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Article in *Psychiatry Research Case Reports* · September 2022

DOI: 10.1016/j.psycr.2022.100059

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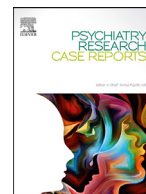
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## Changes in autism symptoms associated with screen exposure: Case report of two young children



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### ARTICLE INFO

#### Keywords:

Autism spectrum disorder  
Screen time reduction  
Social engagement  
Virtual autism  
Restrictive/repetitive behavior

### ABSTRACT

**Introduction:** Excessive early-life screen media exposure has been associated with developmental delay and autism symptoms. Improvements in developmental trajectory in young children with ASD and high digital screen exposure have been reported when screen time is replaced with socially oriented activities.

**Method:** We report on two young children with autism spectrum disorder who had high early-life screen exposure which was later reduced and replaced with parent-child social time. After the initial screen reduction, both children had an ensuing period with higher screen exposure, which was again decreased.

**Results:** These children had marked improvements in developmental trajectories when screen time was replaced with social time, and worsening symptoms when screen exposure was subsequently increased, which improved when screen exposure was again reduced. One child exhibited marked fluctuations of repetitive/restricted behavior, which coincided with changes in screen exposure.

**Conclusion:** These cases support literature suggesting that screen exposure may impact therapeutic response in young children with autism. These cases additionally show fluctuations in autistic symptoms, including repetitive behavior, associated with fluctuations in screen time. Interventionists may consider a trial of replacement of screen time with socially engaging activities in young children with a history of high screen exposure and autism spectrum disorder.

### Introduction

Excessive screen exposure in the youngest children has been associated with a multitude of health and developmental problems (Kostyrka-Allchorne et al., 2017; Madigan et al., 2019; Poitras et al., 2017; Chonchaiya et al., 2015; Lissak, 2018). Many of these delays and difficulties associated with high screen exposure, such as language delay, cognitive impairment, ADHD, behavioral difficulties, disordered sleep, as well as difficulties with emotional regulation and executive function, more commonly co-occur among children with autism spectrum disorder (ASD) than among typically developing children (Carlsson et al., 2013; Levy et al., 2019; Keluskar et al., 2021; Demetriou et al., 2018). Children with ASD often have high screen exposure and may be particularly vulnerable to potential negative effects (Slobodin et al., 2019; Gwynette et al., 2018). Early-life screen exposure is also associated with ASD-like symptoms and ASD diagnosis (Chen et al., 2020; Chonchaiya et al., 2011; Heffler et al., 2020; Kushima et al., 2022).

Improvements in social function and social brain response have been reported with early intervention for ASD focusing on social attention and engagement (Dawson et al., 2012). However, screen time interferes with social experience (Kirkorian et al., 2009). A reduction in screen exposure among young children with ASD and high screen time could theoretically provide benefits by allowing greater opportunities for social engagement and less distraction from social interaction for both children and parents. Programs to reduce screen exposure in children have shown some promising health, cognitive, and social outcomes (Wu et al., 2016; Gadberry, 1980; Uhls et al., 2014).

We report on two young children with ASD and a history of high screen exposure early in life. These children had subsequent changes in their screen exposure during their pre-school years. This research was approved by the Institutional Review Board and parents gave informed consent. These case reports are based on evidence gathered through direct observation, parent interview and report, and review of early intervention and school records.

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## Case presentations

### Case 1

This full-term male child was delivered by Caesarian section. The child's parent completed a questionnaire about the child's early screen viewing when the child was 3 1/2 years old. The parent reported that the child's typical daily screen exposure beginning at 2 months of age, included three hours of background television, such as news programming or adult-oriented shows and one-half hour of baby-oriented videos viewed on a television. Between 6 and 12 months of age, his screen exposure increased to 7 h daily including 3 h of background (adult-oriented) television and 4 h of child-oriented videos.

