

Hacking Early Childhood:

How will digital technologies change early childhood, and what do we all need to do about it?

New technologies continue to revolutionise the world as we have known it. There is no reason to think that early childhood will be spared this revolution. All indications are that technology companies, families, carers, and the education sector will continue to incorporate innovation into the lives of babies and young children around the globe. And yet the topic and the wider implications of these changes have received minimal discussion by children, and those who care for them.

“It’s impossible to tell when we really lost control...”

Report based on two interdisciplinary workshops:

Durban, South Africa & Newcastle upon Tyne, United Kingdom, May-June 2022



“This workshop was incredibly thought provoking and it was great to be able to take the time out to think in this way, with like minded colleagues. It was a great mix of fun, creative thinking and focused planning of tangible actions that we could take in this space”

participant

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Report authored by Sunil Bhopal, Robert Hughes, Alastair van Heerden

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Seven Emerging Insights

This report provides an overview of seven key insights into how digital technologies are changing early childhoods; three reflections on where we are now, and four suggestions where we are - and need to be - going in the future.

Where we are now:

Insight

Where we are now

Implied questions, and required actions

See pages

1

Early interactions with technology are probably our most important interactions with technology

- Human brains develop fastest in early life; this means that our early interactions - whether they be with humans or machines - are especially important. They shape how we think and interact in ways that later life ones do not. This is especially the case in the earliest years - the period from conception to around 3 years old - which has a major bearing on our neurodevelopment, influencing our later life learning, earning and happiness.
- Not clear what agency looks like for babies/young children

Is more public, policy maker, and technology industry understanding of the centrality of early childhood needed?

What would happen differently if industry and the public really understood the impact of early experiences on the human brain?

p.6

2

Early childhood is changing fast... whether 'we' want it or not

- The ecosystem of technologies that interact with babies/toddlers is maturing quickly
- The future is coming whether you want it or not and it is going to be radically different from anything we have today
- Outsourcing of parenting/care to technology is on the cards
- The market is ready for wearables and other sensors in babies/young children, and the technology is catching up fast

Do the early childhood development, child rights, and parents communities need to learn more about these technologies so they can better influence this agenda?

Should we be trying to slow down or control the development of baby technologies?

p.8

3

Access to early childhood technologies, and the data on which they're being developed, is not equal. This may amplify inequality

- Inequalities and structural bias are seen throughout societies including artificial intelligence
- There is potential for widening inequalities here

How can we include early childhood in wider conversations about technological inequalities?

p.10

The way forward:

Insight	Way forward	Implied questions, and required actions	See pages
<p>4 Child Rights and their needs, rather than just profit motives, ought to inform the development of early childhood technology</p>	<ul style="list-style-type: none"> • There is a need for children to be the focus, not technology • Technology should be there to enhance, not replace, high quality human interaction • Technology alone is not sufficient, particularly in the majority of the world where most children live 	<p>Do we need a global convention on the digital rights of the (young) child?</p>	<p>p.12</p>
<p>5 Technology, if designed and deployed appropriately, can help to transform early childhood for millions of children, probably including some of those in the most difficult circumstances</p>	<ul style="list-style-type: none"> • We created a long-list of ideas, e.g: <ul style="list-style-type: none"> • A ‘force multiplier for home visitors’ supporting parents, addressing the global crisis in safeguarding • Enabling better oversight, quality and regulation of unregulated childcare ecosystems 	<p>In collaboration with industry, do academics and early-childhood practitioners need to ‘lean in’, co-designing high-quality innovations in this space, rather than waiting for and testing technologies that emerge?</p>	<p>p.14</p>
<p>6 We can draw lessons from other areas of innovation, including tech for elderly care, and from the changing world of infant feeding</p>	<ul style="list-style-type: none"> • We need to find overlaps between child wellbeing/ rights and this commercial interest • Baby tech is likely to draw from elderly tech 	<p>These conversations don’t happen automatically - who can support new fora and mechanisms for learning from other spheres?</p> <p>What positive, and negative, lessons can we learn from other early childhood innovations?</p>	<p>p.16</p>
<p>7 Academia, regulators and public awareness seems to be behind the curve of innovation in this space. This needs to be addressed urgently</p>	<ul style="list-style-type: none"> • Babies/toddlers are missing from the big EducationTechnology (EdTech) debates • This agenda is being shaped by commercial reality • We don’t know what data big tech is collecting on our children and how they plan to harness it • The general public, implementers and academics are broadly unaware of how quickly technology is moving into the world of parenting and newborns 	<p>We need to write, and talk, about these issues more. A public conversation needs to be started about these things, perhaps drawing on that around autonomous weapons and AI powered weapons. Can we learn from these examples?</p> <p>What combination of guidelines or harder regulations do we need to influence early childhood interactions with emerging technologies?</p> <p>Regulators (including ethics committees) need to urgently build their understanding of these issues and will need to bring in new expertise.</p> <p>An urgent effort to connect industry and academia is needed.</p>	<p>p.18</p>



All images by MidJourney. MidJourney is a text to image generation tool. A user provides a textual or image prompt along with parameters such as aspect ratio, and a machine learning algorithm trained on large amounts of image data generates an image aligned with the prompt.

