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Opinion paper

Intensive early screen exposure as a causal factor for symptoms of autistic spectrum disorder: The case for «*Virtual autism*»

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A B S T R A C T

Intensive Early Screen Exposure (IESE) has been associated with detrimental outcomes on different variables including attention, language, emotion regulation and socialisation, some of which are central to the diagnosis of *neurodevelopmental disorders*, such as ADHD and learning disorders. Following Bradford-Hill's recommendations, we argue that there is growing clinical and empirical evidence supporting a causal relationship between intensive early screen exposure (more than 4 h a day) and subsequent symptoms of Autism Spectrum Disorders in some possibly vulnerable younger children (less than 6 years old). Clinicians should also be aware of the existence of cases of recovery or dramatic improvement after parents accept to stop screen exposure for a few months, associated with daily moments of dyadic interaction, since this intervention has repeatedly been found to be effective with no known side-effects.

1. Article

1.1. Intensive early screen exposure (IESE) and detrimental outcomes

Leading institutions such as the *American Academy of Pediatrics* [1] and the *Canadian Paediatric Society* [2] are regularly issuing evidence-based guidelines about the exposure of younger children to screen media, which review the numerous detrimental effects associated with excessive screen time (ST) on cognitive, affective, social, and physical variables - both on the short and long-term. The current recommendations are thus quite restrictive even though the available data show an ever increasing use of screen media by toddlers and babies [3]. These variables are also used in the diagnosis of « *neurodevelopmental disorders* », making it perfectly plausible that IESE increases the risk of being diagnosed as having ADHD and learning disorders according to epidemiological and some experimental data. Such disorders are commonly associated with biological or genetic causes although Gene x Environment (GxE) models are more plausible. Recently, in the DSM-5, Autistic Spectrum Disorders (ASD) have been grouped with ADHD, learning disorders, motor disorders and mental retardation in « *neurodevelopmental disorders* »

1.2. ASD as another instance of « neurodevelopmental multifactorial » disorder

Autism was first described in 1943 by psychiatrist Leo Kanner and its diagnostic criteria have evolved to the current definition of Autistic Spectrum Disorders. Simultaneously, the prevalence of this disorder has risen from 4.5/10,000 in 1966 to 1/59. [4] Such increase in prevalence has been explained by different factors such as widening of diagnostic criteria, diagnostic relabelling of some patients, but some epidemiologists also regularly point out the possible involvement of environmental causes (usually chemicals are suspected). [5] Up to 200 genes have been associated with autism, and many insults potentially affecting brain development during intrauterine and post-natal life have been proposed to increase the risk of ASD [6]. So, according to Tordjman and colleagues, a GxE model is highly likely for autism. Autistic children and adolescents are known to be at risk for problematic use of screen-media, due to their tendency towards restricted interests and repetitive behaviours. [7] They also tend to use screen media in less social ways than peers in other disability groups. [8] Tablet computers are increasingly being used as therapeutic and pedagogical tools, with limited backing evidence in this population. [9]

1.3. « Virtual autism » as an emerging clinical phenomenon

In this article, we use Sir Austin Bradford-Hill's landmark 1965 article [10] as a guide for the discussion of the potential causal link between IESE and symptoms of ASD in children younger than 6 years old. In Bradford-Hill's terminology, there is some *Consistency* in the clinical observations: clinicians from different countries (France, Japan, Romania, USA, Thailand, Tunisia and Qatar) have independently witnessed a phenomenon not described previously in younger children, who have been heavily exposed to screen media (more than four hours a day, sometimes significantly more) from a very young age (usually from their first year of life), i.e., symptoms of ASD, sometimes formally diagnosed by independent diagnostic centres with reference diagnostic tools (ADOS and ADI-R), which disappear or dramatically decline

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within months after parents accept to remove Electronic Screen Media (ESM) and replace them with daily dyadic playful interaction. Heffler and colleagues have presented a poster describing 3 such cases at the IMFAR 2017 congress. [11] In France, Dr Anne-Lise Ducanda, who posted a video on Youtube in 2017 trying to alert on this emerging phenomenon, presented 8 such cases in April 2018 at the national congress of French General Practitioners. [12] Clinical psychologist, with expertise in diagnosis and treatment of ASD patients, Sabine Duflo independently saw the same evolution in some of her patients, as well as paediatrician Sylvie Osika. Similar observations were made by psychologist Marius Zamfir, in Bucharest Romania, who had evaluated and treated autistic children in Bucharest for more than ten years and who coined the term « *virtual autism* » . The association was further observed by Child and Adolescent Psychiatrist Professor Naoufel Gaddour in Monastir, Tunisia and by Professor Chanditha Pruksananonda in Bangkok Thaïland and her colleague Dr Weesarak Chonchaiya. In 2018, paediatric neurologist Dr Numata-Uematsu and her colleagues from Tohoku and Fukushima Universities in Japan published a case-report about a 5-years old boy who was overexposed and who displayed symptoms of autism which regressed after his exposure to screen was removed, making it the first officially published case in the medical literature. [13]