He began early intervention special instructor services for "red flags" of autism and language delay at 20 months of age. The child's subscale scores on The Battelle Developmental Inventory at 20 months were as follows: Cognitive 87, Social/Emotional 92, Physical 103, Adaptive 100. The Battelle Developmental Inventory has a mean of 100 and a standard deviation of 15. His standard score on the Preschool Language Scale was 61. This score is 2.6 standard deviations below the mean for a child his age. The special instructor recommended adaptive and strategic social strategies for the parents to use with their child. These included: imitating their child, being animated to get his attention, joining him in play, following his lead, and holding objects up to the parent's eyes to encourage eye contact. The parents limited free access to toys and favorite snacks to promote requesting behavior on his part. At this time, the child's expressive language consisted of 3 words.

At 20 months, the parents reduced screen viewing to 1 hour/day for a period of 6 weeks, replacing the previous screen time with social time using the same strategies they had previously been using, but now for a greater portion of the day. The child's special instructor recommended avoidance of screen viewing and greater time with social activities, having seen the benefits of this for other children with whom she had worked. Social activities included physical activities such as chase, and tickles, reading to the child while pointing out items in the pictures, and joining the child in his favorite activities. The parents were encouraged to socially engage the child through all daily routines. For example, during mealtime, it was suggested that the parents eat with the child, using simple language to describe what the child was eating, including the color, texture, and taste of the food. Also, the child was included in other routines such as simple cooking steps, for example, assisting his mother with holding a spoon while his mother was stirring and saying "Mix, mix, we are mixing." As indicated on the child's individual education program (IEP) progress update, after just 6 weeks of screen reduction, he exhibited improved eye contact, a growth in receptive vocabulary to 20 words, and was able to follow one-step directions. However, when the child's sibling was born, he resumed screen media viewing, 3 to 4 h daily. Although the parents were generally in the room with the child, they were not usually interacting with the him when he was viewing. According to the child's IEP report at 26 months of age, following this increase in screen exposure, he lost the language and social skills he previously gained.

At 29 months old, he was diagnosed with ASD, including an ADOS-2 score of 12. He used few words, had poor eye contact, poor response to name, threw toys without purposeful play, and used his mother's hand as a tool to obtain desired objects. He repetitively lined up trains and bounced balls on a hard floor, and exhibited toe walking. At 31 months of age, he had worsening global development documented by Battelle (BDI-2) with the following standard subscales reported: Cognitive 68, Social/Emotional 76, Communication 55, Physical 91, and Adaptive 89. He also exhibited poor goal progress. At 35-months-old, he began participating in a special education program for 2 half days a week, as well as speech therapy for 30 minutes/week.

Recalling the progress that the child had made with the previous trial of screen reduction, the family removed screen media viewing from this child at 36 months of age, allowing only one movie per week. The pre-

vious screen time was replaced with socially oriented activities, such as joining the child in play, including the child in family routines, and reading to the child. According to IEP progress updates and reports written by his special needs preschool staff, he showed marked developmental growth over the subsequent 6 months. He developed improved eye contact, rapidly increased his expression of needs and wants in phrases (see Fig. 1), and showed good functional and imaginative play with peers. This was a distinct contrast from his previous record of regression and lack of progress on goals, except for the brief period during which he had previously decreased screen viewing.