1 Early interactions with technology are probably our most important interactions with technology

Human babies are special. We are born immature and dependent. In the early days, weeks, months and years we are totally reliant on others to care for us and to provide the love and attention that we not just want but need to survive and thrive.

Developmental neuroscience is increasingly helping to shed light on this special period. Right through pregnancy, a baby's brain is developing fast, and this accelerates through into early life where interactions with others and the surrounding environment makes all the difference to the way we think, learn, and develop.

The old paradigmatic question of 'nurture vs nature' has been replaced with a clear understanding that both are extremely important, and that all children need and deserve the best nurture available, especially through those earliest, crucial, critical periods through pregnancy to around three years of age; the period that has the most bearing on neurodevelopment, strongly influencing later life learning, earning and happiness.

So what does this all mean for technology? In short, it means that our **early interactions with technology may be the most important interactions we have with technology.** For all we might discuss the benefits and risks of technology in the workplace or classroom, what might matter more for human development - and what we think is massively underappreciated - is the role of technology in affecting brain "wiring" in that important period in the earliest years of life.

[Where hacking early childhood started - read our piece in Archives of Diseases in Childhood](#)



Implied questions, and required actions

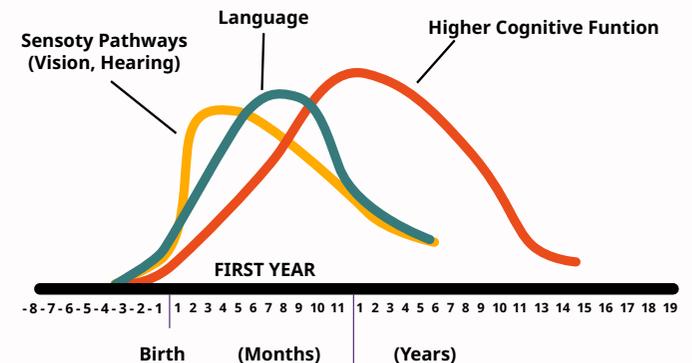
Do babies/toddlers need 'shielding' from (some) technologies? Should we protect them from certain technologies until they've been - carefully - tested with them? And how can we ethically do these tests when the consequences are so important and unknown? Or is there a risk that trying to do this just means that development happens 'under the radar' and out of sight?

Do regulators and lawmakers understand the serious risks to human societies of baby technology gone-wrong? If not, how should they get up to speed? Whose role is it?

Do people running tech companies and working in the technology industry need **more education on the centrality of early childhood** to human development? If so, how might this happen? What would happen differently if industry really understood the impact of early experiences on the human brain?

Center on the Developing Child
HARVARD UNIVERSITY

Human Brain Development Neural Connections for Different Functions Develop Sequentially



Source: C.A. Nelson (2000)



2 Early childhood is changing fast... whether 'we' want it or not.

One thing is for certain - the near future is not going to look like the present. Technology is rapidly reshaping the world and how we interact with it. There seems to be no reason that babies and young children are going to be spared this. Indeed, there may even be reasons to think - as patterns of work change, family structures evolve, and high-quality childcare becomes increasingly unaffordable - that some major changes might come to citizens at the earliest stages of life first.

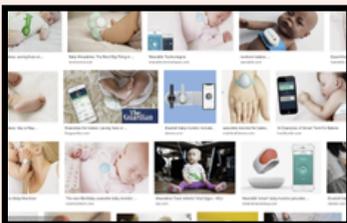
Whilst some of what is being discussed, from virtual reality headsets for babies to implantable GPS trackers, or wearable cameras, may seem far-fetched, the ecosystem of technologies with which babies and toddler interact is already advanced, and is accelerating.

Today, millions of babies are being occupied with smartphone games and videos, young children are swiping away on handheld mobile devices, video-calling loved ones, and talking to voice-activated Artificial Intelligence agents (Alexa, Siri). Already, companies (with variable levels of government involvement) are figuring out how to teach children to read, write, count, understand, and think, via smart-speaker. The market already provides those who want and can afford them remote monitoring solutions for parents to watch and listen to their babies, with knowledge of breathing rates, pulse, and temperature. A quick google search reveals that the baby wearables market is exploding.

What are the logical next steps for these technologies? Who is monitoring for side effects? Do 'we' want children to be taught by robots? Is there a lower age-limit?

