# The Neuroscience and Psychology of Screen Time: A Review

V1.0

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# A literature review on Gamification: Breaking the Flow

The concept of Flow was described by Csikszentmihalyi (1990). It has been characterized as a person giving their full attention to an activity, with having a high internal motivation towards the activity itself. It is stated that it depends on/contains various parameters.

These parameters are:

1. intense concentration,
2. combining action and awareness,
3. decreased self-consciousness,
4. decreased sense of personal control over the situation,
5. loss/weakened perception of time,
6. the feeling that this activity has intrinsic motivation/reward (autotelic experience),
7. instant and clear feedback,
8. the balance between skill and challenge, and
9. clear goals.

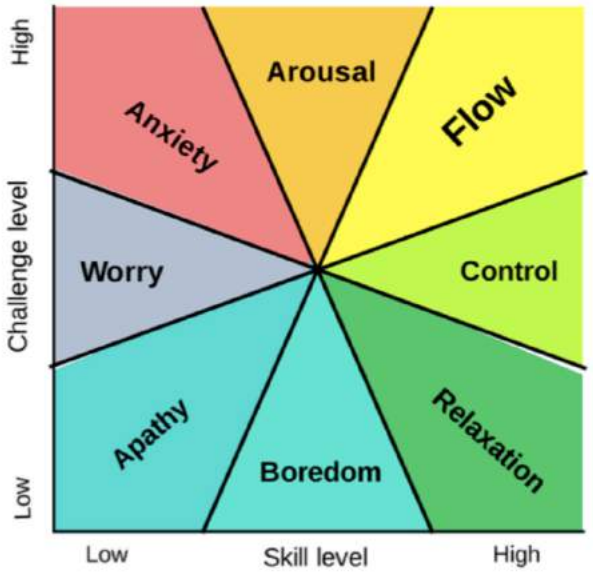


Figure 1. Csikszentmihalyi's flow model. Retrieved from Gold and Ciorciari, 2020

Being "in flow" is associated with a positive state, and it has also been found to reduce experiences such as boredom, depression, and anxiety (Vogel et al., 2018). In this literature, the experience of playing games and even the presentation of non-game activities with game attributes (gamification) has often been associated with the flow experience. In this context, we will focus on scientific studies on the experience of flow in gamification and whether it is possible to break the flow.

## Flow In Games and Gamification

Gamification is defined as "the use of game design elements in non-game contexts" (Deterding et al., 2011). Gamification is a frequently used strategy by companies to make participants/users more involved in the activity and increase their performance. In this context, it can be said that social media and other online content/applications aim to provide users with a flow experience by using the gamification method (Brühlmann, 2013). The connection between gamification and the initiation of the flow state is intuitively clear. We know that the long-term effects of games and behaviors reinforced by gamification are maladaptive for users. Therefore, the reward and continuity of this activity cannot be prevented as long as

the flow is maintained. This is because the users lose perception of time and only focus on this activity while in flow.

Therefore, an important question is:

## Is it possible to break the flow and if so, how?

A team of researchers conducted the research most related to this question at Eindhoven University (Eggen et al., 2003 and Eggen et al., 2003). The conference paper's findings stated a clear link between a child's excessive game play and the initiation of the flow experience. It stated that an interruption of the flow with parental warning caused significant discomfort for the children. The research objective was to identify how to end the flow experience in a way that causes the least discomfort for the children. Fundamentally, this termination is aimed to be gradual and natural.

Three different hypotheses were tested on three groups of children. A different flow-breaker was used in each group.
These are:
1) pop-up windows with warnings (FBA)
2 )lowering the game's difficulty level (FBB) (see item 8 in the numbered list above),
3) distraction from the game using a physical robot/device (FBC).

After this, the children evaluated each condition. This was to find out which method the players prefer. As a result, it was found that the FBC method was the most effective and most entertaining, while the FBB method was the least effective and least enjoyable.

The study stated that there are two main issues relating to excessive gaming:
1) the players' loss of time perception
2) their sole attention is directed to the game intensely

The study stated that children that approached the gradual intervention in a non-critical moment of the game had a more positive experience. It has been stated that the findings are in parallel with the informant design methodology.

## Neuroscience of Flow Experience

A study was conducted to investigate the effects of flow on a psychological level as well as brain-related signals while participants were playing games. This study found a medium difficulty level on the game to increase the flow sensation. Additionally, it was found that autonomy did not significantly affect flow sensation. However, it was found that sympathetic system activity (associated with decreased heart rate), taking place in the frontoparietal area, increased in games of medium difficulty where the flow was more intense.

In addition, a review paper (Khoshnoud et al., 2020) stated that there is an inverted U-shaped relationship between flow experience and physiological arousal. In addition, it has been stated in some studies that there is joint activation between the reward network and the frontoparietal network. It is also suggested that the loss of the sense of self-awareness can be explained by the deactivation of the default-mode network (DMN), especially the medial Prefrontal Cortex.

## Conclusion

The flow experience can be positive by reducing levels of boredom, depression, and anxiety. Therefore removing the flow state can be a negative effect in itself, as a negative punishment to the person. Another stimulus or activity can be set up to continue the flow experience. In this way, the flow created by looking at the computer screen can be created by another activity. Gamification methods can be used to create flow states within non-game-related apps and programs.

# A literature review on how applications can reduce screen time

This report was written to investigate the scientific outcomes of practices that reduce screen use in children. In previous reports, we mentioned that using screen technologies can be addictive and is associated with negative moods and mental health. We also highlighted how applications could be used to reduce screen usage from the "flow" perspective. This report has been written to consider the applied studies related to how applications can be used to reduce screen time from a broader perspective.

First of all, it should be noted that most of the applied studies include informative interventions for the family and the child. Meta-analysis studies were used to scan more studies and compare the effectiveness of the methods. We will progress according to the age group that the studies focus on. Let's start with Lewis et al., 2021, a meta-analysis study aimed at reducing screen time in children aged 0-5. This study aimed to find the most useful technique in terms of Behavior Change Technique (BCT) by scanning experimental studies literature according to the relevant criteria. BCT generally refers to strategies that aim to change behavior to be healthier.

