

REVIEW ARTICLE

The effects of infant media usage: what do we know and what should we learn?

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Abstract

The rise of infant TV viewing began in the late 1990s and has become an increasingly common occurrence. Today, over 90% of children begin watching TV regularly before the age of 2 years in spite of recommendations to the contrary. This article reviews what is known about the effects of infant TV viewing on multiple domains of child development including language, cognition and attentional capacity as well as directions for future research.

Conclusion: No studies to date have demonstrated benefits associated with early infant TV viewing. The preponderance of existing evidence suggests the potential for harm. Parents should exercise due caution in exposing infants to excessive media.

THE RISE OF INFANT TV VIEWING

Since its invention in 1950, television has quickly evolved to occupy a central role in the lives of many families. By 1955, three-fourth of US households owned a TV set (1). This rapid dissemination of a new technology is remarkable even when compared to recent inventions such as cellular telephones. As with many products, usage is often driven by economic and regulatory factors. In the case of TV, these factors have had myriad predictable effects on TV ownership and viewing habits. For example, what was once an expensive technology has become so affordable that there are more televisions than toilets in most developed and developing countries. The typical household has two to three sets. Furthermore, for many families, having several sets has evolved as a natural consequence of the explosion in channels which has segmented the market creating a 'long tail' so that there is something for everyone to watch all the time (2). No longer is a one-show-for-all approach the norm as was the case in the 1950s when the presence of one TV per household made family friendly fare frequent. For children, the extensive offerings have led to them spending an average of 3–6 h/day watching screens, more time than in any singular activity except sleeping (3–5). Most estimates of screen time have relied on parental report of home viewing

and have not, by definition, included viewing that occurs in non-parental caregiving situations such as day care. A recent study found that children in US day cares watch as much as 1.39 additional hours per day with those in home-based programs watching more than those in institutional ones (4). All totalled then, young children spend an average of about 3–4 h/day watching TV which means many children under two, who are only awake for about 10–12 h/day, are spending as much as 30–40% of their waking hours doing so.

The amount of household viewing (at least in US households) has been remarkably steady for some time. In fact, it has plateaued since 1980 (Fig. 1). Quasi-experimental studies also suggest that access to TV leads to a fixed amount of viewing, quickly hitting a ceiling (6). For example, in the seminal NoTel, Unitel, Multitel study, researchers followed three towns in Canada. For topographical reasons, one town received no television reception at all (NoTel), one received a single Canadian Station (Unitel) and one received that station plus US broadcast networks (MultiTel). Notably, there was no meaningful difference in the hours per week viewed between Unitel and Multitel and a year later when NoTel received a signal, no difference between all three (6). Growing the market then, required greater

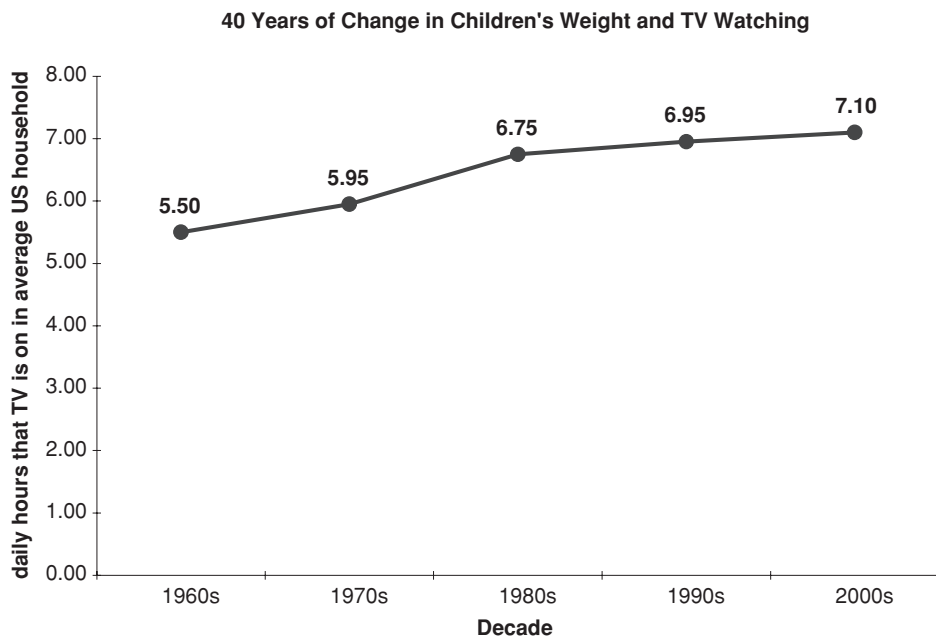


Figure 1 US family television viewing over time.