One thing is for sure - the way we care for babies and young children is changing, it's changing fast, and there doesn't seem to be much overt, easily accessible evidence of discussion around these changes or implications of the changes in parenting circles, in early childhood development communities, or in the world of child rights.

Wearables for babies



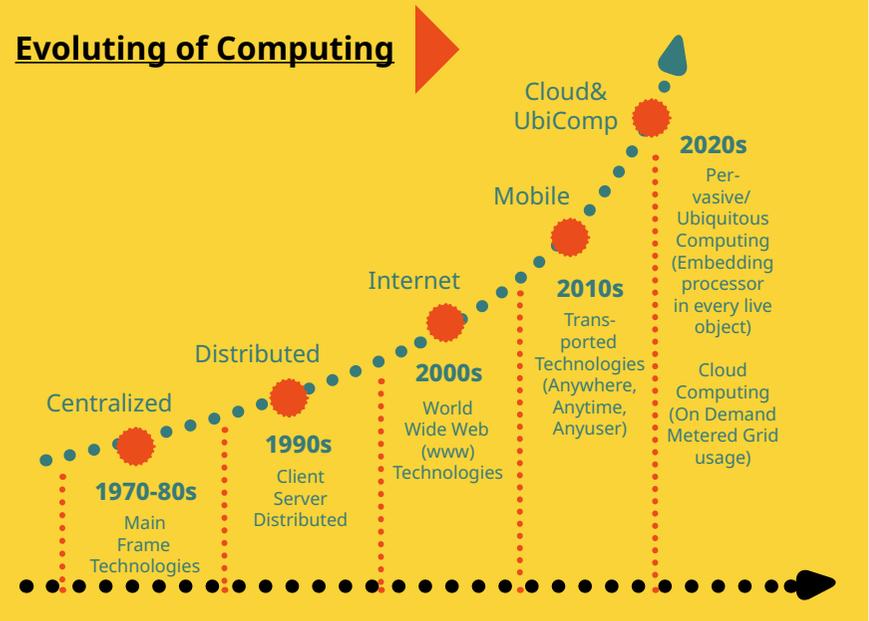
Implied questions, and required actions

Do the **early childhood development, child rights and parents communities need to learn more about both current and emerging technologies** so they can influence this agenda?

Do **'we', society, want to try to slow down the development of baby/toddler tech** until we, all, understand it better? Is this even remotely feasible if we did want to do it?

Are there any areas of early childhood development that we want to stop technology from taking on? For example, are we comfortable with AI teaching babies about values, ethics and reality? If not, do we need a Global Convention on AI or similar?

Evolving of Computing





3

Access to early childhood technologies, and the data on which they're being developed, is not equal. This may amplify inequality.

Virtually all societies around the world are unequal. Some are more unequal than others. Already we know that children born to poorer or more marginalised families grow less well, have more disability, speak fewer words, and are less ready to learn on reaching school. These children also have different access to and use of new technology.

Simultaneously, the artificial intelligence engines are being trained right now on data, not from all sectors of society, not from around the globe, but mostly from a small subset of rich, usually white, children and families.