Those clinicians all describe a similar course of evolution: after a few months of screen removal and interaction, many younger ASD patients are reevaluated as being non-autistic. The overall impression is an unusually quick recovery with a development which seems to restart abruptly after the parents make the aforementioned environmental changes, and provided this happens early enough in life (before 6 or even better, before 4 years of age). Sometimes, after an initial phase of up to two weeks of a withdrawal-like state with irritability, the most impressive and usually the first clinical changes to occur are in the facial expressions: those children whose faces were blank and inexpressive animated, displaying more social facial expressions. They suddenly seem to pay attention to family members around them and this is usually a very rewarding experience for the parents. Those children often keep some degree of language delay and hyperactivity but after a few months they no longer display the core symptoms of autism. Clinicians describe parents who are themselves impressed by the magnitude of the effect, even when their children had previously been enrolled in some intensive early intervention program. The author by now has collected testimonies of parents who share the impression that, among all interventions, removing screen media was the most beneficial one. Of course, we advise parents to keep their child under any other intervention (i.e. psychosocial therapy, speech therapy…) until they are free of ASD symptoms and have recovered from developmental delays.

It should be mentioned that younger children initially diagnosed with ASD who do not subsequently fulfil the diagnostic criteria for ASD are not unheard of in the scientific literature: a subgroup of patients (about 5%) of the PACT intervention study, [14] « *the best early intervention study to this day* » according to researcher Pr Laurent Mottron, went from ASD to non-autistic during the course of the study. Researcher Deborah Fein [15] has also studied a group of ASD patients who had subsequently lost their diagnosis, what she has called « *optimal outcome* ». Some colleagues have argued that our cases might just be false positives or misdiagnosed. This seems unlikely for the following reasons: First, the clinicians were experienced and had years of expertise in ASD. Secondly, when our patients have independently been diagnosed by experts, they were labelled « moderate to severe ». They were neither borderline nor doubtful cases. Our observations could also be interpreted as a lack of specificity of the symptoms currently used in the diagnosis of ASD in this subpopulation of overexposed children.

To this date, a most interesting cohort was described by Zamfir, [16] showing that his younger ASD patients who were exposed more than 2 h of screen media a day improved faster, when screen removal was implemented, with less intervention time from professionals. In addition, more of them could go back to the normal schooling system within months, when compared to his non-exposed ASD patients who evolved as any professional would classically expect (i.e., slowly even with intensive behavioural therapy). Zamfir estimated that the time spent in classical CBT with his virtual autism patients was about four times more effective than for his classical « non-exposed » patients. In favour of a causal link between screen exposure and ASD symptoms, we have seen in different countries (at least France and the USA) several cases in which the symptoms, which had regressed after screen-removal, reappeared when the ESM were reintroduced three to four hours a day. These cases of « *challenge-dechallenge-rechallenge* » are in our opinion a strong argument in favour of causality. [17] We have seen cases which suggest some biological vulnerability interacting with IESE: in one instance a father with Asperger syndrome had a son with « virtual autism » who fully recovered, another patient had a second degree cousin with autism. In a third family we have seen two children, the first and the third affected (a boy and a girl), whereas the second child with probably very similar IESE never displayed any ASD symptom.

2. Epidemiological backing evidence

Few publications have investigated the correlates of media-use in patients with ASD, even fewer among younger ASD patients. [18] The proposed link between IESE and subsequent ASD symptoms is *Coherent*, in Bradford-Hill's terminology, with this literature: no publication contradicts our hypothesis, showing, for example, a protective or even neutral effect of IESE, and several published papers actually do support it.