variety and more TV sets so that more people could watch within a household. In effect, market forces dictated that families begin to watch separately so that households could up the number of hours that were being watched. In the US today, 30% of pre-school children and 75% of adolescents have televisions in their bedrooms (3,5,7). The final frontier in TV viewing was infants, who remained the only members of households who were yet to be taken in by the screen that changed in 1997 when a mother developed a line of video products because she felt there was no age appropriate fare for her infant daughter and a few years later, when her small company was purchased by Walt Disney, 'Baby Einstein' was launched. The demographic that has resulted from introducing infants to screens has been dramatic. In 1971, the average age at which children began to watch television was almost 4 years; today it is 5 months (8).

In a relatively short time, infant TV viewing has become an enormous international industry. Average US sale for baby DVD's is currently \$500 million (9). The rise of products directly marketed to infants has been fuelled in large part by educational claims made explicitly or implicitly. The titles of the products (e.g. 'Baby Einstein', 'Brainy Baby') are themselves highly suggestive of beneficial effects for infants' cognitive abilities. The testimonials on packages and websites take it further stating for example '*This video will teach your child about language and logic, patterns and sequencing, analyzing details, and more*'. These marketing strategies have proven highly effective. A survey of 1000 families found that the most common reason people report for having their infants watch TV (endorsed by 29% of parents) is that it is 'good for their brains' (8). However, a comprehensive review of infant video products found that the claims made by manufacturers are unsubstantiated by peer-reviewed or

even internal industry studies (10). Purveyors of these products rely preferentially on parental testimonials which they view as more effective than science in motivating consumers and easier to come by (10). And the market marches on. In 2006, the 'Baby First TV' cable channel was launched. Available by subscription, it provides 24-h baby TV programming and is quickly spreading internationally.

Infant TV viewing is not without its critics. Although its guidelines are frequently misquoted in the media, the American Academy of Pediatrics (AAP) does not 'prohibit' or 'ban' but rather '*discourages*' TV viewing in the first 2 years of life (11). Only 6% of US parents are even aware of these guidelines despite the attention they continue to receive, a fact which may explain, in part, why 90% of parents appear to ignore this advice (8,12). Figure 2 depicts the proportion of children under the age of 2 years who watch TV and DVDs on a regular basis. The AAP recommendations, initially made in 2001, were based largely on expert opinion that there are other, more appropriate activities for children to engage in during that critical window of neurological development. Since then an emerging body of evidence, which will be reviewed extensively in this article, supports these recommendations. Before reviewing that evidence, however, I will first review the theoretical reasons to be concerned about infant TV viewing.

THEORETICAL CONCERNS ABOUT INFANT TV VIEWING

Human infants are born with brains that are not fully developed. This evolutionary tradeoff occurred with the marked increase in the ultimate brain (and thus head) size afforded humans and the limited capacity of the female pelvis. Based on extrapolations from other non-human primates, it is

