THE ART & SCIENCE OF

# LOOKING UP

**Transforming our brains, bodies, relationships and experience of the world by the simple act of looking up.**

DR FIONA KERR & LEKKI MAZE

# Contents


Looking up and out can change your brain,
your body, your relationships, your perspective,
and your sense of identity and belonging.

It has the potential to shape how we live and the societies we build together.

# Purpose & Intent

**Title**

The Art & Science of Looking Up

Transforming our brains, bodies, relationships and experience of the world by the simple act of looking up.

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**Background**

This paper brings together the research and work of Dr Fiona Kerr, and the Look Up framework and invitation.

## Project Purpose

The Art & Science of Looking Up is not a discussion on why we shouldn't look down or how bad looking at our screens is for our attention span, our health, happiness and sense of belonging.

Instead it is a glorious romp into the science of why it is so amazing for us to look up and out – and how that tiny, seemingly inconsequential decision to lift our head, is one of the most basic things we can do, yet it has some of the most profound effects on us as human beings.

## Project Intent

This work is created to be read and shared.

It meshes the science with relatable ideas and language, in order to translate these important findings about who we are as human beings, to be understood by many.

The Look Up Project is about us all.

# About

**Dr Fiona Kerr**
**Research & Writing**

Fiona is founder of the NeuroTech Institute, an independent body working at the intersection of neuroscience, emerging technology and ethical practice. It offers a truly multi-disciplinary approach to investigating how humans shape each other, how technology shapes us and thus how we should shape technology.

Her own diverse qualifications include cognitive neuroscience, complex systems engineering, anthropology and psychology built up over forty years, with almost thirty years in industry.

Fiona advises and works with organisations ranging from US Defense to Cirque du Soleil, with projects including how soldiers interact with autonomous systems in decision making, how to design multimodal gadgets which have a positive cognitive impact, and why face-to-face interaction with a nurse makes a patient heal better.

Fiona is passionate about people understanding the wonders of human connection, cognition and neurogenesis, and how we then leverage the transformative power of technology to build quality, moral partnerships between humans and AI. And also when we shouldn't.

She is an international speaker, appears regularly in media and works across five countries with companies, research bodies and governments such as Finland's steering committee to design their future AI program.

Fiona is an adjunct at the University of Adelaide, a Research Fellow with the South Australian Health and Medical Research Institute (SAHMRI) and an honorary professor for University College Dublin.

**Lekki Maze**
**Architecture & Editing**

Lekki is founder of research and conceptual studio Glider, whose work centres on human connection and conversation as a means of exploring and better understanding our shared human experience. She is also founder of the Conversation Dinners Project, Hard Things To Talk About.

Whether by reimagining public life and place, developing future scenarios or curating public exhibitions, immersive experiences or collective conversations, Lekki creates innovative, often unexpected, new forms that get people connecting, thinking and talking in new ways.

Underpinned by human-centred research, conversation theory and dialogue architecture, these experiences create the conditions that are conducive to real conversations about the wonder and complexity of being alive, and all the fullness of what it is to Be Human.

Endlessly curious about people, her work seeks to spark conversation in the public realm and unearth and inspire new ways of seeing, being and living well together… across communities and cultures.

The notion and invitation to Look Up is a core element woven through her work with cities, organisations and communities.

Her projects include: Be. Live the City a public exhibition experience inviting people to pause and look up and be more connected to their surroundings and each other; States of Being a performance installation experience; research-based artist residency and global photographic exhibition, The Story Of Our Planet Unfolds with climate change photographer Michael Hall; Bias: Against the Grain an immersive conversation experience and participatory research installation Realms of Possibility and Intangible Architectures exhibited in London for Future Fest.

# Foreword

## Look Up

As humans we are unique creatures. We are pulsing, dynamic aliveness – innately equipped with extraordinary capacities for insight, imagination, relationship and community. Our capacity for connectedness and our ability to make meaning set us apart and are essential aspects of our human experience.

The quality of our relationships – to our selves, to each other and to the places we live – shape our sense of identity and belonging and are what ultimately determines the health of our societies.

