

Immersive Virtual Reality and the Child's Well-being

Abstract:

Virtual reality technologies have become increasingly ubiquitous, popular, and successful at reading the users' kinesthetic data to render and pipe back immersive environments. Children are a growing user group of immersive virtual reality (IVR) for entertainment and educational purposes. The paucity of large and long-term studies of children's experience of virtual reality means that little is certain of how these differ from the adult experience. While prior research has examined the threat that IVR technologies pose in further enabling invasive surveillance capitalist practices, the confluence of factors of children in IVR, where younger users are more susceptible to dark patterns such as embedded advertising, remains to be explored. This work seeks to evaluate the extent of the threats and some of the benefits to children by considering perspectives from the philosophy of childhood, as well as applying surveillance capitalism concepts to show how children in IVR represent a new and unprecedented avenue of behavioral prediction and modification. Immersive virtual reality enables datafication via intimate spatial sensors; IVR extends deeply embedded advertisements via the blurring of content and noncontent; IVR is especially salient to children both socially and sensorially. While these capabilities make IVR a valuable tool across child-facing disciplines from education to research to medicine, these same capabilities render IVR a new conduit for child-targeted surveillance capitalism, deserving of renewed scrutiny and specific regulation.

1. Introduction

On October 7th, 2022, the New York Times published an article titled *This is Life in the Metaverse*. Kashmir Hill, a privacy reporter, donned a Quest 2 virtual reality headset and found herself peering into *Horizon Worlds*, the three-dimensional, real-time social network world within the 'Metaverse' of the newly christened Metaverse Platforms Inc. (formerly Facebook). Still in its early stages, the human inhabitants operating the floating avatars of the Metaverse that Hill encountered were pioneers of the new world, discovering, inventing, and sometimes pushing the proper etiquette of how to converse and socialize in Meta's virtual reality. One user group, not necessarily invited to the virtual party, proved surprisingly ubiquitous in Hill's adventure - children.

These younger users were not easily discerned at first, as it is not currently possible to customize one's avatar to appear childlike - but vocal cues and content quickly often an age gap, as one avatar stepped onto a virtual stage for a comedy performance: "Want to hear a story about my school?" he asks in a youthful voice that suggests a tale of sixth-grade woes" (Hill, 2022). Hill and her interviewees note the constant presence of children in the Metaverse, even in virtual spaces specifically reserved for users over the age of eighteen. The Quest 2 Headset user manual notes that the product is not intended whatsoever for anyone under the age of thirteen, but Hill's five-year-old child is enamored with the headset and is allowed to try out a simple video game in virtual reality. Other reviews of the Horizon Worlds application and journalists covering the topic also note the surprising presence of kids in the Metaverse, highlighting that the virtual mixing of young kids and adults represents a new possibility for online sexual abuse (Oremus, 2022). As virtual reality technology becomes more widespread, and more children find their way onto virtual reality platforms, what new issues arise, and how do older problems of children's media use change?

Virtual reality, or "VR", is something of a catch-all phrase referring usually to a navigable world displayed to a user via a headset that replaces sensory input from 'real' reality with simulated input from another coherent 'virtual one'. This is usually achieved through the use of a headset worn in front of the eyes, such as Meta's *Quest 2*. There are other acronyms that populate the space between 'real' and 'virtual' reality - the terms 'augmented reality' (AR), 'mixed reality' (MR), and 'extended reality (XR)' all refer to a blend of virtual input layered onto or replacing real-world input. This article focuses on 'immersive' virtual reality (IVR), which "places users directly into virtual scenarios by blocking out the physical world, creating vivid and personal environments" (Bailey and Bailenson, 2017). The most recent five years of innovation have seen the rise of commercial virtual reality technologies, their initial adoption, and heavy investments in this market from the biggest technology companies. In the year 2021, Meta took a \$10 billion hit to its bottom line to invest in 'Facebook Reality Labs', its AR/VR/Metaverse development division (and the descendant of Oculus, a groundbreaking crowd-funded VR startup acquired by Facebook in 2014 for \$2 billion) (Dredge, 2014). Google, HTC, Sony, and Microsoft have also made expensive forays into the space (Egliston and Carter, 2021).

Commercially-viable immersive IVR headsets, which set off this boom in IVR-related investments, were made possible only recently with advances in relatively cheap computational power and miniaturization (Egliston and Carter, 2021). With these investments came a bevy of IVR research, often focused on how to optimize the user's experience of being 'present' in the virtual space, rather than the real space in which they sit (Gugenheimer et al., 2019,

Sanchez-Vivez and Slater, 2005). Designers often aim to create a sense of presence via immersive technologies, where presence is the subjective experience of the individual enabled at a nonconscious level by multisensory coherent experiences and the fidelity of sensory-motor mappings in the virtual world (Bailey and Bailenson 2017a). The ultimate aim of immersive VR, then, is for the user to lose themselves in the virtual world to the point where it seems real to them. Ideal presence is 'the illusion that a mediated experience is not mediated' (Lombard and Ditton, 1997, as quoted in Jones and Dawkins, 2018).

The increasingly realistic nature of IVR technologies is especially salient to children, who are especially sensitive to rich sensory experiences (Bailey and Bailenson, 2017a). In many cases, this makes IVR a beneficial tool - for education, pain management, and behavioral research and measurement. However, specifically when considered through the lens of the economic imperatives of the companies that produce them, children's experience of virtual reality presents a challenge that deserves renewed scrutiny. The convergence of improvements in the statistical and machine learning tools of surveillance capitalism with innovations in the immersiveness of virtual reality technology results in a new means of behavioral modification for which children are the most vulnerable user group.

