

THE EARLY YEARS, EMOTIONAL DEVELOPMENT, SOCIAL COHESION AND THE FUTURE OF WORK

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I am a former pediatrician, developmental neuroscientist, evolutionary biologist and science advisor to government. All these different perspectives have something to offer to today's discussion. I am going to the question of the future of work rather indirectly because what we are really talking about is the future of people and their mental health in a rapidly changing world.

Societal resilience and social cohesion are increasingly threatened, particularly in many of the liberal democracies. There are many causes, but at the core of the existential threats we face is the enormous range of pervasive innovations that have accumulated at an increasing rate. This includes climate change driven by our innovations of 100 years ago in fossil fuel-based energy systems; biodiversity loss and issues of water and food security, driven by the population growth that arose from the public health innovations over the past 150 years; and the impact of social media and digitalization in all its forms on the way we live our lives.

Coincidentally, today Harvard University Press has published our new book *Ingenious*¹, which I coauthored with my long-time collaborator Mark Hanson. It asks the question of whether our capacity to progressively innovate has started to bite back and harm us.

Biological evolution is in general driven by producing progeny who themselves reproduce, thus maintaining gene flow. The male peacock's tail is a glorious illustration of nature's beauty – but why did it evolve? The prevailing concept in evolutionary biology, which has its origins in the debates between Darwin and Wallace, the two parallel discoverers of natural selection, is that the peacock's tail evolved because it was attractive signal to the peahen; for in many birds it is the female who chooses the males with which to mate. Those with more attractive tails were more likely to mate and so gradually the male peacock evolved to have longer tails. While this feature gave advantage of in terms of sexual success, it was in a sense runaway, in that there was no brake. And as the tail reached extreme lengths it started to become a handicap, making it harder to fly and escape predators. And so nature had started to bite back, via a constraint imposed on the biological selection process.

But humans in many ways are a distinct animal – we have big brains, we have unique dexterity with our hands, we have sophisticated oral communication, we learn from each other in ways that build off prior learnings, and we can cumulatively innovate. This innovation is largely because as social

¹ Gluckman P and Hanson M (2019) *Ingenious: The Unintended Consequences of Human Innovation*. Cambridge, MA: Harvard University Press.

animals with these attributes, we can store knowledge collectively rather than just individually – at first orally, then over the last 10,000 years through symbolic means such as writing and thus to stone tablets, papyrus, paper and digital media. It is this collective package of attributes that gives us the unique capacity to innovate and create technologies, from stone tools to super computers. And because we can learn and store information, we evolve not just through biological evolution but also through cultural evolution, via both the social and technological aspects of our lives. But whereas biological evolution is driven by the need to preserve gene flow, our cultural evolution is no longer driven by survival and reproduction but by seeking to improve comforts of our current lives, seeking pleasure and leisure, or seeking power and resources. Cultural evolution includes both social and societal innovation and technological dimensions. All have runaway characteristics and we need to consider what are the constraints, and whether they are within the limits such that our evolution does not handicap us.

Over past 100 years we have invented industrial food production systems. They have been very convenient and have created economic growth, but it is not without a cost to us – obesity, heart disease and diabetes. The discovery of antibiotics allowed us to fight bacterial infections, but it also created the environment in which resistance genes spread rapidly, thus setting up an arms race of inventing a new antibiotic to overcome the resistance set up by bacteria in response to the last antibiotic. But now, in part because of antibiotic misuse, we face the specter of superbugs. Could we be returning to the experiences of the pre-antibiotic age? No doubt we will seek a new technology to solve the problem, and indeed, this has been the response to every instance that nature starts to bite back. We caused obesity and diabetes, so we seek drugs and surgery to solve the problem we created. Climate change solutions in no small part depend on hopeful and as yet unproven developments in technology, such as carbon capture technologies at scale.

So what about the impacts of digitalization? In 2018 INGSA prepared, at the request of the OECD, the report *Understanding wellbeing in the context of rapid digital and associated transformations - Implications for research, policy and measurement*², on the impact of the digital transformation on wellbeing. The report emerged after over a year of expert consultation and it points out the broad range of impacts of the digital transformation, broadly defined, on the institutions of self, and of social and civic life.

We should not be surprised by the impacts of digitalization. It is distinguished from previous great and disruptive transformations – the agricultural, the printing and industrial revolutions – by its speed and pervasiveness. As our report makes clear, it is impacting on every aspect of our existence and in very fundamental ways, from how we develop and learn, to how we interact with each other, to how we live in organized society. Let me focus on the issues of human development.

² Gluckman P and Allen K (2018) *Understanding wellbeing in the context of rapid digital and associated transformations: implications for research, policy and measurement*. A discussion paper. Auckland: International Network for Government Science Advice.