The Look Up Project has been created in collaboration, as a collective conversation. Beamed throughout Australia and shared around the world, it is one of the most relevant and timely public conversations we can have together today.

Look Up is an invitation to live life with a deeper connection to our surroundings, and each other. It is a gentle nudge and reminder for us all – to engage more fully with the world around us, and the people we share it with.

Turning left instead of right.
Walking more slowly. Noticing the details.
Sitting still. Giving time.
Creating space. Breathing out.
Daydreaming...
Looking up.
Looking at each other.
Being here.
Being here together.

The Look Up Project has the power to create something new in the world, by reminding us of what we all already have available to us – purely by being alive.

Aliveness sits at the heart of this project.

Aliveness to how amazing our brains are, and what they naturally want to do if we allow them the space and time to do so.

Aliveness to our surroundings and the places we live, work and spend our time.

Aliveness to each other and who we share the world around us with.

Aliveness to what it is to be human.

The wonder and complexity of being human is that we have choice.

From the first moment we are born we are in relationship. We are wired for connection, individually and at scale. And the science shows us that connection we create, can be positive or negative.

Our intent with this project is that it will inspire people to simply tilt their heads and look up and enjoy the multitude of benefits it brings. And that it might spark reflection and conversation on how we live, what we value and the innate capacity we have to positively shape our societies and how we live together, now and into the future.

Lekki Maze

Founder, Conversation Dinners Project
Hard Things to Talk About
Director, Glider Global

# Overview

## Why Should You Look Up?

**How Looking Up Can Change Your Brain & Your Life**

**The connection you make by looking up and out – at your streets, suburbs and cities, at the sky, trees or the horizon line, and at each other with a glance, smile or short conversation – is more than a way to pass the time. It meets a fundamental human need in our hardwiring for connection.**

**When allowed to roam, our brain does wonderful things. By letting it riff we allow ourselves the opportunity to increase creativity, develop new ideas, unearth insights, hone our intuition and solve problems differently by lengthening and broadening our viewpoint to think longer term.**

**When you look up at someone you light up their brain and start synchronising with them. And we each have the power to rewire both our brains, and those of the people we interact with.**

**In a complex, powerful and beautiful system such as the societies we live in, the power and beauty is in the connections between individuals. It is what shapes our social system and determines its health, and ours.**