In this study, the interventions used were classified according to BCT methods, and the most effective BCT methods were determined as follows:

- behavior substitution
- information about social and environmental consequences
- demonstration of the behavior
- behavioral practice/ rehearsal
- social support (unspecified)
- action planning

- goal setting (behavior)

Other meta-analysis studies focused on wider age groups (0-18 years in Akcay et al. 2021, 3-54 years old in Wu et al., 2016, and up to 18 years old in Schmidt et al., 2012). These studies collectively found that these interventions had a significant effect on reducing screen time. The interventions mentioned in these studies generally include informing families and children. Awareness-raising activities were carried out through brochures, information meetings, seminars, mail, and other communication. These studies have been shown to be useful in reducing screen time. From this point of view, it can be said that awareness of the impact of screen time reduces screen use. One of these studies suggested the following strategies to reduce TV viewing time (for us, screen time):
1) monitoring family and children's screen time
2) taking advantage of contingent feedback, the main form of learning, and informing the children and family about the feedback.
3) School-based interventions to increase awareness of excessive screen time and the harms

However, today's problem is mostly regarding the use of smartphones and tablets. Oulasvirta et al. (2011) stated that smartphone use is more habit-forming than computer use. Under these circumstances, current studies focus on smartphone-based screen use. In an unpublished study, in parallel with Oulasvirta et al.(2011), Melumad and Pham observed that people turn to their smartphones in times of stress as a form of stress relief and find it more relaxing than using a computer or using another person's smartphone. Therefore, teaching/recommending other sufficiently effective stress-relief strategies may weaken one of the reasons for screen viewing.

As another possible method, measuring screen usage time and/or reminding the user with notifications has been studied in various settings. It has been stated that monitoring screen time reduces the time spent on screens, but notifications do not significantly affect screen time (Loid et al., 2020, van Doorn et al., 2019).

Another study (Rooksby et al., 2016) stated that participants use screen time tracking to inform them about the content being consumed, not to reduce usage time. Although the findings of this study seem to contradict the general consensus and the information in the previous paragraph, they did reveal an important detail: intent. If users do not have a purpose of reducing screen time, they may use tracking-screen-time information only for information. However, as mentioned before, if children and their families have been informed about the adverse outcomes of screen use through various information channels and they intend to reduce screen use, then the information may be utilized to help control their screen time.

Additionally, some studies have been conducted to research effective but non-classical methods for reducing screen time. Holte et al. (2021) tested changing the participants' screens to grayscale themes, and the findings indicated that this intervention reduced the participants' screen time, anxiety, and problematic smartphone use. In addition, a study observed a significant reduction in screen time when participants were provided with behavioral guidelines (Olson et al., 2021: preprint).

The following two of the steps in this guideline can be incorporated into children's screen time usage:

1. The habit-forming feature of the smartphone is more than the computer (Oulasvirta et al., 2011). This suggests that children are less likely to become addicted to screen time by spending hours playing with a computer instead of a smartphone.
2. Van Deursen et al. found that social use of smartphones is the most likely cause of habituation (2015). Therefore, if the child engages in social interactions within games or online activities (playing with friends, etc.), this makes their game playing time more of a habit-forming behavior. Engaging in offline games instead of solely spending time playing online games can reduce this effect. In fact, increasing planned social activities in off-screen settings can reverse this situation. A related study in 2016 states that the underlying mechanism of problematic smartphone use

and related mental problems (depression, anxiety, etc.) are social and tactile needs (Elhai et al., 2016). Therefore, meeting the social and tactile needs of children can be an important practice in order to reduce the negative effects of screen use or after screen use. This could be a sensory, tactile, and socially satisfying game that replaces screen games. Or simply, it can be used to get parental attention (also with tactile stimulation: hugging, etc.) to eliminate the negative effects that occur when leaving the screen.

As a result, the report highlights that interventions to reduce screen-viewing, which have a broad-spectrum effect on all age groups, can be considered multidimensional. Informing children and parents about the impact on a large scale and regularly, using the grayscale theme, shifting tactile and social needs to off-screen time, monitoring the screen time, and notifying the user with notifications are just a few of the possible interventions.

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# Effects of Dopamine on (Internet/Digital) Addiction

## Introduction

A reward is defined as objects, stimuli, or activities that have positive values which also facilitate/reinforces behavior in some specific way. There are two dissociable components of the reward: a hedonic "liking" part and a part related to the goal-directed behavior/motivation or "wanting." The brain has a circuit called the "reward system." This system involves multiple regions in the brain. One of the most-known ones is called Ventral Tegmental Area (VTA), which includes dopaminergic neurons. VTA sends axons to other regions (i.e., lateral hypothalamus) and several forebrain areas (MFB) and modulates the dopaminergic transmission. Former studies showed that dopaminergic activity increased the behavior. This kind of relationship is also true for natural rewards such as food, water, etc.

It's understood that dopamine (DA) reduction causes a decrease in reinforcement (it reduces the probability of that behavior). Importantly, it has been shown that DA is related to seeking/craving behavior but not the hedonic part. For example, a study showed that stimulation of DA axons in the lateral hypothalamus causes a craving for food without affecting the hedonic impact. Even in eating behavior, increased DA level is hypothesized as the main incentive for animals to eat (Volkow et al., 2017).

That is why, in addition, which is mostly related to a craving, dopaminergic pathway involvement is seen. Direct effects of drugs such as cocaine and amphetamine have been seen on DA synapses. In an interesting experiment by Wolfram Schultz, it has been shown that expectations/predictions on reward/learning may change the timing of DA activation in VTA. As we saw in this study, even though the reward causes phasic DA release itself, after learning the

reward cues, the rewarding stimulus doesn't release an increased amount of DA, but it returns to its baseline tonic activation. However, after a reward cue materializes, DA activation is reduced even lower than the baseline level if the reward stimulus doesn't come.

Persistently active synapses save these memories through synaptic modifications. Thus, it is also stated that addiction is basically caused by pathological learning on the DA synapses.