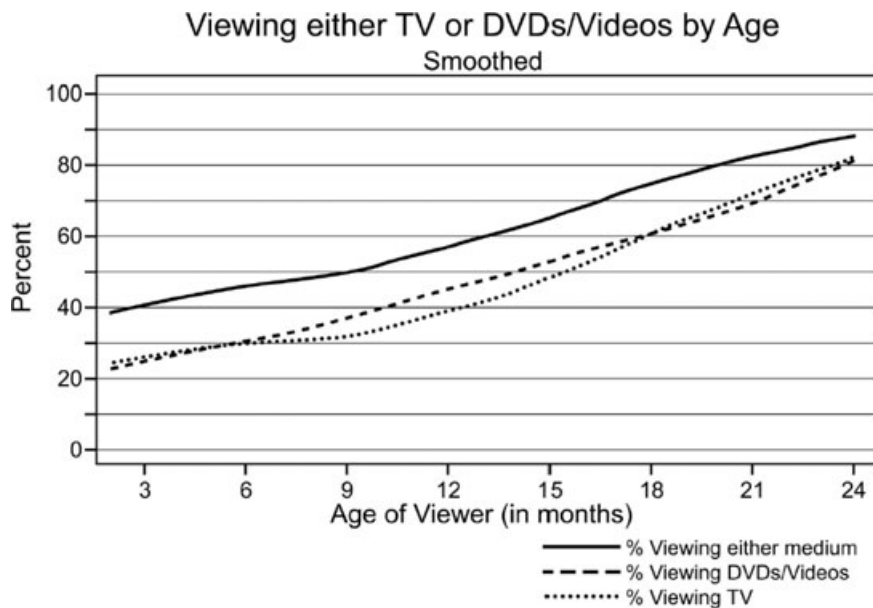


Figure 2 Infant TV and DVD viewing over the first 24 months of life.

estimated that the gestational period of humans should be closer to 18 months rather than 9 (13). The net result is that the newborn brain triples in size in the first 2 years of life from an average of 333 g to almost 1 kg. This growth occurs in direct response to external stimulation. Early life experiences are critical to developmental trajectories as has been shown in both human and animal studies (14–16). In the context of this extraordinary brain growth and the critical role it plays in life-long function, the question of what effects TV exposure might have and how they might be mediated naturally emerges.

Infants do attend to TV and even those as young as 14 months have been shown to imitate what they see on screen (17–19). Nevertheless, a well-described video deficit (20–22) exists whereby children do not learn as well from television as they do from live presentations. For example, Kuhl et al. found that infants learned Mandarin Chinese from a native speaker but not from a videotaped recording of that same speaker (21). Current research has focused on ways to narrow this gap via prior exposure or increased parental interaction, (23) and the ability of infants to demonstrate deferred imitation has been enhanced (18,19). However, these laboratory-based experiments have been conducted in controlled circumstances, with short, slow-paced video segments that are not commercially available nor are they similar to what is currently in the market. Furthermore, the fundamental research question is not *can* infants learn from a screen under ideal circumstances (including an interactive parent) but *is* that learning somehow superior to alternative means of advancing child development. For example, distribution of plastic building blocks together with suggested interactive play activities promoted language development in low-income 18- to 24-month-old children (24). How does a language-promoting DVD compare?

A conceptual model for the effects of TV on children is presented in Figure 3. A great deal of research on the effects of TV on children has focused on exposure and a series of outcomes (e.g. obesity, social functioning, cognition) as represented by arrow 1. This approach has been chosen in many cases because data are frequently collected with respect to the amount of TV that children watch. The quantity of TV viewed is low-lying fruit in media research. As a primary independent variable, however, it is insufficiently nuanced. It treats television monolithically – as a single entity – and then seeks to answer the question is it good or bad? This conceptual limitation has led to considerably less attention has being paid to two critical mediators: content and context. Ample data exist to suggest that *what* children watch (content) and *how* they watch (context) is more important than how much they watch (25–28). For example, certain shows have demonstrable benefits with respect to cognitive and behavioural outcomes while others have been shown to

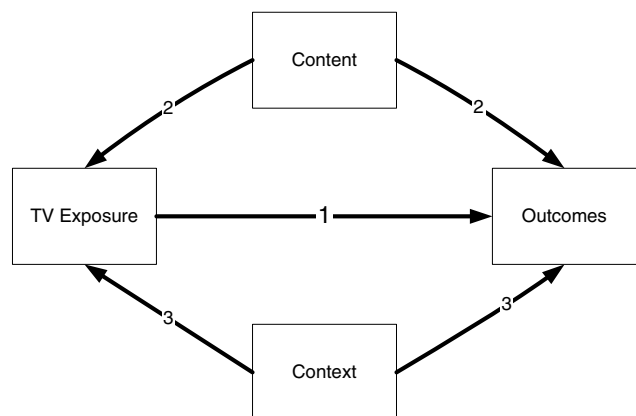


Figure 3 Conceptual model of television exposure and child outcomes.

