often also contain action or violence, the stimuli used in the experiments are typically "innocent" programs [e.g., the video clip of an adult

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reading a children's story in the Cooper et al. study (37)], which differ greatly from the typical favorite programs in the age group. Finally, program pacing has been operationalized in a multitude of different ways across the different experiments (for an overview, see ref. 35). For example, while the Cooper et al. study (37) focused on camera angle changes, the Anderson et al. study (13) focused on multiple factors, including camera cuts, voice changes, and scene changes. It is quite possible that such differences in the operationalization of pacing complicate valid comparisons across studies.

Effects of Violent Media Content. Unlike studies into the effects of program pace on ADHD-related behavior, studies on the effects of violent media content have mostly relied on correlational survey studies rather than experiments. As for the effects of media violence on ADHD-related behaviors, the empirical results are more consistent than those of the effects of program pacing. Several studies and the meta-analysis of Nikkelen et al. (10) have confirmed that exposure to violent television and video games is positively related to ADHD-related behaviors (26, 29, 39–43). For example, Kronenberger et al. (29) found that adolescents' violent media use was associated with attention problems. However, as observed by Nikkelen et al. (10), most studies into the relationship between media violence and ADHD were cross-sectional studies, hence preventing any conclusions about the direction of the relationship between media use and ADHD-related behaviors.

Conditional Media Effects: Who Is Affected in the Media–ADHD Relationship?

A second proposition of the DSMM is that any media effect can be enhanced or reduced by certain person-based or environmental factors (12). This proposition is in line with several other media-effects theories, which propose that some individuals are more susceptible to the effects of screen media than others [e.g., Slater's Reinforcing Spirals Model (44) and Bandura's Social Cognitive Theory (45)]. Children's susceptibility to the effect of the use of screen media on ADHD-related behaviors may depend on three different factors: developmental, dispositional, and social factors (12).

Developmental Susceptibility. In terms of developmental susceptibility, scholars have hypothesized that young children are more susceptible than older children and adolescents to the effects of screen media on ADHD-related behaviors (10). The argument is that young children are less capable of controlling their arousal levels when using violent and arousing media (46), and as such, the effect of media on children's media-induced arousal may be stronger for young children than for older children and adolescents. However, to date, research has not provided consistent evidence for such differences. For example, the meta-analysis of Nikkelen et al. (10) did not provide evidence for a moderating role of age in the relationship between media use and ADHD-related behaviors. Nikkelen et al. (10) attributed this lack of evidence to the fact that hardly any of the empirical studies included in their meta-analysis had actually investigated age differences.

Of course, meta-analyses are only as good as the empirical studies that they attempt to integrate. If the empirical studies fail to investigate age differences in susceptibility, a meta-analysis based on these studies can hardly compensate for these omissions (20). Recently, Linebarger (42) did study age differences in the relationships between children's video game playing, hyperactivity, and attention problems. She found a direct, positive relationship between video game playing and hyperactivity among preschoolers, but not among school-age children. However, this relationship disappeared after adjusting for parenting style. Linebarger (42) found no relationship between video game playing and attention problems among either age group.

Thus, while theoretical arguments exist to expect age differences in the relationship between children's media use and ADHD-related behaviors, there is as yet not enough empirical evidence to support this claim. While some work suggests that younger children are more susceptible to the effects of screen media on ADHD-related behaviors (10, 42), more research is needed to arrive at any decisive conclusions.

Dispositional Susceptibility. Dispositional susceptibly refers to all person-based characteristics of children that may enhance their susceptibility to media effects (12). Researchers have thus far investigated the role of children's sex, level of aggression, and genetic disposition. Regarding sex differences, scholars have hypothesized that boys may be more susceptible to the effects of media on ADHD-related behaviors. On average, boys exhibit lower levels of inhibitory control than girls (47). As a result, scholars have hypothesized that the effect of media on media-induced arousal and, ultimately, ADHD-related behaviors, may be stronger for boys (48). The meta-analysis of Nikkelen et al. (10) indeed suggests that boys may be more susceptible than girls to the effect of screen media on ADHD-related behaviors. However, again, very few studies included in this meta-analysis actually investigated sex differences in susceptibility. Two more recent studies did look for a moderating effect of sex. Nikkelen et al. (48) found that only for boys (and not for girls), both overall and violent television viewing were positively associated with ADHD-related behaviors. However, Ansari and Crosnoe (49) found an opposite trend: higher levels of television viewing were related to higher levels of hyperactivity among girls but not among boys.