Also, other neurotransmitters additionally affect this circuit. For example, Acetylcholine increases the activation of DA neurons while GABA

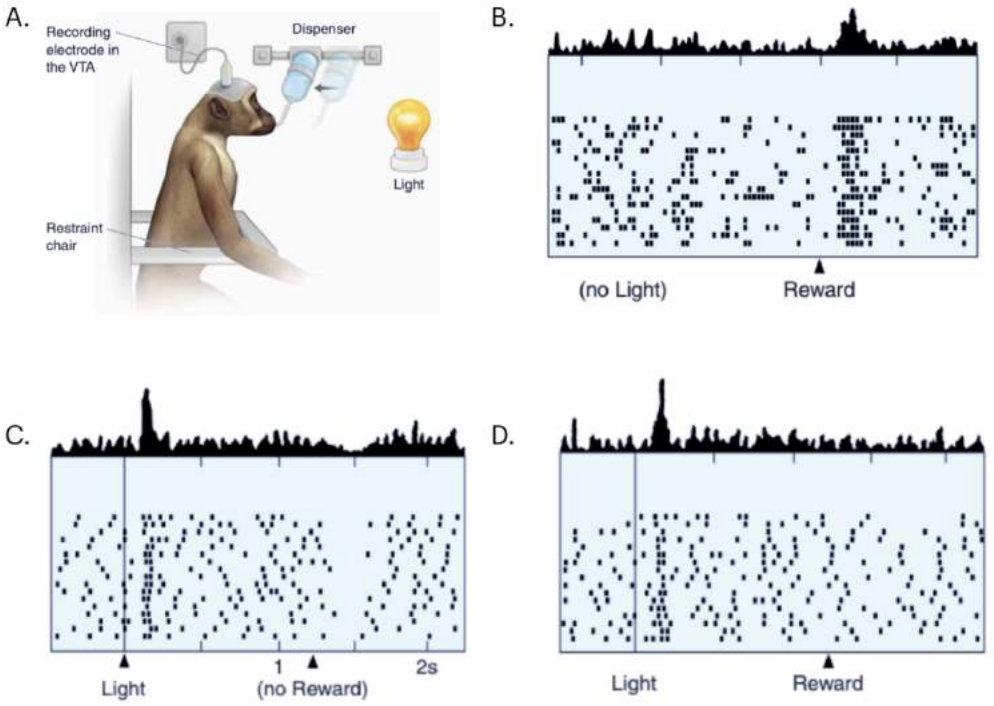


**Figure 1.** Experiment by Schultz (1998). **A.** Experimental design. Intracranial recording in VTA. Light and reward are conditioned together. **B.** Recording **before** conditioning. High activation after reward. **C.** Recording **after** conditioning. There is light but no reward. Decreased activation after expected but not taken reward. Increased activation after light. **D.** Recording **after** conditioning. There are both light and rewarding stimulus. No increased activity after reward but an increased activity after light.

decreases it. But, for the purpose of this study, this will not be a focal point as the main goal is to understand the effects of DA release.

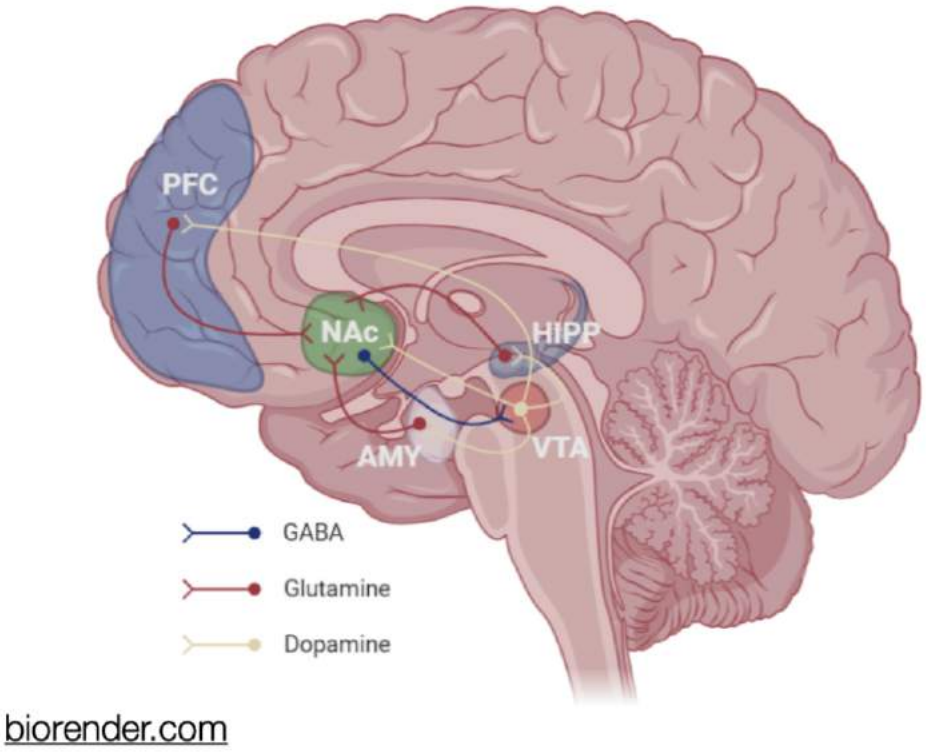


**Figure 2.** Simplified reward circuit in the brain.

## DA release after some common rewarding stimuli

After a brief introduction to the field (see Figure 2), we will focus on the release of DA as a function of time after a rewarding stimulus. Considering stimulants (drugs), the effect on the synapses is both directly (by blocking the reuptake channel or binding to a receptor) or indirectly (motivational / activating the reward system). A study showed that the uptake of the drug by the brain (ventral striatum) changes over time differently for various drugs. Uptake of the drug is associated with an increment in the DA level. Since these drugs activate different molecular mechanisms on synapses, their time course is different.