promote aggression (29–33). The salubrious effects of television can be enhanced and the harmful effects mitigated by the presence of an adult moderator (26,28,34,35). These contextual features have also undergone significant transformation. In the early days of television, families typically had single centrally located sets watched together. Today, the vast majority of households have multiple sets and children of all ages frequently watch alone. In the case of infant viewing, watching alone means imposing a structural limitation on the amount of human interaction a child could receive during a critical period of brain development. In fact TV has facilitated infants spending considerable periods of time ‘alone’, something that would not previously have been easily accomplished given their limited capacity to self-entertain.

From a theoretical perspective, there are two mechanisms by which television might, at least potentially, exert deleterious effects. The first mechanism is via the formal features of the medium. That is, the flashing lights, scene changes, quick edits and auditory cuts may be overstimulating to developing brains. This can occur either in the course of active viewing or by what has been described as background viewing, namely a set that is on without the intention of having an infant watch it. For example, background viewing has been found to disrupt child toy play (36). The second mechanism is essentially via displacement of other more developmentally appropriate or important activities. Recall that infants who watch 3 h of TV per day are spending, approximately, 20% of their waking time in front of a screen calling into question what they may be missing as a result. Studies in Romanian orphans and children removed from neglectful environments suggest the critical role that early human interactions have on child development (37,38). The extent to which such egregious examples of neglect can be applied to situations where infants are placed in front of a screen and at worst ignored is unknown, but the point that time spent with human caregivers is crucial retains saliency. Research to date has not been able to disentangle these contextual effects in part because of the lack of precision with respect to how interactive parents are with their children when they watch outside of laboratory settings. One small laboratory-based study found that parents interact less with their children in the presence of a television set that is turned on (39) and one retrospective observational study found that parents reportedly talked to their children less the more TV they watched (40). However, in truth, content and context are so confounded that it may be impossible to isolate the independent effects of each. When infants watch TV, in spite of claims made to the contrary, they are less interactive with parents and other caregivers and are *simultaneously* exposed to the formal features of the medium. Measuring exposure to television then is at once measuring in large part both *decreased* adult interaction and *increased* stimulation. Nevertheless, from a public health standpoint the net result is the same, unless parents do actually watch with their infants and succeed in actively engage them. However, given that there are other alternatives for interaction (e.g. reading) which are of proven benefit why would we promote co-viewing in infancy

as opposed to other parent–child activities? (41–43) Indeed, 21% of parents report that their primary motivation for having their infants watch TV was so that they could have some time to themselves, an understandable and realistic need, but not one that should be actively promoted (8).

EFFECTS OF TV ON LANGUAGE DEVELOPMENT

Among the most critical (and amazing) milestones of early childhood is the acquisition of language. Beginning at birth with the development of phonemes and progressing through single words and ultimately sentences, the early years of a child’s life are focused in large part on meeting this developmental challenge. The infant brain is well suited to this task and, in fact, the ability to acquire language (and in particular specific phonemes) is limited to this early age (13). The role that ‘mother or parentese plays in this phenomenon is well described although somewhat controversial; however, it remains clear that infants learn language better from a native speaker than from a screen even if it is a tape of a native speaker (13,21,44–46) These findings beg the question of why many DVD’s claim to improve language development (e.g. *Baby Einstein ‘Language Nursery’*). These claims have never been substantiated by robust experimental studies (10). Moreover, a cross-sectional study of 1000 children under the age of 2 years failed to find any benefits to infant viewing. In fact, in that study, infants between the ages of 7 and 16 months who watched baby DVDs had poorer language as assessed by the MacArthur Bates Communicative Development Inventory (47). Specifically, for each hour of baby DVD’s that infants watched, they knew on average about 6–8 fewer words (47). There were no differences noted in children 17–24 months of age suggesting that detriments may be transitory. This study’s cross-sectional nature prohibits drawing causal conclusions regarding early TV’s effects on language development. For example, it is possible, though less plausible, that parents who were concerned about their child’s delayed language exposed them to more DVD’s in an effort to enhance it. A more recent study conducted in Thailand found that early intense exposure to TV defined as viewing 2 or more hours per day before 12 months was associated with a sixfold increase in the likelihood of language delay (48). Notably, the delay in language development associated with infant TV is not limited to programs targeting young infants. Even programs of proven educational benefit for 3–5-year-old children such as *Sesame Street* can delay language acquisition when viewed by younger children (49). In summary, there is no evidence that early exposure to TV can enhance children’s language development, and in fact, the prevailing scientific evidence suggests the opposite which is consistent with what could be expected based on theories of infant language development.