In the meta-analysis of Nikkelen et al. (10), it was impossible to investigate the moderating effects of other dispositional variables because too few studies in the meta-analysis had done so and, therefore, it was not possible to arrive at a pooled effect size. That said, several individual studies did explore the role of other dispositional factors. Kronenberger et al. (29) found that physically aggressive adolescents were more susceptible to the effect of violent media on attention problems. This finding might, at least partly, explain why boys are more susceptible to the effects of media on ADHD-related behaviors than girls, since boys tend to exhibit more physical aggression (50, 51). In other work, researchers investigated the role of genes in the relationship between children's media use and ADHD-related behaviors. Nikkelen et al. (52) investigated whether children's genetic disposition to violent media exposure and ADHD-related behaviors moderated the relationship between children's violent media use and ADHD-related behaviors. Although they found that genetic disposition did predict children's use of violent media, it did not moderate the effect of violent media on their ADHD-related behaviors.

All told then, the meta-analysis of Nikkelen et al. (10) and their empirical work (48) suggest that boys are more susceptible to the effects of media on ADHD-related behaviors than girls (but see ref. 49). This may also hold for aggressive adolescents (29). However, more robust evidence for the moderating role of these and other dispositional variables has yet to be established.

Social Susceptibility. Social susceptibility refers to all social-context factors that may enhance or reduce media effects, such as parenting style, media-specific parenting, or peer pressure (12). Thus far, only a handful of studies have investigated social susceptibility, focusing upon parenting styles, media-specific parenting, demographic characteristics, and parental well-being. In fact, none of the studies included in the meta-analysis of Nikkelen et al. (10) considered social susceptibility to media effects. It is only very recently that scholars have begun to include social factors as potential moderators of the media use–ADHD relationship in their studies. One study asked about the moderating role of parenting styles and demographic risk (e.g., low maternal

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education and single-parent status) (42). Results indicated that responsive parenting reduced the effect of video game playing on hyperactivity among preschoolers who did not experience demographic risks, but enhanced its effect among school-age children who did experience demographic risks. As for attention problems, the results were the opposite in that the reducing effect of responsive parenting was found for preschoolers who did experience demographic risks and school-age children who did not experience such risks.

Besides general parenting, media-specific parenting has also been investigated as a potential moderator of the media–ADHD relationship. In their study on the relationship between violent media use and ADHD-related behaviors among adolescents, Nikkelen et al. (43) investigated the moderating role of active media-specific parenting, distinguishing between controlling active media-specific parenting (i.e., providing rules about violent media use in a threatening way) and autonomy-supportive media-specific parenting (i.e., providing explanations about media use rules). Their study did not provide evidence for a moderating role of media-specific parenting.

In other work, Ansari and Crosnoe (49) investigated the role of socioeconomic status and parental well-being as moderators of the relationship between hyperactivity and television viewing. The study showed that higher levels of hyperactivity were associated with a subsequent increase in television viewing only among children whose parents had lower income and lower levels of education. In the same vein, Ansari and Crosnoe found that parental depression moderated the relationship between hyperactivity and television viewing, but parenting stress did not. Children with higher levels of hyperactivity watched more television 1 y later only when parents experienced high levels of depression.

In all, then, we find very little evidence in the literature in support of children's social susceptibility to the effects of media use on ADHD-related behaviors. The few studies that have investigated social susceptibility factors suggest that parenting style (42), demographic factors, and parental well-being (49) enhance the effects of children's media use on ADHD-related behaviors. However, more robust evidence is needed.

Transactional Media Effects: What Is the Directional Nature of the Media–ADHD Relationship?

A third proposition of the DSMM is that many media effects are transactional or reciprocal (12). In line with other recent media-effects theories, such as the Reinforcing Spirals Model (44) and the Social Cognitive Model (45), the DSMM proposes that media use may generate certain outcomes, which, in turn, may predict subsequent media use (12). Transactional media-effects models are based on three subpropositions. A first subproposition is that children (and adults) have a tendency to expose themselves to media content that is congruent with their dispositions (53). It has been found, for example, that children with an aggressive temperament are more likely to choose violent media content (54). A second subproposition is that media content can only influence those children who expose themselves to this content: a child who never watches media violence can logically not be influenced by such violence (12). This subproposition thus implies that children, by shaping their own media use, also partly shape their own media effects (15).

