



Living the Future:

The Technological Family and
the Connected Home

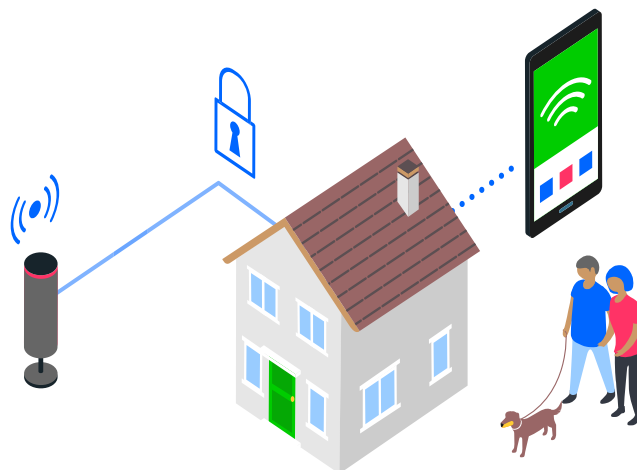


Professor Lynne Hall

in partnership with Internet Matters

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Foreword

Carolyn Bunting

CEO, Internet Matters

Whilst many families might have had a chequered relationship with their children's connected technology, there can be no doubt that the global pandemic has changed the way we feel about it, potentially forever. It has been the thing that has held us together socially and emotionally, it has been the key to home schooling our children and enabling us to connect with our parents. This report suggests our lockdown experiences will have a longer-term impact on our behaviours and the technology we adopt in our homes.

With the support of our long-standing partner Huawei, we are delighted to have been able to work with the University of Sunderland to deliver this timely and insightful report. It shines a light on how technology might be used by the family in 2025 and beyond. Children, young people, technology thinkers, child safety experts and academics have all contributed, and together they suggest a family life where the home is even more

central to our lives, as technology compliments our desire to be ever more efficient, entertained and more widely connected. The report is richer for their contribution and we are indebted to them.

Understanding how young people both use and think about technology has been critical in thinking through the issues raised in the report. Society needs our best thinkers working out how to enjoy the benefits of connected technology safely. The tech coming into our homes is designed precisely to be convenient, to entertain and perhaps to educate. With the deployment of home tech at scale comes a raft of safety and privacy concerns.

This report airs those issues – and acknowledges the reality that for many families, convenience trumps online safety. That means its even more important that we all take seriously our shared responsibility to minimise the risks so that children can thrive online. That conversation has never been more necessary.

Victor Zhang

Vice President, Huawei Technologies

Huawei is proud to be a partner of Internet Matters and to support its important work to keep children safe online. We are also pleased to sponsor: 'Living the Future – The Technological Family and the Connected Home', a research report which looks at the challenges and opportunities presented by new technologies in the home and their intensified use during the lockdown.

At Huawei, our responsibility, right across the world and here in the UK, has been to help keep communities connected. As a manufacturer of network equipment and the world's second largest producer of smartphones and other home technologies, we are committed to bringing the benefits of the digital revolution to everyone.

Nowhere is that more evident than the impact it has on young people. It not only broadens the knowledge and information young people can access, but also improves their education and life chances.

Technology plays a crucial role in connecting not just wider society but families and friends. As this report shows, families everywhere are adapting how they socialise, work and consume entertainment in the home.

We share Internet Matters' commitment to ensuring that during this period of great change children are kept safe online as they learn, communicate and play. We would like to thank you for reading this important research report and hope it will advance our thinking on how to work towards better-connected societies and families.

Methodology

We took a wide approach to gathering information:

- **Rapid Evidence Assessment (REA):** review of research, technical and grey (policy and stakeholder) literature on technologies in the home and family focusing on Smart Home, Voice Assistants, Virtual Reality and Interactive Toys. From the evidence we identified and developed a series of themes and gaps for further exploration.

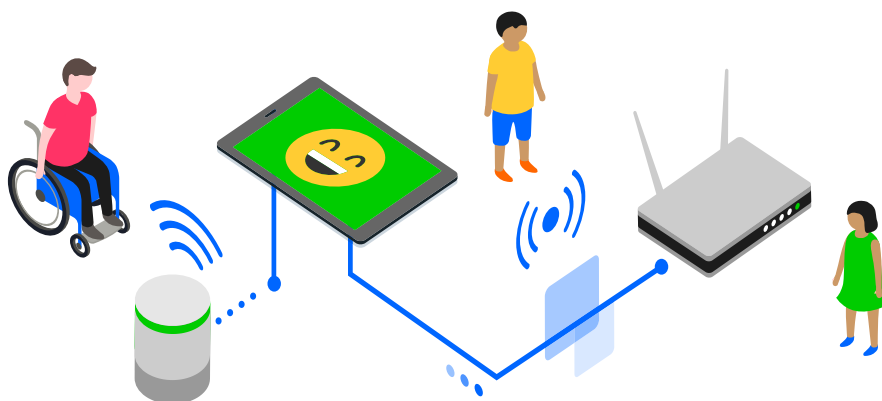
Before COVID-19

- **Expert Interviews:** interviews involving 15 experts from universities, technology corporates and stakeholder organisations to explore their perspectives on near-future technology in the home.
- **Delphi Study:** based on the REA and the expert interviews, questions were created for a 2-round Delphi study, involving 21 experts from universities, technology corporates, stakeholder organisations and also schools.
- **Workshops and Questionnaires with Teenagers:** using qualitative, quantitative and speculative design-based approaches to consider the future with 136 teenagers, giving their views and perspectives on technology and completing questionnaires.

- **Parent Questionnaire:** through an online survey, parents were asked about their views of future home technologies, to which 402 parents responded from across the UK with all age ranges represented for both children and parents.

During COVID-19

- **Longitudinal interviews:** 13 families participated in 3 phone interviews – at the beginning of lockdown (late March/early April), mid-lockdown (early May) and as lockdown was beginning to ease (early July) with parents talking about their family's experiences of living, learning, working and socialising in the home.
- **Parent Questionnaire:** in late May/early June a further online survey was carried out with parents about their lockdown experience and use of technology in the home to support work, learning and social life. We received responses from 232 parents across the UK who were also asked for their views on future home technologies.





Executive Summary

This report provides a spotlight on the future of technology and impact on the family and home in the next five years. Aiming to provide a future scene setter, the focus is on home technologies likely to have an impact on families including smart devices, voice assistants, interactive toys and virtual reality. This research looks at how technology has changed and will continue to change family life and the benefits and challenges this creates.

There are many different family types and homes in the UK. Families live in a diversity of spaces and ways, from extended families with grandparents providing childcare to single parents with no family support. From fragmented families with children having multiple homes and relationships, to the traditional family of two parents, two kids and a bedroom each, and families living in cramped homes (or rooms) struggling with their finances. There is no singular notion of 'The Family' and we acknowledge upfront that our findings and conclusions may not be relevant for every family or home. Even so, technology advances - most notably superfast connectivity - will have an impact on almost all families.

Though key workers including medics, shop workers, teachers and delivery drivers went to work during the COVID-19 lockdown, their social and family life, just as for everyone else, was locked to the home. As families stampeded onto the internet, suddenly, the industry and research hype and benefits of the connected home and family were clear. Technology provided our only portal to spaces and faces beyond our household.

COVID-19 further highlighted the broad spectrum of family types and homes, but also, as was so evident during lockdown, very different kinds of access to technology and connectivity. COVID-19 has changed use and perception of technology for the family and the home so significantly, it required a reconsideration of earlier findings in response to this paradigmatic shift.

From the research, the main findings and predictions are:

1. Homes will be voice-enabled with a blurring of the Voice Assistant and the house itself, achieved through a significant rise in smart devices. The Voice Assistant will be a home control, personal organiser, entertainer and source of information. Everyone will have one and it will connect families and homes.
2. Concerns around data mean that families don't necessarily trust the technology that connects them – it's not a friend. However, as they get used to the benefits this domestic technology brings, their initial concerns about data deployment and privacy seem to fade. All players in this field – families themselves, tech companies, privacy and safety campaigners and regulators have a role to play to determine whether this passive acceptance and ensuing data sharing is desirable. At the very least, users should have more information on what data is used and how, so that they are better able to give informed consent.
3. vCommerce or shopping through a Voice Assistant is on the rise and will be another typical way to shop for many families. Living with COVID-19, families do less convenience purchasing, requiring a complete shopping list for delivery. Voice will make this easy to compile, order and track.
4. There will be more screens, media channels and content in homes than ever before, but families may be forced into funnels by algorithms that provide children, teenagers and adults with the same content recommendations. This is another cause for concern with the retreat into the home potentially accompanied by the establishment of a personalised echo chamber.

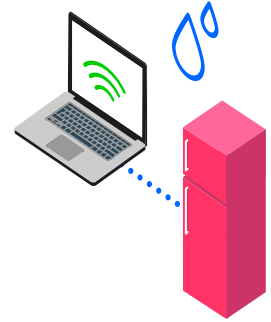
Work began on this report into future technology and family life in late 2019, around the same time COVID-19 emerged. The home as the place families would stay in and do most everything from was no longer a prediction, it was to become an enforced reality for many.

5. It was already predictable that families would be more at home, physically meeting less but more connected with friends and family beyond the home. Coronavirus has reinforced this and from now until at least 2025, homes will be more central to family lives than for generations. External communications will be virtual and internally the Voice Assistant as messenger and mediator will provide a way of communicating within the home.
6. Families and children living with no or limited connectivity and without devices appropriate for learning and socialising are excluded not only from everyday activities but from aspirational futures. The solution to this social challenge is to connect homes and provide children with devices. Such inclusion to the connected world could have more impact on children's potential to 'level up' than almost any other intervention strategy or policy, particularly in a new normal where without connectivity lives are less rich, engaging or enjoyable.
7. Virtual Reality is for the next generation and will be taken far beyond gaming with 5G and gigabyte broadband providing the breakthrough of connectivity, bandwidth and speed needed to support interaction in these new spaces. Unlike in industry, it will not be realism that wins the race, instead Virtual Reality will be more about what can be done with it to support socialising, streaming and new ways to play.
8. Stories of security flaws found by consumer organisations have driven caution around interactive toys, but recent innovations such as Voice Assistant-enabled toys are likely to have great success. COVID-19 has highlighted that toy tech for remote collaborative play is not available and again this use case is one with considerable opportunity for toy manufacturers and tech corporates.
9. There are considerable implications for design and security as tech learns ever more about the families who use connected products and opens up new routes for young people to socialise and access content. Ensuring that legislation and compliance are in step will be critical to minimise risk for families, to shine a light on how data is collected and used and the implications for homes as truly private spaces.
10. The growth in children's screen time and use of connected technology, escalated during the coronavirus pandemic, illustrates the ongoing need to continue the dialogue on digital literacy. As technology enhances the ability of children and young people to access multiple virtual worlds and meet in virtual spaces, to live the future families must be educated on maximising benefits as well as reducing risks in their connected home.



The 2025 Smart Home





While more technology will appear in our homes, the bigger change for the family will be that they speak to it and it will be speaking to them.

What will family homes look like in five years' time? The technology families have access to will drive big changes in the way they live, how they interact with devices in their homes and as a consequence, with each other.

With gigabit capable broadband enabling connectivity in homes and 1.4 billion smart home devices predicted worldwide by 2023¹, smart appliances, utilities, screens, security cameras, lighting and plugs will be seamlessly integrated and designed into furniture and homes. This is even more certain in a world where families may be spending more time at home, needing more space and wanting domestic life to require minimal effort.

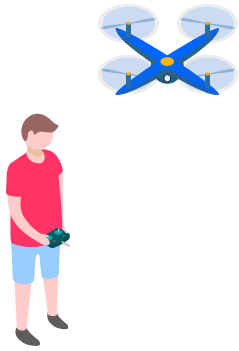
To make life easy, families will choose a smart home platform and it's likely Amazon and Google will dominate². This will drive product development as families buy compatible devices to avoid connectivity challenges. Some 42% of families in our study already have connected devices and they are on the wish list for another 39% who are intending to buy. In normal circumstances, the traditional bell curve of technology adoption would be expected, with the natural replacement of old technology with more useful, integrated and connected devices. But now a very different trajectory may emerge, with much faster adoption would be expected, coupled with significant development and innovation in home-tech as the smart family is forced into existence.

Wires and boxes will disappear, screens will be ever thinner and chargers integrated. Homes will be multi-screened³ with each screen having multiple purposes - relaying family messages and providing scheduling alerts as well as shopping, communication and

entertainment. Families will have dedicated spaces for technology-mediated engagements set up for them to work and socialise.

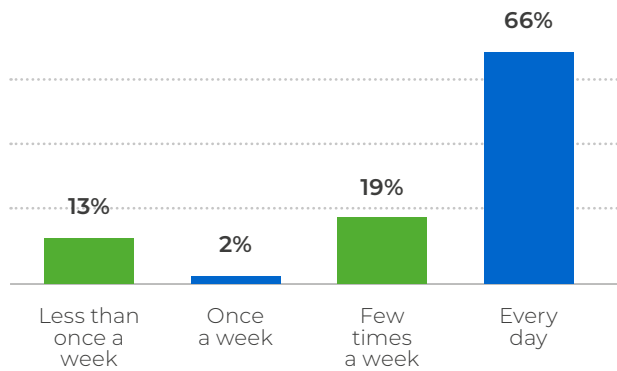
While more technology will appear in homes, the bigger change for the family will be that they speak to it and it will be speaking to them⁴. Voice will be the main way families engage with technology in the home, with voice activation automatically bundled in domestic technology, such as lights, heating systems and white goods. In the Delphi study, technological experts and academics, along with market, technical and research forecasts⁵, agreed that families will mainly choose voice over dials, controls and buttons. It will be easier and children will adapt even quicker than parents. By 2025, 7-year-olds will use voice to select what they are going to watch, search for information or ask what time dinner will be ready.

With the increased use of voice-enabled technology comes the increased use of Voice Assistants. Like smartphones today, soon families won't be able to imagine how they managed before they had them. In our survey, 62% of families had one and ownership will grow, with multiple devices appearing in homes⁶. Within five years it is expected that most children from birth upwards will have Voice Assistants in their bedrooms⁷. And already during lockdown, there has been a significant increase in using Voice Assistants⁸ as families turn to multiple devices to be entertained and engaged at home. However, with data collection as quid pro quo payment for such content and services, homes are also becoming more porous, less private spaces, where knowledge about the family is being steadily and invisibly gathered.

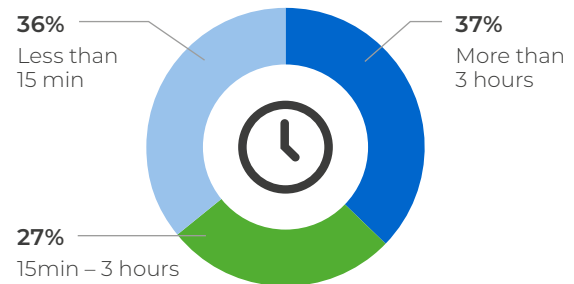


Teens Use of Voice Assistants

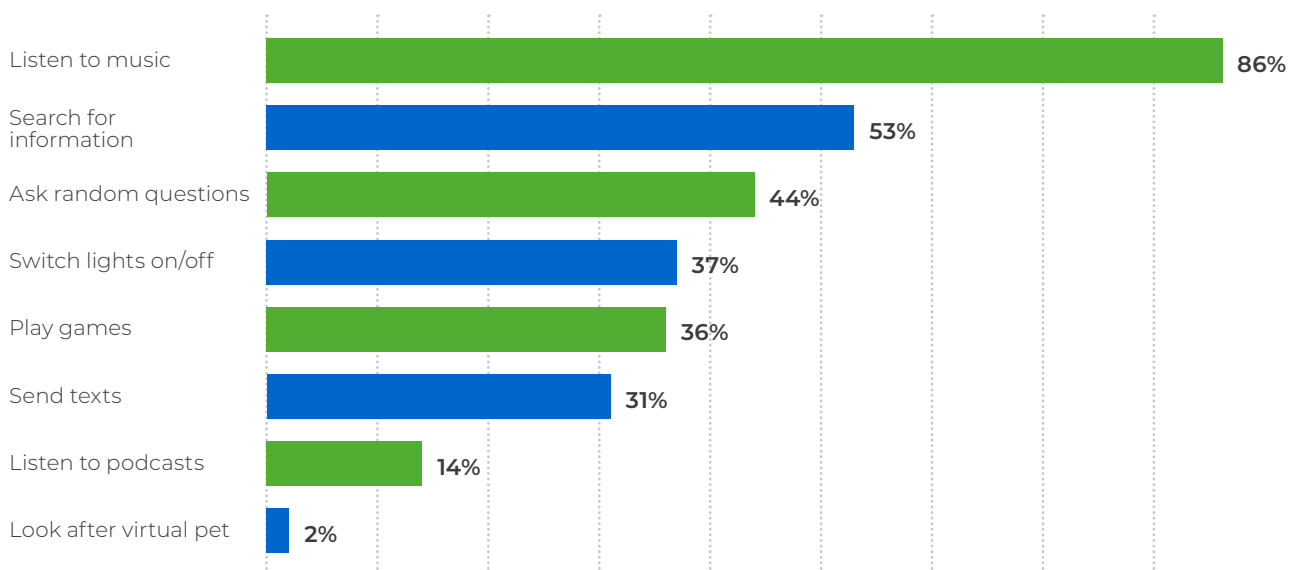
How often do you use a Voice Assistant?