EFFECTS OF TV ON INFANTS’ COGNITIVE DEVELOPMENT

Beyond effects on language, exposure to early TV may have effects on cognitive development more broadly. Notably, here again the marketing campaigns have been making

claims of benefit. One brand even has 'Left Brain' and 'Right Brain' lines of their product suggesting that specific regions of the mind can be developed through regular usage. In part, the success of the industry in advancing claims of benefit is based on a public perception that high quality educational programming can boost academic achievement. This is true for older children. The best-studied show of all is *Sesame Street* which has proven benefits when watched by 3–5-year-old children that persist into adolescence (50).

Bridging from these demonstrated beneficial effects in pre-schoolers to infants is not without a theoretical basis. Early experiences, do influence long-term cognitive processes (16). Animal studies of rats reared in enriched environments have shown benefits in terms of maze effects and human studies of high quality pre-schools and early home-based intervention have also shown long-term benefits (14,51–53). The effects of TV on older children's academic achievement has been extensively studied although data for infants are relatively sparse (54,55). In a longitudinal study of early exposure to television and cognitive outcomes at school age, we found no evidence of benefit and in fact found detriment (56). Each hour of average daily television viewing before age of 3 years was associated with deleterious effects on the Peabody Individual Achievement Test Reading Recognition Scale of 0.31 points (95% confidence interval [CI], –0.61 to –0.01 points), on the Peabody Individual Achievement Test Reading Comprehension Scale of 0.58 points (95% CI, –0.94 to –0.21 points) and on the Memory for Digit Span assessment from the Wechsler Intelligence Scales for Children of –0.10 points (95% CI, –0.20 to 0 points). Again, whether these associations are mediated via a direct effect of the medium or via displacement is unclear, but this study did attempt to control for cognitive stimulation that infants received from their home environment.

TV'S EFFECTS ON CHILDREN'S ATTENTIONAL CAPACITY

Concerns about the potential of televisions to reduce children's attention spans began as long as 40 years ago but until recently empirical data to support them has been lacking (57). Attention-deficit/hyperactivity disorder (ADHD) is among the most common diseases of childhood, affecting somewhere between 5% and 20% of children (58–65). The United States has seen a 10-fold increase in the frequency with which attention-deficit disorder is diagnosed in the past 20 years (66–68). This almost certainly reflects both an increase in prevalence and an increased recognition of the disorder. Although an enormous amount of research is published on ADHD every year (59), comparatively little is known about environmental risk factors (59,63,69). Yet, given an increasing recognition of gene–environment interactions in the genesis of ADHD, more research into environmental factors is clearly warranted. As stated in the Surgeon General's report on mental health, 'for most children with ADHD, the overall effects of these gene abnormalities appear small, suggesting that nongenetic factors also are important' (70).

The concern that television might play a role in the development of ADHD is founded on the neurodevelopmental theory discussed earlier. In contrast to the pace with which real life unfolds, television, particularly television directed at young infants, typically employs rapid scene changes and quick edits. These formal features of the medium are used to engage infants' orienting response, the primitive reflex that fixes attention on strange sights or sounds, effectively keeping them focused on the screen. However, the surreal aspects of the scenes may be overstimulating to developing brains, training them in effect to expect intense input and making reality underwhelming or even boring by comparison.