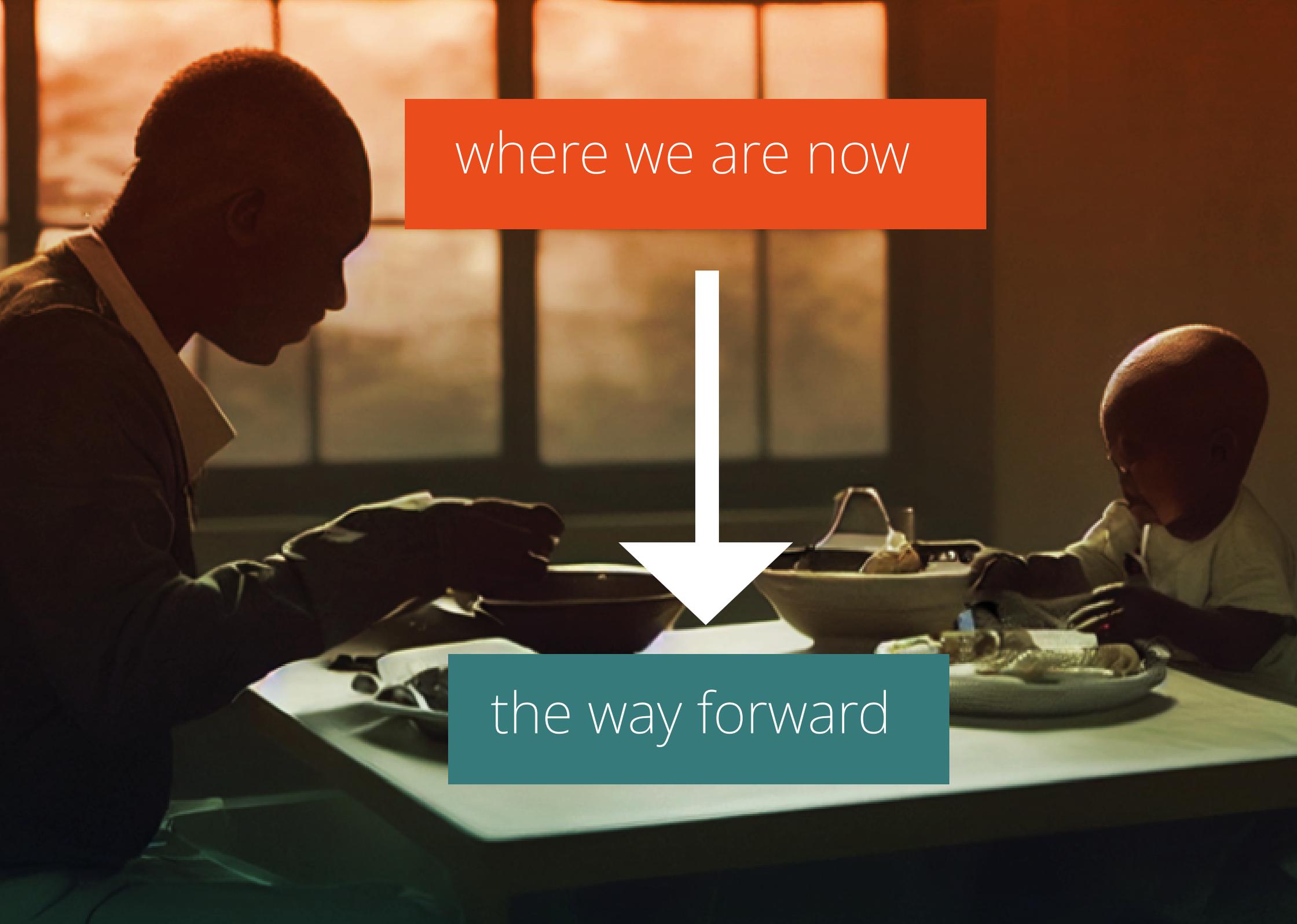
The implications of both differing access to technology, and structural bias in artificial intelligence, is a key unknown in this new future in which babies interact more with technology. There is serious potential for worsening of inequalities due to implementation choices - the implications of this in early childhood specifically might mean deepening and entrenching of inequality through child- and adult-hood, given the lifelong impacts of early life experiences.

Whilst all new innovation brings the risk of worsening inequality, there are many choices to be made in implementation. Societies can choose to prioritise 'narrowing the gap', or to prioritise the poor and most marginalised. This may be all the more important when discussing young children - our newest citizens - who have had no role to play in any societal positioning, access to wealth or status, and no influence upon these factors.



Implied questions, and required actions

All technologies have the potential to increase or reduce inequalities. We have options. Given the important for whole-of-life health and wellbeing, inequality needs to be front and centre in all discussion regarding technology and early childhood.

A photograph of a man and a young child sitting at a table, eating a meal. The man is on the left, wearing a dark shirt and a white apron, looking down at his bowl. The child is on the right, also looking down at their food. The table is set with several bowls and plates of food. The background shows a window with a view of a cityscape, and the lighting is warm and soft. Two text boxes are overlaid on the image: an orange one at the top and a teal one at the bottom, connected by a white arrow pointing downwards.

where we are now

the way forward

4

Child Rights and their needs, rather than just profit motives, ought to inform the development of early childhood technology

Who decides?

At present, technology development is largely driven by technology developers. Nearly all of these are for-profit groups aiming for greatest market share, first-mover advantage, and to reward investors.

But in a field as sensitive as this, where the future of individual human-lives, and the wellbeing of whole societies, is open to change...is this enough? There are other areas of society where governments have recognised crucial human rights and need for protection - for example, pharmaceuticals. There are stringent processes in place ensuring that new drugs have been tested appropriately, are safe enough for use, and that they work for some intended purpose. If a medicine is found to be unsafe, there are mechanisms for removal from the market, support for those affected, perhaps including financial compensation, and penalties for those who may have caused harm.

What sort of regulatory framework is reasonable to expect of technologies with the capacity to harm babies and young children? Surely there are ways of developing technology in a way that enhances (rather than replaces) high-quality human-human interaction? There are major questions that need answers as this development occurs: for example - must young children and babies always be cared for by adult humans? When is it acceptable for machines to provide love, care, nutrition? Who decides?

Implied questions, and required actions

How do we balance the need for innovation, the opportunities that such innovation might bring, with protecting our most vulnerable citizens, focussing on their rights and needs?

Do we need a global convention on the digital rights of the (young) child?

Imaginary tech-friends are already here for adults - when will this be available for babies?