A third subproposition is that transactional media effects are especially likely when the outcomes of media use are an important aspect of a child's temperament (44). Children high in ADHD-related behaviors may therefore be more likely to choose violent or otherwise arousing media, which may in turn increase their ADHD-related behaviors. An explanation as to why ADHD may influence children's media use has to do with arousal. Specifically, research has shown that children who display ADHD-related behaviors typically experience low baseline arousal levels (55, 56). This is often experienced as an unpleasant physiological state (57), and to alleviate this state, children with ADHD-related behaviors tend to seek out and engage in arousing activities (58). Media use, particularly violent or fast-paced media, may serve as a sufficiently arousing activity.

Another explanation may be that children who display ADHD-related behaviors often experience social difficulties with parents and peers. Indeed, children's ADHD-related behaviors may easily elicit parent–child or peer–peer conflict (59–61). Scholars suggested that media may be an important means to avoid or escape such conflicts (62). While theoretically children may escape family conflict by using any type of media content or react against family conflict by using nonviolent content, empirical support exists for a "social context-content congruency" hypothesis whereby children are most apt to escape family conflict by using violent media (62).

While transactional effects are likely for outcome variables such as ADHD-related behaviors (12), most empirical work has failed to conceptualize such effects. The meta-analysis of Nikkelen et al. (10) found that, of the 45 empirical studies included in their meta-analysis, the far majority of studies conceptualized media use as a cause of ADHD-related behaviors. In fact, only three studies considered transactional or reciprocal effects (63–65).

The three studies in the Nikkelen et al. meta-analysis (10) and a recent fourth study by Ansari and Crosnoe (49) provided mixed evidence for transactional relationships. Only one of these four studies, a study by Gentile et al. (63), found evidence for a transactional relationship between video game playing (both overall and violent) and attention problems and impulsivity. The other studies found that overall television viewing was related to subsequent attention problems, but not vice versa (64), that higher levels of hyperactivity were related to a subsequent increase in television viewing (49), or that television viewing, attention problems, and hyperactivity were not related whatsoever (65).

Discussion and Avenues for Future Research

If anything, it should be clear from this review that the relationship between children's screen media use and ADHD-related behaviors is more theoretically than empirically grounded. Indeed, while there are many hypotheses to explain how and why media use and ADHD-related behaviors may be linked, as well as for whom they may be linked, the empirical work seems to lag behind. The remainder of this paper presents some general conclusions and avenues for future research.

The Effects of Program Content and Pacing. As this review shows, studies into the effects of program pacing and those into the effects of violent content on ADHD-related behavior are hindered by different types of problems. Because exposure to fast-paced programs is difficult to measure via questionnaires, this strand of research mostly consists of experiments. But due to several factors, such as ethical constraints to expose young children to age-inappropriate entertainment programs and a lack of agreement in the field how to operationalize program pace in experiments, the results of these experiments are too mixed to arrive at any decisive conclusions. Conversely, research into the effects of violent media is dominated by correlational research. Although this research is more consistent in its conclusions than studies into the effects of program pacing, it does not allow us to assess the causal direction of the relationship between media violence and ADHD-related behaviors.

In both strands of research, all explanatory hypotheses propose that the effects of screen media use on ADHD-related behaviors are indirect: that is, mediated through its influence on cognitive and excitative response states. However, the existing studies do not evaluate such indirect, mediated effects. In fact, a large portion of the correlational studies rely on existing cohort studies that typically do not include measures of underlying mechanisms. Ignoring mediated effects is a serious omission for two reasons. First, mediating variables provide important

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explanations for why and how media effects occur and, thus, they can be helpful when designing prevention and intervention programs (15). Second, ignoring mediated effects could lead to an underestimation of effect sizes in empirical research and, thus, in meta-analyses (66). After all, it is the combination of direct and indirect effects that makes up the total effect of screen media use on ADHD-related behaviors. To quote Raykov and Marcoulides (67), "if an indirect effect does not receive proper attention, the relationship between two variables of concern may not be fully considered" (for a further discussion, see ref. 15). Hence, to obtain a true understanding of the effects of media use on ADHD-related behaviors, there is a vital need for studies that measure children's responses to programs that differ in content (e.g., violent, fantastic) or pace: for example, through the use of think-aloud methods (68) or via physiological measures, such as heart rate, galvanic skin response, and facial expressions (69, 70).

Another way to move the field forward is to examine associations of different types of media use with executive functioning skills, including working memory, inhibitory control, and attention (71), that have been linked to ADHD-related behaviors. Recent research has shown that media use can affect children's executive functioning (25, 72–74) and that executive functioning is a precursor of ADHD (30, 75). Although the results of these disparate studies suggest a mediating role of executive functioning in the media–ADHD relationship, this hypothesis has never been investigated. Therefore, this is an important avenue for future research.