Small, laboratory-based experimental studies in the psychology literature are few and have evaluated the effects of TV watching on attention span immediately after viewing. A 1973 study found that children who watched *Mr. Rogers' Neighborhood* in a lab setting or played instead of watching any TV had greater tolerance for delay immediately afterward than children who had watched *Batman* (25). In another study, those who watched *Power Rangers* had shorter attentional capacity immediately afterward than those who had watched *Mr. Rogers* or played (71). Finally, another study found no difference in impulsivity after children watched 40 min of slow-paced or fast-paced versions of *Sesame Street* (72). This study may have produced a negative result because of small sample size or because the pacing of educational content is less important than the type of content. Despite being underpowered to detect small, but clinically significant effects of TV viewing, these studies also failed to account for cumulative effects occurring during the critical window of early brain development since all of them were conducted in older children.

In 2004, we conducted a large observational study of over 1300 children and found a modest association between TV viewing before age 3 and attentional problems at age 7 (73). In that study, parents were prospectively asked how much television their child watched when they were between 1 and 2 years of age and again how much they watched when they were between 3 and 4 years of age. At age 7, they completed the Behavioural Problems Index which includes questions related to attention and impulsivity (73). The more TV children watched as infants, the more likely they were to have attentional problems at age 7 after adjusting for an exhaustive list of co-variables. Specifically, each hour of TV watched on average was associated with an increased risk of being in the 90(th) percentile for attentional problems (OR 1.09 [1.03–1.15]). A follow-up study claimed to refute these findings (74) but TV viewing was measured at age 5 and attention was measured at age 6, placing the exposure period outside the first 3 critical years of life. Indeed emerging data now suggest that the timing of exposure is a critical mediator of effects which is consistent with the developmental theory of early brain development (75).

In a follow-up study using a different sample, we replicated our findings testing the hypothesis that the content of programming would mediate the relationship between early exposure and subsequent attention problems. If, as we theorized, pacing was responsible for the association

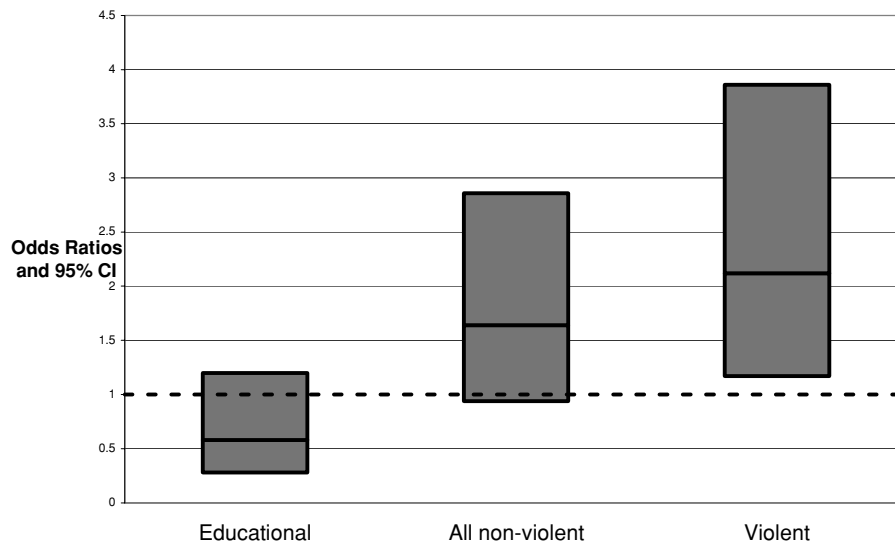


Figure 4 Content of programming viewed at ages 0–3 and odds ratios for attention problems at ages 5–8.

between early exposure and subsequent attention problems, then certain types of shows (e.g. violent or entertainment ones) should pose greater risk than educational ones which are typically slower paced (76,77). That analysis conducted in approximately 500 children again followed longitudinally. In this case, however, the content of the programming they watched was captured and taxonomized by an expert panel into three categories: educational, violent or non-violent non-educational. As shown in Figure 4, both violent and non-violent educational programs were associated with significantly increased risks of attentional problems, but educational programming was not thereby lending further credence to the overstimulation hypothesis.