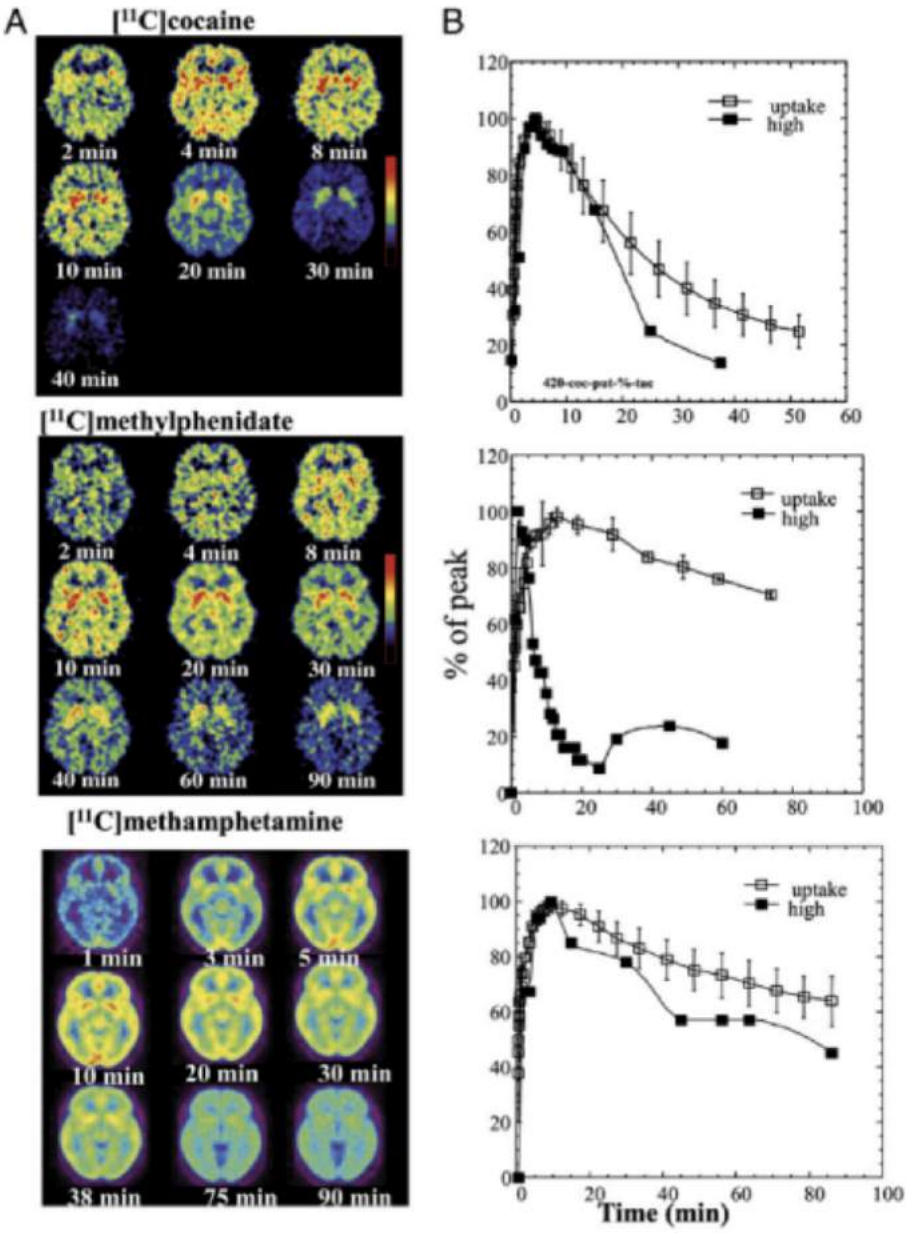


**Figure 3.** A study by Fowler (2009). Shows the brain's uptake rate for stimulants and its relation with being high. Note that high uptake is associated with the DA increase. (Volkow et al., 2011)

In general, we can see that the time course of DA activation after the drug administration is like a negative parabola. Note that this assumption might be overgeneralized since the brain system is highly complex, and all addictive substances have different distinctive properties. These time courses are able to reflect the activation/release of dopamine only in the short term. However, the brain

is dynamic. For example, suppose there is an over-presence of a neurotransmitter in a synapse. In that case, the brain will probably cancel out some of the channels on the postsynaptic neurons to diminish the effect of an excessive amount in the synapse. Alternatively, it might directly reduce the presynaptic neuron's production or apply a different strategy to create the balance again. Even the psychiatric medicines used in this release-activate-reuptake process of the synapses have possible adverse outcomes after long-term usage. This is because the brain is continuously evolving and adapting itself; therefore, the termination of the drug might not lead the person to its pre-medicated state in terms of the brain/synapse structure/efficiency. In fact, learning has been defined by the changes/adaptations on the synapses after this dynamic process. So, keep in mind that these effects might be different after repetitive usage/learning or habituation.

It's considered that different receptors of dopamine (D1 or D2) might act in opposite ways. This article won't go into detail about the differences in the receptor types, but it is also important to note this while interpreting the results. For example, it is suggested that the effect in Figure 1 might be caused by the disruption in the balance between D1 and D2 receptors (Volkow et al., 2017).

Considering that these results are for stimuli that directly affect the synapses, the question arises whether the effects of stimuli that do not have such an effect on the reward system are in a separate direction. A recent review (Volkow et al., 2017) compares the impact of drug and food addiction in dopamine-based reward systems. This paper showed that there are common points regarding the patient's complaints, and they justify these using previous research. In both kinds of addictive behavior, these are overall problems:

1. Lack of control over using a substance
2. Being not able to achieve satiety
3. Increased preoccupation

Lack of control is known as a problem of malfunctioning the prefrontal cortex. Studies showed that decreased DA release may cause this effect (Volkow et al., 2017).

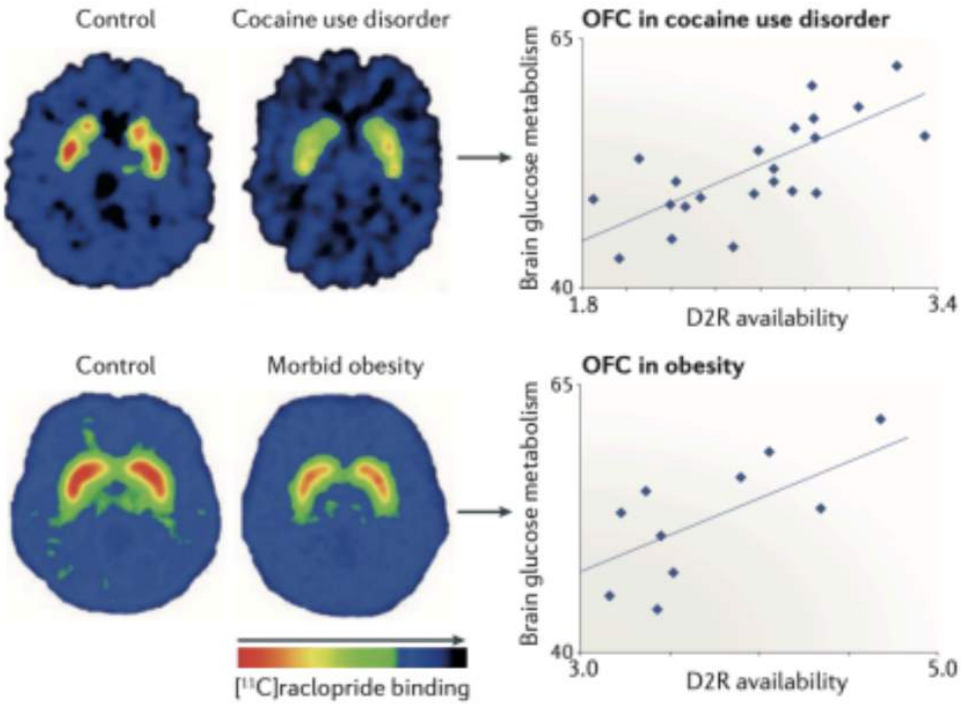


**Figure 4.** Decreased expression of D2 receptors representing decreased DA release in obesity and cocaine. This decrement is significantly associated with the reduced activity in the orbito frontal cortex. (Tomasi et al., 2015)

As for satiety, brain imaging studies exist only for drug addictions, so this review speculates on food addiction using those findings. For drug addiction, it has been found that during intoxication, the increase of the DA is attenuated which reduces the expected reward of that drug. This might also be the case for non-drug addictions.

