The Impact of Screens on the Developing Brain

Anne E. Dawson, Ph.D. & Jamie Quattlebaum, Ph.D.
Division of Pediatric Psychology & Neuropsychology

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Objectives

1. Learn the typical course of brain development and cognitive functions in childhood.

1. Examine how screen time may influence child brain development.

1. Explore evidence-based recommendations about harm reduction strategies in managing screen exposure.

Brain Development: Basics

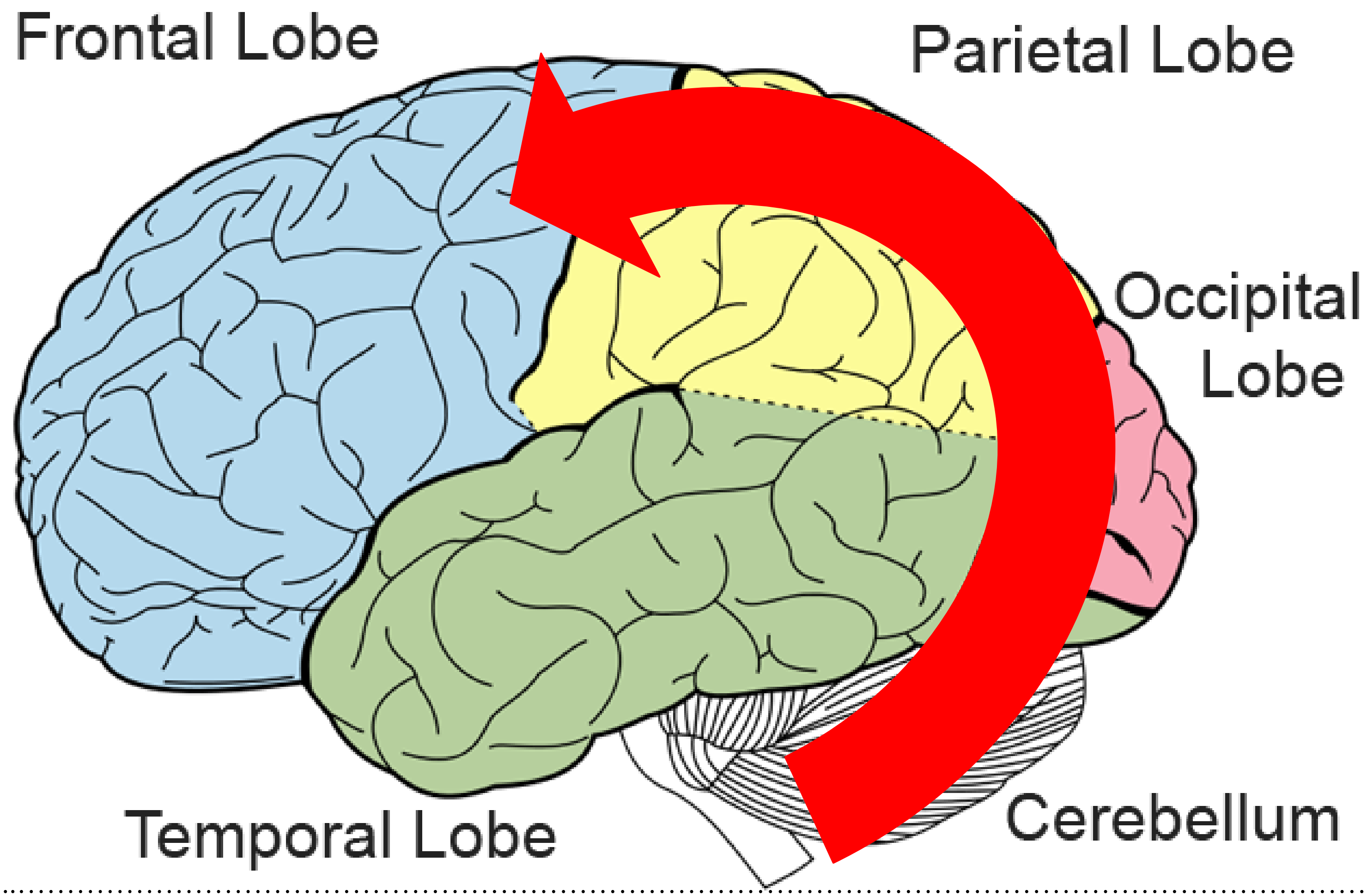
Sensitive Periods

- Periods of heightened plasticity
- Sensitive to specific environmental input
- Specific areas of the brain are "sensitive"
- The "window closes" - consolidation