How long do you use it for?



What do you use it for?



By 2025, Voice Assistants will be fully integrated into homes, cars, mobile devices and wearables⁹.

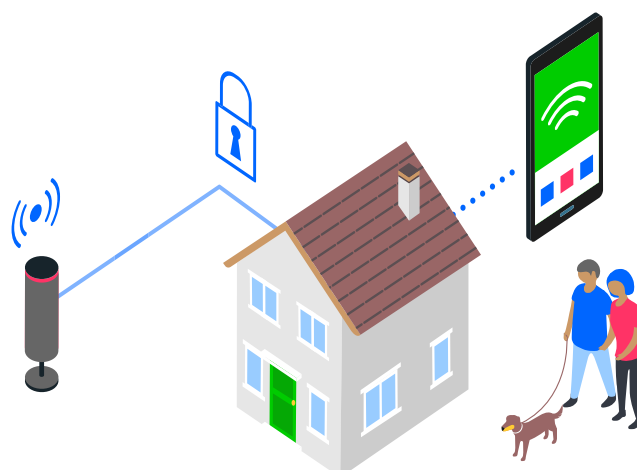
Control, Command and Connect – Voice in the Home

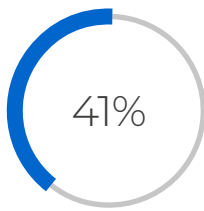
Voice Assistants will still perform the most popular tasks they're used for today⁶ like listening to music, searching for information and increasingly news, as seen during the coronavirus pandemic. They are likely to replace the screen as a main source of facts and information¹⁰. Usage will be more natural and frequent¹¹ and will replace the smartphone and its apps for communications tasks like updating social media and sending texts, as well as controlling the smart home.

In our workshops, teenagers completed storyboards imagining what the Voice Assistant of the future might be like and what they might be using it for in the home. As shown overleaf, most of the storyboards used the Voice Assistant for routine tasks - to control technology in the home “turn lights down,” to select and stream media “play my playlist,” to ask simple queries and support activities such as homework. Some imagined the Voice Assistant connected to new devices to meet teenagers' needs, including a robotic ‘pasta arm’ that made and delivered pasta or devices that automatically ran the bath, adding bubble-bath and checking the temperature.

The Voice Assistant will need ‘staff’ and home robots will find their niche - task specific, tied to a particular context and function, such as with robot hoovers and lawn mowers. So far there are few compelling or affordable home-robots. As Amazon are testing delivery drones, Tesco are also experimenting with robot shoppers and a robot ‘porter’ who would receive our goods at the gate or flat entrance and deliver them into the home. With the current need for non-contact delivery, retailers and the home delivery sector may push harder in this area. There is a significant market opportunity to creatively consider how small, affordable robots could add value to the domestic requirements of the family.

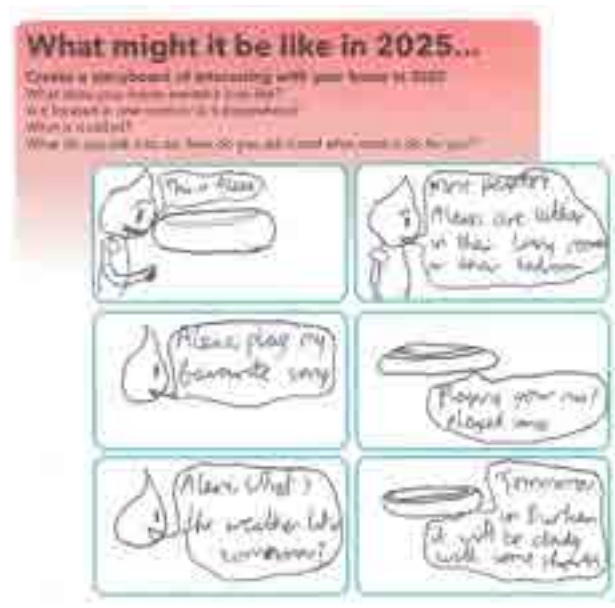
Despite general acceptance that families will use voice in the home, those in our research were hesitant to acknowledge the potential value of voice-activation, with dissonance between sitting still and task completion. When asked about using voice to switch off the lights, 48% of parents agreed that it was lazy. Only 37% of teenagers in the workshops thought that using voice was not lazy at all. Such views could reflect a resistance to change rather than what families will actually do or purchase.





*of parents expect to see Voice Assistants
used for homework by 2025*

Examples of Voice Assistant storyboards created in workshops





Research predicts that Voice Assistants will be increasingly used for children's learning in the home¹².

Voice apps exist for learning maths, science, language and literacy using quizzes and games. For younger children, interactive storytelling experiences such as Lego Duplo Stories provide play and learning. For all ages, Voice Assistants already contribute to learning at home through information search. The teenagers in our workshops agreed that they would be using voice to learn in the home, as did the Delphi panel who all viewed the Voice Assistant as a useful, additional education tool. Parent respondents were less convinced, although 41% did expect to see Voice Assistants used for homework by 2025. However, it is not yet known how to effectively use Voice Assistants for children's learning. Voice apps are limited, studies are few and more research is needed to explore learning opportunities¹³.

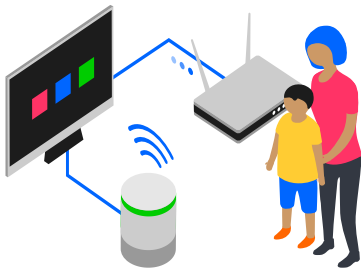
Voice Assistants will also offer a channel for families to explore concerns and seek advice for health and social care¹⁴. The internet is an important source for family lifestyle and health information with mothers preferring social media and web sources over consulting health professionals¹⁵. This study showed that 78.5% of mothers compared to 46.5% of fathers use the internet for information on their own health and 77.1% versus 42.4% for their children's health. Apps also effectively provide pregnancy and early months' support for new parents¹⁶. As the pandemic struck, there was a massive rise in the use of NHS digital services, with over 3.4 million visits to the NHS website on 17th March 2020.

Used in conjunction with healthcare providers and digital health companies, Voice Assistants will offer the ability to book appointments, give and receive updates from care teams and track health improvement goals. Already in partnership with Amazon, the NHS is using voice as a key channel with which to provide gold standard, trusted information to families, using this technology for answering queries, providing data entry

and review along with triage. Replacing the written record, children's early development will be tracked digitally with parents able to access this data using voice.

Coupled with the smart health appliances, wearables and monitoring that are already supporting health and independence for older family members¹⁷, living with COVID-19 means that connectivity is now even more vital to enable both the family and society to monitor and offer care remotely. Although there are many specialised technologies available, increasingly family, carers and professionals rely on everyday technologies, such as Voice Assistants, re-purposed to meet their needs. Voice provides a game-changing connectivity platform for older adults, a means to enhance quality of independent life, to communicate with others and engage with services. Importantly, unlike other technologies with their techno-barrier of the screen, voice provides an affordable, effortless experience that almost anyone can easily use.

As well as facilitating in-home activities, Voice Assistants will connect families back to the home when they leave. They will come with families at all times, already within smartwatches, rings (e.g. Echo Loop) and earbuds. Wearables will be mainstream¹⁸, monitoring health, activity and location and enabling communication without a smartphone¹⁹. Location tracking provides an easy-to-use and reassuring sense of security for many children and parents²⁰. In the Delphi study, experts were in agreement, parents will know where their children, or more specifically their devices, are at all times. This needs to be balanced with the fact that over-surveillance, monitoring and invasive parenting can have a damaging impact on family relationships²¹. In discussions during the workshops, teenagers accepted that parents could know their location at all times: *"Of course they know where I am - they just look on Find my iPhone."* But, and importantly, they did not see this negatively, perceiving critical benefits: *"Well, it is safer isn't it - in case something happens."*



Voice Assistant – The ‘home’ and family mediator

With the integration of voice across devices in and out of the home, the role of the Voice Assistant becomes blurred and it takes on a critical new dimension. Most children viewed the Voice Assistant as representing the home. Comments included: *“it would be like the house - it would know everything, where we were going, when to put the tea on, when stuff was coming.”* The technologist and academic experts agreed - our homes will have many devices and voice apps and for the family it would feel like they were just interacting with a single entity representing all the other technologies.

Studies have anticipated Voice Assistants becoming more conversational, joining in with family conversations more naturally²² and with personalised content⁷. Contrary to this, even though the Voice Assistant represented the home, in our research there were no examples of conversations with the Voice Assistant of the future that included personal, social or emotional engagement. From this, it can be concluded that participants did not anticipate having a relationship with their Voice Assistant, nor treating it as a friend.

The experts we interviewed also disagreed with papers written on this subject. They thought that Voice Assistants would improve and that interaction would become more natural, yet few of them thought that families would have or want conversational Voice Assistants by 2025.

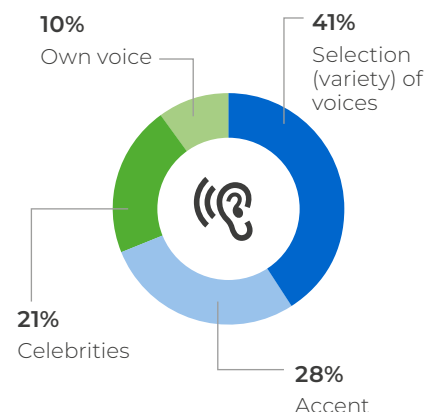
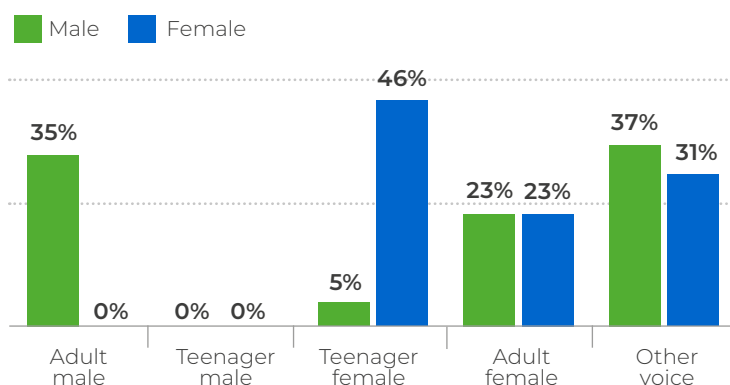
What families want is to enjoy their Voice Assistant and to achieve this they will be customisable. The Delphi panel agreed that low-cost, mass appeal voice-skins will emerge.

In the workshops with teenagers:

- Girls wanted the Voice Assistant to sound like a female teenager while boys prefer an adult male
- More girls than boys were interested in their voice sounding like an influencer or celebrity
- More boys than girls wanted accents, such as Australian or Russian

For boys, voice-skins are to add immediate amusement. For girls the choice is a reflection of themselves, or those they aspire to be like. Branded voice-skins will follow current trends, children and teenagers will change Elsa for Zoella or Taylor Swift for Kim Kardashian as they get bored with or outgrow their choice.

What would you like your Voice Assistant to sound like?



Our homes will have many devices and voice apps and for the family it would feel like they were just interacting with a single entity representing all the other technologies.

Families don't anticipate having conversations with the Voice Assistant, instead they want them to act as messengers. In this function, Voice Assistants could change family interactions, becoming used as an in-house communication channel. This would naturally replace the typed texts that many parents are already sending to their family in the home, with 53% of parents in our survey saying they currently do this.

How do you use technology to communicate with your children at home?

	Never	Occasionally	Often
Send texts	47%	26%	27%
Call each other	54%	22%	24%
Use social media to communicate	60%	23%	17%
Communicate using a Voice Assistant	82%	13%	5%

Data collected from parent survey (Feb 2020)

When teenagers were asked to imagine what they would get the Voice Assistant to tell their parents, all messages were short and functional. No personal nor emotional vocal texts were proposed, as one wrote: *"asking quick questions...[but] just not personal things"*. The most commonly proposed Voice Assistant mediated queries were related to: food, for example when meals would be ready; scheduling or activities *"What time does football start?"* Also homework, either for parents to help with questions or to remind children to complete it.

Almost all teenagers were positive towards the Voice Assistant being a better way to communicate with parents, rather than *"She shouts up, I shout down, my brother shouts down, we all shout"*. For many, it was key that the Voice Assistant would be speaking in *"a relaxed, really relaxed, calm voice"* and would enhance their privacy, for example to *"stop mum coming in."*

As messenger, the Voice Assistant provides neutral, non-emotionally engaged communications. Teenagers

said they would respond in the same way as they do now when they receive other in-home digital messages such as texts: *"It's usually to [tell you to] come down, so you do."* The ease of sending the messages coupled with the high likelihood children and teenagers will do as asked should reduce friction, with evidence to suggest Voice Assistants can improve family harmony²³. In acting as a neutral messenger, the Voice Assistant will enable children to have more privacy and more control over physical entry to their personal spaces. As an expert commented:

"It's hard to be greeted by shrieks of 'Get out!' for parents who are already frustrated by calling for the kids. Teenagers, even younger children view their bedroom as really private, so I think we will start to ask to come in by voice, less effort for everyone."

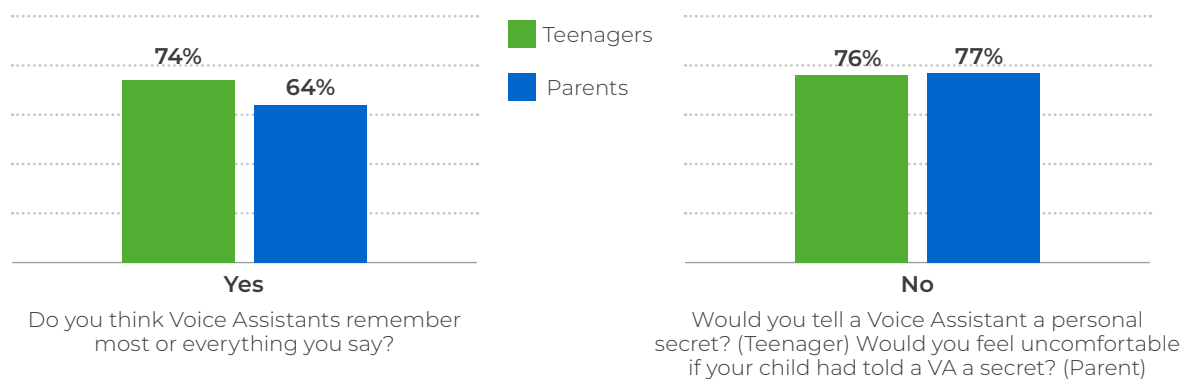
The benefits of improving the family dynamic must be considered against risks children may face using tech in private spaces without appropriate safeguards. The Information Commissioner's Age Appropriate Design Code and the putative online harms regulator, OFCOM, should between them create a safer environment by design, with a threat of significant fines for non-compliance. Technology corporates are in the spotlight and the algorithms are getting better at locating and removing inappropriate content. So far so good, but beyond this are the intangible risks entwined with the donation of the family's data. And importantly, this is no longer just clicks, now with voice the data has become more personal.