Following Bradford-Hill's recommendation, we argue here that the *Biological Gradient* and *Temporality* criteria have some backing evidence, using both cross-sectional and longitudinal studies. In a case-control study, Chonchayia et colleagues [19] showed that children with ASD were exposed to screen media at a younger age (6.44 months vs 12.41 months), for a longer duration of time (4.6 vs 2.06 h a day) and more often on their own (79 vs 13.1%) than typically developing (TD) peers (including children with delayed language development (DLD) who were in an intermediate range for those three variables). Though observational by nature, this research gives some credibility to a causal link, since ASD children were watching on average 4.6 h of television a day and had started on average when 6 months old, an age when most were still considered asymptomatic and at which television watching a television is more a parental than a baby's choice. Naturally, another potential explanation could be a confounding factor.

Chonchayia et colleagues [20] also did a longitudinal study of healthy children between 6 and 18 months. The time spent on screen media at 6 months and its increase between six and 18 months were both predictors of Pervasive Development Disorders (the DSM-IV label for ASD) symptoms as screened by the CBCL (standardised ??=0.16 and 0.15 respectively) in a multilinear regression model adjusted for many covariates (age, gender, parental income and education, temperament).

Several other case-control studies in other countries found an increase in ST in the first three years for ASD children compared with TD peers (Kheir et al. 2012 in Qatar [21]) or with DLD peers (Jahan et al. 2014 in Bangladesh [22]). An unpublished yet large cohort studied by Gaddour and Brahim [23] in Tunisia showed strikingly similar results with a very IESE for ASD children ($n = =150$) compared with TD peers ($n = =150$) with an onset within the first year in all ASD children whereas only 55% of TD peers had been exposed in their first year, in a more moderate manner.

More recently, a Chinese cohort of 8900 kindergarten children aged 3 to 6 studied by Wu and colleagues [24] showed a positive correlation between ST and autistic symptoms as described by the *Clancy Autism Behaviour Scale* (CABS), an epidemiological tool widely used in China with correct concordance with ADOS and ADI. ST has been treated as a categorical variable in this study (less than two versus more than two

hours a day to conform to the APA recommendations). The multiple logistic regression adjusted for many relevant covariates shows an adjusted odds-ratio of 1.47 (95%CI 1.22-1.17) for « being at risk of autism », as defined by a CABS-score > 14, for children in the > 2 h a day group, and the authors confirmed that, when treating ST as a continuous variable, there was a significant linear relationship between ST and ASD symptoms (after logarithmic transformation of ST, ?? = 0.051, 95%CI 0.042–0.061, $p < 0.001$) suggestive of a dose-effect relationship.

Lastly, economy professor Michael Waldman, an early proponent of the causal relationship between ST and ASD symptoms is following up on his early research. [25–27] By using the Instrumental Variable Method, a statistical method widely used in econometrics but less so in epidemiology, he attempts to demonstrate a causal link with observational data by using variables thought to be randomly determined and not related to ASD, specifically precipitation rates and children cable TV subscription rates. After showing that these two variables are positively correlated with screen time, he goes on by showing a positive relationship between those two variables when children were between zero and two and the subsequent rate of ASD diagnosis in the geographical region. Waldman et al. also use different « negative controls », such as the rates of mental retardation (MR) diagnoses and of news cable TV channels subscriptions, to show that those variables had respectively an inverse and no correlation with ASD diagnoses, as predicted. In Waldman's model, Children's cable TV subscription rates could explain around 19% of the increase of ASD diagnosis between 1972 and 1992. All those research papers clearly support the correlation and some of them give some credit to the proposed causal link.

2.1. Potential mechanisms involved and further questions

In line with Bradford-Hill's criteria of *Plausibility*, one paper by Heffler and Oestreicher [28] has discussed the potential biological mechanisms by which ESM could act as a potential « *environmental trigger* » for ASD. These authors show that the screen media hypothesis is compatible with other current etiological theories of ASD. They also refer to some research in the field of developmental visual physiology by Frank and colleagues [29] who show that the preference for human faces over light and movement is an emerging feature of the visual system that develops after 9 months of age. Heffler and Oestreicher speculate that screen media might interfere with this process, leading, in some vulnerable children, to the gaze avoidance so typical of autistic children.

In my view, the first three years come with a higher risk, as this is the time-frame of social gaze development. I am well aware that many mechanisms can be involved with additive effects, involving for instance the time taken from social interactions or sleep by excessive ST, i.e. the classical « *stolen-time effect* » classically associated with screen media exposure. Nevertheless I am convinced that ESM carry some specific effect: first, they seem to act as « *human presence simulators* » on our attachment system, by-passing the need for relational proximity and, secondly, as experienced clinicians we have all encouraged parent-child interactions before trying screen removal, yet never have observed such dramatic effects.