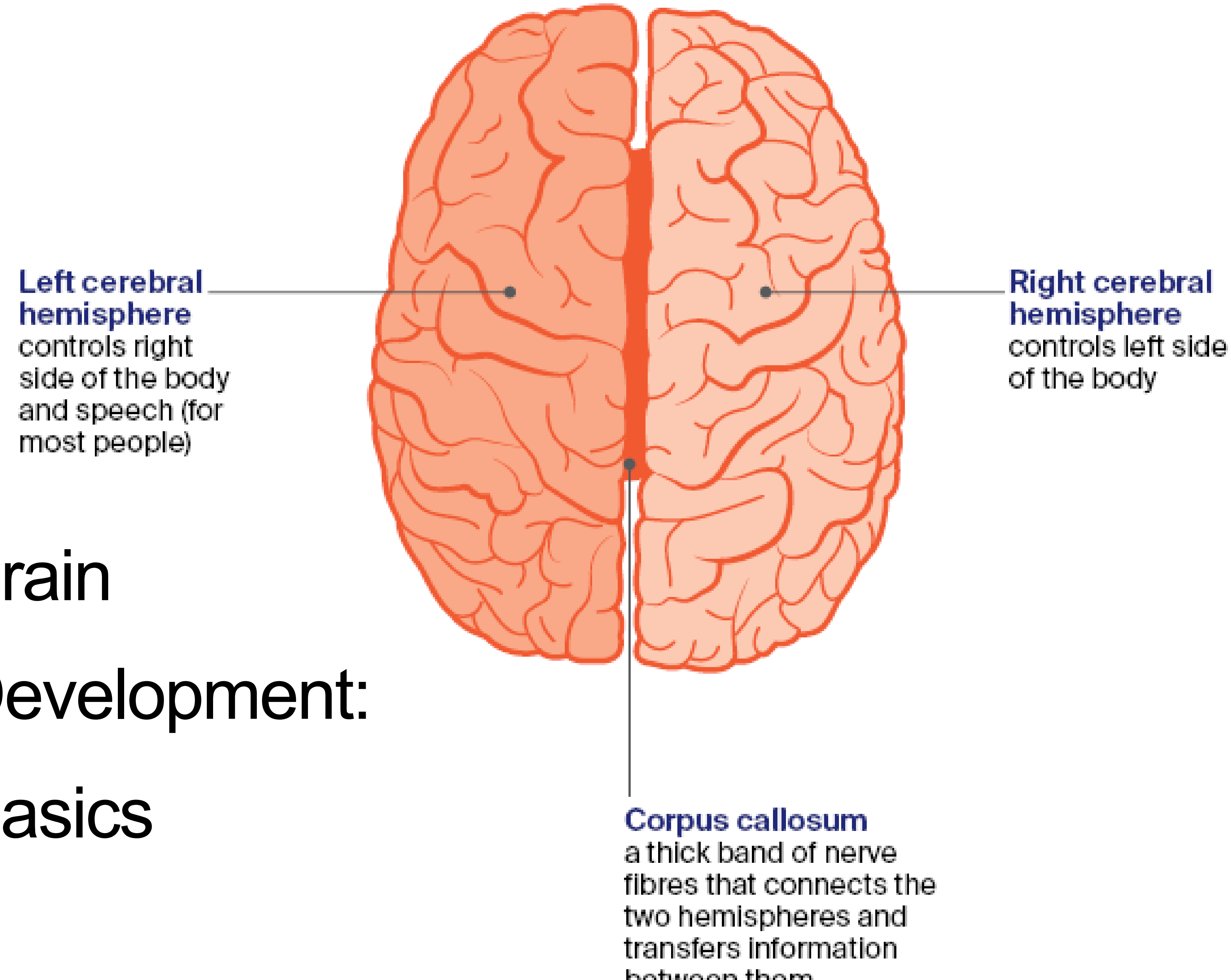
<u>In Humans</u>

- Attachment
- Language
- Social-Emotional Processing *(adolescent/early adult)*

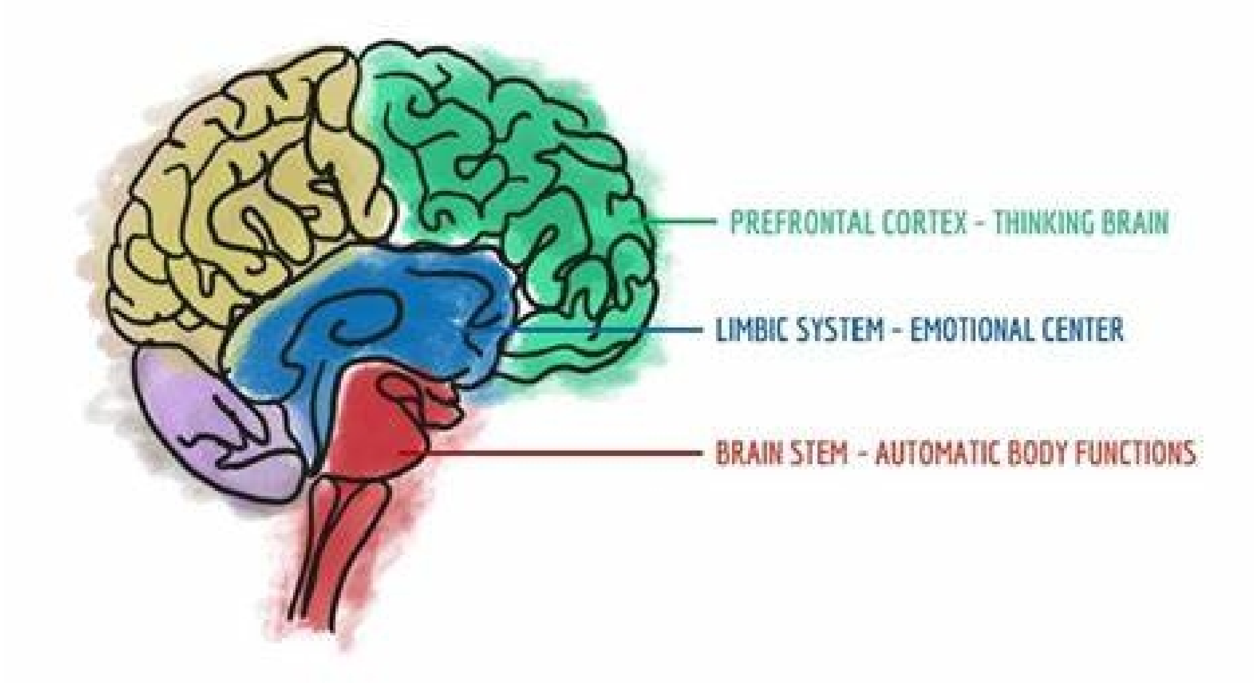
Brain Development: Basics



Brain Development: Basics



Brain Development: Basics

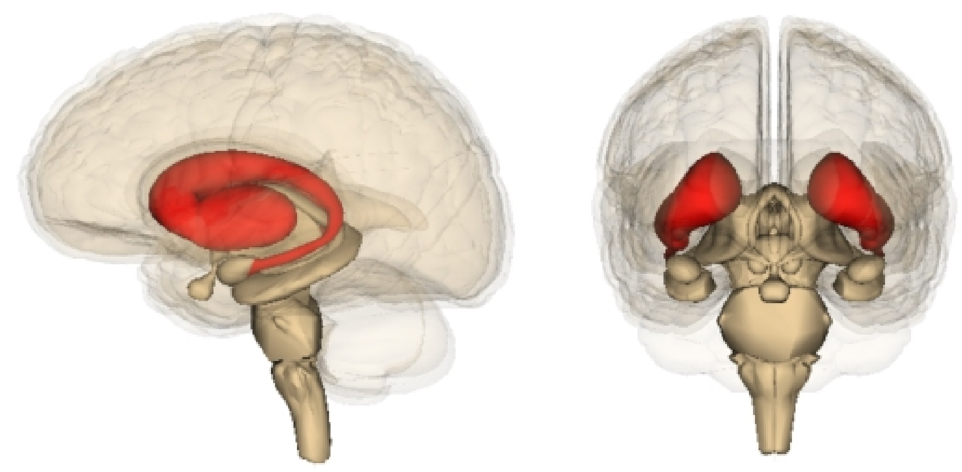


- Amygdala – emotions
- Hippocampus – memory
- Basal Ganglia – lots of stuff + learning by reward