Parents are concerned about the presence of corporate entities in family homes, of profiling using massive amounts of data now collectible via smart devices. From the corporates, there is a lack of transparency about what data is collected, and particularly what it will be used for. Clearer information on this, some timeframe for deletion and other such basic data ethics could be something that families should expect. As technology and what children do with it continues to evolve, the role of regulators will be critical in ensuring the safety not only of current and future connected experiences, but also of the data that this generates.

Nearly three quarters (74%) of teenagers and 64% of parents believe that Voice Assistants remember most or everything you say.

The Trust Paradox

The Voice Assistant may become synonymous with the home, but it is neither family nor friend. The results from parents and teens highlight a stark lack of trust.



Data collected from workshop questionnaires (Nov 2019, Feb 2020) and parent survey (Feb 2020)

Nearly three quarters (74%) of teenagers and 64% of parents believe that Voice Assistants remember most or everything you say. For teenagers, remembering meant continual recording, believing that: *"It is recording all the time."* So when it came to telling a Voice Assistant a personal secret, 76% of teenagers said *"No Way!"*. Parents shared this caution, with 77% agreeing that they would feel uncomfortable if their child said they had told a Voice Assistant a personal secret.

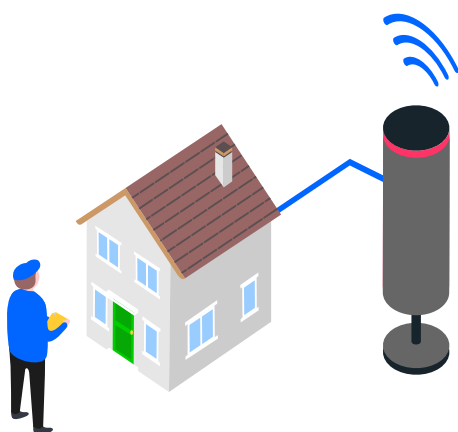
Amazon and others have tried to dispel fears of continual surveillance via the Voice Assistant²⁴, however, concerns remain about potential use⁴, recording and security flaws²⁵. The technical literature, legislators and most of our experts agreed that Voice Assistants such as Alexa are not continually recording. However, they are recording family utterances and quite what happens with this data remains obfuscated. The Delphi Panel concede that the companies need

the voice data to improve the product and speech recognition: *"... for the companies to get great speech recognition...they need masses of volumes of data coming from different people globally."* However, there was a common theme of concern about the volume and depth of this information and what else it may be used for: *"[they are] collecting more [voice] data just on the basis that it might be more valuable in the future."*

Although there is value accrued by the family through the improving technology, value lies in its use by marketers with the clear potential to bring further targeted advertising into the home. More transparency is needed in relation to who gets access to deeply personal data such as voice, and what they should be allowed to do with it. There is a clear question of whether the home and family do gain sufficiently from this trade and particularly whether this data really needs to be endlessly collected and retained.

It has recently been reported²⁶ that one of the main concerns parents have about their children being online is the worry that companies are collecting data on what they're doing. However, the Voice Assistant with its low cost and many functions seems to be so useful that many families are prepared to ignore trust, privacy and data concerns. In this case, the focus on the tangible and understandable benefits to the family may outweigh concern about exactly how these machines are learning. Or indeed, what the AIs will find out over the next five years. Families may be concerned and distrustful of data use and reduction of privacy, but not enough to stop many using connected devices.

This slightly dissonant decision to buy a Voice Assistant or other emerging technology despite underlying worries and concerns around data is supported by what seems to have emerged as the family's belief that 'someone' is looking after this and keeping them safe. The role of the legislator and the regulator are critical in this, with the ICO's Age Appropriate Design Code using the Voice Assistant as example. In addition, with data potential continually evolving, stakeholders and their organisations play a vital surrogate role in ensuring that families are informed, represented and that concerns about data, experience, privacy and security in the home are addressed.



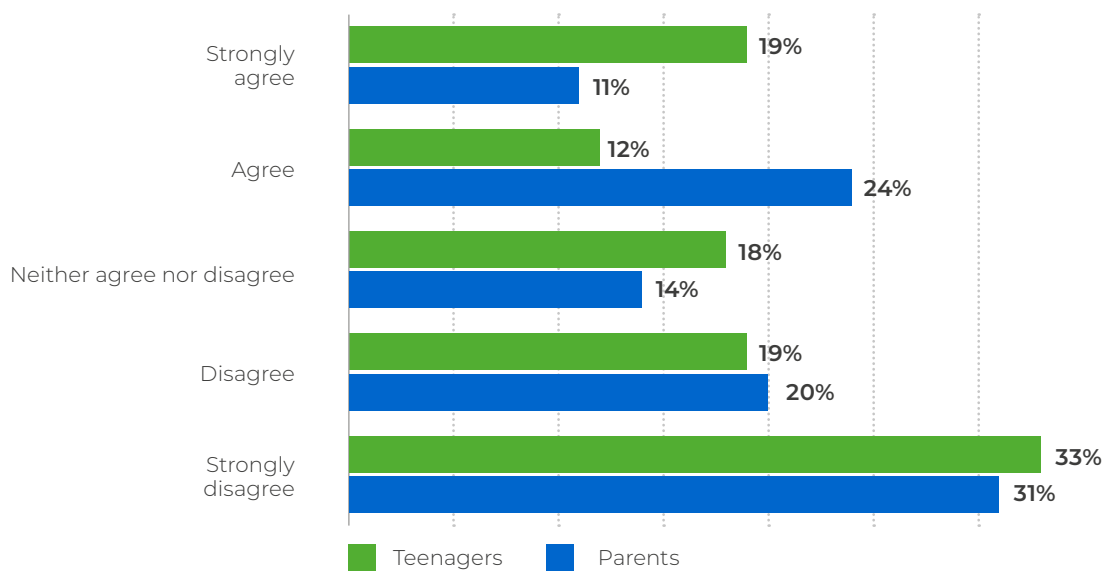
The 2025 Smart Home: As Domestic Space

By 2025, standard white goods and appliances will be smart and voice-controlled, with changes similar to those seen with TV screens with non-smart devices phased out. However, this will not be true for all families and there are significant and valid concerns about a home-tech gap and the notion of digital poverty. At the time of coronavirus this has mattered more than ever. It is essential that all homes are connected to the internet, that every child and family can access the connected services and support that can improve quality of life. Long before 2025 this will become a basic requirement as essential as water. Ubiquitous connectivity will stimulate the home-tech market, with wide variety in device price and functionality allowing most families to steadily smarten their homes.

Families will get used to voice to control, and quickly they will also get ready to use voice for shopping with vCommerce expected to rise significantly, with increase already seen during coronavirus. In 2018, only 2% of users were using Voice Assistants to shop⁸², however, by 2019, in the Microsoft Bing Ads study 40% of respondents had tried using a Voice Assistant to purchase⁷ and by 2025, 54% believed that their Voice Assistants would be supporting shopping. In the UK, 1 in 10 have already used their Voice Assistant to shop, and 20% use them to track deliveries²⁷. Although families will be happy to shop for themselves, they were less convinced about ceding this control to the home. Over half of parents and teenagers disagreed that they would give control to the Voice Assistant to automatically purchase goods for the home.

Families will get used to voice control, and quickly they will also get ready to use voice for shopping.

Would you like your Voice Assistant to order your shopping when you need to restock?



Data collected from workshop questionnaires (Nov 2019, Feb 2020) and parent survey (Feb 2020)

Connected technologies can really improve family tasks such as monitoring children or remote family care, but there remains a mismatch in many of the tasks connected technologies are trying to offer and the requirements of the family. Women who typically undertake more household tasks and spend more time in the home than men, are much less likely than men to adopt home-tech²⁸.

Home-tech is led by technology and academic push, often ignoring family concerns and preferences, such as retaining purchase control or the disinterest in conversational companions and for most parents,

their and their children's privacy coupled with the integrity of their family home.. There was consensus across the Delphi panel that the design of the smart home needed to be bottom-up, grounded by the real requirements of children and parents and involving them in the process: "Only then will we see what being connected might really mean, when we actually ask the families rather than having the tech sector designing for the tech savvy."



While families may be consuming more media content, there is less variety, funnelled through recommendations engines to provide more of the same.

The 2025 Smart Home: As Entertainment Space

Homes will be entertainment spaces, supporting dramatically changing viewing and entertainment habits. Families select, consume and watch in an increasingly fragmented way, with children and teenagers often watching user-generated content for short time periods. This was seen in our workshops with teenagers:

- Only 23% watch a programme at a set time
- They mainly watch YouTube and streaming services on phones (55%) and TV screens (71%), with 80% changing devices during their viewing (32% often, 48% sometimes)
- 76% watch and enjoy programmes alone, with family (38%) and with friends (17%)

With many screens in the home, families will continue to consume personalised media as individuals using their own preferred devices. Children will be acutely aware of a hierarchy of entertainment devices in the home - from tablet and TV for younger children to games consoles and then smartphones, with preference reinforced by age-specific content. Teenagers at our workshops used a variety of devices at home, with the smartphone used most. Few teenagers were using iPads, these are seen as being for younger children, with some of our teenagers passing on technology in the family: “[I] gave it to my little brother, it’s more for his sort of age ... he’s 6.”

And from the 3-year-old watching Paw Patrol on the iPad, the 12-year-old streaming YouTube on their phone, to the teenager listening to music on their Voice Assistant, the technology will know enough about families to suggest what they consume next. Already, 70% of YouTube watch-time is driven by automated recommendations rather than search²⁹. Younger children seem to enjoy auto recommendations as it allows them to see

additional content. Many adults seem to prefer the algorithm doing the work of finding their content. In the workshops, most teenagers liked receiving suggestions about what they might watch and had gone on to view the content. This passivity may become problematic.

Media consumption in the family – lake or funnel?

Families have access to endless media: streaming services, user-generated content, social media, music, ebooks and audio. However, in the interviews, some of the Delphi panel raised concerns about the ‘narrowing’ of media that families were consuming. Popular content is more regularly offered to consumers, recommendations are often ‘more of the same’, possibly reducing the broadness of media exposure that a family may have. The narrowing will be further increased by voice search with most users accepting the first recommendation. This results in another home-tech paradox, of being in an age where ever more content is available, where families may be consuming more, but of less variety. Again, the nature of technology, this perspective of the family member as data subject rather than person, has brought unintended consequences. Algorithms aiming to personalise experience drive families down homogeneous funnels. Technology makes selection tasks easier, converting families into passive recipients exerting less choice and control about what they view.

This creates a challenge for the family, if the service provides them with media they want to consume, then why would they explore further. Active participation in media selection is and will be important for families to avoid children and adults developing a shallow awareness and limited understanding of the world around them. Through engaging in diverse programme formats, topics and contexts, more and broader perspectives are absorbed, extending

families' horizons and enabling them to explore the media space to find our own interests. The prevalence of algorithmically-created echo chambers presents a number of significant societal challenges as world views are narrowed, prejudices affirmed and exposure to difference denied.

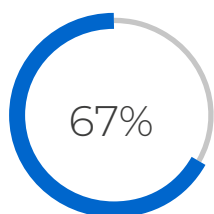
Significant concerns about exposure to inappropriate content have led to improvements from the streaming and media platforms. Compliance to legislation and regulation is expected and will be enforced, yet, inappropriate user-generated content will continue to be hidden but discoverable for the determined child or teenager. It is critical that parents support digital and media literacy by talking to children and teenagers about technology and media use, including what they watch and where and how they watch it. For the connected family, screen time will be an outdated concept with voice, screens and devices used to consume media, socialise, complete homework, play games and communicate. Parents do need to talk with children about the competing requirements of family, school, homework, friends and leisure. Increasingly this conversation will be about the balance between activities mediated by technology.

The 2025 Smart Home: As Social Space

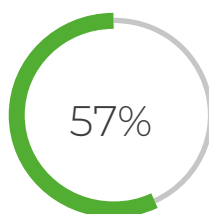
Isolation during coronavirus has completely changed how families use their homes as social spaces. By 2020, technology-mediated friendships and remote engagement were already the norm for older children, teenagers and many adults, with apps, etiquette and infrastructure in place. Easy and effective to use, most parents and older adults have embraced chat groups and visual conversations; not as good as the real thing, but better than going without seeing each other.

As a result of busy family lives, more conversation was already happening virtually and families were using technology to organise social lives. Although constantly in touch with people through tech at home, families appeared to have less time for actual visitors in physical spaces, needing these visits to be pre-planned. During lockdown, online visitors and socialising became a lifeline, yet just like physical gatherings they too are planned and organised in advance. Families and friends don't just call, they give each other time to get comfortable, to get to their communication space to be ready to welcome one another in.

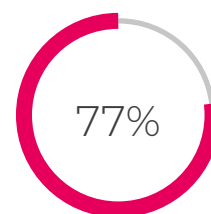
Children's usage of technology during lockdown



of parents reporting their child is using video calling more than before



of parents reporting their child is gaming more than before



of parents reporting their child is learning online more than before

During lockdown, virtual connections have saved the day, providing effective and rich ways for extended families and friendship groups to share, chat and see one another.

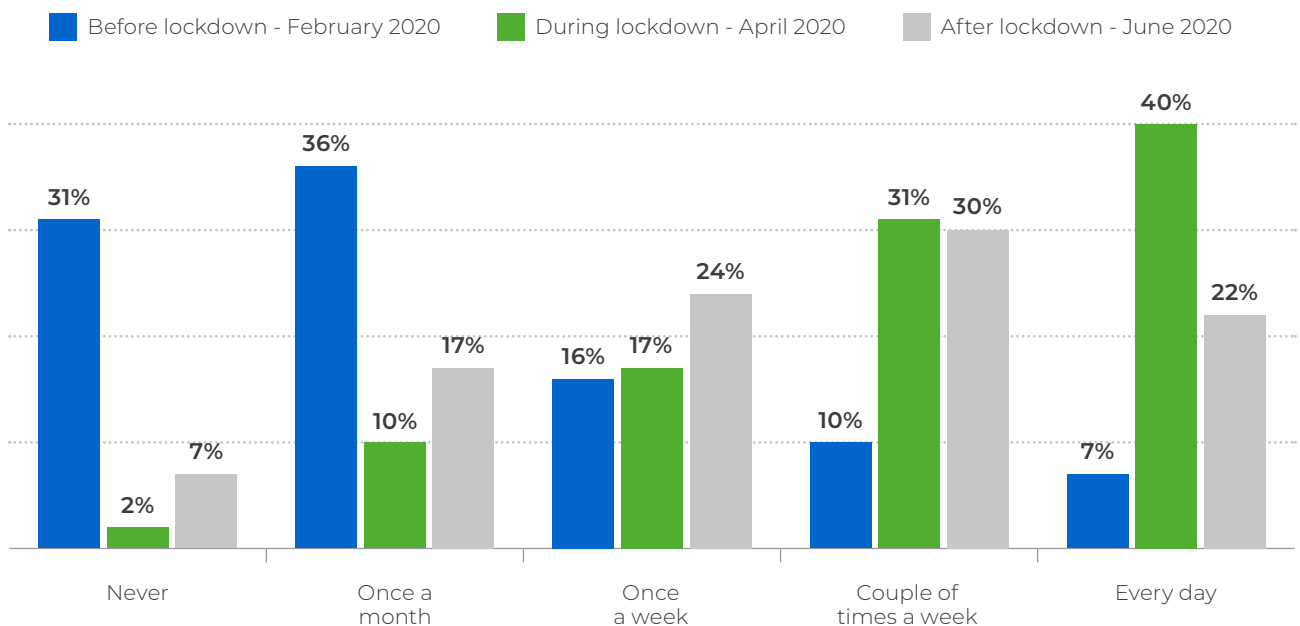
Most children and teenagers have their bedrooms already set-up for learning and leisure – their physical backdrop for the digital life in place. Considering what is 'in-shot' is a new perspective for many adults now having to curate a two-metre vision of home. Currently, families don't want digital fakery. They are seeking intimacy and this is increased through seeing another's private, physical space. There are digital backgrounds available to make their environment look more exciting but even by 2025 families are still likely to want to see each other 'for real'.