Danish mental health surveys³, amongst others, show a frightening rise in mental health morbidity over the past decade, particularly in young women. There are multiple possible explanations, but there is sufficient evidence I think to say that at least one significant factor is the digital milieu – it changes the way young people interact, it changes the nature of their peer groups and how they spend their time. But equally there are other components that are not independent of each other. The heightened exposure to drugs and alcohol, a major issue in many countries for young people, is itself a reflection of a very changed societal milieu impacted on and expedited by the digital world. The ambitions and expectations of young people, and arguably a growing tendency to exhibit narcissistic traits, is in no small part driven by social media – how many young people now see their future as a celebrity or an influencer? Yet at the same time, the existential risks of environmental collapse are clearly enhancing the fears of many young people and this is both understandable and not unrealistic.

The fundamental way we rear our children has changed from a loose-tight to a tight-loose pattern. This may create real issues in the context of normal risk-taking behavior of adolescence. Prepubertal children in most societies, including our own, until relatively recently had reasonably loose environments at least after school. Increasingly, and especially in the West and in Asia, children are now heavily managed from the end of school until bed. There are multiple reasons for this change, ranging from parental expectations, to childcare arrangements to parental issues of concerns for safety. In contrast, teenage years a generation ago were rather tightly regulated – yet now they are anything but. Curriculum choices have widened enormously. Credit cards, access to cash and particularly the intimate and liberating nature of the smart phone mean that even when at home they are in a loose environment. If we look at traditional cultures, we can see that humans evolved to have a loose-tight child rearing pattern; this reversal is unique in our evolutionary history, and likely has major impacts on the maturation of executive function in the brain. This reversal diminishes the potential development of risk assessment and judgement skills in the prepubertal years, and exacerbates the risks of inappropriate risk-taking in adolescence.

The age of puberty has fallen in recent decades. We know that children with younger ages of puberty are more likely to have psychological problems in adolescence because of the greater mismatch that occurs⁴. Risk-taking pathways in the brain emerge at puberty because of the impacts of sex hormones on the brain, and the digital milieu in many ways creates pressures for greater risk-taking behavior. On the other hand, executive function – that is, wisdom and judgement – does not fully mature until into the third decade of life. The data linking early onset of puberty to greater psychological morbidity is strong. In turn, this creates a challenge that education systems designed

³ Sundhedsstyrelsen (2018). Danskernes Sundhed: Den Nationale Sundhedsprofil 2017.

⁴ Office of the Prime Minister's Chief Science Advisor (2011) Improving the transition: Reducing social and psychological morbidity during adolescence. Auckland: Office of the Prime Minister's Chief Science Advisor.

60 years ago, with middle schools designed to separate prepubertal and post-pubertal children, are now redundant.

Youth suicide in many countries including my own is unacceptably high. This cannot be understood simply in terms of traditional mental health diagnoses. While certainly some children suffer from depressive disorders, the reality is much youth suicidality reflects deficient emotional self-control⁵. This is then exacerbated by drugs and alcohol, and this occurs in the context of the normative adolescent transition from parent-related control to peer-related influences. Thus, in the absence of well-developed self-control, what might be of little consequence for many individuals becomes stressful, threatening and potentially catastrophic.

The educational challenge is how to increase emotional self-control, and here we must go back to the early years of life. For example, the use of good behavior games and similar educational tools in early school years clearly reduces suicidality in teenage years.

Then the question must be asked: what are the possibilities for enhancing self-control and mental health through education in the teenage years? Schools are increasingly recognizing the importance of critical thinking skills. The potential for individualized development of these skills through AI-based learning is emerging. Is there a role for going further using online tools to deliver other forms of emotional intervention therapies for those at need? There is limited evidence to suggest that investing in those skills can impact on emotionality and judgment, even reducing the risks of radicalization. There is an obvious and urgent educational research agenda here.

But we need to go even earlier in the life course and think more about prevention. Much of my research career has been committed to understanding prenatal and early infant influences on postnatal life – what has been called the first 1000 days. However, the term is misleading in the sense that the cycle of development starts well before conception, with growing evidence that parental health before conception has effects on the egg and sperm through epigenetic mechanisms, which in turn can have long-term health consequences that might cross several generations.

But let me focus on pregnancy itself. In Singapore I help lead what may be the most detailed study of child development This is the GUSTO cohort of about 1200 children of Indian, Chinese or Malay ethnicity, who have been studied from 10 weeks of pregnancy and are now about 8 to 10 years of age. The depth of neural, behavioral and emotional phenotyping especially in the first two years of life is unprecedented – functional, genetic, biochemical, electrophysiological and imaging data are all brought together. The children were seen 8 times in the first 2 years of life, then regularly for very in-depth study thereafter. GUSTO is now supplemented by an even more complex study in

⁵ Gluckman P (2017) Youth suicide: A discussion paper. Auckland: Office of the Prime Minister's Chief Science Advisor.

which 350 pregnancies have been studied, starting with the mothers who were characterized in-depth before conception and from the earliest phases of pregnancy.