Brain Development: Basics

Striatum

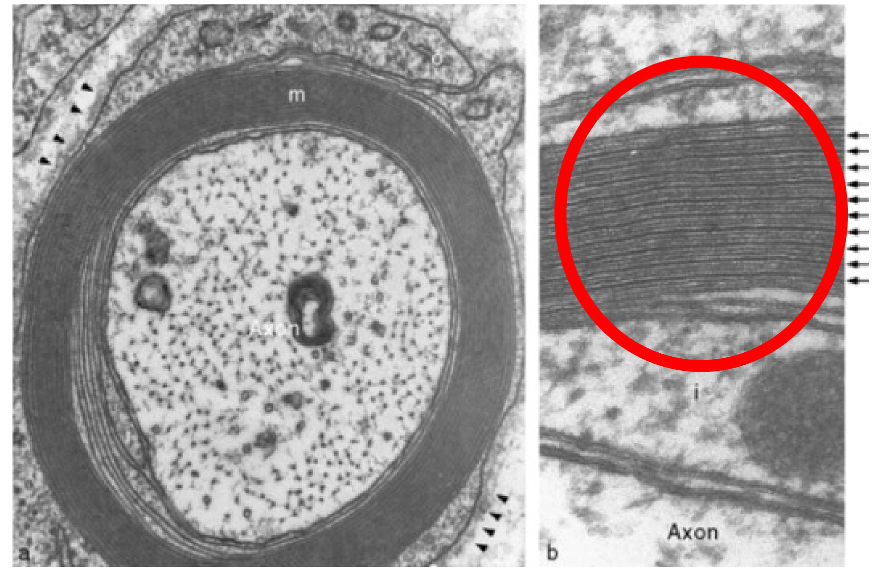
- Largest part of Basal Ganglia
- Reward-based learning
- Controlling impulses
- Push/Pull dynamic



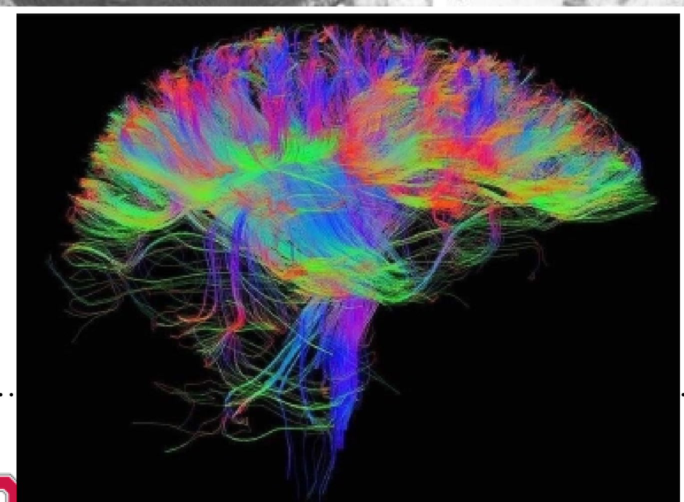
Brain Development: Key Considerations

White Matter

- Efficiency and connectivity
- Myelination = maturation/use
- Continues throughout life



- **Increases** with sensitive periods



Brain Development: With Age

Age Range	Brain Development	Skills/Development
Birth, Toddlerhood, and Preschool (0-5)	Myelination begins High plasticity	Foundation for sensory, emotional, and language learning
Childhood/School Age (6-12)	Brain systems strengthen	Strengthening memory, attention, and cognitive control
Adolescence (13+)	Fontal lobe finalization	Refining complex skills and regulation

Theories About Screen Time

Sensitive Periods for Brain Development

Displacement Theory

Chicken vs. Egg Theories

Kraut et al (1998); Maheux et al (2024); Ophir et al. (2023)

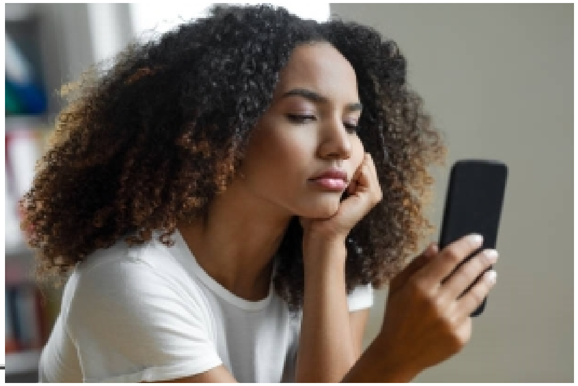
Screen Recommendations

	American Academy of Pediatrics*	American Psychological Association	World Health Organization
Infants	No screens (except video chatting)	No screens (except video chatting)	No screens
2yo	≤ 1 hour, less better	≤ 1 hour	≤ 1 hour, less better
3-4yo	≤ 1 hour, less better	≤ 1 hour	≤ 1 hour

Longstanding lack of following guidelines in USA (Heller, 2021; Trinh et al., 2020; Vandewater et al., 2007)- but this is also observed internationally

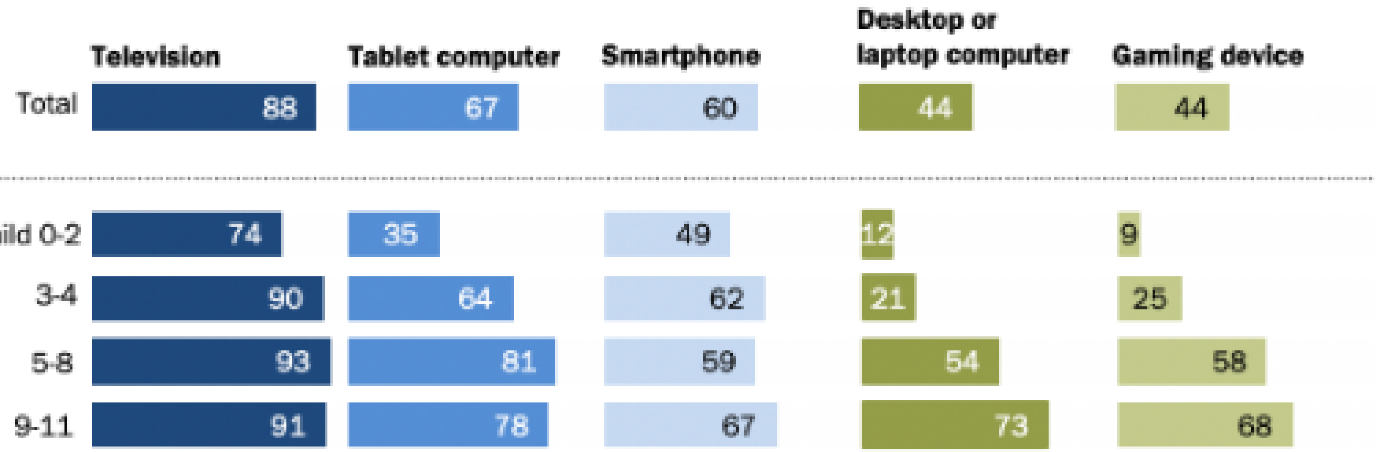
Screen Use

Screen use is a "family" issue



Children's engagement with certain types of digital devices varies widely by age

% of U.S. parents of a child age 11 or younger who say that, as far as they know, their child ever uses or interacts with a ...