Clearly the use of devices in bedrooms is a cause for concern amongst many children's charities and consideration should be given to how children's safety

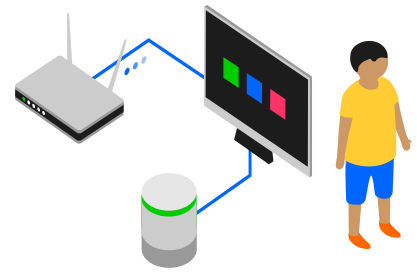
can be ensured when physical space and a desire for privacy may strain both relationships and space.

While it can't replace direct human contact, for many connectivity has saved the day with a massive increase in communication between friends and family. The likes of Zoom, WhatsApp and FaceTime provide effective and rich ways for extended families and friendship groups to share, chat and see one another. While there have been concerns about the negative impacts on social and family relationships of fewer face-to-face conversations and human interaction in physical space³⁰, the impact of lived experience of video conversations has been overwhelmingly positive.

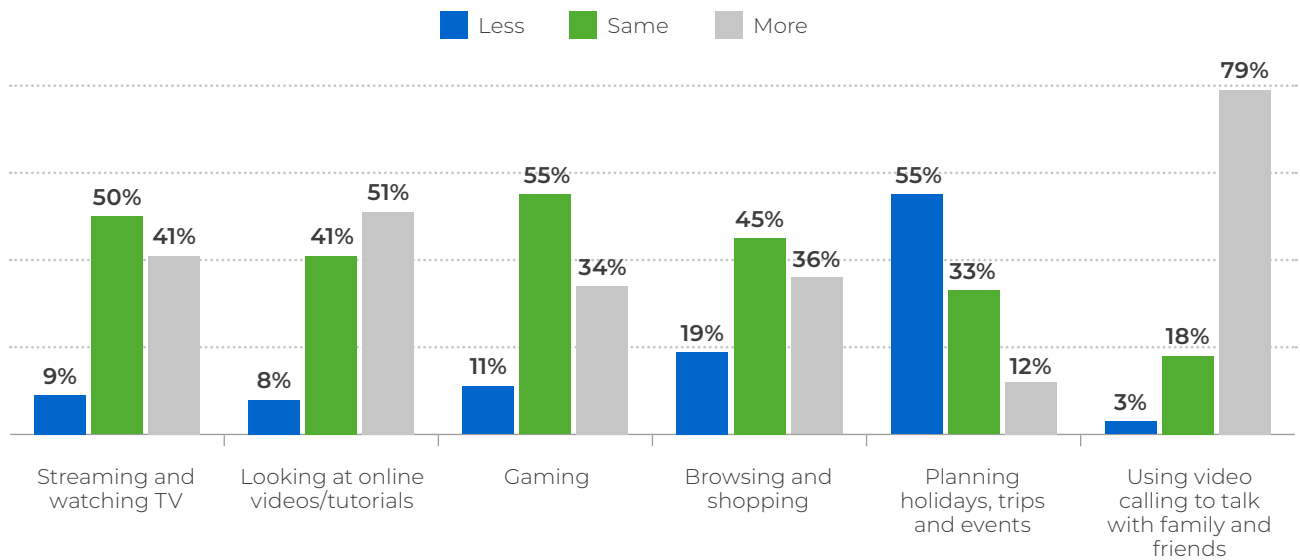
How often did / are you using video calling socially?



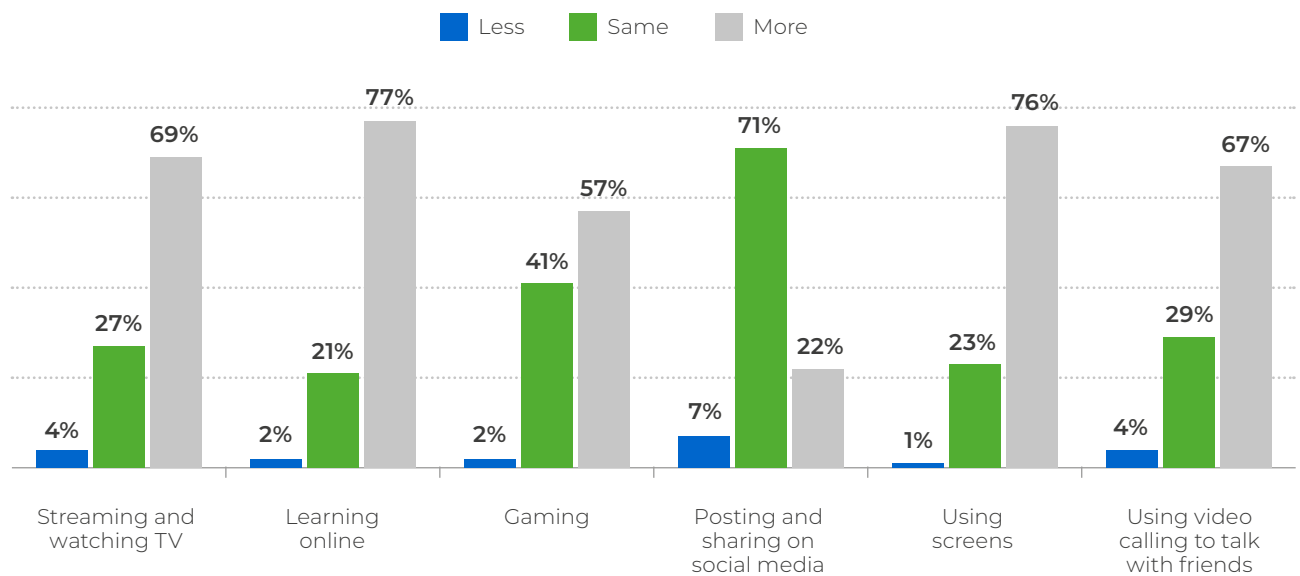
Data collected from parent survey (June 2020)



Have you changed how much you are doing activities together as a family using technology?



How has your child been using technology on their own?



Data collected from parent survey (June 2020)

Rather than diminishing relationships, video conversations do offer viable and valuable ways to connect and engage.

Connectivity provides a social space for those with established relationships and also for those aiming to develop new relationships. Ready-made groups exist online for most hobbies and interests, offering new friendship opportunities. Online dating apps are already the most typical way to initiate new relationships whether casual or permanent. Virtual dates have entertained many during lockdown and are likely to continue. For relationships in the future, the make or break issue might well be whether or not to meet for real.

Rather than diminishing relationships, video conversations do offer viable and valuable ways to connect and engage. The experience will radically improve and long before 2025, families will no longer be squinting at phones or screens. Projected visual conversation walls will allow us to chat easily to many. The closer to life size the image, the greater the sense of presence and intimacy. Whilst chatting, families will be using voice as control, rather than fumbling with buttons, they will be able to connect, show and share photos - *"show grandma the cake I just made"* or 'meet' and then 'go' as a group to view a movie together. With self-isolation there will be a surge in opportunities for haptics, and perhaps just as video conversations have been so vital, virtual touch may also allow a grandparent to hug their family.

The 2025 Smart Home: As Work and Learning Space

Of the parents who responded to the survey in lockdown, 70% were new to working at home. Most found it a positive experience, with good support via technology and from employers, with only 7% of parents now wanting to return entirely

to the workplace. Working at home has been an overwhelming success for many families and employers. All of the parents we interviewed who were working partially or completely at home had found positives, particularly being able to spend more time as a family.

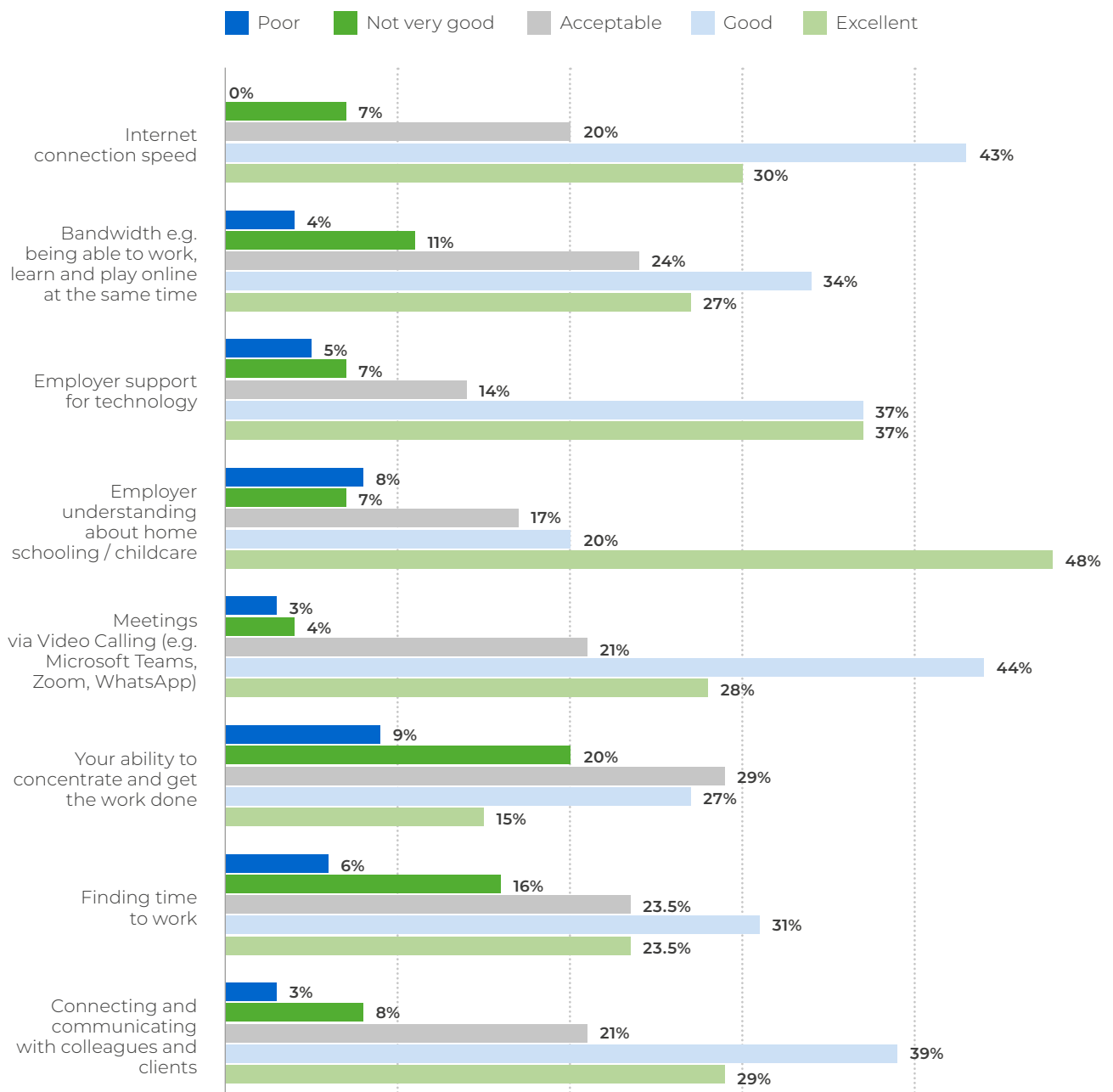
The biggest technological issue has been bandwidth. One of the families we interviewed where all five wanted to be online at the same time made the decision to upgrade their connectivity. *"That was a real gamechanger for us, we could all do whatever we wanted at once."* Other parents raised concerns about whether connectivity would limit or enhance employability: *"will it matter that it takes me half an hour to upload a file or I can't use video?"*

Changing job or even a new role within the same organisation will bring differences in the development of new working relationships and practices, of learning organisational culture, fitting in and making friends. With many sectors already using online approaches, there is plentiful best-practice to enable new workers or teams to integrate, and by 2025 with most people working partially at home, it will be more typical to work and meet via technology than physically.

Homes do not necessarily include spaces that can be readily turned into workplaces with only 38% of parents responding to the survey having a separate space for work, with many rooms having to double up. By 2025, where it's possible, working from home will be standard and homes will be designed to have spaces for work. Small rooms with doors will be fashionable again. However, the main challenge for parents working at home was not finding the space but rather finding time to work and being able to concentrate.



How was your experience of working at home during the lockdown?



In the next five years, children's learning will be increasingly mediated and delivered via technology.

During lockdown, many parents had to double up as teachers, but childcare and work might not always be compatible. The younger the child, unsurprisingly, the more support their learning needs and the shorter their attention span. Although frequent adult input is required for younger children's learning, for older children technology will have an even greater role than now, with teaching and learning more online than offline.

In the near future, being in a school environment will, at best, mean restricted and limited hours for most children and independent learning will be a major part of the new normal. From interviews with parents and responses to the questionnaire, learning has been generally well supported, typically via emails and online resources. In secondary, whole-school online platforms provide access to learning materials, information and activities, functioning as a repository to be accessed independently. Primary schools are also using online platforms but rather than the focus being on learning materials, it is on the social aspects and school community.

Home schooling requires learning spaces to exist within homes. And in those spaces, children need to be adequately provisioned with connectivity and

devices to enable learning to occur. Coronavirus has highlighted that some were not. With many schools only providing materials digitally, this provided significant challenges for some families in accessing learning or their learning community. Connectivity is essential and has been found to benefit all families. It has been seen to have a significant, long-term impact particularly for parents on low incomes, as well as for those with low educational attainment and/or those for whom English is an additional language³¹.

In the next five years, children's learning will be increasingly mediated and delivered via technology. This will generate significant advances in learning content and activities as teachers will need to appropriate connected technologies into their teaching. Learning will become more autonomous, studying at home will prepare children for discussion and engagement in the classroom. The added value of being in class will be for those things that should be done together, rather than those that can be done as well or better online. With younger children often unable to conduct relationships via screens, such value add also comes from the social aspects of school - of making friends, of collaborating, cooperating and working together.

How has your children's nursery, school and/or college been using technology for supporting your children's learning?

	Pre-school	Primary School	Secondary School	College/ University
Emails	15%	41%	34%	10%
Video calls using Zoom, Skype, FaceTime, etc.	9%	35%	37%	19%
Schools online social media platform / website	9%	50%	34%	7%
Phone calls	12%	39.5%	39.5%	9%
Packs of print-outs sent via mail	9%	62%	23%	6%
Teacher's comments and posts on children's work	10%	49%	32%	9%

Data collected from parent survey (June 2020)



Summary

Voice provides the easiest, most natural way to control the home and its connected devices, to search for and be presented with information for health, learning and leisure, and to organise families' interconnected routines and tasks. By 2025, Voice Assistants will feel synonymous with the house, customised to those living within it and regulating in-house communications. Yet, they are unlikely to become 'one of the family' as there is a lack of trust, and families are unsure about their Voice Assistant's collection, retention and use of what they are saying.

Reinforcing this distrust is an underlying sense that privacy is compromised by the lack of transparency and comprehensibility related to what happens with this voice data and who manages, accesses, manipulates and benefits from it. The Terms & Conditions families sign up to could justify a great many, possibly not-yet-known uses of data.

As evidenced during COVID-19, entertainment and socialising are well-supported by home-tech, devices and apps. Families being at home will spur on even more advances with a critical requirement for industry to engage with families in solving actual domestic

needs and requirements. By 2025, every household might still be missing a robot butler, but they may see more specialised, small robots and smart appliances with specific tasks and roles.

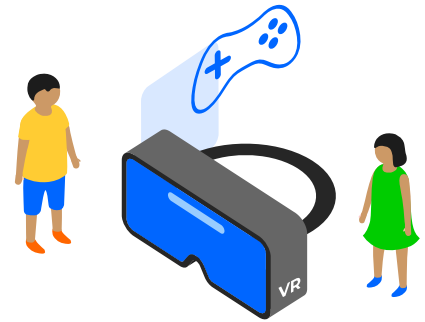
Streaming is the main home entertainment for many families, with an overwhelming choice of content supported ably by algorithms. However, funnelling and narrowing are of concern and quite how media serendipity can be introduced or what the basis for expanding viewing horizons could be is not clear. What is clear is that it will be the streaming provider that will need to offer this additionality, with the family likely to have ceded control to the algorithms.