Modern developmental theories of how children construct concepts of the world, and how they behave in it, hinge on the gathering of information about their immediate environment via observation of the world to which they are exposed (Clement and Koenig 2018, Bandura and Walters, 1977). Children have been increasingly exposed to digital media as significant parts of their environment and tools through which to experience their environment, from television to personal computers to smartphones, throughout the last thirty years. Over these three decades, these media have become more proximal to the child, from the television across the room, to hand-held devices, culminating in modern wearables and headsets. Furthermore, these media have allowed for increasingly complex interactions as communication channel capacities between child and machine have increased, from highly pixelated televisions on which one could only change the channel, to multisensory immersive navigable worlds run on systems that read physiological signals as inputs. These decades also saw the widespread adoption of the internet and its integration into daily life, as well as the economic rise of the corporations that produce and sell the hardware and software elements of the machines and the internet.

The apparent consensus from medical, developmental, and educational experts throughout this progression of adoption of new digital media technologies has been neither an endorsement nor a denouncement. Rather, moderation has been the emphasis, and the matter has been seen as nuanced and highly dependent on the age, temperament, and habits of the child, as well as the specific content and themes of the media itself (Wilson, 2008; Hassinger-Das et al., 2020). However, with the aforementioned progression of proximity and intimacy in the child-device relationship comes the shifting of concerns. Personal cyberbullying was not possible via the centralized one-to-many television broadcast model, but required peer-to-peer connections now afforded by social media. Privacy worries regarding location-tracking became more relevant when computers became small and powerful enough to carry in one's pocket as a smartphone, and with children particularly as the average age of first-smartphone-use decreased (Sipior et al., 2014, Rideout, 2019). Widespread outcry over large technology firms capitalizing on children's data for targeted advertisements occurred after machine learning and statistical innovations made such monetization possible. Virtual reality

technologies, as capable of presenting content in an unprecedentedly immersive manner and as reliant on especially detailed spatial data from user and environment, bring both entirely novel concerns and compound existing ones. This necessitates this investigation at the intersection of childhood studies, empirical psychology approaches to children in IVR, and critical technology studies of IVR.

There already exist largely separate bodies of work on the empirical psychology of children's experience of virtual reality and the moral and social values baked into technologies such as IVR. However, these approaches are infrequently considered at once. As investments in virtual reality technologies ramp up and more IVR headsets are brought into homes and used by children, the multidisciplinary problems posed by children's use of immersive commercial virtual reality grow in relevance (Aubrey et al., 2018). This article lays out modern theoretical understandings of childhood, empirical psychology research into children's experience of virtual reality, and the recent rise of commercial virtual reality through the lens of surveillance capitalism. Put in dialogue together, these lines of thinking form an attempt to delimit the nature of the threat to children's rights and well-being, and imagine the form such a threat may take as virtual reality technologies become increasingly ubiquitous. Immersive virtual reality enables datafication via intimate spatial sensors; IVR extends deeply embedded advertisements via the blurring of content and noncontent; IVR is especially salient to children both socially and sensorially. While these capabilities make IVR a valuable tool across child-facing disciplines from education to research to medicine, these same capabilities render IVR a new conduit for child-targeted surveillance capitalism, deserving of renewed scrutiny and specific regulation.

2. Children, Well-being, Rights, and Digital Media

In considering the harms and benefits of immersive virtual reality for children, who counts as a child must first be addressed, as well as how the well-being and moral rights of children differ from those of adults. This section outlines key ideas from the field of childhood studies and discusses recent regulation in the US of internet companies' use of children's data.

The legal age of maturity is 18 years old in the US, but the brain may not stop its maturation and development until 25 years of age (Berman et al., 2009). However, this is not a linear process, and it could be argued that in many ways, the maturity and capability of a 13-year-old are closer to that of a 20-year-old than that of, say, a 6-year-old (Tomlin, 2018, Skelton, 2018). One useful definition describes children as those whose capacities have not yet developed as compared to adults due to their age, which will do for this article (Brighouse and Swift, 2014, as referenced in Hannan, 2018). In terms of well-being, Skelton (2018) spells out the objective-list approach: one may make a list of non-instrumental goods for a child, where fulfilling these items on the list improves the child's well-being. One example of such a list is Brighouse and Swift's (2014) five non-instrumental goods for children: meeting physical requirements like food, time outside, and exercise; cognitive requirements "comprising an interest in acquiring reflective capacities sufficient for autonomy;" emotional requirements for connection and control; a moral requirement, where children ought to learn what constitutes moral behavior and practice it; a final requirement is the enjoyment of childhood itself (Skelton, 2018). While adults might have similar requirements for well-being, the focus with children is the *continuing acquisition of the ability* to make one's own well-being as included in each item on the list.

Another useful perspective examines how the rights of children differ from adults: via the still-emerging nature of their autonomy. As Noggle (2018) lays out this problem, the *interests* approach holds that rights exist to protect what is essential to one's well-being (including, usually, autonomy) whereas the *will* approach to rights holds that rights exist to protect an individual's autonomous choice, particularly because people are autonomous. Progressive Era children's activists of the early 20th century sought and achieved reforms that protected children's rights as interests to be protected (i.e., children have a right to their well-being list in the previous paragraph). A second children's rights movement in the late 20th century fought in contrast for the child's right to higher levels of self-determination, hingeing on the idea that aside from babies, children can be autonomous if afforded autonomy. The modern viewpoint takes a continuous approach where very young children are to have their interests protected and older children are to gradually have their liberty protected (Noggle, 2018). This leaves a very interesting midway point, where children in the range of 9-13 years of age who can be expected to have developed some autonomy but not yet close to full adult capacity may see a range of approaches - treated as having rights only to protect their interests versus treated as completely autonomous. The notion of autonomy is a controversial one, especially in children (Hannan, 2018). Hannan, after reviewing possibilities, concludes we should take autonomy as a domain-specific and continuous property (her example: choosing who to spend time with is different than choosing a career), and that "children's autonomy develops gradually" expanding across domains and degrees over time (Hannan, 2018).