Note: If parent has multiple children, they were asked to focus on one child when answering this question. Those who did not give an answer are not shown.
Source: Survey of U.S. adults conducted March 2-15, 2020.
"Parenting Children in the Age of Screens"

PEW RESEARCH CENTER

https://www.pewresearch.org/internet/2020/07/28/childrens-engagement-with-digital-devices-screen-time/

Method

- Literature Review
- Abstract Review
- Full Text Review (39 articles*)
  - 9 reviews (either scoping, educational, systematic, or meta)
  - International samples: USA, Europe (broadly), Denmark, Japan, China, Thailand, Canada, Brazil, Australia, Taiwan, Sweden, Turkey
- Categorized by domain

Neuro/Biological Correlates

Subtle changes in cerebellum volume associated with screen use.

- Specifically, higher social media use with lower volume and higher video game use with higher volume.
- Nivins, et al. (2024).

Overactive/abnormal activity in reward circuits (striatum and limbic system), with decreased grey matter density in the fontal lobe (with greater screen use).

- Tereschhenko (2023).

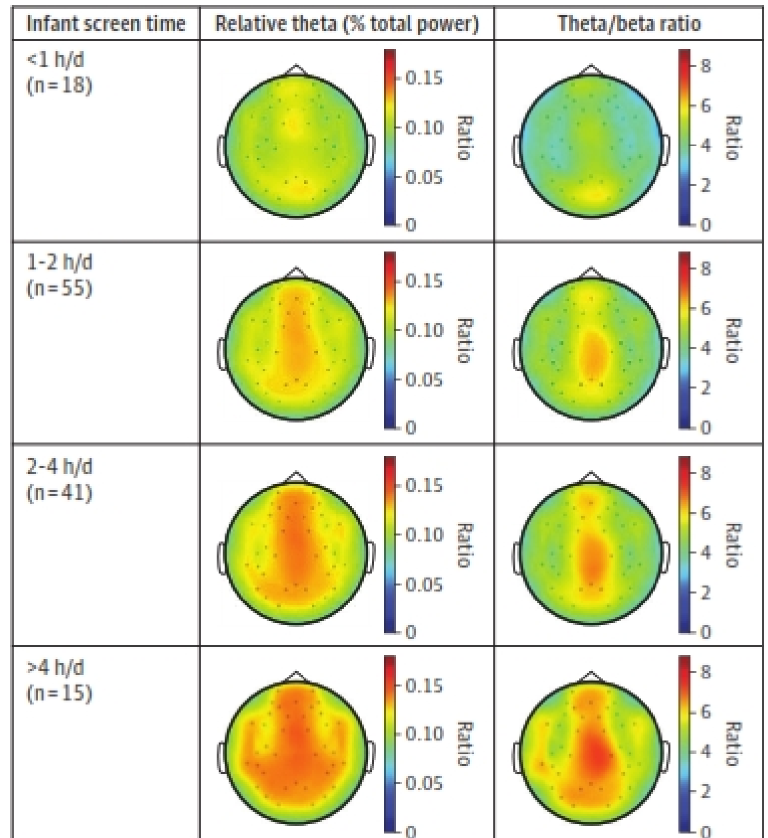
Neuro/Biological Correlates

Higher screen use in infancy (12 mo.) associated with differences on EEG before age 2.

- Specifically, frontoparietal pathways.
- Results suggest a **dose-response relationship** with **each hour** of screen time.

Law, et al. (2023)

Figure 1. Brain Topographic Maps of Postulated Neural Correlates Based on Infant Screen Time per Day



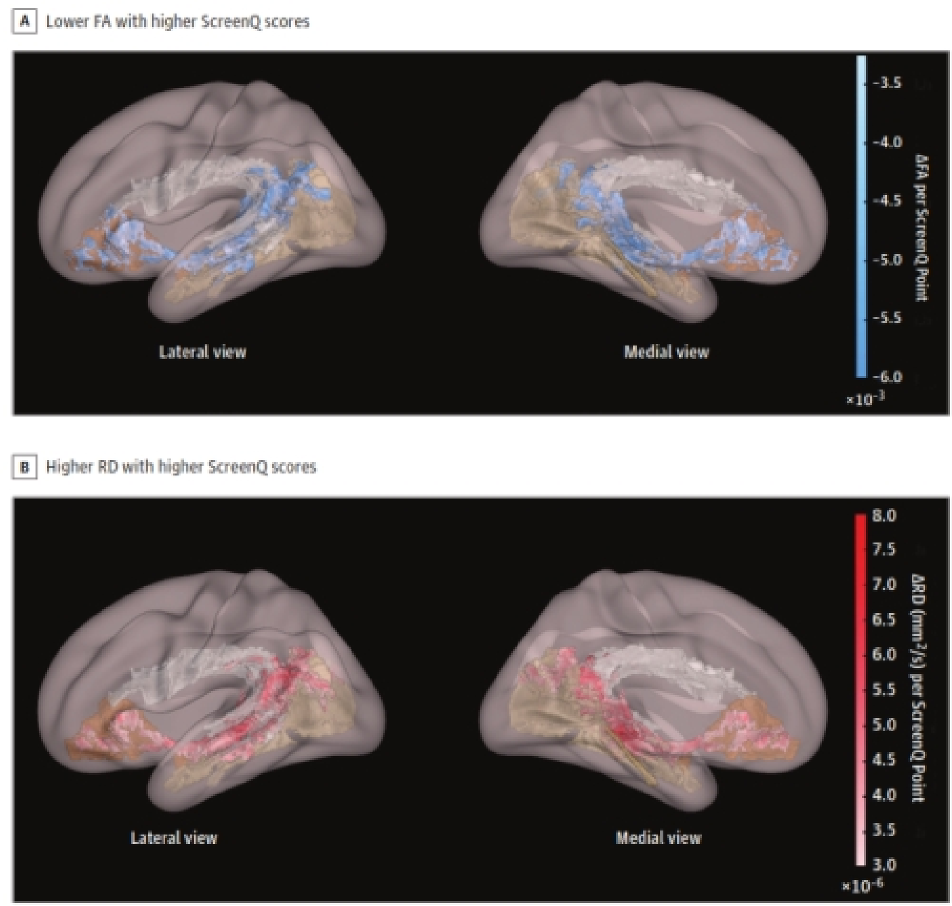
Neuro/Biological Correlates

Children with higher screen time showed:

- Lower performance on language measures (CTOPP and EVT)
- Less white matter development in areas of **language processing**

Hutton, et al. (2020).