With connectivity, by 2025 many homes will be able to support virtual, augmented and social experiences, both inside and beyond its walls. The technology in homes and wearables will be organising families, playing a part in relationships and monitoring wellbeing to the point that there is no longer a concept of technology touchpoints. Technology will have invisibly spread itself through family life, but family concerns and requirements should be adhered to so that privacy and trust concerns can be mitigated through effective enforcement from the regulators and technology corporates pro-active compliance.



Immersive Virtual Reality – A Space for the Children?





Realism is not essential for engagement and fun – it's how you can interact that matters.

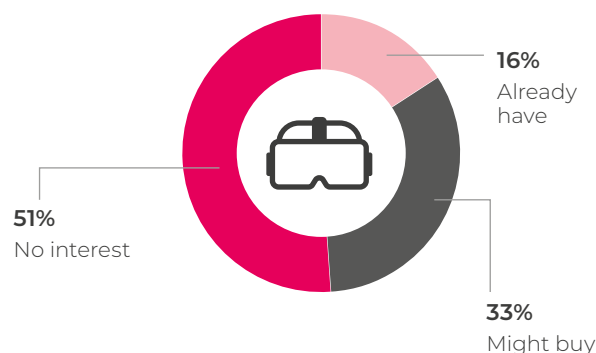
Immersive Virtual Reality (IVR or VR) involves the use of specialised hardware such as headsets to enable users to engage in a virtual space. In the workplace, IVR's future looks bright, with the market expected to increase massively over the next five years³². IVR is effectively used for complex industrial and social challenges where realistic representation has delivered successful outcomes, with documented examples including refitting an oil rig, product design and emergency simulations³³.

Significant growth is also anticipated in post-16 training and education³⁴. IVR is already used for workforce training, from equipment maintenance to health, such as performing operations³⁵. In colleges and universities, the most common applications are for engineering, computer science and astronomy³⁶. IVR is also used to provide student exposure to the workplace, such as Huawei's VR work experience. Using IVR, university students have been proven to be more engaged, spend more time on learning tasks, and to acquire better cognitive, psychomotor and affective skills³⁷.

The potential for IVR as a home-based technology appears to be primarily for gaming and content streaming with 5G transforming homes as limited connectivity becomes an issue of the past. The opportunity here is significant, with more affordable untethered VR-headsets driving family purchase. Beyond this, families have few requirements for IVR's main selling points - realistic representations, learning complex tasks or solving spatial problems - resulting in a lack of applications and content that itself proves a significant barrier for IVR adoption³⁸.

VR shopping³⁹ and social spaces⁴⁰ have been predicted as increasing VR use in the home, but as of yet, there has been little uptake. The Delphi panel agreed, with VR expected to be *"stretching into work more than in the home environment"*. VR is yet to find the domestic challenges it can solve and the added value it can bring to family life. However, with COVID-19 likely to impact on physical gatherings for several years, it could be the catalyst for VR to find its unexpected place in the home.

Does your family own a Virtual Reality headset?





As in other studies⁴¹, parents who answered our survey did not see VR-headsets having utility in the family, with 51% having no interest in purchasing one. The Delphi study also concluded that VR headsets will not become mainstream in the home by 2025. Alternatively, when we asked experts how frequently VR-headsets would be used by children and teenagers, they thought that by 2025 most children would be using VR-headsets at least a few times a week. Children are highly attracted by VR, with a study of 2-15-year-olds in the US and UK finding that almost 70% reported being fairly or extremely interested in using VR⁴². Similarly, at our workshops, the most exciting and enjoyed session was experiencing immersive VR using headsets. VR-headsets may not be 'mainstream' for parents, however, they will be increasingly desirable for children, with products for this age group driving change and stimulating market development.

VR's greatest challenge and perceived negative for parents has been the hardware-bound solitary confinement it imposes. However, after COVID-19 it is an ideal technology to prevent the distractions and noise of children in the home intruding on home workers. Further, if restrictions continue, VR seems the obvious place to get together, although parents we interviewed during our COVID-19 study were not entirely convinced.

There will be a big uptake of social VR platforms but not wearing designer avatars. Instead families and friends are much more likely to look like themselves, with technology offering some sense of physicality and personal authenticity, albeit in a virtual space. With many young children not great visual conversationalists, much preferring doing things together with their wider family, content providers will innovate and rethink VR to support virtual enjoyment between generations. There were doubts that older adults would use VR-headsets but no longer. Their rapid and effective adoption of technologies at the beginning of COVID-19, has highlighted how capable this new market is. However, VR-headsets are expensive and this is likely to continue to make them a premium rather than a likely buy.

IVR and Age Restrictions

Currently, commercially available VR-headsets are for those over-12, an age restriction that does not appear to be based on any scientific rationale, neither physical nor emotional. VR-headsets were uncomfortable and cumbersome but usability is improving. There have been concerns about IVR's physical impact on children⁴³ yet findings indicate that IVR has little effect on visual functions⁴⁴, balance⁴², brain development or health⁴⁵. Studies using the Vive VR-headset reported that eye strain or fatigue in IVR was the same as from a tablet or phone⁴⁶ and only low levels of VR motion sickness were seen in children⁴¹. In a 2019 study, 29% of parents reported that their child had used a VR-headset for gaming, with 9.1 as the average age they first used it⁴⁷.

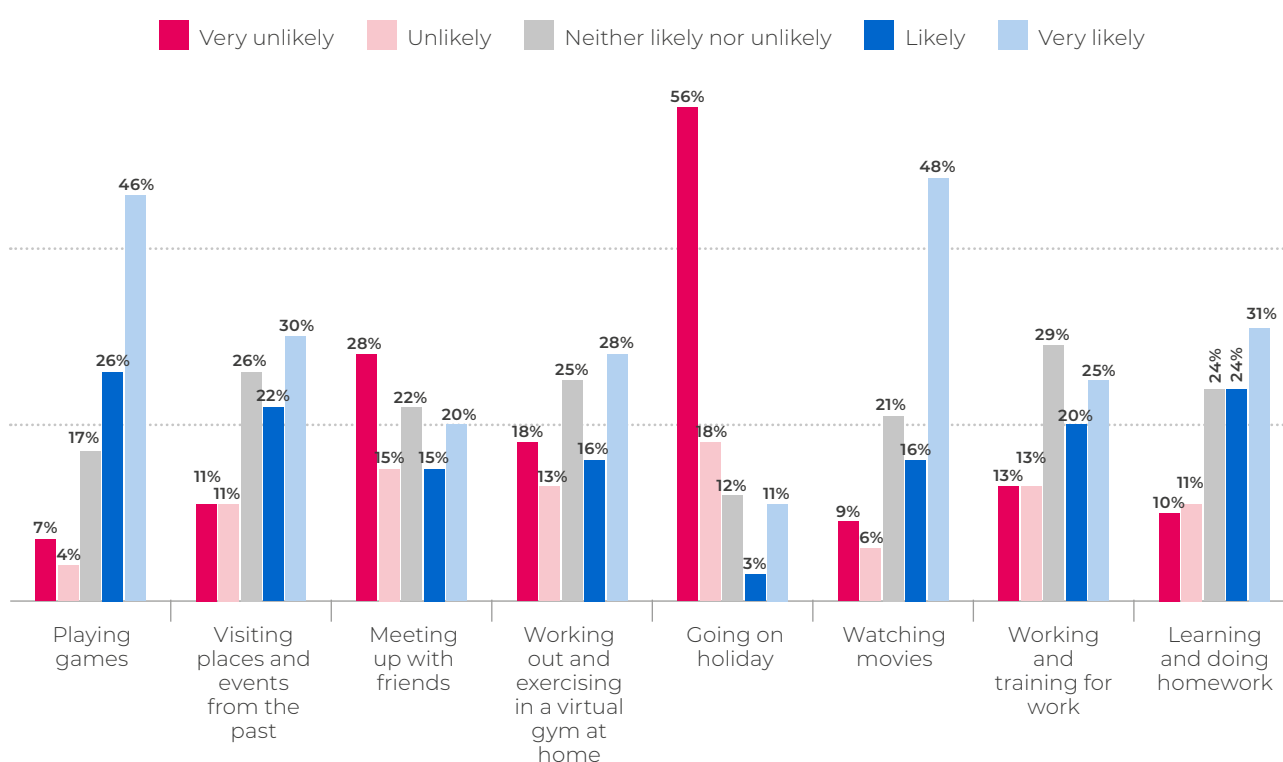
VR content has adopted the age-rating approaches already used by games and films. User-generated content will be legislated, regulated and enforced in the same way as other media formats. Family concerns will be similar to other online activities such as screen-time and exposure to inappropriate content.

As with many technologies, the pornography sector has been an early adopter. VR pornography is the third biggest sector in terms of revenue after gaming and major sports like American Football⁴⁸. However, as a proportion of use, VR consumption is already reported as greater for pornography than for other uses including gaming⁴⁹. As with the risk of exposure to online porn, VR could provide curious and determined teenagers with a new route to access this content. However, VR-headset and content developers do not want their products associated with pornography and approaches from major distributors such as Pornhub have been rejected. This willingness to prioritise parental concerns about access to porn over income from this sector highlights the potential of the under-16 and home market for VR, particularly gaming.

By 2025, VR-headsets will become 'the much-wanted, shiny new toy.' Parents, the Delphi panel and teenagers

*By 2025, VR-headsets will become
'the much-wanted, shiny new toy.'*

How likely do you think it is we'll be using Virtual Reality together in our families to do the following?



Data collected from parent survey (Feb 2020)

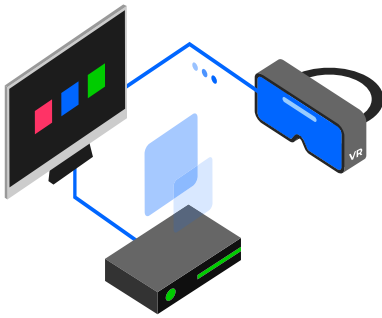
were in agreement that VR-headsets would be used mostly for gaming. However, for the under-12s, it is yet to be fully understood whether VR use is really appropriate or beneficial.

Using IVR for Learning

IVR's potential to provide learning experiences for children in primary and secondary education has long been recognised⁵⁰. Technology can now support successful IVR learning experiences for spatial awareness and model building; understanding history and culture and exploring challenging social contexts. Although studies are typically small, the conclusion is that IVR could provide a useful additional way to learn.

Parents in our study agreed, most expected VR to be used for learning and homework in the future. Our ;Delphi panel supported this view, but with caution, expecting that VR learning would “be a part of a blended learning experience with many ways to study and learn.”

All of our experts reported having seen innovative learning in virtual reality. Experts highlighted that VR offers real advantages and applicability for learning: “[Pupils] can really get much closer to the actual experience of [an] archaeological dig using VR, so I think these sorts of specialised and important applications are going to continue to show up and they'll find their place in education.”

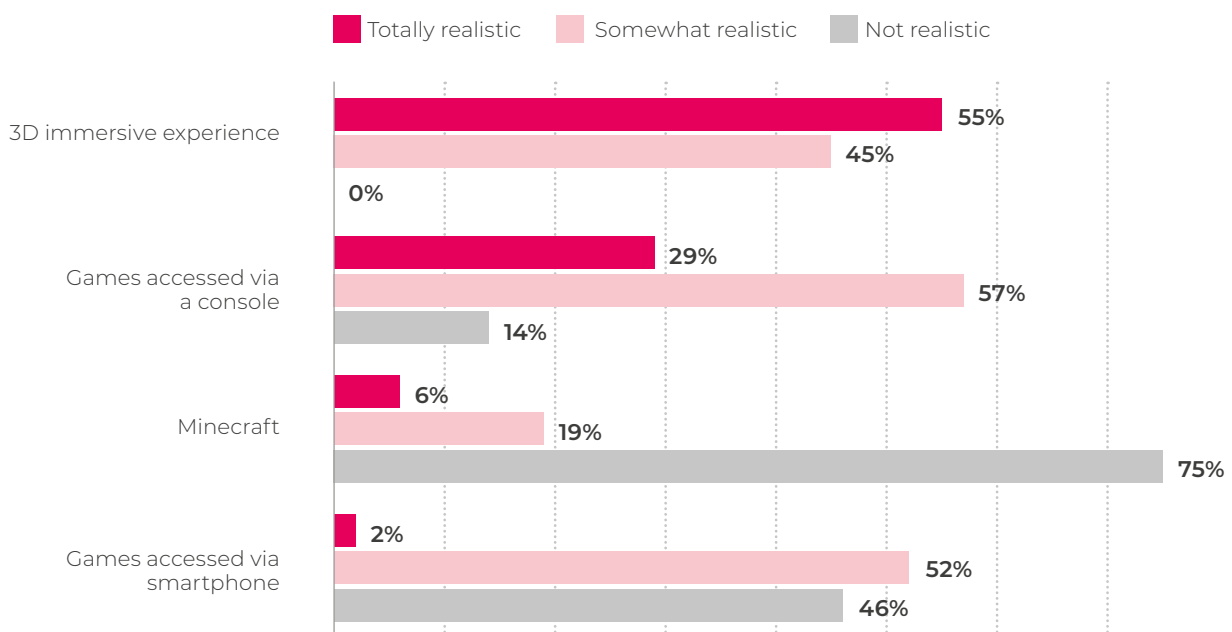


Use of VR for children's and teenagers' learning is slow to emerge. Limited experiences, hardware costs and stretched budgets prohibits adoption for most schools. In the near future, VR is unlikely to make a significant contribution to how children and teenagers learn in formal settings. Potentially for these reasons, only a third of the teenagers at the workshops thought that VR would be used a lot for learning by 2025. On the whole, the teenagers did think learning in VR will be more interesting and fun, but they are less convinced it will help them remember information.

IVR as an Entertainment Channel

IVR streaming is expected to rise significantly with services such as Amazon, Netflix and YouTube already providing VR channels. Movies will be automatically formatted for VR giving them better sound and visuals. Features such as Hulu's social viewing enable families to remotely stream VR together⁵¹ and will provide an alternative to physical visits to cinemas and theatres. Streaming sport in VR has already proved popular⁵² with providers such as Fox, Sky and BT and will continue to rise as events happen behind closed doors. The playing and streaming of VR esports, video

How real do these different experiences feel?



games that require movement in addition to strategy and skill, are also expected to increase significantly⁵³ and during Coronavirus provided some of the only sporting events, increasing interest and audience. This will broaden more significantly to other events and experiences that are currently less obtainable, including music concerts, festivals, museums, galleries and travel. Many children and teenagers are already 'popcorn gamers' - watching others playing games as much or possibly more than playing themselves⁵⁴. With social distancing a continuing reality, through VR, children and teenagers will be able to stream their favourite games and gamers together, watching, cheering and chatting in the same 'stadium' while still in their own homes.

IVR and Gaming

The main use for VR-headsets at home is undoubtedly games. Studies highlight that gaming is the area families believe will benefit the most from VR technology and the sector that receives the most investment and development⁵⁵.

Although both genders enjoy gaming, IVR has seen greater early adoption by young men. First Person Shooters, one of the best-selling VR genres, are men's most preferred games on console and PC, but do not appear in women's top three preferences⁵⁶. However, although Shooters have dominated, the growth in adventure, action, simulation and retro games will make VR as attractive to girls as boys.

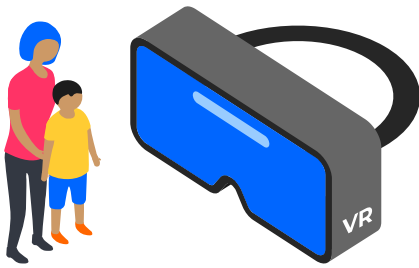
For many VR games, the difference is the device rather than the game, attracting similar players to an experience with better visuals and audio, but where the play and content remains similar. For example, Half-life: Alyx was only released in VR, resulting in nearly a million additional monthly-connected headsets on Steam in March 2020. It makes great use of VR vistas and effects, however, the story, purpose

and experience although immersive is still the same. With the exception of rhythm games such as Beat Saber, VR has yet to offer new types of game.