To summarize these concepts, childhood from birth possesses non-instrumental goods as a well-being list, although at birth, this does not include autonomy (babies are not autonomous and have no right to autonomy). As children develop more capacities and become more autonomous, autonomy becomes more important on their well-being list, and therefore as a right that they increasingly have.

Broadly stated, the use of digital technology to mediate experience could then be seen as contributing to these well-being list items and definitions of children's rights in some ways and detracting from them in others. The use of any digital media might take time away from exercising but allow for more autonomous cognitive exploration. Immediately one could note that technology such as immersive virtual reality would not be fit for children who are so young as to be unable to verbally express themselves or who are still learning fundamental physical principles about the world, i.e., toddlers. But what about children at five years old, like the daughter of the reporter from the introduction, who have some motor skills, have usually begun education, can express basic feelings and desires, and whose autonomy is still early in the process of full development? Similarly, it is not immediately clear how the use of digital media would bear on the rights of children in general, i.e., their growing autonomy, when examined independently of the content shown.

However, with internet and web-based game use increasing in the 1990s, US lawmakers chose to legislate digital media use during an era of childhood: restrictions specially prohibit technology companies from mishandling user data when the user is below the age of 13. This is held by a rule dubbed the Children's Online Privacy Protection Act (COPPA). Passed in 1998 by the US Congress, and set into effect in 2000, COPPA empowered the Federal Trade Commission to enforce regulations that make illegal the collection of a 12-year-old or younger child's personal information by operators of commercially-purposed websites unless fulfilling

several requirements. Essential requirements include notice regarding the information obtained, the consent of the parents that the information is being gathered, the parents' ability to review the information, lack of gamification that induces the divulgence of personal information, and ensuring the security of the information gathered (Jammtgard, 2000). What these measures aimed to achieve was to stop websites from selling children's data to the highest 3rd party bidder as well as to make it harder for predators to make use of identifying online data to target children (Levinson, 2021). What they acknowledge is that younger children are more vulnerable online to manipulations such as gamification or exploitation. As complying with these regulations can be onerous, some platforms, such as Facebook and some apps implemented for the Quest 2 immersive virtual reality, simply block users from making an account if they state their age to be less than 13. Spaces like Meta's *Horizon Worlds* therefore simply are not designed for younger users, leading to a lack of protective implementations that allow children to exit uncomfortable virtual situations (Oremus, 2022).

Writing a critique of COPPA's recent implementation, Levinson (2021) elucidates how the Federal Trade Commission's recent case against YouTube, an online video platform owned by Google, failed to fully penalize the company for its violations and set a poor standard for further incursions into targeted advertising against children. According to a 2020 survey from Pew Research, 80% of US parents of children younger than 12 reported that their kids watch videos on Youtube, 84% of them with a frequency of at least a few times a week (53% daily) (Pew Research Center Youtube Study). The highest-earning YouTuber of 2019 was a 8-year-old child named Ryan Kaji, who helped popularize 'unboxing' videos, which simply feature Ryan unwrapping and reviewing a new toy. His videos pulled in almost 29.5 million USD that year alone. Many of his videos controversially include "embedded advertisements," where the advertised product is included in the content of the video, and its advertised nature is not made clear, or sufficiently clear to its primarily younger audience that has not yet learned to read a disclaimer (Levinson, 2021).

YouTube Kids, the part of the site meant to host videos specifically for children, has come under fire for recently strange and disturbing content that was auto-played or recommended to its young viewers (Papadamou et al., 2020; Bridle, 2017; Orphanides, 2018, Balanzategui, 2021). Given the extremely large and young base of YouTube users and YouTube's model of paying content creators some portion of advertisement revenues, where more streams earn the creator more money, producing viral videos for children on YouTube can be highly lucrative, as we can observe in the case of Ryan's World. In a bid to piggyback onto the viral pull of trending kid's video keywords, many channels, sometimes called 'content farms', upload high volumes of low-quality animated videos featuring trending or popular characters (such as 'Peppa Pig' or *Frozen's* 'Elsa'), acting out a video in a trending format (such as a nursery rhyme video or a 'Finger Family' video), as the demand for such content is strong (Bridle, 2017). This proliferation of largely generated content often yields highly 'uncanny' results, where animated characters move and speak in unnatural ways, voiced sometimes by script-to-speech algorithms rather than by voice actors. Bridle (2017) notes that even when these videos are acted or voiced by humans, it is difficult to determine to what extent the YouTube algorithm has shaped the content, as the same unusual array of characters and behaviors reappears. Videos featuring these content keywords are boosted because the topics are viral and popular, further increasing their virality and popularity, then creating a demand for

creators to lean further into mixing and matching trends to produce more similar content, in an odd, generative loop (Bridle, 2017). Reports of this phenomenon broke into the mainstream media in YEAR, leading to wider discussion and concern over disturbing videos on YouTube that are directly recommended to children (Balanzategui, 2021).

YouTube's autoplay, especially when it leads to dark or dangerous content, is working against children's well-being in that they may learn dangerous or violent behavior, but also in the sense that their autonomy is being usurped rather than developed. If virtual reality is indeed the next hot medium for consuming everyday content, as Meta hopes (many are not convinced, i.e., Pieters, 2022), then it must be considered how patterns and techniques such as embedded advertising and algorithmic boosting of inappropriate content may be medium-dependent. In the next section, medium-specific qualities of virtual reality are discussed with respect to children as users.