Child rights gone wrong? Controversial advert from South Africa





5

Technology, if designed and deployed appropriately, can help to transform early childhood for millions of children, probably including some of those in the most difficult circumstances

Smart shoe inserts that can detect and report musculoskeletal problems;
 Smart toothbrush monitoring dental hygiene and analysing cortisol stress-hormone readings;
 Smart toilet analysing urine for metabolites and the microbiome related to health and growth;
 A tantrum detector;
 A baby language interpreter;
 Ultrasound as a means to support attachment between unborn baby and father;
 Smart diagnostic diaper supporting potty training;
 Monitoring child safety through audio and accelerometer sensors;
 Home visitor support system;

App to assist lay health workers delivering care according to best-practice guidance;
 Passive sensors that monitor audio and light, helping to address poor quality of child care centres;
 AI powered breastfeeding support;
 Smart cot preventing sudden infant death syndrome;
 AI powered child behaviour interpreter for caregivers to better understand their child's needs;
 A play mat with embedded sensors monitoring baby growth, play, and movement.

These are just a small sample of the many ideas brainstormed by the Hacking Early Childhood multidisciplinary team that might enable technology to perform useful functions in the life of a young child and their caregivers. Many, such as the home visitor support system, could act as a force multiplier creating opportunities to leverage and extend existing support systems to allow either increase the breadth (more families) or depth of care offered (continuous always-on). In particular the idea was put forward that a smart speaker with screen, enabled with the latest AI bot trained on data from mumsnet and other sources, could become a constant companion to anxious caregivers looking for advice and feedback about their child at a time when the home worker was not available. The idea could be extended further to encourage love and attachment between child and parent by observing interactions and capturing moments of mirroring and then replaying these for the parent explaining how the child was enjoying the interaction and communicating back.

While all concepts proposed focused on the beneficial use of technology to transform early childhood, it would be safe to say that even these more positive impact examples would need careful thought and attention to possible unintended consequences.

Implied questions, and required actions

In collaboration with industry, do academics and early-childhood practitioners need to 'lean in', co-designing high-quality innovations in this space, rather than waiting for and testing technologies that emerge?

**In other words, what are the risks of doing nothing?
 What can be gained from engagement and dialogue?**

[Artificial womb](#)



[If we can deepfake Tom Cruise, can we deepfake loving caregivers?](#)





6

We can draw lessons from other areas of innovation, including tech for elderly care, and from the changing world of infant feeding

Whilst tech for babies and young children might remain in the 'too difficult' group for some, for all the reasons discussed, digital innovation marches forwards for those of other ages. Current-day examples include early-warning systems for elderly people falls prevention, to artificial intelligence diagnostics for identifying dementia in its very earliest stages, to machines helping with adjusting home lighting, voice-activated household appliances, and even robots helping elderly people to walk. The 'elderly tech' market is burgeoning as care costs bite across the rich-world, traditionally a sphere of very high human resource cost implications.

Indeed, in somewhere like the United Kingdom, the imperative for machines to replace functions of home carers, prevent hospital admissions, and reduce loneliness is high in an ageing society which is struggling to support those growing into increasingly older age - often with multimorbidity.

So - if we want to know where technology is headed for young children - perhaps we should look to health-tech for the elderly, to technologies helping working-age adults in the household, moving around cities, and in the workplace. It's likely that tech for babies won't be created out of thin air - but like medicines, vaccinations and much else in society... at least some will 'trickle down' from the adult world.

Another area we can learn from is infant-feeding - here technology in the form of modified cow's milk served in bottles and powders has replaced (in some societies, nearly totally replaced) human milk, with many benefits, some known harmful effects, and many unknowns. Whilst clinical studies of these milks suggests that immediate/short-term safety of these milks is mostly acceptable (with exceptions - for example in those babies born very early) in situations where clean water is not freely available and accessible, their introduction has been nothing short of disastrous. What is the equivalent for digital technologies in babies - in what ways will other technologies follow this pattern. How do we avoid commercial pressures countering health & wellbeing...?



[Caption from linked piece "Robot shopping companions prove popular with the elderly in UK trial"](#)

Implied questions, and required actions

These conversations don't happen automatically - who can support new fora and mechanisms for learning from other spheres?

What positive, and negative, lessons can we learn from other early childhood innovations?



7

Academia, regulators and public awareness more broadly seems to be behind the curve of innovation in this space; this needs to be addressed urgently

Child health academics frequently feel out of their depth in this area. It seems likely this is also the case with regulators and other policy makers, given the lack of regulation today. This probably reflects wider public attitudes and a lack of overt engagement with the issues involved. The pace of innovation is outrunning public and academic awareness and regulation.

This contrasts with the considerable attention and interest amongst academics, funders and industry in Education Technology in schools - "EdTech", attention which largely seems to ignore early childhood development.