Figure 3. Tract-Based Spatial Statistical Analysis in the Left Hemisphere



Neuro/Biological Correlates

6th & 7th graders and social media use

- Highest use of social media = initial under activation and later overactivation
- Opposite pattern for lowest social media use
- Push and pull of **sensitivity**, **experience**, and **regulation** development

Maza, et al. (2023).

Figure 1. Functional Activation in the Left Amygdala, Posterior Insula (PI), and Ventral Striatum (VS) During the Anticipation of Social Feedback

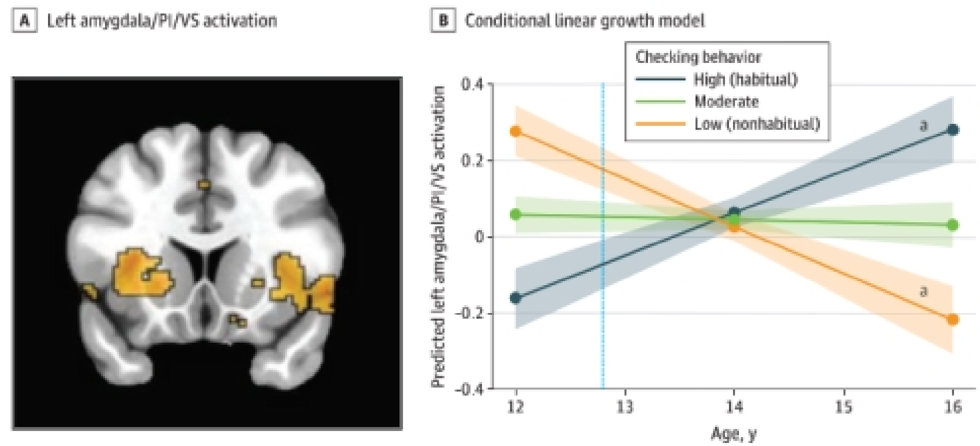
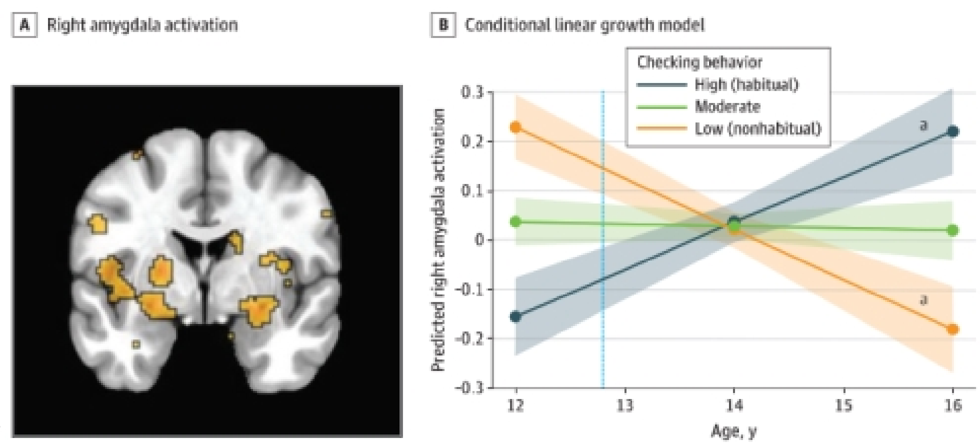


Figure 2. Functional Activation in the Right Amygdala During the Anticipation of Social Feedback



Functional Outcomes: Overall Early Dev

In general, high screen time use is associated with **global developmental delays** (motor, **cognitive**, & language)

- McArthur et al. (2021); Tekin et al (2023); Kracth et al (2022); Yaun et al (2024)

Considerations:

- Onset of screen exposure is significant (Kratch et al., 2022; Supanitayanon et al. 2020)
- Excessive screen time is ***really*** bad (2-4+hr/day) (Binet et al. 2024; Gaustad et al., 2023)
- Parental factors matter (education, parenting beh) (Gaustad et al., 2023; Supanitayanon et al. 2020)
- May be differences in boys/girls (McArthur et al. 2021; Tekin et al., 2023)

Functional Outcomes: Executive Fx

In general, increased screen time is associated with **worse attention,** especially in younger children

- Bal et al (2024); Huber et al (2018); Jourden et al. (2023); Santos et al (2022)

Considerations:

- Faster pace and adult/non-educational content of screen exposure may negatively impact attention
  - Jourden et al. (2023)

- Activity level and (perhaps) content matters!
  - Huber et al (2018)

Functional Outcomes: Language

In general, increased screen time is associated with **lower language development** (receptive and expressive language) and less communication.

- Bal et al., (2024) Karani et al (2022); Kucker et al. (2022); Rayce et al (2024); Sundqvist et al (2023); Sugiyami et al (2023)

Considerations:

- Guidelines seem to matter
- Content is important
- Parental education/SES may explain associations; parent interaction may moderate associations
- Delayed onset not as problematic as early exposure
- Bal et al (2024); Chowsomchat et al. (2023); Karani et al (2022]

Functional Outcomes: Language

An Example

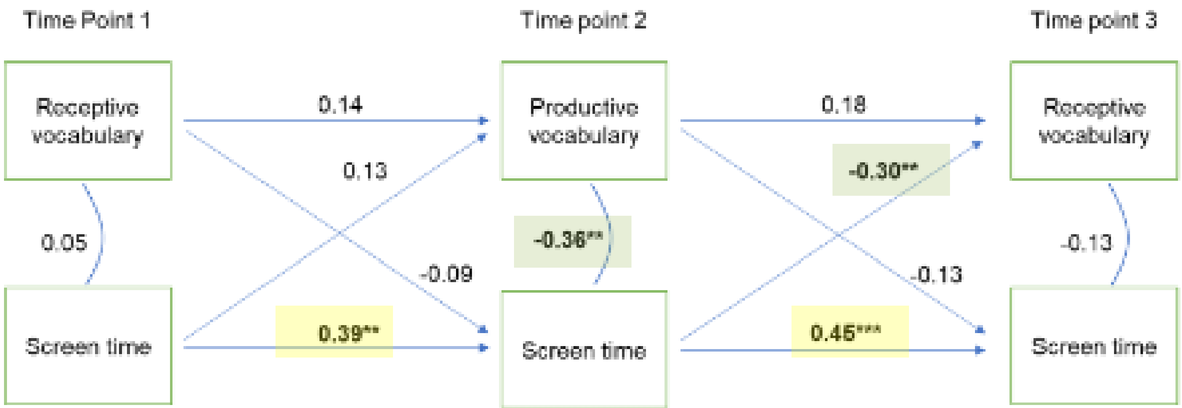


FIGURE 1 The cross-lagged regression model for vocabulary and screen time from 9 months, 2 years and 5 years of age.