3. Children in Immersive Virtual Reality

Immersive virtual reality is made 'immersive' by causing the user to forget that their experience is being mediated at all. In such an immersed state, the user ideally no longer notices the pressure of the headset against their face or the fact that the world they are navigating is projected onto a screen just in front of their eyes. Key to inducing this sense of presence is the embodiment that one feels in a well-designed virtual reality experience. Embodiment is the sense of having a physical body in the virtual world, one that moves about the world according to the user's intended movements, and may affect the world in ways the user intends (Bailey et al., 2016). Embodiment in IVR is enabled by tracking technologies built into the headset and controllers, often held in each hand during use. Compared to web browsing, or other activities on a laptop, the data gathered are more granular biological kinematic data rather than purely behavioral on a 2D screen. Some research implementations include gaze tracking, a feature that may soon become more widely implemented in commercial IVR, as Meta plans to do with an upcoming IVR headset (Robertson, 2021).

These immersive factors differentiate IVR technologies from earlier forms of media like television or mobile phone use in that they aim to shut out sensory input from the outside world completely, making the content inside the virtual world seem much more real. This has a strong impact, particularly on children. A key study found two relevant differences in children's experience of virtual reality as compared to less immersive media: young children struggle more to inhibit dominant motor responses and they are more likely to perceive characters as socially real and obey their requests in immersive virtual reality (Bailey et al., 2019). This study had two conditions - one where the researchers had the children wear an IVR headset, and one where the kids sat in front of a TV screen. The authors investigated three key hypotheses: they believed that the increased salience of the IVR condition would make it more difficult for children to exhibit inhibitory control behavior, that the increased sense of reality of Grover's character in IVR would make social compliance to a request more likely, and that the children's inclination to share a prized item with Grover would be higher in the IVR condition, where the character seems more real. The authors were able to show significant effects due to condition for the inhibition control and the social compliance hypotheses, but not the sharing hypothesis. They suggested that the increased salience and reality of the character in VR made the Simon Says inhibitory control task more like playing with a real person, and pointed out that

the easily controllable VR scenarios could be useful for controlled executive functioning testing (Bailey et al., 2019).

The new immersive affordances of IVR and their psychological impacts on children as detailed above are in some ways instrumentally good for many items on the children's well-being list. Enhancements to education are a prime example. IVR solves key issues that arise when children are learning via screens, which became increasingly common in the past decades, especially since the coronavirus pandemic (Hassinger-Das et al., 2022). Hassinger-Das and co-authors (2020) summarize recent results on the utilities and shortcomings of educational digital media by evaluating them through the lens of core principles from the science of learning, referred to as 'the four pillars of learning science.' These comprise 'active,' 'socially interactive,' 'engaged,' and 'meaningful' aspects of learning (Hassinger-Das et al., 2020). The authors evaluate television and video media as well as e-books and apps in terms of how well they enable each pillar. For example, considering the 'active' pillar: while television programming at its baseline is not interactive, programs such as *Blues Clues* that encourage participation from young viewers improve the viewer's comprehension of the educational content (Calvert et al., 2007, as referenced in Hassinger-Das et al., 2020). Immersive virtual reality, while discussed at the end as a 'new frontier', is not evaluated for each pillar, perhaps due to a paucity of relevant research.

However, the immersive and computable aspects of IVR solve many of the issues presented by less immersive traditional media when evaluated from the science-of-learning pillars perspective. Following the previous example, children playing along to a *Blues Clues* scene could have deeper interactions with the characters in virtual reality as these characters could be engineered to conditionally respond to the children's active participation. This is made possible by the fact that the child's movements are necessarily measured via the virtual reality system. This feedback and the corresponding individualized interaction would allow for a more active, engaging, and potentially personally meaningful experience. The ability of immersive virtual reality to render individuals proximal to each other in a virtual space, even when those users are at a distance in reality, could further enhance the social aspect of such an experience. Instead of experiencing *Blues Clues* on their own, children engaged in virtual reality educational programming could be watching in the same virtual living room as other kids down the block or across the country.

Immersive VR addresses key issues initially presented by on-screen learning: children may better associate new concepts with their real-world equivalents, and help limit outside distraction as compared to traditional media. Aladé et al. (2016) studied the effects of the interactiveness of educational media (a non-interactive video versus a similar interactive tablet lesson) on task performance and skill transfer. The authors noted both pros and cons of the increased interactivity condition, ultimately suggesting that the context of the tablet made it difficult for subjects to carry forward what they learned into new contexts (Alade et al., 2016, as cited in Hirsch-Pasek et al., 2019). If the screen-context issue was what was preventing those subjects from transferring their skills to novel tasks, immersive virtual reality, a medium that seeks to disappear, could solve this issue by bringing the 'on-screen' context into three dimensions and closer to real life. This same effect could solve a problem illustrated by Gola et al. (2013), whereby children learn best when playing physically with a representation of the same character they are watching on the screen (Gola et al., 2013, Hirsch-Pasek et al., 2019).

Furthermore, as immersive VR blocks out sensory input from physical reality, outside distractors are more limited than when viewing educational content through traditional media, potentially blocking interruptions to play (Schmidt et al., 2008, Hirsch-Pasek et al., 2019).