By 2025, academics and technologists agreed that low-resolution, non-realistic Virtual Reality games that run on reasonably priced hardware will provide new interactions and approaches. Reduced visual quality is seen as a barrier to the adoption of more affordable VR-headsets⁵⁷. However, for children and teenagers low resolution will be enough, with realism not essential for engagement and fun. A quarter of teenagers at the workshops found the non-realistic, pixelated environment of Minecraft to have elements of real life. Imagination fills in the gaps of imperfect virtual spaces and children and teenagers are engaged and immersed irrespective of the lack of realism⁵⁸.

This is validated by the view that however good the VR could be, most teenagers and parents we surveyed did not believe that an experience in VR would be as good as the real thing, with only 17% of teenagers thinking that a visit in VR would be a good substitute for real life and only 13% of parents positive towards VR trips. The Delphi panel agreed. Technological experts and academics predict a rise in haptics to enhance VR, with the lack of touch and interactivity seen as a major challenge: *"haptic gloves ... letting you feel and touch the unreal and interact with a game world more naturally."* As previously highlighted, social distancing could have an accelerator role here with haptics offering the opportunity to touch, even if this is virtually.

To drive adoption, the 'set' is not so important, it is what families will do in it. And this will need to be more than just experiencing realistic surroundings. IVR must also focus on the interactivity, fun and playing with others that children, young people and gamers are seeking.



Immersive Virtual Reality - reinforcing solitary experiences or connecting friends?

Surveyed before the pandemic, the Delphi panel did not believe that VR experiences would emerge aimed at the whole family. Instead, with gaming as their main usage, VR headsets are most likely to reinforce, but improve, the solitary life of tweens and teenagers within the family and continue their connected life with friends⁵⁹. As one expert noted: *“VR headsets will offer access to incredible, engaging and often communal and social experiences from the comfort of the bedroom.”*

In our workshops, teenagers were not interested in doing things in VR with their families. If teenagers did go on a VR holiday, they would prefer to do so either with their friends (49%), or alone (34%), with the family in last place (17%). Surveys of adult gamers⁶⁰ highlight that VR-headset users want communications and social interactions - being together in VR. The social experiences are completely interlinked with the games being played. The importance of socialising in games worlds should not be underestimated for teenagers, with friendship groups often requiring participation in the right games⁴⁷, providing vital social spaces and helping maintain friendships in and beyond school⁵⁹. For boys, games provide important socialising time with friends that may not be replaced if a game is not played⁶¹.

VR and Privacy

VR as a space for children and teenagers brings with it brilliant social opportunities. Yet as with other social online spaces, privacy and safety issues remain, such as sharing personal information, cyberbullying and grooming. Also needing more consideration is the additionality of VR – personal embodiment, interaction

and action that cognitively is as real as that of physical space. It is easy to continually record and stream using a VR-headset, however, it is not completely clear what ‘rights’ other players or bystanders have to prevent the distribution of their data nor how they might feel about others seeing streams of their virtual selves.

Legislated and regulated as other entertainment experiences and devices, Virtual Reality not only brings a new dimension for play and entertainment, but also for quantifiable data. Similar to other devices, the VR-headset collects personal data about location, equipment and interactions. Unlike other devices, with its microphone and infrared camera it is recording both the player and the room in which they are playing, all the while collecting, processing and storing micro-movements of the body. With all communication via the social features of VR also collected, a substantial, longitudinal record of virtual lives will become permanently retained.

Most VR games are not yet directly using biometrics, such as heart rate, however, many soon will be, with VR privacy policies including clauses that already allow for this⁶². This may result in excellent advances in games and experiences, with collection, processing and storage of data to some extent justified as needed for improving and innovating gameplay, but current messages from the VR sector highlight that this will not be the only use⁶³.

Almost all VR companies identify in their privacy policies that data will be used for marketing purposes and shared with networks and affiliates. This opens the door for biometric data to be used to create biological maps and keys of users⁶⁴ enabling yet more novel marketing and persuasive techniques. With much VR-data likely to be generated by children and teenagers, how such unique, biological data will be used and commercialised could be a growing concern for parents by 2025. Alternatively, and ideally, this data issue will be seriously addressed and regulated before VR use by children massively grows.

Summary

Immersive Virtual Reality offers children and teenagers a new, different way to connect and be. Currently, the lack of applications and content are a significant barrier for IVR adoption. This lack is linked to a possibly incorrect expectation that high performance visual realism is required. VR-headsets can be comfortably designed and affordable for children but content is urgently required. As this develops, and more children use VR-headsets for gaming, they will begin to realise their potential usage as a channel for socialising and learning.

Challenges and issues for VR data remain unresolved. Current practices indicate that VR companies would retain permanent record of children's physiological, interactive, verbal and interpersonal virtual activities. There are many excellent things that could emerge from such data, yet it is invasive, with legislation needed as to acceptable uses of, and restrictions on, super personal data. It's also likely that the implementation of

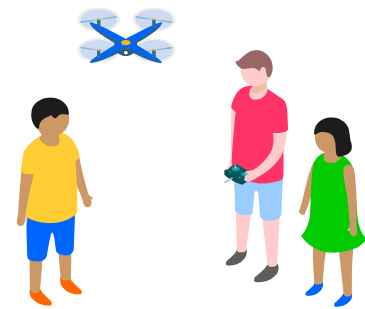
the Age Appropriate Design Code (scheduled for Nov 2020) will provide further challenge to these practices, as developers will have to demonstrate they have considered and acted on the best interests of the child, if children (determined to be under 18) are 'likely' to use the service, platform or app. The principle of data minimisation established under the GDPR regime will also affect developments in this area.

For the family, if restrictions on movements continue, then social IVR apps and content will grow rapidly, used for working, socialising and learning. IVR removes the distractions of the home and with children and teenagers clearly motivated and interested by learning and being in IVR, it could make a significant contribution to enabling education beyond the classroom. The advent of COVID-19 has made it more likely that, by 2025, VR-headsets will provide an everyday way for children and teenagers to experience life, learn and socialise together by removing the physical boundary of the home.



Playing in the Connected Home





Partnership and collaboration between toy makers, tech corporates and families are essential to drive innovation.

Play is an important aspect of family life, a key element in a child's neurological, physical, social and intellectual development with toys providing indispensable tools for play. Toys are becoming more interactive and responsive, reacting to children's actions and responding and replying to verbal commands. In the connected home, play is changing. For example, just as adults multi-device, so too do 3-5-year-olds, with play incorporating traditional and interactive toys along with connected devices such as tablets⁶⁵. Homes lacking connectivity or where children do not have access to devices limit potential for play and learning, thus reducing digital literacy from the earliest age. This has been starkly demonstrated during lockdown, with many households not connected or where the only device is the parent's smartphone.

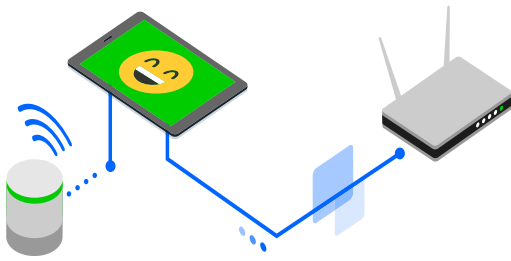
<i>Interactive Toys</i>	Interactive toys incorporate technology to provide play, typically using built in routines and activities. Examples include Baby Einstein's sensory and physical interactivity toys or Vtech's phones and tablets that enable pretend play.
<i>Smart Toys</i>	Smart toys have intelligent characteristics, such as being able to speak or undertake purposeful tasks. Examples include Gilobaby's toy robots that talk, dance and offer a range of interactive games. For older children STEM based toys such as programmable robots.
<i>Connected Toys</i>	Connected toys are interactive and smart, connecting via the internet to retrieve information, exchanging data between a child and a server or an internet platform. Developments in this area include premium toys such as an Amazon Echo-enabled kitchen.

Play and Learning

Interactive toys range from the traditional with built-in routines to those that connect to the internet to support play. Recent toy tech innovations include screen free audio toys, such as Toniebox, providing music and games activated through toy figures, plus app-enabled toys such as Play Impossible's sensor-based Gameball, providing physical play albeit at a premium price. However, interactivity doesn't

guarantee playability, with parents and young children typically finding traditional interactive toys to be somewhat limited and boring⁶⁶.

Parents want children to get more from play than fun⁶⁷ and almost all interactive toys claim to have educational benefits. Such claims are not based on scientific evidence⁶⁸. Assumed to support learning through play, interactive toys seem to be viewed as inherently educational. When interviewed, experts



agreed that educational benefits were likely, but none were aware of any direct evidence to support such claims. Teenagers, parents and the Delphi panel were all in agreement that learning through interactive toys would be mainstream in our homes by 2025.

Children's playtime appears to be decreasing. More rushed family lives, greater focus on formal schooling and homework from a younger age, along with scheduled activities such as clubs and sports had significantly reduced time for play. Children also receive less parental support for play than previous generations⁶⁹. However, during lockdown and potentially for several years ahead, children will be playing more at home and parents will need interactive toys to entertain and engage, freeing them up to undertake tasks with technology providing play for their child.

Connecting with Toys

Connectivity requires information or data to be exchanged between the child and the server, with the anticipation that an Internet of Toys would provide a new way to play. Although few toys are connected, some that require local connectivity using Bluetooth continue to have well-publicised security flaws, such as unauthorised devices being able to pair with such toys⁷⁰.

With high profile connected toys such as Hello Barbie no longer available, security issues are currently driving caution in the toy sector. This has resulted in a very limited range of connected toys. The Information Commissioner's Office Age-Appropriate Design Code⁷¹ is applied to all devices, including toys, which collect personal data and transmit it via a network connection. In their guidance only a single example of an internet-connected toy, a teddy bear, is provided, although this has also been discontinued.

In response to the security and safety challenges of connectivity, along with the need for toys to be affordable, a recent innovation has been to use existing home technology, with Amazon Echo-enabled toys beginning to emerge. One of the first is Gemmy's Twerking Bear, a dancing and talking bear paired to an Echo device that lip-synchs Alexa's spoken words. More ambitious is Kidcraft's Alexa-enabled Kitchen and Market⁷², where items and surfaces have electronic tags and sensors which allow Alexa to become a playmate of sorts. For example, if the child places a lettuce on the scale in the market, Alexa will start discussing salads and what else they need to buy. Still in development, this type of toy offers a way to play alone at home and could be developed to permit play across homes. Using Alexa also provides a safe way for toymakers to adopt the internet. Although as we have reported, families may be uneasy about what their data is being used for, they do trust Amazon's strict policies and monitoring of content provided via Alexa to children.

Robots have long been proposed as playmates, but even by 2025 this doesn't look likely. Social robots such as Nao are too expensive for most families. Vector, the affordable, internet-enabled, voice-controlled, app-connected robot has been discontinued with only limited support still available. Current toy technology trends include extending physical toys with Augmented Reality, such as Lego's Hidden Side universe, where buildable models are integrated with an AR app. Interaction with the Haunted Fairground model, for example, triggers events in a digital world, such as a roller coaster ride, experienced through a phone or tablet. Although this adds significant play value and more toys of this type are anticipated, whether this will be another short-lived toy fashion such as the 'toys-to-life' gaming genre is not yet clear.

Connected toys need to be made for the many families with mediocre tech and limited disposable income rather than the few who want premium products with sophisticated AI.

The main connected and interactive devices that children play with are tablets and smartphones. Although not legally defined as toys nor perceived of by parents as toys, they are the main way in which children and teenagers play, learn and are entertained with thousands of apps, games and playful experiences available. Apps such as Mathletics and Spellodrome for example, really provide primary children with learning through play. Although play with digital technologies is less likely to extend children's physical capacities than traditional play, the activities offer excellent approaches to keeping children entertained, having fun and connected with others.

Gazumped by the excellent interactivity, entertainment and play of the smartphone and tablet, the interactive toy market has been contracting and it was difficult to predict that connected toys had much of a future or that toy makers would innovate. Before COVID-19 remote play had no clear market or need but in interviews during lockdown, parents reported that younger children found video conversations hard. Not knowing what to say or do, children missed shared activities with adults so families improvised by playing cards, games and quizzes. Connected toys could fill that gap.

To do this a change in perspective is needed, even the innovative Alexa-enabled kitchen still focuses on the child playing alone, transporting the child as player into the imaginary world of the toy. Now families need something different - connected toys that can transport others into the 'real' play world of the child. This is almost a perfect scenario for the Internet of Toys, but caution – pragmatic and inclusive innovation are needed. Connected toys need to be made for the many families with mediocre tech and limited disposable income rather than the few who want premium products with sophisticated AI. This offers a clear opportunity for toy makers to add value to remote family and intergenerational relationships as well as bringing play into the connected world.

Summary

After considerable hype surrounding the Internet of Toys, it seems strange how few connected toys there are. Concerns about connected toys' data safety and security have led to parents assuming there are many flawed connected toys available. In reality, most reported security issues are identified by ethical hackers and not actually exploited. Nonetheless perception matters, especially around the toys parents allow their children to have.

With connectivity comes issues not only of safety and security, but also of data and privacy, with the ICO's clear guidance that a connected toy or device must conform to GDPR. However, such conformance will still allow for the collection of extensive amounts of data, potentially with children's play utterances, practices and lives stored digitally on corporate servers⁷³. This brings immediate concerns related to possible uses and monetisation of data for marketing and advertising⁷⁴, but playful verbal and physical data is badly needed, with toymakers and technologists still needing to understand how to design connected toys with significant play value.

As with the home, a big change for toys is that they will be increasingly voice-enabled. To some degree this approach removes the urgency for toy makers and tech companies to collaborate, but partnership and innovation are needed. The Delphi panel were in consensus, partnerships and incorporating tech and security expertise will be essential to progress the toy sector. Using the voice interface, augmented reality and other advances will see tech giants working with major toy manufacturers. Many partnerships and developments are high-end, high-cost premium products. This isn't what is needed, instead low-cost toy tech for remote play offers a clear use case. Adoption will be followed by appropriation as children and families use the toy in the way they want to play.

The Vulnerable Technological Family – Children and Teenagers with SEND



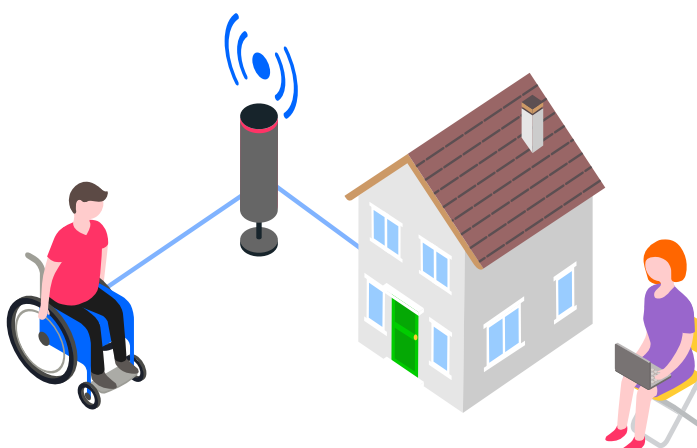
The majority of children and teenagers with SEND want the same experiences as their peers, using tablets and then smartphones for play, learning and life.

Many specialised assistive technologies, smart medical devices and sensory experiences are already effectively used to improve the quality of life for children with SEND. However, voice and the connected home are a game changer. It provides an accessible way for a great diversity of children, teenagers and adults with disabilities and special needs to do what everyone else does - control the home, find information, access media and communicate with others. Voice recognition continues to improve, now able to learn and process those with disabilities impacting speech⁷⁵, those with non-native accented speech⁷⁶ as well as younger children.

The majority of children and teenagers with SEND want the same experiences as their peers, using tablets and then smartphones for play, learning and life. There are a wide range of apps and experiences for different educational needs, neurodiverse and disabled children. Apps such as those of Special iApps have been designed for children with autism, cerebral palsy, down syndrome, dyslexia and sensory impairment. For children with autism, Minecraft has had particular success in supporting social skill development⁷⁷ particularly by educators⁷⁸. Charities such as Special Effect identify and create accessible technology ensuring those with physical disabilities can play video games.