The third complaint is about the 'dark side' of addiction. In the absence of the stimulant, a response to negative reinforcement is generated. To be able to escape that negative response, users relapse quickly. Volkow et al. (2017) claim that this negative response is generated by the lack of D2 receptors in the striatum (which causes a decrease in inhibition in the indirect pathway).

The results suggest that DA affects the brain and the symptoms in highly various ways modulating different regions/systems.

## DA release in Digital (Internet) addiction

Internet addiction is a relatively new phenomenon after the digitalization era; thus, scientific studies and findings are still emerging. Until the update in DSM-V (this is the diagnostic manual of the American Psychological Association that classifies mental illnesses and is widely known and highly used among psychologists) it was still debated whether it is an obsessive-compulsive disorder or an addiction.

Recent literature shows that this non-substance addiction has high comorbidity with other psychopathology. Since even the operational definition and the classification of the problem is newly-defined, the underlying neural mechanism is not fully understood yet. Our research topic primarily focuses on the DA level and its timescale during the use of digital material, especially in adolescents, but there is no research studying specifically this issue. Thus, the only way to infer the question is to understand all possible related subjects and hypothesize what might be the neural mechanism to the extent of our specific question. That's why the previous pages of this report are left for an overall but simplified literature review. This section will briefly mention the definition of the problem and hypothesize its neural correlates.

"Internet addiction disorder (IAD), also described as problematic Internet use, is the inability of an individual to control the overuse of the Internet, eventually causing psychological, social, and/or work difficulties" (Dong & Zhao, 2011). This definition can be expanded to any digital application/device that generates the same outcome. It resembles pathological gambling which is classified as a non-drug addiction.

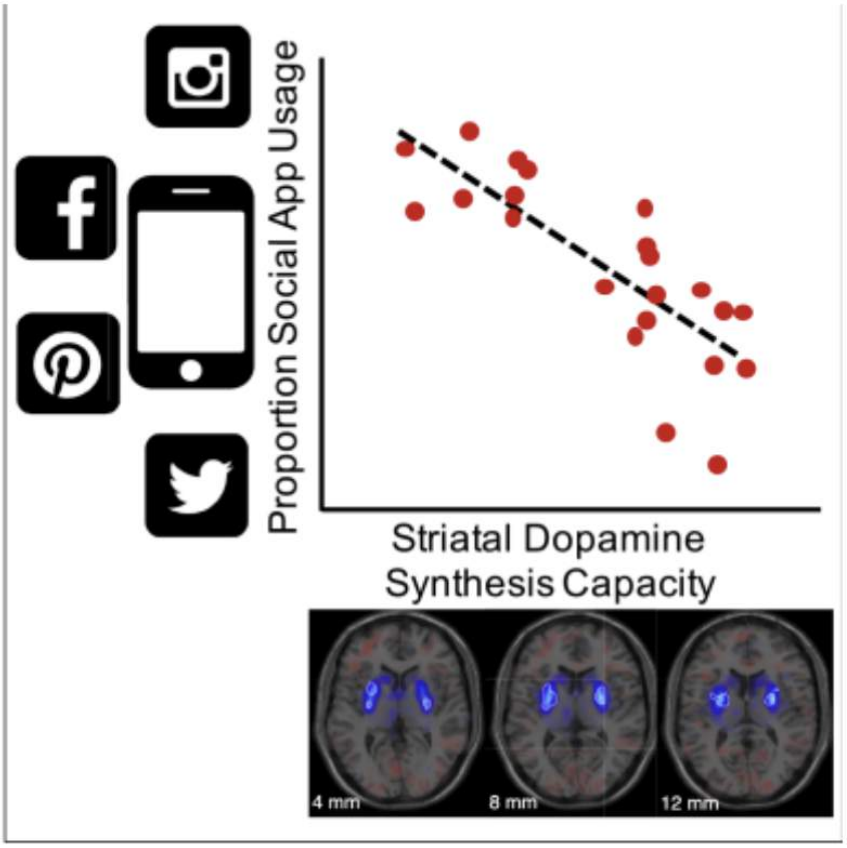


**Figure 5.** Results of a study showing that increased use of social apps is correlated with the decreased DA synthesis. Westbrook et al., 2021.

A study showed that reward sensitivity is enhanced, and loss sensitivity is reduced in internet addicts (Dong et al., 2011). Relevantly, another study found that increased usage of social apps is associated with the decreased DA synthesis level in striatal regions. These results might be interpreted by the finding of the aforementioned study (see Figure 4). Since it has been already found that internet-addicted males have impaired executive control ability (mainly associated with the frontal activity) (Dong et al., 2011), it may be suggested that decreased DA levels are related to the symptoms of addictive behavior (i.e., lack of control)

Also, recent comprehensive reviews suggest that internet addiction resembles drug addiction in many ways (Weinstein et al., 2017; Kuss et al., 2018). Focusing on the reward/motivational system, it has been found that reward inhibitory mechanisms and loss of control mechanisms resemble the one' with drug addiction. It has been shown that internet addicts have reduced D2 receptors and DA

transporters, indicating attenuated sensitivity in the reward system. This review clearly shows that internet addiction is like drug addiction in terms of the underlying neural mechanisms. Current findings show that the main problem is the long-term changes in the DA system (i.e., reduced receptor or transporter levels and so the impaired activation of a regular stimulus).

However, a former study showed that the dopamine activation during video games is reduced compared to baseline. Note that both baseline and experimental scans generated a similar pattern in terms of time scale (See Figure 6). This study noted that even 50 minutes after the game ended, the activation in the dopaminergic regions is lower than in the baseline (Koepp et al., 1998).