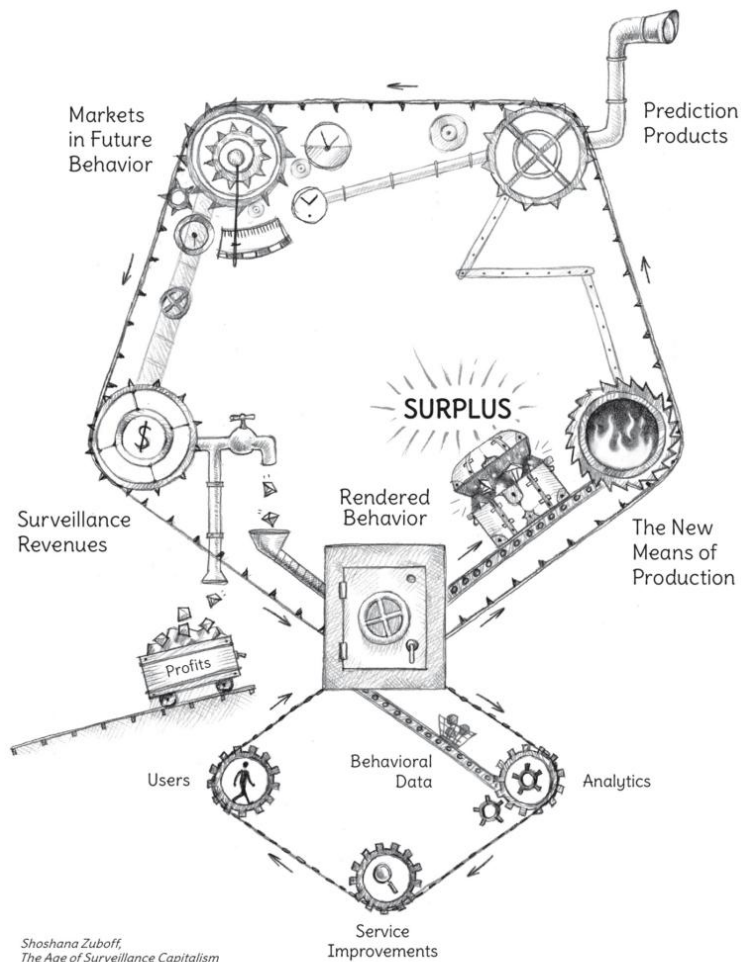
Immersive virtual reality should be no substitute for time face-to-face with a human caregiver. But if the alternative is descending into YouTube Kids as a time sink, even with content labeled by YouTube as educational (which, as we've seen, may not be at all age-appropriate), perhaps IVR could better serve learning outcomes while keeping the child occupied. To best understand the motivations of the companies that manufacture and market IVR technologies to kids, one must consider the method by which these firms make most of their profits: surveillance capitalism.

4. Children as Targets of Surveillance Capitalism

While the intensely real flavor of IVR offers benefits, the array of potential dangers to children is broad. A recent literature review (Kaimara et al., 2022) outlines risks in three categories: physical, cognitive, and psychosocial. Physical risks examined included cybersickness, obesity, sleep disruption due to excessive blue light; and radiation exposure. In the cognitive domain, both risks and benefits were associated with attention, learning, and spatial cognition. Further psychosocial issues were discussed regarding their association with IVR use, such as anxiety, addiction, and Internet Gaming Disorder. However, notably missing from this otherwise exhaustive review was a treatment of the risks associated with the new methods of surveillance capitalism enabled by physiological tracking (body output) and control over sensory input (body input) technologically required for IVR experiences.

Shoshannah Zuboff's concept of 'surveillance capitalism' is a useful lens through which to examine corporate technical practices that make use of personal data to target advertisements, monetize attention, and modify behavior on a large scale. The very companies that developed and honed these methodologies are those that design the hardware and software underlying the most popular commercial IVR systems: Meta and Google.

Figure 1 (Figure 2 in *The Age of Surveillance Capitalism* [Zuboff, 2019]), titled, "The Discovery of Behavioral Surplus", begins with users using digital products, like Google Search or Meta's Facebook and Instagram products, on the bottom left. Users behave in measurable ways - they search certain queries, they click on certain photos. This "rendered behavior" feeds down into the lower loop of analytics, which allows for service improvements, optimizing how useful a given user's Google search results are or selecting the cat videos they are predicted to enjoy. This in turn is designed, in the case of Google, to monopolistically perform a valuable, everyday service, and in the case of Meta's social media products, to keep users scrolling through their social media feeds and returning regularly. The process also feeds this behavioral data, which Zuboff calls 'behavioral surplus', up into the upper loop, fueling the creation of "prediction products", also powered by machine learning algorithms. This is targeted advertising - using the vast data gathered about each user, directly from their entries or covertly from context, to predict many manners of their behavior with high accuracy. The companies sell these predictions to advertisers, who capitalize by selling those users exactly the products they were predicted to have wanted, which is markedly more successful than advertising without prediction products, yielding massive added value. The companies selling goods and the advertisers they hire then pay exorbitantly for this service, yielding surveillance revenues and profits, at the end of the upper loop on the left.



Shoshana Zuboff,
The Age of Surveillance Capitalism

Figure 1 (Figure 2 in original text): The Discovery of Behavioral Surplus (reprinted from Zuboff, 2019)

The second key figure, titled ‘The Dynamic of Behavioral Surplus Accumulation’, details how Surveillance Capital mechanisms search out increasingly invasive and predictive sources of behavioral surplus, using an apt snowball metaphor. Each level of the snowball’s descent toward the village at the base of the mountain is a source of data - current mechanisms work off of user online behavior, which is plenty rich for massive modern-day revenue. But ubiquitous computing products like Alexa are equipped to gather behavioral surplus on the ‘Your Daily Life’ tier, outside of computer-mediated behavior on the Web. Next-gen smartwatches now gather data intimately from the body directly, on the ‘Your Body & Self’ tier. Fully realized immersive virtual reality for surveillance capitalism belongs somewhere on this level, and perhaps towards the ‘Modified Behavior’ tier at the bottom of the slope, nearest to the town. Eye tracking is easily implemented on head-mounted displays, the data from which yields powerful knowledge about the salience of any given object in the environment. The user that casts a longing gaze at the (virtual)

polished shoes for which he’s been considering a splurge then alerts the shoe company’s advertisers of the high probability that he is interested. Perhaps there needs to be no human in the loop, and this user’s high measured salience value of the shoes triggers the same shoes to be rendered on attractive or high-status individuals in this virtual world, *tailored just to this user’s experience* (the same avatar’s shoes could be rendered differently to other users), depending on the ‘ad spend’ by the shoe company with the platform’s advertising business.