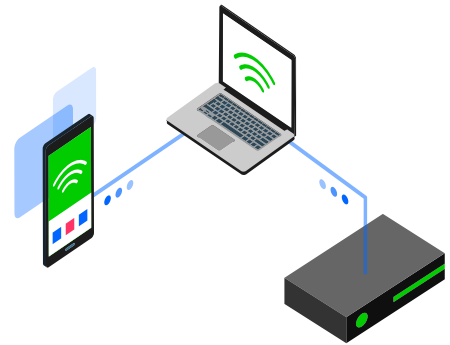
Interactive toys have been developed for children with physical, sensory and intellectual disabilities, autism, attention deficit and neurological conditions such as Cerebral Palsy, where early intervention has been long recognised as helping to prevent developmental delay⁷⁹. There are many examples of effective innovative interactive toys for therapeutic play, such as Polipo⁸⁰, a multisensory interactive toy for neurological conditions. Commercially, excellent interactive toys are provided by specialist toymakers such as TFH using technology to create playful, fun experiences that are child-centred, designed to interest and to engage while also meeting specific needs. With many SEND children having multiple needs, interactive toys often need to be customised and adapted. Increasing availability of components and sharing of knowledge online have enabled tech-savvy parents and teachers to tailor interactivity and play.

Developing abilities to thrive online relies on play and experiences during childhood and early adolescence. Providing appropriate guidance and support for SEND children and teenagers to develop digital literacy and to provide safe, secure online and virtual experiences and enabling them to have autonomy and privacy can be challenging⁸¹. The landscape is improving with greater responsibility demonstrated by the tech corporates in monitoring content; more effective and enforced legislation; and multiple ways to access support and guidance for schools, parents and children.



Conclusions





Greater corporate responsibility, effective legislation and ongoing digital literacy education will enable the technological family of the future to thrive. Above all this, COVID-19 has demonstrated that there is an urgent need to level up the digital playing field.

For family and society:

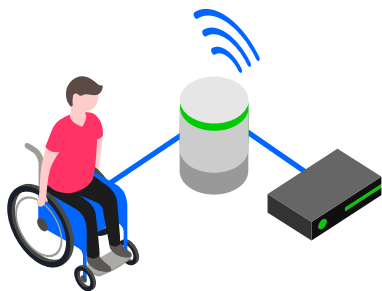
1. During the COVID-19 lockdown technology demonstrated the immense contribution it can make connecting families and friends, providing access to entertainment, culture and commerce. Connectivity can bring extended families together, reducing isolation and offering a sense of safety and security with visual conversations supporting remote care and contact. Meanwhile, solitary children and teenagers upstairs alone or even sitting on the sofa, are often in an exciting, engaging social space playing and relaxing with their friends.

With different interests, friendship and family networks catered for, unintentionally, connectivity lowers the need to spend time together as families at home. Socialising within the family – for tweens, teenagers and young adults at home had been reducing. Personalised streaming encourages media consumption as an individual. Interactive toys support solo play. Gaming, streaming or socialising in VR is typically with friends. Social media supports relationships and social lives often beyond the family. Less time together was a concern in 2019, however, this is now a significant positive for many families who are spending more time at home together than ever before. In the new normal, connectivity provides a vital passport to social experiences beyond the family. But, by 2025, inevitably many families will once again be grumbling (via the Voice Assistant) at tweens and teenagers to join in family activities (whether online or real) and stop playing with their friends.

2. Families will increasingly learn and develop skills in the home with some technologies having more promise than others. The Voice Assistant offers potential, but quite how it can be used most effectively and enjoyably to learn beyond information vocalisation has not yet been established. Voice does have clear benefits for many SEND children providing an easier way to control, interact and find digital information, and this will drive innovation with voice apps tailored to support specific needs and disabilities. VR-headsets also offer great potential for learning. By 2025, they will be much more affordable with more educational content for the pre-16 age group, resulting in significant innovations once content providers begin to create VR for children.

Families perceive that technology targeting children will have some inherent learning value, although frequently such claims are not evidenced, just assumed. After COVID-19 the purchase goal is more likely to be engagement and it will be this rather than learning that drives innovation. However, whether for play or educational value, collaboration is needed in the toy sector to deliver this.





3. In 2020 the digital divide became bleakly apparent as connectivity and device access became essential for children's socialising, entertainment and particularly learning. Connectivity is a basic utility but it is not the only problem, rather this is continual access to the appropriate device (e.g. ownership). The digital divide is entrenched and reinforced by the smartphone, which is not the most effective learning technology. With schools closed, younger children need a tablet and KS3 cannot learn or create their life chances effectively without a device like a laptop or screen with keyboard and sufficient processing power. Having tech enabled and tech poor children will reinforce who can, not just who might, aspire to the knowledge economy and white-collar jobs. This is not a difficult problem to solve, the issue, just as with connectivity, is who will pay.

For industry:

1. Homes will become ever more connected with home-tech the cornerstone for improving quality of family life. Now so much at home, families will begin to identify elements of their lives that need improvement and integrate technology that will meet this need, whether this be storytelling for the young child, the wake-up routine for the sleepy tween or peace of mind about remote family members. For new opportunities to be discovered and exploited it is key that families and children are engaged in innovating with companies.
2. COVID-19 could be a catalyst for Virtual Reality, a place to get together as well as for gaming and streaming. More focus is needed on what can be done and experienced in the virtual world rather than how good this looks or sounds. Children and families will want different experiences to the gamer or streamer, ways to be together to socialise rather than to game or watch.

3. Innovation is needed for interactive toys to benefit from connectivity, with Alexa-enabled toys an example of a major development. Toy manufacturers and tech corporates need to collaborate both with each other and with children and families. Making toy tech affordable and playable for the many not the privileged few will be key.
4. Industry would do well to proactively focus on the very real data leakage and privacy concerns raised by an ever-connected world. Whilst regulators are playing catch up, it would be more effective for the companies that benefit from connected tech to address these issues.



Implications for privacy and online safety:

1. For families, connectivity brings and will continue to bring benefits for homes and everyday lives. However, as a result, homes will become ever more porous, as connected devices continually collect data. Families seem willing to give this data, yet this means their homes have become places where they no longer feel entirely private. Present for most families, this low level of trust and privacy conflicts, but seemingly does not outweigh their desire to buy technology and to evolve their homes.

Tech corporates need to do more voluntarily to ensure that their connectivity, devices and online spaces are safe for families and offer more transparency about what their data is being used for. With the growing use of voice technology, we should not readily accept that the erosion of privacy and the commercialisation of personal data is the price families pay for convenience and an easier life.

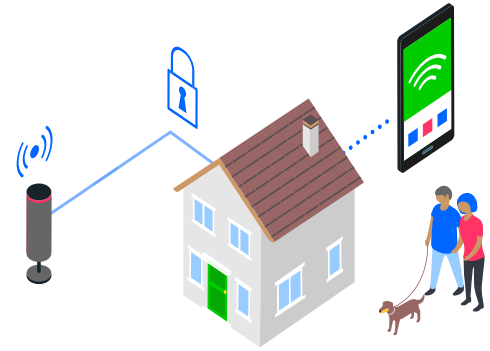
Parents have concerns about Voice Assistants recording what they say, but seem much less aware of the data being continually collected and permanently stored through growing technologies like VR-headsets. With VR, intimate personal information has already started to be given away, and while driving innovation for the consumer, there needs to be greater clarity on who else is benefitting so families can crucially make more informed choices about what products they adopt.

2. The risks inherent in connected technologies to home safety, security and privacy are not perceived by the family to be their responsibility. Many children and teenagers access information and have social contact privately, without parental intervention. With more new types of connected tech emerging, there will be more reliance on stakeholders, legislators and regulators to ensure that at a macro-level everyone and particularly children will be safe and secure. The response to the Online Harms White Paper, the Age Appropriate Design Code and the increased role of the regulator intends to increase the safety of digital spaces. However, it is yet to be seen how compliance to regulation will be effectively enforced, and it will always lag behind technological innovation and user appropriation.
3. As legislation will not offer blanket protection – digital literacy and education about appropriate online behaviours and relationships remain essential for all. To truly be the safest place in the world to be online – which is the stated ambition of DCMS – all users, children, teenagers, adults and seniors must have the education, training and skills to enable them to take responsibility for their online lives. This will require a public education campaign – the need of which has been ably demonstrated by the lockdown. Educating families about digital wellbeing has never been more critical, both now and well into the future of the technological family.



Recommendations





Connectivity is key to ensuring that families can succeed

Perhaps the greatest leveller ever, connectivity provides a new route to alternative futures for children and families. And the time for infrastructure improvements is now. However, the improvement must not just be the techno-focus of the superfast network, it must also be in how society provides and ensures access to it. Connectivity should be provided as a low-cost utility to all homes in the UK. It should not be possible to be disconnected.

Radical change is needed for learning

The mindset needs to change, digital learning is not a 'second best' but an effective way to learn for many subjects. VR could radically change what learning at home means. Appropriate funding streams are needed to enable schools to engage in collaboration, research and innovation for future education to enable such developments to emerge.

With more learning happening beyond the school, parents have an increased role which requires a national programme to ensure that all parents are educated in supporting their children in digital learning and literacy. Schools must be supported to provide all children and teenagers with devices and libraries of digital learning resources.

End-user collaboration should be prioritised

Tech corporates must collaborate with families to ensure their technology is being developed for real challenges and issues in the home. A fundamental requirement is based on children's and parents' expectations that home-tech is safe, secure, regulated and compliant.

New enjoyable ways to search and choose media are needed and the benefits of consuming novel content must be reinforced within digital literacy at home and school. Streaming service providers must focus not only on content but also on how to work with and engage children and families in promoting pro-active search. Alternatives to recommender systems leading to algorithmic funnelling should be prioritised in research and innovation.

Greater debate is needed to address data concerns

As the pace of change increases and families adopt new technology to adapt to more life lived at home, concerns about privacy and data use must be acknowledged. Families are wary of what their tech knows about them and what it is doing and will do with this information. With the use of voice assistance and VR and therefore the amount and type of data collected predicted to rise, the implications of this should be addressed both by industry, civil society and regulators.

Regulation and education must work hand in hand

Legislation and regulation will soon be in place, what is essential is that enforcement is proportionate, sufficient and highly publicised to ensure compliance and the proper treatment of data to create a safer digital space for families. The challenge will be to keep up with the pace of technological change. This must go hand in hand with a recognition that industry, professionals, educators and the third sector must continue to provide the right information and advice to help families navigate and benefit safely from connected technology both now and in the future.

References

1. V. Petrock, 'Smart Homes 2020', emarketer, Dec. 2019. Accessed: Mar. 10, 2020. [Online]. Available: <https://www.emarketer.com/content/smart-homes-2020>.
2. M. Goulden, "'Delete the family': platform families and the colonisation of the smart home", *Inf. Commun. Soc.*, pp. 1–18, Sep. 2019, doi: 10.1080/1369118X.2019.1668454.
3. S. E. Domoff, J. S. Radesky, K. Harrison, H. Riley, J. C. Lumeng, and A. L. Miller, 'A Naturalistic Study of Child and Family Screen Media and Mobile Device Use', *J. Child Fam. Stud.*, vol. 28, no. 2, pp. 401–410, Feb. 2019, doi: 10.1007/s10826-018-1275-1.
4. Centre for Data Ethics and Innovation, 'Snapshot Paper - Smart Speakers and Voice Assistants', 2019. Accessed: Oct. 28, 2019. [Online]. Available: <https://www.gov.uk/government/publications/cdei-publishes-its-first-series-of-three-snapshot-papers-ethical-issues-in-ai/snapshot-paper-smart-speakers-and-voice-assistants>.
5. M. Lang, 'How Growing Up with Voice Will Change Assistant Design', RAIN, 2019. Accessed: Mar. 10, 2020. [Online]. Available: <https://rain.agency/growing-up-voice-technology/>.
6. Code Computerlove, 'Home voice assistant survey data 2019: How are people using their voice assistants?', *Code Computerlove*, 2019. <https://www.codecomputerlove.com/blog/voice-assistant-survey-2019> (accessed Oct. 28, 2019).
7. C. Olson and K. Kemery, 'Voice report - From answers to action: customer adoption of voice technology and digital assistants', Microsoft & Bing, 2019.
8. Voxly Digital, 'Time to shine, Alexa. Getting the UK through Isolation', 2020. <https://www.voxlydigital.com/post/time-to-shine-alexa-getting-the-uk-through-isolation>
9. B. Kinsella, 'Google Will Acquire Fitbit for \$2.1 Billion and Strengthen its Google Assistant Wearables Strategy', *Voicebot.ai*, Nov. 01, 2019. <https://voicebot.ai/2019/11/01/google-will-acquire-fitbit-for-2-1-billion-and-strengthen-its-google-assistant-wearables-strategy/> (accessed Mar. 10, 2020).
10. I. Ammari, J. Kaye, J. Y. Tsai, and F. Bentley, 'Music, Search, and IoT: How People (Really) Use Voice Assistants', *ACM Trans. Comput.-Hum. Interact.*, vol. 26, no. 3, pp. 1–28, Apr. 2019, doi: 10.1145/3311956.
11. M. Taylor et al., 'Smart Talk - How organizations and consumers are embracing voice and chat assistants', Capgemini Research Institute, 2019. [Online]. Available: https://www.capgemini.com/wp-content/uploads/2019/09/Report-%E2%80%93-Conversational-Interfaces_Web-Final.pdf.
12. D. Beirl, Y. Rogers, and N. Yuill, 'Using voice assistant skills in family life', *Computer-Supported Collaborative Learning Conference, CSCCL*, Jun. 21, 2019. <https://csccl2019.com/> (accessed Feb. 21, 2020).
13. Y. Cheng, K. Yen, Y. Chen, S. Chen, and A. Hiniker, 'Why doesn't it work? voice-driven interfaces and young children's communication repair strategies', in *Proceedings of the 17th ACM Conference on Interaction Design and Children*, Trondheim, Norway, Jun. 2018, pp. 337–348, doi: 10.1145/3202185.3202749.
14. E. Sezgin, L. Militello, Y. Huang, and S. Lin, 'A Scoping Review of Patient-Facing, Behavioral Health Interventions with Voice Assistant Technology Targeting Self-management and Healthy Lifestyle Behaviors', Social Science Research Network, Rochester, NY, SSRN Scholarly Paper ID 3381183, Apr. 2019. doi: 10.2139/ssrn.3381183.
15. R. Laws, A. D. Walsh, K. D. Hesketh, K. L. Downing, K. Kuswara, and K. J. Campbell, 'Differences Between Mothers and Fathers of Young Children in Their Use of the Internet to Support Healthy Family Lifestyle Behaviors: Cross-Sectional Study', *J. Med. Internet Res.*, vol. 21, no. 1, p. e11454, 2019, doi: 10.2196/11454.
16. G. M. Thomas and D. Lupton, 'Threats and thrills: pregnancy apps, risk and consumption', *Health Risk Soc.*, vol. 17, no. 7–8, pp. 495–509, Feb. 2016, doi: 10.1080/13698575.2015.1127333.
17. D. Dojchinovski, A. Ilievski, and M. Gusev, 'Interactive home healthcare system with integrated voice assistant', in *2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, May 2019, pp. 284–288, doi: 10.23919/MIPRO.2019.8756983.
18. Hart Research Associates, 'Connected Families: How Parents Think & Feel about Wearables, Toys, and the Internet of Things', Family Online Safety Institute, 2017. <https://www.fosi.org/policy-research/connected-families/>
19. SafeWise, '10 Best Kids GPS Trackers and Devices of 2020', Mar. 10, 2020. <https://www.safewise.com/resources/wearable-gps-tracking-devices-for-kids-guide/> (accessed Mar. 11, 2020).
20. M. Ferron, C. Leonardi, P. Massa, G. Schiavo, A. L. Murphy, and E. Farella, 'A Walk on the Child Side: Investigating Parents' and Children's Experience and Perspective on Mobile Technology for Outdoor Child Independent Mobility', in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Glasgow, Scotland UK, May 2019, pp. 1–12, doi: 10.1145/3290605.3300827.
21. L. Tilton-Weaver, 'Adolescents information management: comparing ideas about why adolescents disclose to or keep secrets from their parents', *J. Youth Adolesc.*, vol. 43, no. 5, pp. 803–813, May 2014, doi: 10.1007/s10964-013-0008-4.
22. S. Yarosh et al., 'Children asking questions: speech interface reformulations and personification preferences', in *Proceedings of the 17th ACM Conference on Interaction Design and Children*, Trondheim, Norway, Jun. 2018, pp. 300–312, doi: 10.1145/3202185.3202207.
23. K. Lee, K. Y. Lee, and L. Sheehan, 'Hey Alexa! A Magic Spell of Social Glue?: Sharing a Smart Voice Assistant Speaker and Its Impact on Users' Perception of Group Harmony', *Inf. Syst. Front.*, Dec. 2019, doi: 10.1007/s10796-019-09975-1.
24. M. Day and M. Gurman, 'Amazon Focuses on Alexa Privacy as It Unveils New Gadgets', *Bloomberg.com*, 2019. <https://www.bloomberg.com/news/articles/2019-09-25/amazon-focuses-on-alexa-privacy-as-it-unveils-new-gadgets>
25. D. Lynskey, "'Alexa, are you invading my privacy?' – the dark side of our voice assistants", *The Guardian*, Oct. 09, 2019. <https://www.theguardian.com/technology/2019/oct/09/alexa-are-you-invading-my-privacy-the-dark-side-of-our-voice-assistants>
26. OFCOM, 'Children and parents: media use and attitudes report 2019', 2019. Accessed: Apr. 20, 2020. [Online]. Available: <https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-and-parents-media-use-and-attitudes-report-2019>.
27. OC&C Strategy Consultants, 'Voice shopping in the UK to be worth £3.5bn by 2022', 2018. <https://www.ocstrategy.com/pl/about-occ/news-and-media/article/id/1938/2018/02/voice-shopping-in-the-uk-to-be-worth-35bn-by-2022>