- Higher screen time in infancy is associated with increasing screen time across childhood
- Screen time at 2 yo is associated with lower expressive vocab at 2 years old, and lower receptive vocab at 5 yo.
- Lower vocabulary at 2 yo does NOT predict screen time at 5 yo

Sundqvist et al (2023)

Functional Outcomes: Academics

In general, **increased screen time is associated with lower academic readiness** and engagement in academic activities

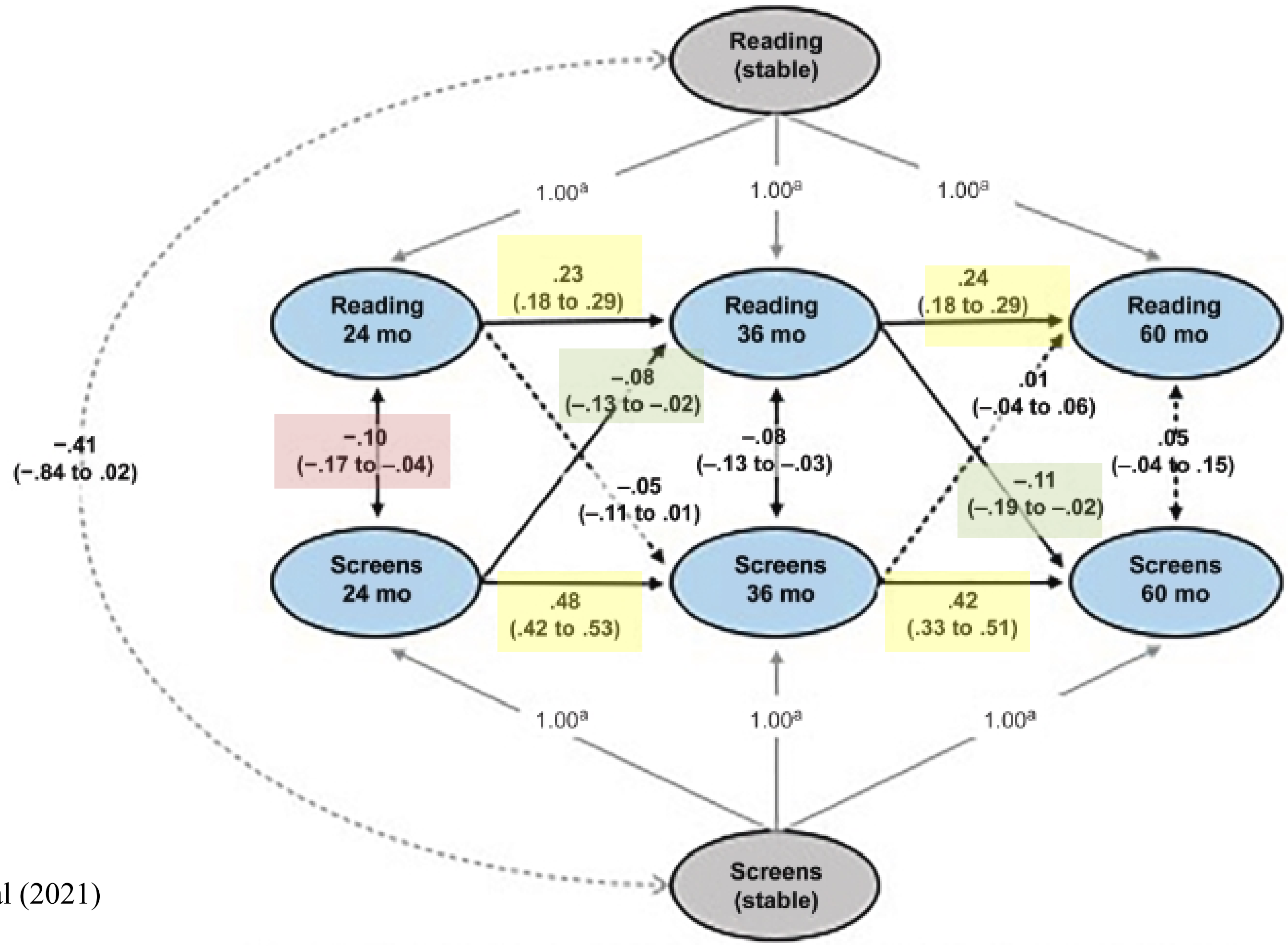
- McArthur et al. (2021); Tekin et al (2023)

Considerations:

- Parent education may contribute
- Type of screen time may matter (TV vs. **mobile**)
- Displacement theory seems at play here (screen time is replacing academic engagement)
- Early onset of screens may be most dangerous

McArthur et al. (2021); Tekin et al (2023)

Functional Outcomes - Academics



McArthur et al (2021)

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FIGURE 1
The standard RI-CLPM revealing within-person association between screen use and reading from ages 24 to 60 months, controlling for between-person differences. Standardized estimates (β) and 95% CIs are presented. Solid lines represent estimates in which 95% CIs do not include 0. The central, blue-tinted part of the model is the within-person (dynamic) part, and the outer, gray-tinted part of the model is the between-person (stable) component.
[a] Pathways constrained to 1.00 to extract between-person factor (n = 2440).