Virtual reality is necessarily a condition in which one’s motor behavior is almost completely read from and one’s targeted senses are completely written to. Ryan the Famous Young YouTuber’s embedded ads now become three-dimensional and lifelike, perhaps the Lego set that was predicted to be popular to a given seven-year-old is made to appear on a shelf of the virtual room in which he meets and speaks to his friend’s avatar. It can be made to flash and shake as he passes his tracked eyes over it. Any rendering is possible. Zuboff’s work is useful in framing the lucrative feedback loops that power the “inevitable” progression of ubiquitous and powerful displays.

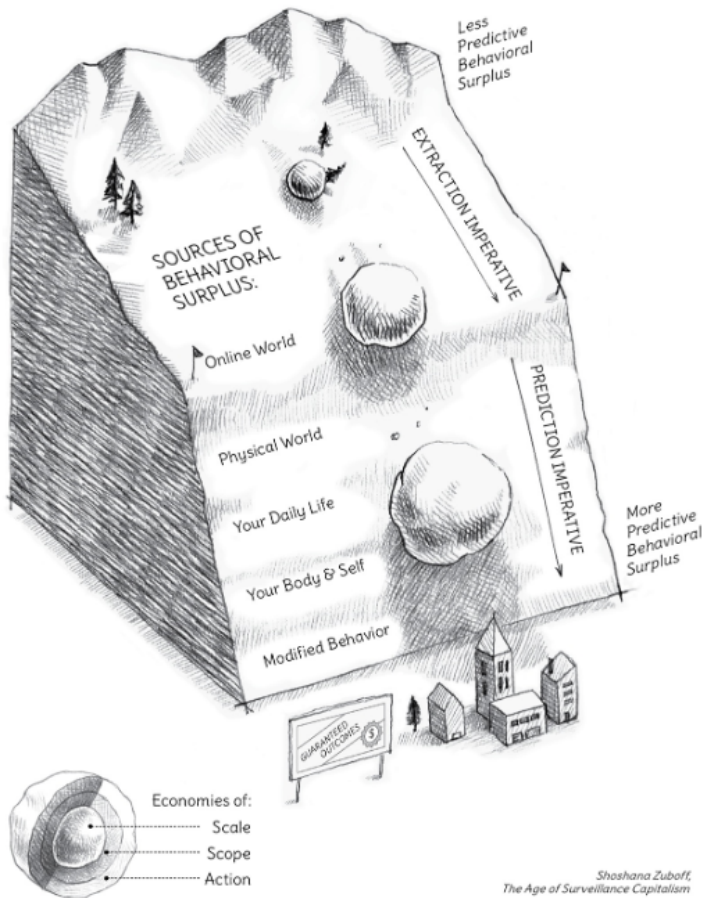


Figure 2 (Figure 3 in original text): The Dynamic of Behavioral Surplus Accumulation (reprinted from Zuboff, 2019)

While the operational mechanism of how profit is gleaned from behavioral surplus has been clarified, what remains unclear is the extent of the drawback of this process for the everyday person. After all, highly useful services like Google Search and Google Maps and highly entertaining networks like Facebook and Instagram are free, in terms of money, to use. The crux of the argument for why an individual's use of these products is net-harmful, as crafted by Zuboff, takes the form of a descriptive personal essay. Key background to this descriptive essay is her history of surveillance capitalism is her uncovering of its theoretical underpinnings. She links the contemporary practice of predicting user behavior to the theories of B. F. Skinner, who put forward evidence from his studies on operant conditioning to argue that animal behavior was a function of stimuli and their context and that behavior was shapeable with carefully crafted reward and punishment programs. Skinner also argued philosophically and prescriptively via his novel, *Walden Two* (1948) and other works, such as *Beyond Freedom & Dignity* (1971), that not only were humans in a behaviorist sense 'programmable' but that they should indeed be 'programmed' on a societal scale, as he considered individual

'free will' to be an illusory construct invented to explain yet-to-be scientifically described cognitive processes (Zuboff, 2019, p.367).

Zuboff, pulling together ideas on free will from Arendt and Searle, connects anti-behavioralism freedom to the language of rights, coining '*the right to the future tense.*' She begins with the meta example of her efforts to write *The Age of Surveillance Capitalism*, describing her experience dedicating hours to the long-term effort of completing the book, out of her desire to finally accomplish its completion. Her prediction of her own future, and her actions to make that future a reality, constitute, in her words, her '*claim to the future tense.*' Extending Arendt's concept of will as an '*organ for the future*', Zuboff brings the appropriations, predictions, and modifications of *the organ for the future* into the language of bodily harm:

The freedom of will is the existential bone structure that carries the moral flesh of every promise... These bones are the necessary condition for the possibility of civilization as a "moral milieu" that favors the dignity of the individual and respects the distinctly human capacities for

dialogue and problem-solving. Any person, idea, or practice that breaks these bones and tears this flesh robs us of a self-authored and we-authored future (Zuboff, 2019, 331).

Problems remain with this optimistic treatment, the most pressing of which is the unpleasant philosophy of behaviorism, that 'will' can and eventually shall be reduced to predictable scientific descriptions, goes still unanswered. Rather, it seems that the course of action suggested here is that we should not attempt to answer the freedom issue as this poses problems for the way that we conceive of ourselves and others, and threatens our 'right to the future tense'. Zuboff does well to counter that rights don't have to originate in scientific results to be useful in protecting the good human life, but rather should be accepted if what was once taken for granted becomes threatened. In exchange for the 'free' service from Google and Meta, users at scale give up the reins to a small part of their own future, a disastrous cost (Zuboff, 2019).