The first suggestions of the long-term consequences of maternal stress and mental health came from studying changes in the epigenetic state of the fetal tissues – the umbilical cord⁶. This showed that maternal mood, as measured at 28 weeks, was in fact the biggest influence on the infant's epigenetic state. As the research has gone on, we have found that maternal mental health in pregnancy affects the infant's structural brain development, in particular the limbic system which regulates emotions, and certainly their functional development. Importantly, this is not about the extremes of women with clinically significant mood disorders. Rather, it reflects the difference between the 50% of women who were in great emotional health in pregnancy and those who had mild symptomology as revealed on the questionnaires.

Michael Meaney and his team have developed a battery of tests we colloquially call the school readiness test, and validated its use at 4 years of age. It has remarkable sensitivity and specificity for school performance at 7 years of age, and we believe we will be able to bring it down to a younger age. The battery is shown here. Using this battery and other tests we examined the effect of maternal mood on offspring brain development. We were able to show significant effects of maternal mood on neuro-emotional development at 4 years of age.

Statistical modelling suggests maternal mood in pregnancy, rather than maternal mood after birth or parental style, has the most major effects on offspring outcome. This suggests the role of biological mediators, and we have evidence indicating what these may be. Intriguingly the effects of socioeconomic status on children's emotional-cognitive development, which are well known, were mediated in a significant part through maternal mental health. On reflection, this is perhaps not surprising. For people of lower socioeconomic resilience, pregnancy creates additional pressures and stresses. The implications for intervention and prevention are very real.

Experiences after birth are also very important, as we know from much research. Emotional and cognitive development, and executive function, are all influenced by postnatal experiences including parenting style or capacity, family circumstance, abuse, health and level of stimulation. For example, in Singapore just 10 minutes of extra reading per day in the first 2 years of life delivers better cognitive performance, especially in those of lowest socioeconomic status.

The world we face is one of constant change – change at a pace and of a pervasive nature not previously seen. And societies have difficulty with rapid change, as the great scholar of innovation,

⁶ Teh AL, Pan H, Chen L et al. (2014) The effect of genotype and in utero environment on inter-individual variation in neonate DNA methylomes. *Genome Research* 24: 1064-1074.

Calestous Juma, pointed out⁷. And the work of Charles Fadel⁸ illustrates how it can take a generation for the consequence of new technology to move from pain of transition to the gain of an adjusted society.

But in this new world of constant transition, the risks are very high. They tend to have been minimized by the policy community and private sector in the drive for economic growth. However, productivity alone is not the societal goal – well-being is. These rapid transitions will threaten both social cohesion and individual mental health.

So let me make a direct comment about the future of work. Lots of assumptions are being made. What kinds of jobs will disappear, what jobs will emerge, what jobs will change and at what pace? I am not going to address those questions, but rather the question of the aging work force in this context. Boredom and then mental illness comes from not working and not being valued; excessive leisure may sound nice, but could well lead to the dystopian future Aldous Huxley describes in his novel *Brave New World*. So, the assumption has to be made that as one set of needed skills disappears, people will have to gain new skills. But what do we really know about what retraining means? Brain plasticity is not unlimited as it declines with age. Do we really know what lifelong learning and retraining means for a 25 year old versus a 45 year old or a 65 year old? Increasingly, 65 year olds will have another 20 or more years of productive life ahead. The opportunities, the needed approach and the level of divergence from base functional skills will vary according to age. Where is the formal neuroscience and educational research needed on this critical question?

So where do we go from here? The answers must be based on enhancing resilience both at the individual and societal level. Technological change is inevitable, yet regulation alone can no longer deal with it, as we have seen in privacy-related issues or in the difficulties in preventing live-streaming of horrific events on social media, as happened in Christchurch earlier this year. We have talked a lot about psychological resilience – that requires a very different focus and attention to the youngest minds, perhaps even before they are born. The nature of education needs to shift with a sense of urgency that is not obvious in most jurisdictions; parents need to understand the new world their children are facing. The goal needs to shift; psychological and emotional health is key. Critical thinking is needed in a broader context than simply the future of work. Critical thinking helps with resilience; it helps with learning how to separate fiction from reality, and there is some evidence that it reduces the risks of polarization, which is a threat to social cohesion. Education has become very focused on cognitive skills, in part because they are easier to measure. It now needs to focus on emotional competencies, and not just starting in the compulsory school years, but much earlier – before the child is born. And importantly, early childhood experience and education needs

⁷ Juma C (2016) *Innovation and its enemies: Why people resist new technologies*. Oxford: Oxford University Press.

⁸ Fadel C, What should students learn in the 21st century? <https://curriculumredesign.org/wp-content/uploads/CCR-Futurists-meeting-Day-1-Charles-Fadel.pdf>, Slide 19

to be considered much more actively in the policy sector, and not left as a largely passive, ignored domain.

The world is in a vulnerable space primarily because of our actions as a technologically innovative species. Individuals, social life and societies, as institutions, are all under stress. We have reached a point in our evolution where our human created environment is biting back. The solutions will be multi-dimensional, but the environments from conception through to adolescence will play a crucial role in determining our futures.