Future hypotheses also need to address differentiations in the measurement of ADHD. For example, Nikkelen et al. (10) argued that violent media use may be more strongly related to impulsivity than to hyperactivity and attention problems. And some recent empirical work suggests that screen media use is related differently to hyperactivity than to attention problems (42). Because existing studies have often clustered the three ADHD-related behaviors, we are unable to clearly identify which ADHD-related behaviors are affected most. In fact, the ADHD literature, as well as the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) (76) and most contemporary measures of ADHD, focus on an ADHD classification that distinguishes three ADHD subtypes: ADHD-inattentive subtype, ADHD-hyperactive/impulsive subtype, and ADHD-combined subtype (30, 76).

Individual Differences. While most media-effects theories argue that some children might be more susceptible to the effects of media (12, 44, 45), few studies investigating the media–ADHD relationship have included individual difference factors and those that did yielded mixed results. Moreover, in most media–ADHD studies, individual difference variables, if considered at all, are typically regarded as noise. In experiments, such variables are disregarded because they are assumed to be cancelled out by random assignment (77). In concurrent and longitudinal survey studies, they are, at best, modeled as controls. In many of these cases, a theoretical reason as to why these variables are modeled as controls (rather than moderators) is often lacking.

Developmental, dispositional, and social-context factors influence what type of media (content) children use as well as how they respond to such media (content). As such, these individual difference factors provide pivotal guidelines as to who is particularly susceptible to media effects (and who is not). Future studies should continue to establish further evidence for potential age, sex, and temperament differences in susceptibility, as well as systematically examine how parents and peers affect the relationship between children's media use and ADHD-related behaviors. Research has shown that parent factors, such as parental ADHD, parental temperament, parenting stress, family conflict, unresponsive parenting, and chaotic parenting are negatively linked to ADHD-related behaviors (78, 79), and that responsive parenting can suppress ADHD-related behaviors (79). Future research should build on this knowledge and systematically investigate how these parent factors may moderate potential effects of media on ADHD-related behaviors.

Furthermore, there is a need for future research to investigate how parents may influence children's cognitive, affective, and excitative responses to media content and pace. For example, by talking to their children about media content, parents may mitigate the formation of aggressive cognitive scripts that likely result from watching violent media and that may ultimately lead to ADHD-related behaviors (43). Likewise, by supporting the development of focused attention (through responsive parenting and rehearsing sustained attention) parents may prevent the development of attentional focusing deficits resulting from exposure to fast-paced media (80).

Transactional Effects. Although some of the hypotheses on the media–ADHD relationship, such as the scan-and-shift hypothesis, lend themselves to short-term experimental investigation, most other hypotheses, such as the fast-pace arousal-habituation hypothesis and the violence-induced arousal-habituation hypothesis, argue for a longer-term cumulative effect of repeated media exposure. To investigate these latter hypotheses, longitudinal studies are needed. Such studies are also needed to investigate potential transactional effects. As this review shows, although transactional effects are likely when it comes to the media–ADHD relationship, empirical evidence is too scant to allow any conclusions on their validity. The question of causality in the media use–ADHD relationship has as yet received little research attention, mainly due to the concurrent nature of most empirical studies (10). Consequently, it remains unclear as to whether media use is a cause or a consequence of children's ADHD-related behaviors, or both.

However, investigating transactional effects is challenging. In our experience, the investigation of such effects is complicated due to differences in the state and trait nature of media use and ADHD-related behaviors. Since ADHD is a trait-like variable (4), it is a stable construct with high stability coefficients over time. These high-stability coefficients imply that ADHD-related behavior measured at a certain time point is largely explained by its measurement at previous time points (81). Conversely, media use is a state-like variable, which usually leads to lower stability coefficients, and, as a result, inevitably leaves more variance left to be explained by other independent variables. This difference in the trait-state nature of concepts in cross-lagged models may render it more difficult to find effects from media use to ADHD-like behavior rather than the other way around. Therefore, as argued by Adachi and Willoughby (81), in longitudinal autoregressive models even very small effects should be considered meaningful when there is strong stability in the outcome variable.

Conclusion

Through a comprehensive review of the literature on the relationship between screen media use and ADHD-related behaviors among children and adolescents, we attempted to understand what is known and what remains open for investigation. It seems fair to conclude that there does exist a relationship between children's media use and ADHD-related behaviors, albeit statistically small (10). However, the direction of the relationship, the boundary conditions of the relationship, and the pathway through which this relationship occurs are all largely open questions, calling for a systematic series of empirical investigations. We hope that researchers embrace the challenges we have offered, and in doing so, help answer the important questions associated with the media–ADHD relationship.

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