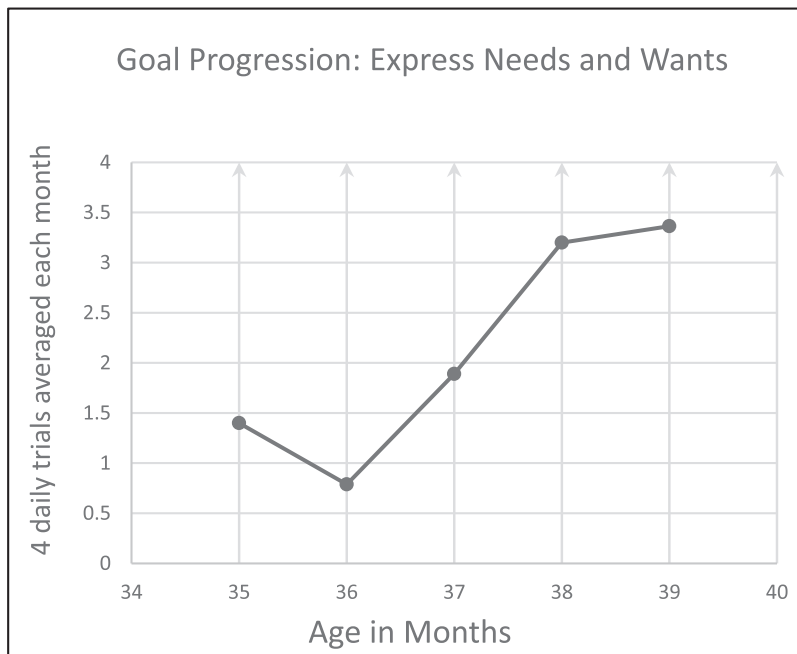
By 45 months of age, 9-months post screen reduction, he was using full sentences, showed extended play with peers, and was no longer repetitively lining up items or showing any other restrictive/repetitive behavior. Over the subsequent year, speech therapy was gradually reduced to 30 minutes once a month for maintenance. He attended a typical kindergarten without therapy or supports. Retesting at age 8 revealed no signs or symptoms of ASD and no special services were recommended.

### Case 2

This otherwise healthy male child was diagnosed with ASD at 34 months. He had both speech therapy and special instruction one hour per week. He used single-words, self-isolated and spent much of his time repetitively shaking (flapping) objects such as strings, ribbon, and leaves that he held in his hands while staring at the items. According to the questionnaire completed by the mother when the child was three years of age, he had screen exposure consisting of 4 to 6 h a day of parent-oriented background television since birth. Screen exposure increased by 6-months of age to 5 h of baby/child-oriented video on a large-screen television, 30 minutes of video viewed on a tablet, and 2 h of adult-oriented television per day. At 35 months, the parents turned off screens and attempted to engage the child in social time, joining him in play as tolerated, and imitating the child's actions to gain the child's attention. They used language that was directed toward the child and related to what the child was focused on, read books in a social manner, used strategies to encourage eye contact, such as holding items of interest up to their eyes, and included him in family routines throughout the day.

Throughout the next 5 months, they limited his screen time to one movie a week or less. He progressed developmentally and behaviorally over the next 5 months demonstrating excellent social responsiveness, talking in full phrases, and exhibited consistent eye contact and pretend play. The repetitive behavior diminished within a few weeks of the decreased screen exposure and within 2 months following screen time reduction, he engaged in the repetitive behavior occasionally, such as once or twice a week, with no display of repetitive behavior during some weeks, based on weekly reports provided by the parents.

Due to Covid-19 pandemic related changes in childcare and parent work schedules, six months after reducing the screen exposure, the child began watching 2 h of children's videos daily. According to the parent weekly report, after 5 days of increased screen exposure, the repetitive behavior returned. The child flapped his hands and twirled all types of objects in front of his eyes continuously throughout the day. The parents noted that the child was quite absorbed in the isolating activity, and it was difficult to attract and maintain his attention. The parents felt that the repetitive behavior coincided with the child's increased screen time and discontinued his screen viewing after a total of 10 days of 2 h per day of exposure. The repetitive behavior substantially decreased within a few days, and by 2 weeks, the parents reported that the child was not doing the movements, but once or twice a week he picked up a leaf or string and stared at it without flicking or shaking it. After 1 month of no screens, the child was allowed to watch 1 movie every 2 weeks and the parents commented that the child engaged in more self-stimming of flapping objects in the day or two after viewing the movie.



**Fig. 1.** Case 1, Progress on goal of expressing needs and wants from 35 to 39 months of age. Screen viewing was 3-4 hours/day prior to 36 months, reduced to 2 hours/week or less at 36 months.

## Discussion

The cases in this report illustrate the improvement in ASD symptoms with reduction of screen exposure and replacement of the screen time with social time in two children with an ASD diagnosis and a history of high screen exposure early in their lives. Despite the usual therapies and social engagement strategies used by the parents, these children had little progress in language development, engaging in appropriate social responses, engaging in age-appropriate play, and in reducing repetitive behavior when screen media viewing was continued for several h per day. It was not until the parents markedly reduced screen media viewing in these children and replaced that time with socially oriented activities that the developmental trajectories changed.