Another important question is « how virtual is virtual autism? ». It could as well be « real autism triggered by IESE ». Virtual autism seems to have, in the beginning, a potentially very different trajectory from classical autism. But being clinically indistinguishable from « atypical autism », we believe that it is possible that after some time it can stabilise in an ASD presentation with some degree of mental retardation and/or language delay. In our experience, the dramatic effects of screen removal are mainly seen with younger children. The proportion of children in the younger ASD population who are actually cases of virtual autism is unknown. Possibly, in some populations with a very intensive early exposure, they represent a significant portion of our patients, as much as 50%. Our main argument is the very predictable improvement or recovery of most overexposed younger ASD patients, showing the *Strength* of the association, in Bradford-Hill's terminology. It could also be true that IESE is detrimental even for « classic » autistic patients, especially on behavioural and sleep problems, and ESM removal could be beneficial in both cases but with effects of a different magnitude. For instance, there is some published evidence that ASD children are even more prone to the detrimental effects of ESM on sleep than their typically developing peers. [30] Clinicians like Gwynette and colleagues [7] have recently published words of caution concerning excessive ST for children and adolescents with ASD based on the published literature.

2.2. Common objections

Many colleagues are involved, at the moment, in researching the potential uses of digital media as therapeutic tools for ASD children, and some psychologists and speech therapists are already using them in their everyday practice. Though the current degree of evidence backing those practices is still quite limited, we would like to emphasise that all « *virtual autism* » cases we have seen were exposed at a very young age in ways which depart completely from the current ST recommendations. We believe that if ESM has some therapeutic potential, it is probably not with exposure rates that contradict those recommendations. Some colleagues have argued that leaving a toddler for more than four hours a day in front of a screen is a case of severe emotional deprivation, such as the one experienced by children in Romanian orphanages. [31] We believe this objection could only be made by people who don't meet patients as part of a clinical work or never interact with social services: we have never heard of cases of children being put into foster care for such a reason. Social services don't seem to recognise overexposure as such a big problem for the simple reason that it is widespread and that the scientific, medical and psychological communities do not seem to have reached any consensus on the seriousness of that problem. Some colleagues, for example, when diagnosing a 30 months old child with ASD see « *a positive emerging skill* » in the way this child is good at using a smartphone and imitates everything on TV, without any consideration for the 6 h spent on ESM every day. Some colleagues also said that putting a child on a tablet computer four hours a day is akin to locking him in a cupboard: an instance of maltreatment. To this, I respond that the tablet computer is extremely attractive compared to the cupboard and no cupboard is sold to parents, at the moment, as being of « *incredible pedagogical value* ». Finally, some sceptical colleagues have argued that our idea is a new MMR-vaccine hoax. First, we believe we have some backing evidence, as shown above. Second, our contention has practical consequences: we have seen many children improve in ways we had never seen before, and a three month screen-free diagnostic trial is risk-free and can be of significant therapeutic value. In the case of the MMR-vaccine hoax, there was definitely a risk spreading doubt on the safety of a vaccine with no therapeutic consequence once symptoms were present.

3. Conclusion

Professionals should be aware of a possible causal link between excessive ST and ASD symptoms in younger children. This finding should not discourage any diagnostic and treatment procedure for those children but we advocate for a minimum of three months screen-free regimen for overexposed younger children with ASD symptoms, accompanied by daily playful interaction with the parents, to differentiate between classical and « *virtual autism* ». We believe that some predisposed children display a particular sensitivity to screen media than can be revealed as ASD symptoms usually accompanied by a language delay, an already well-known consequence of excessive ST. Naturally, given all this accumulating evidence, the severity of the ASD diagnosis for children and parents, and its cost for society, not testing the hypothesis further would be unscientific. We expect more information on

the distribution of ST in the younger populations, more relevant epidemiological longitudinal studies including repeated ST and ASD symptoms measurements. A well-designed randomised intervention study would be a possible ethical option to prove causality in this situation.

4. Ethical statement

I testify that this article submitted to Trends in Neuroscience and Education:

1 has not been published in whole or in part elsewhere;
2 is not currently being considered for publication in another journal;
3 that I have been personally and actively involved in writing the manuscript, and will hold responsible for its content.

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Declaration of Competing Interest

The author reports no conflict of interest.

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