Kant might have agreed with Zuboff that surveillance capitalism practices of using prediction products to drive behavioral modification to drive revenue, may be painted as inhumane, as it threatens the consumers' autonomy. The Kantian view is that a key separation between humans and animals is that we are capable of acting for reasons that we have ourselves come derived instead of solely instinct (Schapiro 1999 as referenced in Hannan 2018). Surveillance capitalism that aims for behavioral modification can be seen as inhumane in the sense that it aims to manipulate behavior, not through rational argument (i.e., an advertisement that persuades one via rational argument to buy a product), but through a lower level, personalized manipulation that is targeted to baser instincts, for example, 'dark' design patterns that make the 'buy' button larger to raise the likelihood that you will click it (dark design patterns). These are, however, often difficult to tease apart, in that surveillance capitalism practices that martial personal data are sometimes used to craft a personalized yet rational targeted advertisement. Some individuals prefer targeted advertisements as they may guide the consumer to products they would want but were not yet aware that they *did want* (Marrotta et al., 2015). It can perhaps fairly be said, then, that the calculated, personalized approach, using personally-tuned behavioral modification techniques to drive consumer behavior, fed with data beyond what the consumer intended to share, is the aspect that constitutes inhumane treatment, according to Kant.

Children, in particular, are vulnerable to the now-clearer costs of surveillance capitalism. By definition, children have a greater quantity of future than adults. However, children have less of an immediate 'right' to their future tense. Zuboff places special importance on the idea of a promise as a bond between present and future, and a connection to another actor about what will happen in the meantime. Children cannot make legally-binding promises on their own, and even more casually, the value of a child's promise is generally related to their age (one would expect a 16-year-old to be more likely to keep a promise than a 4-year-old) (Lyon and Evans, 2014). Their right to the future tense is in a sense in the custody of the adult(s) who are caring for the child. This is especially true according to the view that a child's autonomy develops over time continuously, and given that the capacity for autonomy is both required for and protected by Zuboff's right to the future tense.

Key surveillance capitalism methods and examples that target children specifically further illustrate that the child's right to the future tense is both especially valuable, morally and monetarily, and especially vulnerable. Education technology, shortened to 'Ed-Tech', is a

growing market for software and machine learning products that can streamline teaching and assessment. A significant portion of the demand in this sector comes from public school systems, which often contract tech companies to use their software for educational purposes, prime examples being Google Classroom and ClassDojo. Some of these products are also 'free' in the earlier surveillance capitalism sense, in that they churn out profits by measuring and analyzing user behavior (Figure 1). Stockman and Nottingham (2022) consider the educational impact of surveillance technologies in schools, uncovering complicated and conflicting power structures, such as the rights of European children over their digital data under the General Data Protection Regulation (GDPR) versus the mandate of the school leadership to efficiently and successfully educate the students. They point to concerns that cash-strapped educators cannot afford to be critical about tools that come at no monetary cost, setting a poor example for their pupils concerning critical thinking ability. The authors conclude that digital surveillance in educational contexts serves many purposes, including the school's goals, but that third-party commercialization of data works against the 'development of a healthy personhood,' using David Lyon's 'personhood' concept of identity and responsibility in digital citizenship.

In Stockman and Nottingham's account, the public interest of education where the goal is 'to help the children' represents a nuanced entry point for surveillance technologies without protest. The ethical painting of surveillance practices goes from more seemingly black and white in the case of commercial use to a gray zone when surveillance is employed in the public interest and not explicitly for profit; for example, a school or federal education bureau that employs surveillance-enabled educational technologies in the classroom to keep students safe from online bullying.

That surveillance capitalists would seek out a gray-zone use case/port of entry to a new user base aligns cleanly with key properties of surveillance capitalism that Zuboff puts forth - namely that a larger user base is always sought after, and that surveillance capitalism seeks to remain under the hood, undetected or at least not understood, by the users who generate the profits. While describing Facebook's social contagion large-scale research project on Australian youth, Zuboff highlights Facebook's successful efforts to manipulate individuals without their awareness, writing "This evasion is neither accidental nor incidental, but actually essential to the structure of the whole surveillance capitalist project. Individual awareness is the enemy of telestimulation because it is the necessary condition for the mobilization of cognitive and existential resources" (Zuboff, 2019, 306). This line of reasoning leads to the principle that self-awareness is essential to self-regulation, and therefore a host of other cognitive capacities that Zuboff asserts compose 'freedom of will'. Children, who are still learning to self-regulate and become self-aware, regardless of subtle online influences, are then excellent targets for such manipulations, as their defenses remain untrained.

The consideration of surveillance capitalism as interfering with one's right to the future pertains directly to the philosophy of children's rights and autonomy, wherein one accepted theoretical approach to developing a child's autonomy considers raising a child for a 'maximally open future.' Hannan (2018) insists on the importance of examining the question of children's autonomy, pointing out that the autonomy of an individual largely shapes how we should treat that individual. She argues that children naturally gradually become more autonomous through development and that if we find that 15-year-olds are as autonomous as 40-year-olds, it is wrong of us to restrict the teenager's behavior. Importantly for this discussion, on the subject of

children who are not yet autonomous, Hannan imports Feinberg's (1992) idea of anticipatory rights - that it is because of their potential to later become autonomous that young children should be led to a life with many choices and possibilities over which they may then exercise their autonomy. This point of view is extended by her treatment of Matthew Clayton's independence account of children's autonomy, which leads to the (somewhat extreme) conclusion that the job of a caretaker is to keep the life of a child so open as to not actively enroll them in any activities so as not to usurp the child's independence even in the slightest, where possible, even for their later, greater good. Finally, these connect back to Noggle's (2018) discussion of children's rights, which follows similar lines of heteronomous children still deriving special status as pre-autonomous beings. Feinberg appears yet again with a mention of 'rights in trust'.