Functional Outcomes: Neurodevelopmental

In general, **greater screen time** is associated with **more ADHD and/or ASD**-like symptoms and diagnoses

- Cai et al., (2023); Chen et al (2020); Kushima et al (2022); Ophir et al. (2023); Shih et al., (2023); Takahashi et al., (2023); Zhou et al (2023);

Considerations:

- Use of screens weekdays AND weekends (Zhou et al., 2023)
- Early screen exposure (<3yo) might be most dangerous (Cai et al., 2023; Chen et al., 2020)
- Excessive screen time is really bad (1-2+hr/day), also for EF (Likhitweerawong et al. 2024; Zhou et al., 2023)
- Chicken versus egg considerations (Takahashi et al., 2023)
- Parent-child interaction may mediate (technoference); Chen et al., 2020 Mother screen time (primary caregiver) may matter most! Shih et al., 2023
- Cool promise for reducing autism symptoms with screen time intervention (Heffler et al., 2022)

Functional Outcomes: Neurodevelopmental

Time 1
18-40 months old
Confirmed ASD diagnosis

PARENT TRAINING

- 40 minute educational video re: risks of screens and developmental problems
- Weekly support (6 months)
  - 1 hour in-home support to reduce screen time
    - Increase acceptance of parent as social/play partner of child
    - Transition isolating activities to socially engaged activities
    - Increase child's attention toward parent and social contingencies
    - Provide a social-communication rich environment

Time 2
(6 months later)

Screen Time:
5.56h/day

Parental Stress:
21.67
BOSCC = 41.33

Screen Time:
4.72min/day

Parental Stress:
13.67
BOSCC = 32.83

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Implications

- In general, potential for negative influence seems to outweigh positive (Karani et al., 2022)

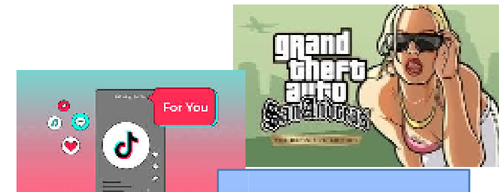
- Ask (open-ended) questions about screen time- ask parents, ask children (be thoughtful about "technoference")

- Best approach is likely a **harm-reduction approach** (Heller et al., 2021)

- Not clear causal pathways (reduce blame/guilt) and consider third factors

- Have resources that you can offer in your discussion
    - **CommonSenseMedia.org**
    - **Healthy Children (AAP)**
    - **Screen Time Action Network**
    - **Tech Parenting 101**

Harmful activities on a continuum



BEST | Time Spent → | WORST

Low Volume	Loud Volume
Slow Pace	Fast-Paced
Developmentally appropriate	Developmentally inappropriate
Educational	Non-educational
Prosocial content/moral lessons	Amoral/immoral
Parent-involved/Social (co-viewing)	Watched alone
Requires attention	Short/Interactive Touch screen*
TV	Mobile/Tablet
Older age at onset	Younger age at onset
Still engaging in health behaviors	Screen time displacing health behaviors

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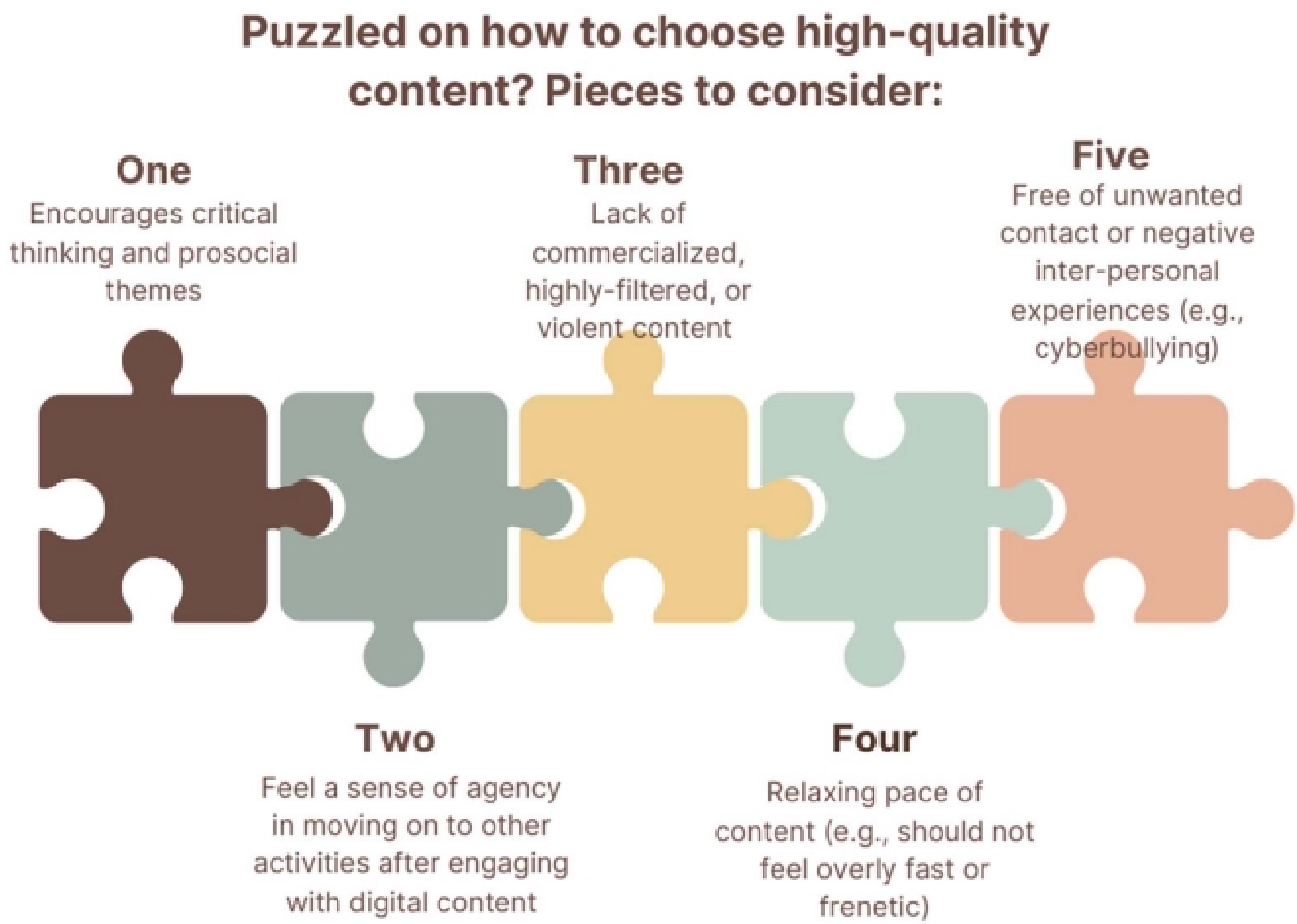
Harmful activities on a continuum



Recommendations

Table 1
Example Recommendations for Infant Media Use Informed by Harm Reduction and Bioecological Approaches.

For Parents

1. If digital media use is part of the family's lifestyle, be sure to allocate adequate time for sleep and additional activities that develop motor, language and cognitive skills.
2. Engage with media content together; talk about what infants are seeing, point out important features, and relate content to daily activities.
3. Limit content to educational and prosocial programming (e.g. PBS shows like Sesame Street, Daniel Tiger's Neighborhood)
4. Turn off background media when not in use, especially during infant play and reading time.
5. Avoid watching adult-directed programming around infants.
6. Avoid evening screen use.
7. Limit parent and sibling screen use to model appropriate levels of screen time and create adequate opportunities for infant-family social engagement.