POLICY IMPLICATIONS

The explosion in infant TV viewing and the potential risks associated with it raise several important policy implications. First and foremost, the lack of regulation related to claims made by the purveyors of such products is problematic. Educational claims should (and can) be based on a scientific data. In response to litigation, Baby Einstein has recently modified its claims and de-emphasized the educational components of its advertising. Nevertheless, the names of the products themselves, and the testimonials that are circulated, serve to further convince parents that infant TV viewing has a positive impact. Second, parents themselves need to be better informed about what activities really do promote healthy development in their young children. This may provide some defence against the aggressive marketing techniques being employed and has implications beyond the use of media in terms of promoting health development. Recently, France has taken the step of banning programming directed at infants. Finally, more resources need to be made available to fund critical research related to the effects of media on young children.

DIRECTIONS FOR FUTURE RESEARCH

In the light of current limitations to the existing research base, it is clear that considerable work in the area of infants and media is needed. Media's presence in the lives of young children is large and growing. Simply put, the current state of research has not kept pace with the rise in infant viewing. We are, in many ways, in the midst of an international experiment on the next generation of children given how early and how much TV they watch. In spite of the surprisingly little conclusive data on TV's effects, the preponderance of existing research gives ample reason to be concerned.

In terms of research design, several limitations should be addressed. Many studies to date are laboratory based or observational or focused on short-term outcomes. Population-based, experimental studies with long-term follow-up are needed to redress the major shortcoming of much of the existing research. Laboratory-based studies while allowing robust manipulations, can lack external validity in that they tell us little about the effects of TV as it occurs in the real world. Observational studies, in spite of all efforts to statistically control confounders, leave open the possibility that young viewers of television are in a systematic way different from non-viewers either in genetic make-up or in terms of environmental exposures. It may be for example, that children with ADHD watch more TV as infants because they are favourably disposed to it even at that young age. Definitely answering the role that early exposure to TV has on attentional capacity will require a long-term intensive intervention to reduce early exposure. Because randomizing children to watch television or not would be unethical, we need an experimental design based on an intensive intervention designed to reduce viewing. While not practical on an ongoing basis, such efforts are needed to determine whether such a relationship truly exists. The findings of such research would also shed further light on the role that early environmental influences have on cognitive development. Furthermore,

based on the conceptual model outlined herewith, analogous studies should manipulate and evaluate the effects of content and context of viewing. Is there any program that can be beneficial to infants? Or are their programs that do not pose risks making a harm reduction approach viable for parents who simply feel they need the break that infant DVD's provide?

In addition to efficacy studies, effective trials are needed to test pragmatic, implementable, cost-effective approaches to media optimisation for children. This public health approach is vital to ensuring that what we learn from scientific experiments can be scaled-up to benefit broader populations of children. Efficacy studies can inform effectiveness ones both by providing a definitive understanding of causal relationships and by identifying subpopulations most likely to benefit from a program. To date, very few such studies have been conducted. Both efficacy and effectiveness studies should focus on theory-driven outcomes derived from the existing research base. There are ample hypotheses generated from cross-sectional and longitudinal studies, laboratory-based assessments and general developmental theory. Real-world experimental manipulation of media exposures is needed to test these. Moreover, studies should be solution-oriented in their design, exploring specific approaches and populations that might benefit from interventions (78). In the case of young children the possibility of a primary prevention approach to excessive or inappropriate viewing should be explored. Rather than focusing on television *reduction* strategies later in life, a fruitful approach may be to establish appropriate usage during infancy and early childhood.

Finally, gene-environment effects should be explored. Media exerts considerable environmental influence on children's development. These effects may indeed be more pronounced in the setting of particular genotypes. Candidate genes for depression, externalizing behaviours and attentional problems have been identified. To what extent these interact with media exposure is unknown but of central importance. One can easily imagine for example that the effects that TV may have on attention spans are mediated by the genetic predisposition of an individual. A better understanding of how an environmental exposure such as TV affects such individuals has both scientific implications in terms of the development of attentional capacity, and public health relevance in terms of how the early environments of children at risk for ADHD should be structured.

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