The threat of surveillance capitalism to the individual's right to the future tense is therefore compounded in the case of children. Children have a right to an even broader future tense but, especially for children still lower down on Hannan's autonomy continuum in most domains, are not yet able to fully claim that right, and may not yet enjoy its benefits. It is therefore the job of caretakers and society at large to protect that right-in-trust, pulling from Feinberg, more directly and explicitly than we do for the full adult individual, which is already too little, as Zuboff argues passionately for stronger regulation across the board. This idea of protecting a child's developing autonomy in safeguarding the openness of their future is in direct opposition to the surveillance capitalism ideal: the most lucrative futures are the predictable ones. Zuboff describes it as trading in 'behavioral futures'. Maximally open futures mean lost profits. The threat and the corresponding imperative to protect against it compound again in the case of new immersive technologies such as Immersive Virtual Reality, appealing especially to children, simultaneously yielding unprecedentedly predictive and lucrative personal information available to be harvested and milked for surveillance revenue and profits.

5. Tying it all together: Children and Surveillance Capitalism in Immersive Virtual Reality

For all the surveillance ambitions baked into the business plans of the companies that manufacture IVR, virtual reality in many ways could be a valuable tool in aiding the 'goods' of childhood, as laid out by Noggle (2018) in reference to Tomlin (2018): '...free and unstructured time, play, pretend, and make-believe; a sense of wonder; and an innocence... the flourishing of a child as a *child*' (Noggle, 2018, emphasis in original). As evidenced by the eagerness exhibited by Kashmir Hill's (the New York Times reporter) 5-year-old daughter in the introduction, virtual reality can be seen as a concentrated effort to make make-believe worlds more real, a heavy investment in play and creativity, not exactly necessary for a child's well-being but potentially very germane to it (again, depending on content).

However, to the extent that virtual reality is designed to abet surveillance capitalism processes, it works fundamentally against a child's well-being and interest, which include, perhaps most importantly, the development of autonomy. This final section seeks to elucidate how virtual reality technology opens new frontiers and capabilities in the data-harvesting and behavioral-prediction/modification cycles of Zuboff's Surveillance Capitalism, potentially harming children's developing sense of autonomy in the process.

Researchers have begun to warn about the misuse of non-verbal data via IVR technologies. Writing in the Pediatrics volume of the Journal of the American Medical Association, Jeremy Bailenson emphasizes the volume and intimacy of the data gathered via tracking capabilities, noting that 20 minutes of VR use can yield approximately 2 million data points. Additionally, these data consist of largely involuntary or nonconscious responses, as compared to more intentional behaviors via the clicks and text entry that can be measured on the internet (Bailenson, 2018). Egliston and Carter explore Meta's Oculus products through the lens of Critical Data Studies, examining how spatial sensing marshaled for IVR technologies may 'reinforce unequal power relations.'

The ability to read from the body at new levels is not the only concerning capability introduced by IVR--by writing directly to visual and auditory senses (and increasingly other senses too, see Micaroni et al., 2019 and Dangxiao et al., 2019), virtual reality's latest step comes ever closer to closing the loop between measuring what is desired and producing it. Generative algorithms such as Generative Adversarial Networks, or more recently, stable diffusion algorithms could perhaps largely relegate humans to just monitoring the creative loop. Instead of targeting results calculated from physiological data encouraging an advertiser to embed a certain brand of toy in a specific young user's virtual playspace, more subtle computations could take place where the playroom, from the proportions to the colors, is itself generated to optimize behavioral variables such as toy use or brand preference. This takes 'embedded' advertising to a new level - the nudge or behavioral modification becomes more deeply embedded in the user environment, in ways that are inexplicable from the machine back to the human developer - derived covertly from the many millions of gathered data points.

As before, this follows with the principle of surveillance capitalism's desire to maximally obscure its workings to its targets. Immersive virtual reality in this sense is the ideal medium for surveillance capitalism, one that seeks to disappear from the user's gaze by coming so close that it is not looked at but looked through, not acted upon but acted within, more appendage than an external device. Furthermore, the content/real-life boundary blurs within VR. Whereas all content on social media platforms like Instagram was identifiable as content, contained within the boundaries of the screen, virtual worlds make social sharing of space possible. Hill, the New York Times reporter, attends standup comedy in the Metaverse. While this was one-to-many with a Facebook video, Hill can turn to the avatar next to hers and talk about the performance - a many-to-many situation. When these worlds are constructed by social media companies, it may become difficult to discern the extent to which a given interaction is content versus an uncurated experience. That distinction itself could break down. Children already have trouble determining when a character they like such as in a YouTube video is performing a service for an advertisement to sell them something. Children learn that actors, playing characters other than their own person, do not appear integrated into real life but on screens or stages only. Embedded characters, made more real in immersive virtual reality, could have heightened persuasive power to child users than the same characters in two dimensions (Bailey et al., 2019), giving developers more powerful tools for behavioral modification in service of surveillance revenues.

The scope of this work was to uncover the surveillance capitalist threat posed by IVR to children's well-being, crucially its impact on the developing autonomy of child users. Specifically, as children are still building their understanding of advertiser motives as well as learning to

discern fantasy from reality, they remain prime targets for targeted ads on YouTube and other platforms. Because virtual reality technologies afford developers unprecedented access to the physiological and kinesthetic data required as input to the device, IVR could quickly become a valuable new tool for surveillance revenues, as hinted to by Facebook's pivot to Meta and the Metaverse. The confluence of these factors--young users, vast data flows, increasingly immersive and seemingly unmediated virtual worlds--yield a considerable new problem for regulators and caregivers to consider. This view is beginning to drive further regulatory action, with US lawmakers signaling intent to marshal existing internet protections (COPPA, as discussed earlier) for children and their data in virtual reality spaces (Markey, press release, 2022). While COPPA has had only mixed success as a tool for reigning in tech giants from mining children's data for profit (Levinson, 2021), these developments may prove crucial in the success of efforts to protect children's developing autonomy in virtual spaces.

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