For Pediatricians

8. Provide information about infant media use during prenatal information sessions and well-child visits during the first two years of life.
9. Devise plans with parents to help families address factors that may result in increased and developmentally-inappropriate infant screen media use.

For Guidelines Developers

10. Consult with parents of young children to determine feasibility of guidelines.

Heller, 2021

AAP

POLICY STATEMENT Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

American Academy of Pediatrics

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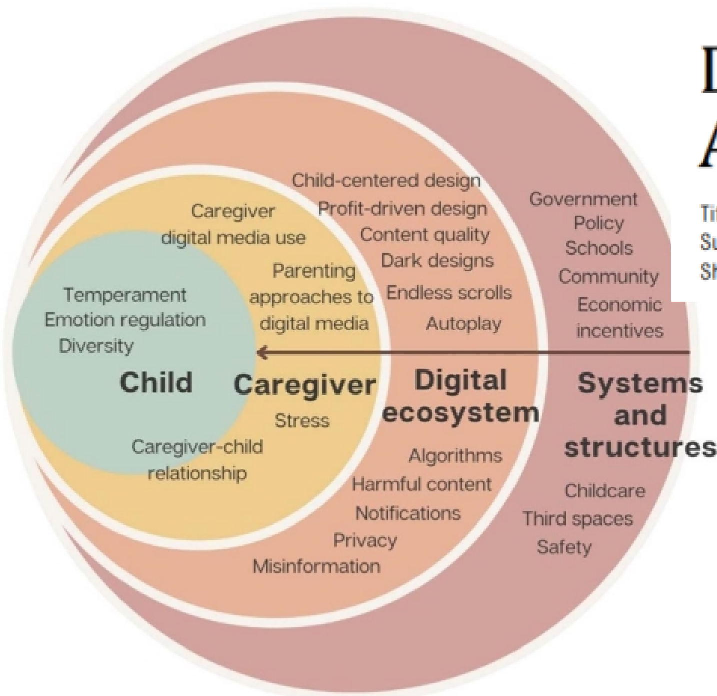

FIGURE 1.
Socioecological model of children's digital ecosystem.

Digital Ecosystems, Children, and Adolescents: Policy Statement

Tiffany Munzer, MD, FAAP,[1] Joanna Parga-Belinkie, MD, FAAP,[2] Libby Matile Milkovich, MD, FAAP,[3] Suzy Tomopoulos, MD, FAAP,[4] Taiwo Ajumobi, DO,[5] Corinn Cross, MD, FAAP,[6] Roslyn Gerwin, DO,[7] Sheri Madigan, PhD, R. Psych,[8,9] and the Council on Communications and Media

To cite: Munzer T, Parga-Belinkie J, Milkovich LM, et al; American Academy of Pediatrics, Council on Communications and Media. Digital Ecosystems, Children, and Adolescents: Policy Statement. *Pediatrics*. 2026;157(2):e2025075320

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5 C’s Strengths-Based Framework

1. **Child**: *Who is your child/adolescent, their unique strengths and challenges? How does this shape their media use and how they react to it?*
2. **Content**: *What content is high-quality and worth our time? How does negative content affect our thoughts and emotions?*
3. **Calm**: *How does your child calm down strong emotions and settle down for sleep?*
4. **Crowding Out**: *When we use media for too long, what does it get in the way of?*
5. **Communication**: *Regularly talking about your family’s digital experiences, supporting critical thinking and problem-solving.*


The 5 Cs of Media Use

Center of Excellence Social Media and Youth Mental Health | American Academy of Pediatrics

YOUNG TEENS: 10-14 YEARS

The early tween and teen years are a time of growing independence, changing bodies, exploring identity, and building a solid sense of self. During this phase, adolescents begin to place increased importance on relationships with peers, which can feel to parents like they are losing connection. Puberty brings changing bodies and strong emotions, comparisons with other kids, and trying to figure out who they are and where they fit. A central question for the early adolescent age range is "Am I normal?" This phase of development is also one in which adolescents can feel that they are "on stage" and that everyone is looking at them, so small social missteps either online or offline can feel devastating to them. It's an important time to establish regular conversations about their digital lives – who they are and what they interact with online.

ASK YOURSELF THE 5 Cs	WHAT YOU CAN DO
Child *Who is your child, how do they react to media, and what are their motivations for using it?*	To understand your child's unique digital life, and how they are navigating their experiences, listening is crucial. This means being present with your child and being available in moments they are ready to share. This may mean putting away your own phone—even in brief moments like car rides. This gives you insight into how they are coping with school, friends, mood, bullying, or are stressed about world news. Understand that comparison in media is a developmentally normal activity, reassure your child that everyone's body and journey through puberty is unique, and that there is no single ideal body type online or offline.
Content *What is worth their attention?*	Use Common Sense Media to check ratings and reviews of video games, movies, apps, and TV and pick ones with positive social and identity messages. In this age range, you may want to ask your child to be part of this process. Social media accounts technically can't be created until kids are 13, so encourage kids not to lie about their age; help them find alternates like messaging apps(e.g., iMessage, Messenger Kids, Kinzoo). For young teens using social media, talk about the fact that inappropriate content might be recommended to them or appear in their feeds, and help them recognize false or mean videos, or idealized body images. In this time of growing exploration and independence, youth may feel more emboldened to explore dangerous or inappropriate content. Questions like "Have you seen anything lately that seemed weird or scary?" may lead your child to open up.
Calm *How do they calm down emotions or go to sleep?*	The early teens years often include a wide range of emotions. Because devices and video games are such an easy distraction, many teens say they use them to escape negative feelings. Support your child in exploring other healthy coping strategies(like talking to trusted friends/family, mind-body exercises, deep breathing, taking a walk, creating art or music, playing with pets.) If you are concerned about how they are coping, talk to your child's pediatrician about finding a therapist. AVOID: Having phones and gaming devices in the bedroom at night, which are consistently linked with poor sleep.

Slide credit: SAMHSA; Center of Excellence Social Media and Youth Mental Health
[The 5 Cs of Media Use](#)

Harmful activities on a continuum

Future Directions

- The pace of research cannot keep up with the pace of technology innovation (so what are we to do?); iterative approach?

- Technology is a fundamental part of our lives- how do we find the silver lining (e.g., video games?)

- The future is changing- we have to care about it
  - what do about kids connecting with AI chat bots?

- How do we consider the role of screen-based instruction and screen time in academic arenas?

An Analogy

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Questions?