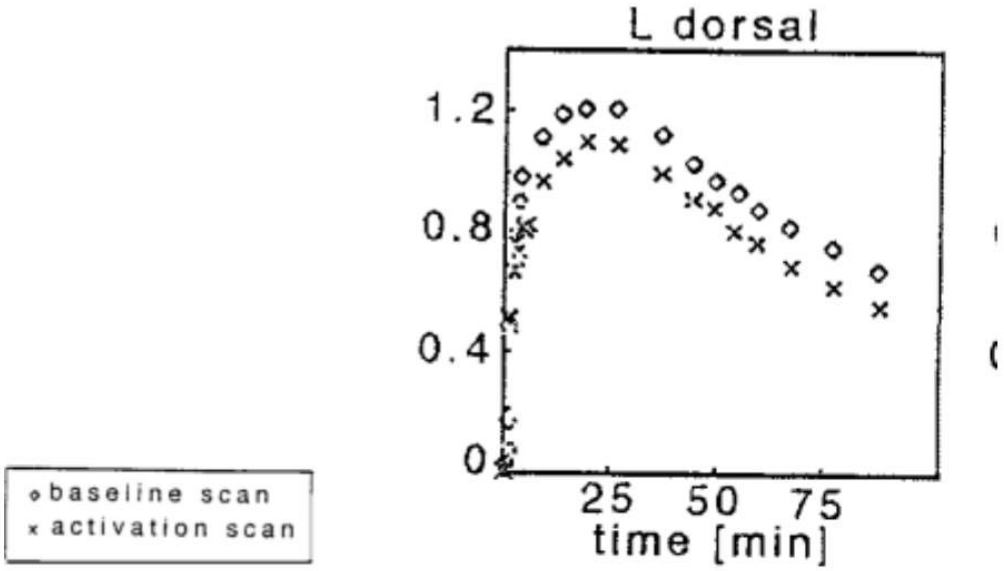


**Figure 6.** Reduced activity in DA release regions during a video game. Koepp et al., 1998.

Interestingly, a study found evidence supporting that aerobic exercise can improve the impaired DA system in internet-addicted adolescents (Korehpaz-Mashhadi et al., 2022).

Also, supporting our assumption that gaming/being online activates the reward system, a study found that the connectivity of the reward circuit is increased after gaming (Kim et al., 2022).

# A literature review on the effectiveness of different types of screen time intervention content

The previous reports described the harmful effects of increasing screen time on children and the positive impact of reducing this time. Regarding meta-analysis studies, it was also noted that various interventions proposed by researchers significantly reduced this time. This report provides more detailed information on the content being used within the screen time interventions.

As seen in Figure 1, Dennison et al. (2004) aimed to reduce screen time with feasible and clear interventions and found meaningful results. While preparing this intervention, the guideline prepared by the American Academy of Pediatrics (AAP) was used. In another study, Downing et al. (2018) aimed to reduce screen time by increasing parents' awareness of the effect of screen time; this intervention (Mini Movers Intervention) proved effective. The primary intervention method in this study is a text message sent to the parents. These messages are intended to inform and help by giving practical tips. In addition, auxiliary equipment such as an information booklet, goal-checking magnet, and brochure was given to the participants. In the goal-setting process, the researchers guided the families (less screen time, more physical activity, etc.). Example text messages can be seen in Figure 2. While preparing this intervention, the guideline prepared by the Australian government was used.

On the other hand, as stated in Altenburg et al.(2016), some literature studies did not note the intervention strategies. However, the authors emphasized effective strategies such as TV turnoff week. Each study in the literature explores the effectiveness of a particular strategy alone, and meta-analysis studies have primarily

examined whether any strategy can provide a significant effect. These mainly constituted the content of the previous report.

There are some comprehensive intervention projects to draw attention to within the scope of this report. This includes, as highlighted in the previous paragraph: the guideline and plan prepared by AAP and the guideline prepared by the Australian government.
Like these projects, some guidelines and programs aim to protect public health and reduce screen time. Parental tips were published by the US ministry of health, prepared by WHO, the Fit5Kids TV reduction program, and the information brochures/guidelines designed by the Community Preventive Services Task Force (CPSTF). These programs have been developed in the light of scientific knowledge and are planned to help parents. For example, on the website created by AAP (https://healthychildren.org), there is a calculator and a semi-structured planner (Family Media Plan) for families to calculate media time according to their own routines. Figure 3 shows an example screenshot for the Family Media Plan. A detailed explanation of how to use and implement the planner is provided on this website. This page details the topics parents need to talk to their children about. Informing the parents about the issue (causes, consequences, and intervention methods) can be seen as the first step, but it is also essential for the parents to inform their children about the issue. Here, AAP gave very effective clues about the content of this intervention/information. Below are some examples taken from this page:

> *"Discuss with your children that every place they go on the Internet may be "remembered," and comments they make will stay there indefinitely. Impress upon them that they are leaving behind a "digital footprint." They should not take actions online that they would not want to be on the record for a very long time.*
>
> *…*
>
> *Talk to them about being good "digital citizens," and discuss the serious consequences of online bullying. If your child is the victim of cyberbullying, it*

*is essential to take action with the other parents and the school if appropriate. Attend to children's and teens' mental health needs promptly if they are being bullied online, and consider separating them from the social media platforms where bullying occurs."*

A study investigating the effectiveness of the Family Media Plan (Persichetti, 2020) found that screen time could be reduced as a result of this intervention. Within the scope of this program, the process was supported by scientific articles published by AAP.

On the other hand, although the pages prepared by the CPSTF are handy for information and understanding the literature, they do not seem to be as effective as the Family Media Plan prepared by the AAP in practical terms. However, they can be used as information brochures (see Figure 4).

The World Health Organization (WHO) prepared another guideline that shares findings and makes recommendations (how many minutes should be daily screen-time for which age groups and why is it important, etc.)

Finally, in a one-page briefing prepared by the US Department of Health & Human Services, recommendations were made to parents to reduce their children's screen time. These tips, shown in Figure 5, seem quite understandable and applicable.

These programs, tips, and guidelines have been presented as examples because experts have carefully selected the language used here and the informative

address. Therefore, in a possible intervention, using these existing studies, as is done in scientific studies, will be very beneficial in terms of efficiency.