Our cases illustrate not only marked improvement in ASD symptoms with altering a young child's environmental exposure of screen time vs social time, but also worsening of symptoms when screen time was increased, despite the therapists and parents continuing with the early intervention therapies and social strategies. The family stressors of a newborn sibling in one case and covid-19 pandemic with related child-care and scheduling demands in the second case led to the increases in screen exposure after initial decreases. Case #1 had worsening of overall developmental delays when screen viewing was resumed for several h a day, and a marked improvement in social and developmental outcomes with subsequent consistent screen time reduction. A limitation of this report is that we do not know the extent to which the stressors which led to the increased screen time in these children directly contributed to the worsening symptoms of the children. However, despite the continued existence of the stressors, the children made rapid changes in symptoms and development once the screen exposure was decreased. The displacement hypothesis suggests that high screen time may have negative effects on health by limiting time spent on other important activities, such as parent-child social engagement, or physical activity (Lizandra et al., 2019). In case #2, the fluctuation of repetitive/restricted behavior with screen exposure additionally suggests a possible direct effect of screens on sensory or attention mechanisms. It has been postulated that the unnatural audiovisual stimulation of screens contributes to the altered sensory neuro-connectivity known to impact attention mechanisms in ASD (Heffler and Oestreich, 2016; Klin et al., 2009). As repetitive/restricted behavior is self-stimulating and isolating, screen induced repetitive or restricted behavior in ASD

could further limit the extent to which the child is responding to social engagement.

Some have referred to screen related autistic symptoms as 'virtual autism' (Harlé, 2019; Zamfir, 2018). There are several reports of rapidly improving autism-like symptoms in young children who had a history of high screen exposure, when usual therapies are accompanied by a marked reduction in screen exposure (Zamfir, 2018; Dieu-Osika et al., 2020; Kaku et al., 2017; Numata-Uematsu et al., 2018; Sadeghi et al., 2019). A recent intervention study involving young children with an ASD diagnosis and high screen time showed that parent education on screen time and child development, combined with parental support to decrease screen time and focus on social interaction strategies with the children, was associated with significant decreases in children's autism symptoms and parental stress (Heffler et al., 2022). High screen time in young children with ASD has been associated with more severe autism symptoms and lower developmental scores than in children with ASD and more modest screen exposure (Dong et al., 2021). Greater screen exposure at 1 year is also associated with greater risk of later autism symptoms and diagnosis (Heffler et al., 2020; Kushima et al., 2022). It is unclear if the negative effects of excessive screen time stem solely from displacement of social/emotional and physically active experiences, or if screens also have any negative direct effects on early brain development. As screen time exposure is a modifiable environmental factor, and so many children have significant struggles related to ASD, which now affects 1 in 44 children (Maenner et al., 2021), more research on the association between early-life screen time and ASD, and awareness of current findings relating ASD-like symptoms to high screen exposure in early childhood is urged. In the meantime, we recommend that parents adhere to the American Academy of Pediatrics screen time recommendations of no exposure before 18 months of age, and no more than 1 h co-viewed per day through age 5 years (Council on Communication and Media, 2016).

## Conclusions

This case report supports other recent research suggesting screen exposure as a potential factor impacting autism-like symptoms and response to therapy in young children with ASD. These cases are unique in that they illustrate not only improvement in autism symptoms with screen time reduction and greater emphasis on social engage-

ment throughout the day, but additionally worsening of symptoms when screen time was later increased, despite continued therapies. We suggest a need for greater research on the association between screen exposure and ASD. Parents and interventionists may wish to consider a trial of screen time reduction, replacing the previous screen time with social time, in young children with ASD or ASD-like symptoms who have a history of high screen exposure.

### Declaration of Competing Interest

After completing involvement with these children, one of the authors (Lori Frome) started a company to support young children with developmental delays and high screen exposure. The other authors have no potential conflicts of interest to disclose.

### Funding

The authors received no funding for this work.

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