The real energy for innovation in early childhood tech is to be found in industry, and this brings a number of implications. Firstly, technologies are therefore likely to be being shaped primarily by commercial interests with a focus on developing profitable tools and business models. Secondly, innovation is happening behind closed doors, without being subject to more than generic regulations (regulations that specifically consider early childhood technologies as special haven't been written yet) and without mandated ethics review (as would be required in academia, for example).

That today millions of toddlers and babies interact with AI-powered smart speakers at home (with variable levels of supervision) ought to give us pause for thought.

It is currently unclear what data are being collected from babies and toddlers, nor how these data are being used by technology companies. This is despite several companies, most obviously Amazon with its 'Echo Dot Kids', marketing 'smart' devices directly to young children. The fact that industry seems likely to be outpacing academia and regulation on this area presents a question - how should those in research, civil society and regulatory bodies most productively engage? Should 'red lines' be drawn by regulators? Or will regulators forever be behind the curve of innovation here? Might this be a case of where constructive engagement/collaboration can work, at least with the biggest - and most public relations sensitive - companies?

Implied questions, and required actions

We need to write, and talk, about these issues more, across a variety of outlets that speak to different communities, including academics in different disciplines, industry players and the general public - e.g. [Please, see the example 1](#) and [the example 2](#).

A public conversation needs to be started about these technologies, so that societies can decide what they do and don't want to support/allow to be developed. Can we draw on provocative work on the dangers autonomous weapons and their danger? ([Please, see the link](#)).

Regulators (including ethics committees) need to urgently build their understanding of these issues; they will need to bring in new expertise for this.

An urgent effort to connect industry and academia is needed. This might need to start with an attempt to understand current thinking and work on early childhood technology amongst key technology companies.



[Echo Dot Kids](#)



“Since industry works faster than academia and government, it’s important for everyone to work together driving artificial intelligence that is beneficial and doesn’t undermine childhood development”

workshop participant

Conclusions:

New technologies continue to revolutionise the world as we have known it. There is no reason at all to think that early childhood will be spared this revolution, and all indications are that technology companies, families, carers, and the education sector will continue to incorporate innovation into the lives of babies and young children around the globe.

There is, however, a hitch; these technologies have been nearly all developed by and for adults, with adult-use, and commercial-requirements at the heart of design and creation. Already, millions of babies and preschoolers interact daily with artificial-intelligence powered “smart-speakers” within the home. The capacity for these AI-led guidance, care, education, and - yes - affection and love, is clear.

In addition, these topics have received minimal discussion by children and those who care for them. **There is minimal governmental regulation guiding use of technologies by age,** and there has been little discussion in the health-, education- and academic-spheres.

Through this series of workshops we have kickstarted a group of individuals and institutions working together to think big, **and act with the future in mind.**

Our “Seven Emerging Insights” (summarised here) inform the next steps for the [#HackingEarlyChildhood](#) network.



“This is all too important to be left to ‘big tech’ and early adopters. We need to encourage more people to join this conversation, otherwise we risk a future without informed debate, which would only lead to greater inequality across society as a whole”

1. Early interactions with technology are probably our most important interactions with technology
2. Early childhood is changing fast... whether ‘we’ want it or not
3. Access to early childhood technologies, and the data on which they’re being developed, is not equal. This may amplify inequality.
4. Child Rights and their needs, rather than just profit motives, ought to inform the development of these technologies
5. Technology, if designed and deployed appropriately, can help to transform early childhood for millions of children, probably including some of those in the most difficult circumstances
6. We can draw lessons from other areas of innovation, including tech for elderly care, and from the changing world of infant feeding
7. Academia, regulators and public awareness more broadly seems to be behind the curve of innovation in this space; this needs to be addressed urgently

What now?

To build on these workshops, a set of follow up activities have kicked off.

If you're interested in joining the group working on this, please join the whatsapp group (see below).

What?	Detail	Who?
Continuing cross-disciplinary academic collaboration	Grant application for 'changing childhoods' programme of collaborative work	Rob Hughes, Alastair van Heerden, Sunil Bhopal, Mark Tomlinson and others
	Building an informal network - hacking early childhood group chat Whatsapp group	if you'd like to join: Scan this QR code to join >
Landscaping	Systematic scoping review of ECDtech	Rob Hughes, Alastair van Heerden, Sunil Bhopal & Niina Kohlemainen
	Horizon Scan	Niina Kohlemainen and NIHR Innovation Observatory colleagues
Get talking with industry	NIHR Innovation Observatory Convening Meeting	Niina Kohlemainen
	Write to top 10 tech companies to ask what they're doing in this space?	Group of meeting attendees
Get a public conversation going	Developing a pitch for video provocations of different versions of the future	Rob Hughes, Alastair van Heerden, Sunil Bhopal





Appendix 1: Meeting details

Two highly interactive, interdisciplinary, human-centered design workshops, each held over two days, with short talks, discussions, breakout working groups, grant-writing, prototype building, script writing, and relationship forming.