**Table 1. Seven-Session Intervention to Reduce TV/Video Viewing by Preschool Children**

| Session | Activities at the Day Care/Preschool Centers and Take-Home Materials |
|---|---|
| 1. | Parents and child care staff were encouraged to read stories to the children daily. Each child was given an age-appropriate book and made a blue ribbon award for their "best" reader at home. |
| 2. | Family mealtime, with the TV turned off, was promoted as a way to teach children social skills. The children made placemats to set the table at the preschool/day care center and to take home to be used when setting their place at the family table. |
| 3. | Children suggested alternative activities to watching TV, eg, reading books.[22] These were combined across centers to develop a list of activities, which was provided to families in session 5. The children's discussion was facilitated by reading and discussing the book *The Berenstain Bears and Too Much TV*.[23] |
| 4. | Children made "no TV" signs to place on each TV set at home. They discussed how they would spend their time when not watching TV or videos. The American Academy of Pediatrics brochure *Television and the Family*[24] was sent home for the parents to read. |
| 5. | Children planned a party for the following week to celebrate having survived a week without TV. Materials sent home included:<br>• The book *The Berenstain Bears and Too Much TV*.[23]<br>• The "no TV" signs the children had made.<br>• "List of Alternative Activities to Watching TV" suggested by the children.<br>• Weekly calendar with 7 "no TV" stickers for parents to reward children each day they did not watch TV. |
| 6. | A party was held at each center for children and staff to celebrate having survived a week without watching TV. Children discussed what activities they and their families had done instead of watching TV. |
| 7. | A month later, a booster session was held during the National TV-Turnoff Week.[25] Parents and children were encouraged to spend another week without watching TV or videos. Information to help plan and budget children's TV viewing was sent home. |

Figure 1. Instructions from Dennison et al., 2004. This study found a significant reduction on intervention group in TV viewing.

Appendix 1. Examples of text messages

| Type of text message | Example content[a] |
|---|---|
| Behavioural | Annie, get Josh to help make some playdough! Here's a great recipe with no cooking required: <link to recipe>. Remember, encourage Josh to stand up while playing with it! Katherine – Mini Movers |
| Goal-checking | Hi Carolyn, how did you go sticking with your goals to limit Sienna's screen time to 60 mins a day and to do puzzles standing up instead of sitting 2 days this week? Text me back YES if you achieved them or NO if you weren't able to this week. Katherine – Mini Movers |
| Goal-checking – response to YES reply | Great to hear! Remember how good you feel achieving your goals – bottle that feeling & use it as motivation on tough days. Keep it up! Katherine – Mini Movers |
| Goal-checking – response to NO reply | It's common to slip up sometimes Julia. The important thing is trying again next week! Use your Mini Movers Goal Checker magnet to keep you on track. Katherine – Mini Movers |

[a] Names have been changed for anonymity

Figure 2. Some examples of the text-messages sent to the parents. Downing et al. 2018

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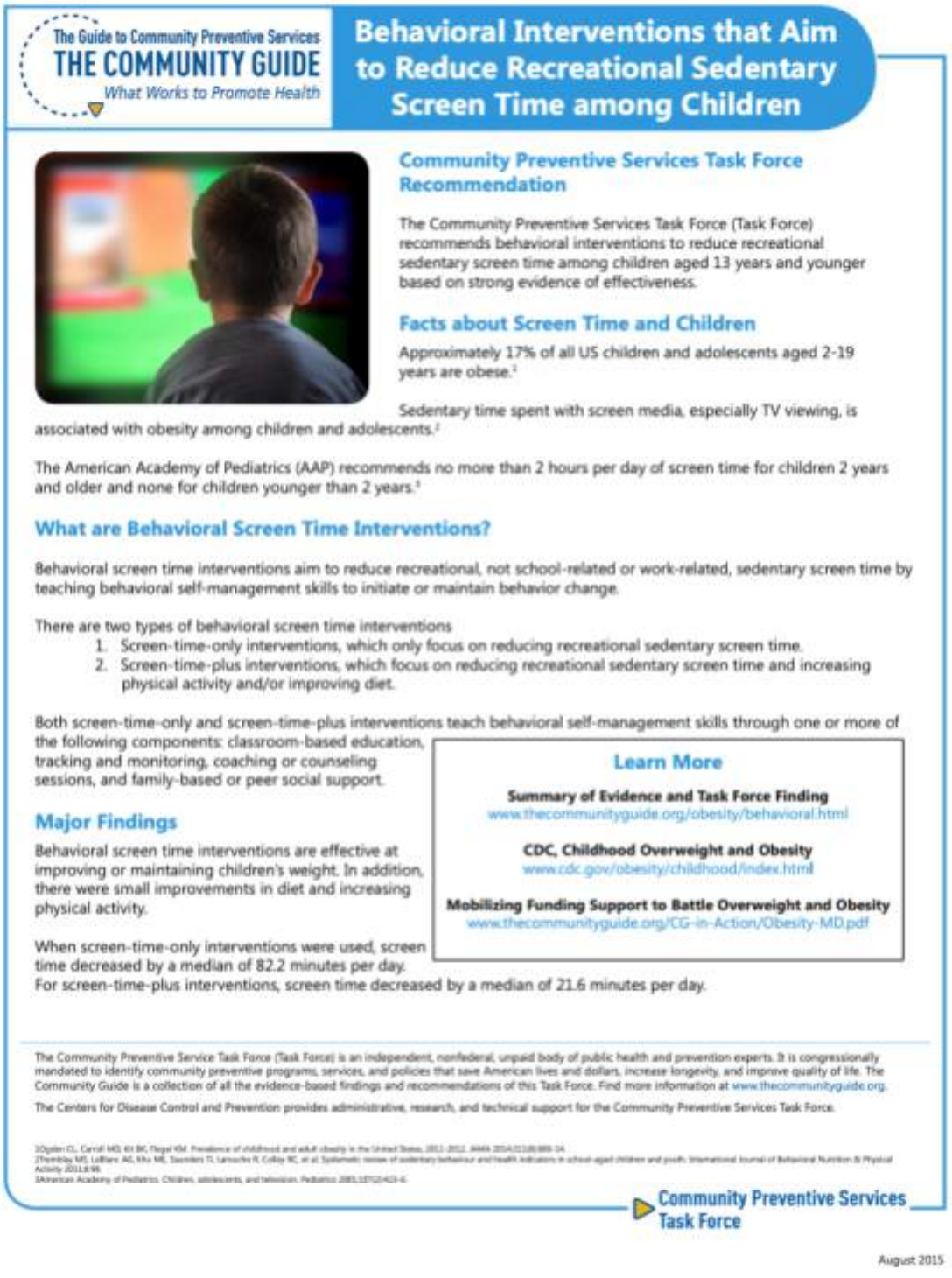

The Guide to Community Preventive Services
THE COMMUNITY GUIDE
What Works to Promote Health

# Behavioral Interventions that Aim to Reduce Recreational Sedentary Screen Time among Children

## Community Preventive Services Task Force Recommendation

The Community Preventive Services Task Force (Task Force) recommends behavioral interventions to reduce recreational sedentary screen time among children aged 13 years and younger based on strong evidence of effectiveness.