28. Y. Strengers, J. Kennedy, P. Arcari, L. Nicholls, and M. Gregg, 'Protection, Productivity and Pleasure in the Smart Home: Emerging Expectations and Gendered Insights from Australian Early Adopters', in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Glasgow, Scotland UK, May 2019, pp. 1–13, doi: 10.1145/3290605.3300875.
29. J. E. Solsman, 'YouTube's AI is the puppet master over most of what you watch', CNET. <https://www.cnet.com/news/youtube-cs-2018-neal-mohan/> (accessed Apr. 20, 2020).
30. S. Turkle, *Reclaiming conversation: The power of talk in a digital age*. Penguin, 2016.
31. V. S. Katz, M. B. Moran, and K. Ognyanova, 'Contextualizing connectivity: how internet connection type and parental factors influence technology use among lower-income children', *Inf. Commun. Soc.*, vol. 22, no. 3, pp. 313–335, Feb. 2019, doi: 10.1080/1369118X.2017.1379551.
32. Fortune, 'Virtual Reality Market Size, Share, Growth - VR Industry Report 2026', 2019. <https://www.fortunebusinessinsights.com/industry-reports/virtual-reality-market-101378> (accessed Mar. 22, 2020).
33. P. Duboe, J. Buvat, L. Cohen, D. Meltont, A. Khadikar, and H. Shah, 'Augmented and Virtual Reality in Operations', Capgemini Research Institute, 2018. [Online]. Available: <https://www.capgemini.com/de-de/wp-content/uploads/sites/5/2018/09/AR-and-VR-in-Operations-Report.pdf>.
34. Technavio, 'Virtual Reality Market in Education Sector by Product, End-user, and Geography - Forecast and Analysis 2020-2024', 2020. <https://www.technavio.com/report/virtual-reality-market-in-education-sector-industry-analysis>.
35. CAICT and iLab, 'Cloud VR+2B Scenario White Paper', Huawei Technologies Co Ltd., 2019. https://www-file.huawei.com/-/media/corporate/pdf/ilab/2019/cloud_vr_2b_scenario_white_paper_en.pdf.
36. J. Radianti, T. A. Majchrzak, J. Fromm, and I. Wohlgenannt, 'A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda', *Comput. Educ.*, vol. 147, p. 103778, Apr. 2020, doi: 10.1016/j.compedu.2019.103778.
37. L. Jensen and F. Konradsen, 'A review of the use of virtual reality head-mounted displays in education and training', *Educ. Inf. Technol.*, vol. 23, no. 4, pp. 1515–1529, Jul. 2018, doi: 10.1007/s10639-017-9676-0.
38. C. Laurell, C. Sandström, A. Berthold, and D. Larsson, 'Exploring barriers to adoption of Virtual Reality through Social Media Analytics and Machine Learning – An assessment of technology, network, price and trialability', *J. Bus. Res.*, vol. 100, pp. 469–474, Jul. 2019, doi: 10.1016/j.jbusres.2019.01.017.
39. N. Xi and J. Hamari, 'VR Shopping: A Review of Literature', *AMCIS 2019 Proc.*, Jul. 2019, [Online]. Available: https://aisel.aisnet.org/amcis2019/human_computer_interact/human_computer_interact/9.
40. J. Lee, J. Kim, and J. Y. Choi, 'The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties', *Telemat. Inform.*, vol. 39, pp. 37–48, 2019, doi: 10.1016/j.tele.2018.12.006.
41. J. Stevens Aubrey, M. Robb, J. Bailey, and J. Bailenson, 'VIRTUAL REALITY 101: What You Need to Know About Kids and VR', Commonsense, 2019. <https://www.common sense media.org/research/virtual-reality-101>
42. D. Yamada-Rice et al., 'Children and Virtual reality: Emerging Possibilities and Challenges', 2017. [Online]. Available: <http://childrenvr.org/>.
43. H. Bouckley, 'A parent's guide to virtual reality gaming: How much does it cost and is it safe?', *BT.com*, 2019. <http://home.bt.com/tech-gadgets/computing/gaming/virtual-reality-gaming-virtual-reality-how-much-does-it-cost-and-is-it-safe-11364193115313>
44. L. Tychsen and P. Foeller, 'Effects of immersive virtual reality viewing on young children: visuomotor function, postural stability and visually induced motion sickness', *J. Am. Assoc. Pediatr. Ophthalmol. Strabismus JAAPOS*, vol. 22, no. 4, p. e5, Aug. 2018, doi: 10.1016/j.jaaapos.2018.07.011.
45. J. O. Bailey and J. N. Bailenson, 'Considering virtual reality in children's lives', *J. Child. Media*, vol. 11, no. 1, pp. 107–113, Jan. 2017, doi: 10.1080/17482798.2016.1268779.
46. skarredghost, 'What is the right age to let kids play in VR? The debate continues...', *The Ghost Howls*, Mar. 14, 2018. <https://skarredghost.com/2018/03/14/what-is-the-right-age-to-let-kids-play-in-vr-the-debate-continues/> (accessed Mar. 17, 2020).
47. Internet Matters, 'Parenting Generation Game', 2019. <https://www.internetmatters.org/hub/research/parenting-generation-game-report/>
48. Marketresearch, 'Virtual-Reality Pornography Market by Regional Analysis - Global Forecast by 2020 - 2025 | Marketresearch', 2020. <https://www.marketresearchengine.com/virtual-reality-pornography-market> (accessed Mar. 22, 2020).
49. K. Greene, 'How VR Porn Is Secretly Driving The Industry', *VRFocus*, 2018. <https://www.vrfocus.com/2018/04/how-vr-porn-is-secretly-driving-the-industry/> (accessed Mar. 22, 2020).
50. M. Roussos, A. Johnson, T. Moher, J. Leigh, C. Vasilakis, and C. Barnes, 'Learning and Building Together in an Immersive Virtual World', *Presence Teleoperators Virtual Environ.*, vol. 8, no. 3, pp. 247–263, Jun. 1999, doi: 10.1162/105474699566215.
51. Daily Dot, 'The future of Hulu may be in VR', *The Daily Dot*, Jul. 27, 2018. <https://www.dailydot.com/upstream/hulu-vr/>
52. Esquire, 'Oculus headset will let you watch live sport in virtual reality', *Esquire Middle East*, 2019. <https://www.esquireme.com/oculus-headset-will-let-you-watch-live-sport-in-virtual-reality>
53. S. Haskins, 'What's Ahead for VR Esports in 2020', *VR Fitness Insider*, Dec. 28, 2019. <https://www.vrfitnessinsider.com/whats-ahead-for-vr-esports-in-2020/>
54. S. Bosman, 'Women Account for 46% of All Game Enthusiasts: Watching Game Video Content and Esports Has Changed How Women and Men Alike Engage with Games', *Newzoo*, 2019. <https://newzoo.com/insights/articles/women-account-for-46-of-all-game-enthusiasts-watching-game-video-content-and-esports-has-changed-how-women-and-men-alike-engage-with-games/> (accessed Apr. 19, 2020).
55. Fortune Business Insights, 'Virtual Reality in Gaming & Entertainment Market Size Forecast, 2026', 2019. <https://www.fortunebusinessinsights.com/industry-reports/virtual-reality-gaming-market-100271> (accessed Mar. 22, 2020).
56. Newzoo, 'Male and Female Gamers: How Their Similarities and Differences Shape the Games Market', *Newzoo*, 2018. <https://newzoo.com/insights/articles/male-and-female-gamers-how-their-similarities-and-differences-shape-the-games-market/> (accessed Mar. 29, 2020).

57. R. Elliott, 'Are U.S. Gamers Ready to Adopt Virtual Reality?', *Newzoo*, 2019. <https://newzoo.com/insights/articles/are-u-s-gamers-ready-to-adopt-virtual-reality/> (accessed Mar. 29, 2020).
58. T. Flint, L. Hall, F. Stewart, and D. Hagan, 'Virtualizing the real: a virtual reality contemporary sculpture park for children', *Digit. Creat.*, vol. 29, no. 2–3, pp. 191–207, Jul. 2018, doi: 10.1080/14626268.2018.1511601.
59. L. Eklund and S. Roman, 'Digital Gaming and Young People's Friendships: A Mixed Methods Study of Time Use and Gaming in School', *YOUNG*, vol. 27, no. 1, pp. 32–47, Feb. 2019, doi: 10.1177/1103308818754990.
60. S. Rex, 'Two-Thirds of U.S. Consumers Are Interested in Social VR, According to 2017 Consumer Report', *Greenlight Insights*, May 17, 2017. <https://greenlightinsights.com/2017-consumer-report-released/> (accessed Mar. 30, 2020).
61. C. Tomlinson, 'Building a Gamer: Player Preferences and Motivations Across Gender and Genre', 2019, http://www.digra.org/wp-content/uploads/digital-library/DiGRA_2019_paper_242.pdf
62. D. Hosfelt, 'How much is that new VR headset really sharing about you?', *Mozilla Mixed Reality Blog*, Dec. 20, 2019. <https://blog.mozvr.com/vr-headset-data-collection/>
63. A. J. Cortese, 'The Deeper Questions About Video Games', *Pandaily*, Oct. 04, 2019. <https://pandaily.com/the-deeper-questions-about-video-games/> (accessed Apr. 17, 2020).
64. D. Adams, A. Bah, and C. Barwulor, 'Ethics Emerging: the Story of Privacy and Security Perceptions in Virtual Reality', in *Fourteenth Symposium on Usable Privacy and Security (SOUPS)*, 2018, pp. 427–442, <https://www.usenix.org/conference/soups2018/presentation/adams>
65. L. Plowman, O. Stevenson, C. Stephen, and J. McPake, 'Preschool children's learning with technology at home', *Comput. Educ.*, vol. 59, no. 1, pp. 30–37, Aug. 2012, doi: 10.1016/j.compedu.2011.11.014.
66. E. McReynolds, S. Hubbard, T. Lau, A. Saraf, M. Cakmak, and F. Roesner, 'Toys That Listen: A Study of Parents, Children, and Internet-Connected Toys', in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, New York, NY, USA, 2017, pp. 5197–5207, doi: 10.1145/3025453.3025735.
67. M. N. Richards, D. L. Putnick, and M. H. Bornstein, 'Toy buying today: Considerations, information seeking, and thoughts about manufacturer suggested age', *J. Appl. Dev. Psychol.*, vol. 68, p. 101134, May 2020, doi: 10.1016/j.appdev.2020.101134.
68. A. Healey and A. Mendelsohn, 'Selecting Appropriate Toys for Young Children in the Digital Era', *Pediatrics*, vol. 143, no. 1, Jan. 2019, doi: 10.1542/peds.2018-3348.
69. J. Goldstein, 'Play in children's development, health and well-being', Toy Industries of Europe, Brussels, 2012. https://www.persil.com/content/dam/unilever/persil/global/english/online_comms/_persil_-_play_in_children_s_development_health_and_well-being-1816599.pdf.
70. A. Laughlin, 'Kids karaoke machines and smart toys from Mattel and Vtech among those found to have security flaws', *Which? News*, Dec. 09, 2019. <https://www.which.co.uk/news/2019/12/kids-karaoke-machines-and-smart-toys-from-mattel-and-vtech-among-those-found-to-have-security-flaws-in-a-which-investigation/>
71. Information Commissioner's Office, 'Age appropriate design: a code of practice for online services', Information Commissioner's Office, May 2020. <https://ico.org.uk/for-organisations/guide-to-data-protection/key-data-protection-themes/age-appropriate-design-a-code-of-practice-for-online-services/>.
72. B. Carey, 'The first Alexa toy is a \$300 kitchen for kids, packed with dad jokes', *CNET*, 2020. <https://www.cnet.com/news/first-amazon-alexa-toy-is-300-kidkraft-kitchen-for-kids/>
73. J. van Dijck, 'Datafication, dataism and dataveillance: Big Data between scientific paradigm and ideology', *Surveill. Soc.*, vol. 12, no. 2, pp. 197–208, May 2014, doi: 10.24908/ss.v12i2.4776.
74. C. Stephane *et al.*, 'Kaleidoscope on the Internet of Toys: Safety, security, privacy and societal insights', 2016, doi: 10.2788/05383.
75. A. Pradhan, K. Mehta, and L. Findlater, '"Accessibility Came by Accident": Use of Voice-Controlled Intelligent Personal Assistants by People with Disabilities', in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, Montreal QC, Canada, Apr. 2018, pp. 1–13, doi: 10.1145/3173574.3174033.
76. S. Moussalli and W. Cardoso, 'Intelligent personal assistants: can they understand and be understood by accented L2 learners?', *Comput. Assist. Lang. Learn.*, vol. 0, no. 0, pp. 1–26, Apr. 2019, doi: 10.1080/09588221.2019.1595664.
77. B. G. Stone, K. A. Mills, and B. Saggars, 'Online multiplayer games for the social interactions of children with autism spectrum disorder: a resource for inclusive education', *Int. J. Incl. Educ.*, vol. 23, no. 2, pp. 209–228, Feb. 2019, doi: 10.1080/13603116.2018.1426051.
78. R. Dundon, *Teaching Social Skills to Children with Autism Using Minecraft®: A Step by Step Guide*. Jessica Kingsley Publishers, 2019.
79. A. Majnemer, 'Benefits of early intervention for children with developmental disabilities', *Semin. Pediatr. Neurol.*, vol. 5, no. 1, pp. 62–69, Mar. 1998, doi: 10.1016/S1071-9091(98)80020-X.
80. V. Tam, M. Gelsomini, and F. Garzotto, 'Polipo: a Tangible Toy for Children with Neurodevelopmental Disorders', in *Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction*, Yokohama, Japan, Mar. 2017, pp. 11–20, doi: 10.1145/3024969.3025006
81. A. Katz, Dr A. El Asam in partnership with Internet Matters, 'Vulnerable Children in the Digital World' 2019. <https://www.internetmatters.org/hub/research/how-can-we-support-vulnerable-children-in-the-digital-world/>
82. P. Anand, 'The Reality Behind Voice Shopping Hype', *The Information*, 2018, <https://www.theinformation.com/articles/the-reality-behind-voice-shopping-hype>

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David Wilson

**internet
matters.org**

Ambassador House,
75 St Michael's Street,
London, W2 1QS

info@internetmatters.org

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