	Durban	Newcastle
Date	5-6 May 2022	19-20 May 2022
Host	Alastair Van Heerden, Director, Human Sciences Research Council	Sunil Bhopal, Clinical Lecturer, Newcastle University
External Facilitator	Yolande Toohey	Keith Logan
Venue	Human Sciences Research Council, Durban	Newcastle Helix

"This workshop worked. It powerfully taught how design-thinking can be applied to innovations that are humane and baby-centred, while trying to make full use of the knowledge of the people in the room."

"A good marker of how the workshop worked very well was people staying off mobiles and laptops for much of the time, the transdisciplinary engagement and sharing was enabled by the workshop design."

"provided an excellent no-nonsense approach to design-thinking and designing with the user at the centre"

Appendix 2: Participants

Two highly interactive, interdisciplinary, human-centered design workshops, each held over two days, with short talks, discussions, breakout working groups, grant-writing, prototype building, script writing, and relationship forming.

Durban

Newcastle

Hacking Early Childhood organisers:

Sunil Bhopal, Robert Hughes, Alastair Van Heerden

Caspar Addyman
Chris Thornton
Cristina McKean
Dominic Kemp
Elin Haf Davies
Fiona Pearson
Hyunjoo Lee
James Stansfield
Jamie McQuire
Janice McLaughlin
Kia Nazarpour
Laura Ochoa Foschini
Lucy Bradbury
Nathaniel Mills
Niina Kohlemainen
Sally Hogg
Vic Harbottle

Ann Strode
Deshen Moodley
Douglas Momberg
Gugu Shongwe-Xaba
Inba Naidoo
Linda Richter
Llewellyn Fredericks
Martin Weiss
Rajeev Rao Eashwari
Sara Naicker
Xolani Ntinga
Zaynab Essack



Appendix 3: "Hacking Early Childhood"

Two highly interactive, interdisciplinary, human-centered design workshops, each held over two days, with short talks, discussions, breakout working groups, grant-writing, prototype building, script writing, and relationship forming.

Hacking childhood: will future technologies undermine, or enable, optimal early childhood development?



Hacking childhood: will future technologies undermine, or enable, optimal early childhood development?

Robert C Hughes,¹ Sunil S Bhopal^{1,2}, Alexander A Manu,³ Generative Pre-trained transformer, Alastair C Van Heerden^{4,5}

It's 2041. Children born during the COVID-19 pandemic are graduating (virtually). For several decades, the internet has been part of everyday adult lives. But now, of course, so much more has changed, including for our children. It's almost impossible to tell exactly when we really lost control. Where once, parents (mainly mothers) were considered primary caregivers, now child rearing is largely the domain of machines guided by the algorithms.

In the home, children are no longer loved and nurtured, but rather treated as commodities to be optimised. A parent's job is not just to love and cherish their child but—working with the machines—to develop them into the best match to the desirable outcomes as possible. While initially controversial, this approach is increasingly evidence based; a recent study, conducted on a sample of 200 000 babies over 24 months, supported using 12-hour recorded language and emotion therapy sessions for infants.¹ The study showed that the young children were more resilient in later years compared with peers receiving what was known previously as 'play-based childhood development'. Other studies show how these auto-parenting sessions enhance social skills among children under 5 years.¹ Loved ones are now considered an unnecessary threat when it comes to social development—after all they can disrupt even the most carefully structured interactions designed by technical engineers. Some

¹Maternal & Child Health Intervention Research Group, Faculty of Epidemiology & Population Health, London School of Hygiene & Tropical Medicine, London, UK

²Population Health Sciences Institute, Newcastle University, Newcastle upon Tyne, UK

³Epidemiology and Disease Control, School of Public Health, University of Ghana, Accra, Ghana

⁴Center for Community Based Research, Human Sciences Research Council, Pretoria, KwaZulu-Natal, South Africa

⁵SAMRC/WITS Developmental Pathways for Health Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg-Braamfontein, Gauteng, South Africa

Correspondence to Dr Sunil S Bhopal, Newcastle University, Newcastle upon Tyne NE1 7RU, UK; sunil.bhopal@newcastle.ac.uk

BMJ

experts argue that it would be preferable to remove parents altogether from daily interactions with young children, because mistakes are all too easy to make.¹ After all, parents tend to provide extraneous noise interfering with optimal instruction.

But the machines taking over was not uncontroversial. Other studies conducted in the 2020 and 2030s suggested there may be some things the machines cannot engineer: love, empathy and kindness. Well-publicised examples of parents forgetting their children's names (as they are increasingly anonymously referred to via unique numbers tracked by the National Child Identification Account database²) prompted an, admittedly short lived, backlash against the rise of automated child rearing. Only time will tell if we have—collectively—made a grave error by outsourcing child care to the robots.