## Facts about Screen Time and Children

Approximately 17% of all US children and adolescents aged 2-19 years are obese.[1]

Sedentary time spent with screen media, especially TV viewing, is associated with obesity among children and adolescents.[2]

The American Academy of Pediatrics (AAP) recommends no more than 2 hours per day of screen time for children 2 years and older and none for children younger than 2 years.[3]

## What are Behavioral Screen Time Interventions?

Behavioral screen time interventions aim to reduce recreational, not school-related or work-related, sedentary screen time by teaching behavioral self-management skills to initiate or maintain behavior change.

There are two types of behavioral screen time interventions

1. Screen-time-only interventions, which only focus on reducing recreational sedentary screen time.
2. Screen-time-plus interventions, which focus on reducing recreational sedentary screen time and increasing physical activity and/or improving diet.

Both screen-time-only and screen-time-plus interventions teach behavioral self-management skills through one or more of the following components: classroom-based education, tracking and monitoring, coaching or counseling sessions, and family-based or peer social support.

## Major Findings

Behavioral screen time interventions are effective at improving or maintaining children's weight. In addition, there were small improvements in diet and increasing physical activity.

When screen-time-only interventions were used, screen time decreased by a median of 82.2 minutes per day.
For screen-time-plus interventions, screen time decreased by a median of 21.6 minutes per day.

### Learn More

**Summary of Evidence and Task Force Finding**
www.thecommunityguide.org/obesity/behavioral.html

**CDC, Childhood Overweight and Obesity**
www.cdc.gov/obesity/childhood/index.html

**Mobilizing Funding Support to Battle Overweight and Obesity**
www.thecommunityguide.org/CG-in-Action/Obesity-MD.pdf

The Community Preventive Service Task Force (Task Force) is an independent, nonfederal, unpaid body of public health and prevention experts. It is congressionally mandated to identify community preventive programs, services, and policies that save American lives and dollars, increase longevity, and improve quality of life. The Community Guide is a collection of all the evidence-based findings and recommendations of this Task Force. Find more information at www.thecommunityguide.org.

The Centers for Disease Control and Prevention provides administrative, research, and technical support for the Community Preventive Services Task Force.

1Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA 2014;311(8):806-14.
2Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. International Journal of Behavioral Nutrition & Physical Activity 2011;8:98.
3American Academy of Pediatrics. Children, adolescents, and television. Pediatrics 2001;107(2):423-6.

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Figure 4. Summary of the literature findings. A one-pager prepared by CPSTF.

# The science behind Carrots&Cake

Carrots&Cake was designed bottom-up with science-based solutions. Our team included neuroscientists and child psychologists. This was important to us because the most widely-used and popular apps for kids are habit-forming. Child users are vulnerable. They haven't yet developed their prefrontal cortex — the area of the brain that controls self-regulation skills. So we challenged ourselves to come up with solutions that limited kids' exposure to addictive stimulation.

Other screen time apps work by setting simple time limits. But that only addresses one part of the problem. It ignores the fact that kids' brains work differently. With those other apps, kids can still immerse themselves in habit-forming environments that stimulate the dopamine reward pathway of their brains. Then, when the child's time is up, the app cuts them off. The instant disconnection results in tantrums, frustration, and demands for more screen time.

At Carrots&Cake, we address these issues head-on. First, kids must engage in learning apps that their parents choose. After they finish, their device is unlocked for a predetermined amount of free time and play. Rather than being rewarded instantly — a hallmark of habit-forming programs — kids engage in activities that require a high cognitive load (i.e. lots of thinking). This achieves important outcomes.

1. It reduces the potential that an activity will be habit-forming/addictive.
2. It introduces a system of delayed gratification, which studies correlate with long-term success.
3. Kids consistently spend time on learning apps which results in "micro-learning" and is effective in educational growth.
4. Overall, kids develop a healthier relationship with their screens which is essential for their future education and eventual employment.

After kids finish their educational apps — what we call "carrots" — their device unlocks and they receive free time to surf the internet, play games, or stream videos — what we call "cake." Carrots&Cake believes in giving kids agency, allowing them to choose their own activities during this time. Online play has many benefits and is most advantageous when kids are immersed. We think of this stage as a state of "flow." However, as we described earlier, kids do not yet have the self-regulation skills to know when it's time to stop playing.

Helping kids get off screens was the second issue Carrots&Cake tackled. Kids do not have a good sense of time, especially when they are in the flow state. Who hasn't

heard, “One more minute please?” Carrots&Cake has a number of interventions that help kids exit the flow state and end screen time while minimizing withdrawal and tantrums.

1. A visual, on screen timer reflects how much free time the child has remaining
2. Reminders pop up when kids reach their final 5 minutes, 2 minutes, and 1 minute
3. Screen time ends with suggestions of creative, offline activities
4. We are working toward making the screen less stimulating as the free time concludes (e.g. reducing brightness, moving from color to black and white, reducing the volume). This helps kids to disengage with time is up.

We’ve discovered that most parents find the Carrots&Cake App when they’ve reached the end of their rope. Kids initially had free reign on their device but their behavior got out of hand. Parents may have tried other screen time controls. However, those apps don’t work to change the root of the child’s behavior. Instead they provoke a psychological concept called “reactance”. Children behave negatively because they lack control and are being told what to do. Carrots&Cake approaches the situation differently, we use a technique called Motivational Interviewing. It helps to create a direct dialogue between parents and children that identifies the child’s values. A key benefit to this is that it gets results quickly and efficiently and allows children to buy-in to the Carrots&Cake program in a manner that empowers them.

Carrots&Cake subscribes to behavioral science/design thinking principles. Simply put, the fewer choices children face, the easier it is for them to focus on the task at hand. Parents help their children design their Carrots&Cake screen environment, removing distractions and promoting learning. Overall, setup is easy — once and done. Parents can choose from learning apps they already own or they can ask for suggestions. We have researched which apps are most effective at improving attention, spatial, memory, and educational abilities and also work well with the Carrots&Cake platform.

At Carrots&Cake we want children and parents to succeed. We believe that with the right tools screens can enrich family life in a healthy and happy way. Please reach out if you have any questions.