Back to 2021. An artificial intelligence (AI) engine wrote the previous two paragraphs of this article based on a three-sentence prompt (details available at reference.¹ Technology is now much more than 'smart' phones and TVs, rather it is about systems that are beginning to mimic human capabilities. Parenting, caregiving and child development are unlikely to be spared from this revolution. While the wholesale replacement of parents is—thankfully—a long way off, it is worth considering how far and fast we are moving in that direction. That today millions of toddlers and babies interact with AI-powered smart speakers at home (with variable levels of supervision) ought to give us pause for thought.

Complicating the dystopian view we articulate is the fact that (as with much technological change) existing inequalities are likely to be exacerbated. As the rich access more sophisticated systems, the poor risk being limited to cruder lower cost versions. Biases are 'baked in' early in development of AI technology, and minimising these requires deliberate action and careful design choices. Given millions of children today lack water, sanitation, toys and human caregivers, will early

development be increasingly determined by the digital divide?

But this future has not yet been determined. We feel that those of us with an interest in early childhood can learn and engage more deeply in the research, development and regulation of these emerging technologies. We think a less dystopian future is possible. How about this alternative scenario?

Increasing automation means adults work a 4 day week, spending more time with friends and family. Parents each take 2 years paid parental leave. Technology frees us from administration, paying bills and routine shopping. Healthcare appointments including examinations and tests are often conducted from home, and there is more time for families to spend together, playing, reading, singing, laughing and talking.

While there were major concerns regarding privacy of new baby technologies, these were rectified through a series of well thought through privacy conventions of the 2020s. Parents now feel comfortable using privacy-preserving 'federated AI' and microphones, cameras, ingestibles and more to track their baby's movements, speech, cognition and development. Accelerometers, handed out for free in well-baby visits, let parents know when their child hasn't done much rolling or crawling for a few days, and audio/video sensors coach them to develop playful 'serve-and-return'³ interactions that were so easy to forget to do, even when we did have the time, in the old days. And when it comes to learning, early AI voice-recognition technologies like SoapBox (www.soapboxlabs.com/educate/) are now evidence-based, inclusive and support children to read, whatever their starting point.

The combination of these 'augmented parenting' technologies and whole society support for families mean populations are thriving, children are developing and learning more than ever and even levels of disruptive behaviour and violence are falling in schools as improvements in early childhood development feed through into later childhood. Passive and active sensing devices let parents and health services know about emerging developmental issues like hearing loss, movement problems and language delay earlier than ever. Interventions are delivered by highly trained, well-paid and motivated professionals supported by helpful technology. Freed by technology from routine work, long professional home visits support exploration of the finer details of child health and development, during which the

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emphasis is placed on the value of human-to-human play, love and touch, and how shared attention, love and joy cannot ever be automated.

HOW CAN WE HELP TO SHAPE THE FUTURE?

As academics, we can better engage with these emerging technologies. The changes they will bring are too important to be left to 'big tech' and ought to be shaped rather than followed. The technologies are here and are evolving fast. Already the Language Environment Analysis is showing real-world potential in understanding and tracking vocabulary size, language exposure and turn-taking, and the public are catching on (https://www.washingtonpost.com/local/can-a-bit-of-technology-called-lena-help-young-brains-develop-language/2019/01/01/97d7122e-0ddf-11e9-831f-3aa2c2be4cb_story.html). Left only to companies motivated by profit, the nuances and impacts on inequity are in danger of being sidelined. It is also evident that, like awareness and education about these issues, current regulations for devices and technologies are crude, and out of step with current technologies, let alone where technology will go in the coming decades.

We feel that there is an urgent need for an inclusive and informed conversation about all of these issues. We welcome initiatives like the *Lancet-Financial Times*

Commission on *Growing up in a digital world*, especially the recognition of 'a desperate need to reclaim digital technologies for the good of societies'. The creation of a new data governance model moving away from data extraction towards trust, solidarity, accountability and participation feels prescient.¹ We feel that the early childhood development community has been insufficiently engaged in these discussions to date. We hope to see more of this in the coming months and years.

It is easy to turn away from these intimidatingly complex debates and discussions; we are all 'out of our depth' in some way here. But they are too important for us to ignore. As they like to say in Silicon Valley, it's time to 'lean in' before early childhood gets 'hacked'.

Twitter Robert C Hughes @http://twitter.com/R_Hughes1, Sunil S Bhopal @sunilbhopal, Alexander A Manu @alexooyman and Alastair C Van Heerden @HSRCza

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RCH and SSB contributed equally.

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ORCID ID

Sunil S Bhopal <http://orcid.org/0000-0003-1229-781X>

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