**Far from being a waste of time, looking up and out is profoundly valuable and utterly necessary.**

# GREAT THINGS HAPPEN TO YOUR BRAIN, & YOUR LIFE, WHEN YOU LOOK UP & OUT.

WHEN YOU DAYDREAM YOUR BRAIN FORMS ABSTRACT CONNECTIONS, CREATIVE IDEAS & AHA! MOMENTS

WHEN YOU LOOK UP & OUT AT THE WORLD AROUND YOU, YOU CAN BUILD NEW BRAIN

WHEN YOU LOOK UP YOU CAN INCREASE AWARENESS & ACCESS INSIGHT

WHEN YOU LOOK AT SOMEONE IN THE EYES YOU LIGHT UP EACH OTHER'S BRAIN

WHEN YOU LOOK UP & OUT IT CAN BUILD EMPATHY, TRUST, AND A SENSE OF HOPE & BELONGING

WHEN YOU LOOK UP IT LENGTHENS & DEEPENS YOUR VIEW SO YOU CAN THINK LONG TERM & BETTER SOLVE COMPLEX PROBLEMS

WHEN WE LOOK UP & OUT AND ENGAGE DIRECTLY WE CAN SYNCHRONISE AS A GROUP

WE CAN SYNCHRONISE AT SCALE, WITH A CONTAGION EFFECT THAT CAN BE POSITIVE OR PROBLEMATIC

WHEN WE LOOK UP & OUT WE CAN IMPACT HOW WE CONNECT, HOW WE LIVE & THE SOCIETIES WE SHAPE TOGETHER

**LOOKING UP & OUT TO CONNECT WITH THE WORLD AROUND US, & EACH OTHER, IS WHAT HUMANS ARE HARDWIRED FOR.**

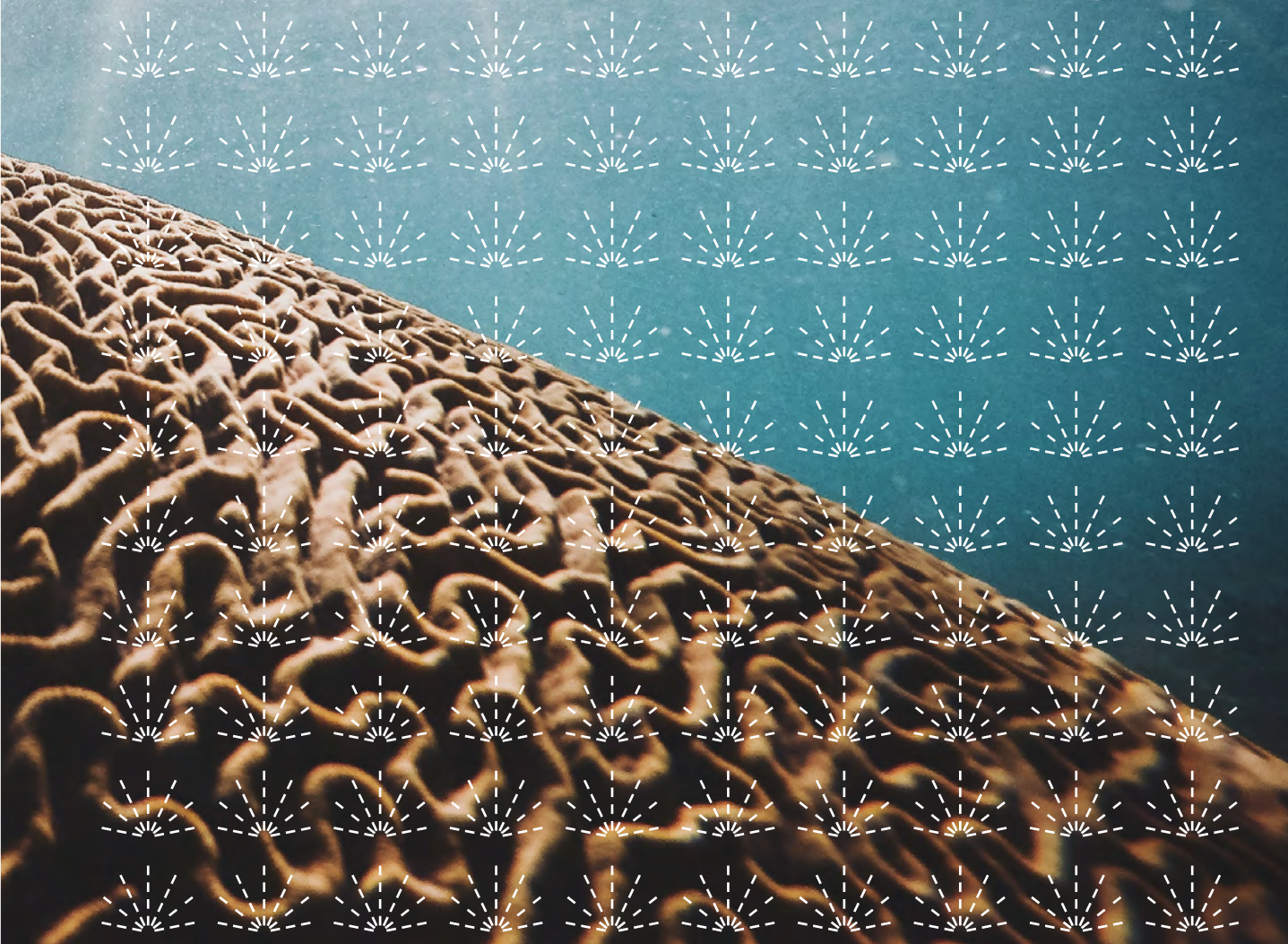
# Overview

# YOUR BRAIN IS AMAZING. YOU HAVE A SUPER POWER YOU MAY NOT BE FULLY AWARE OF.

Our brains are remarkable organs, made up of around 100 billion neurons. To put that in perspective, an average household bucket can hold about a billion grains of sand, so if you piled up 100 buckets of sand, you'd be close to visualising the number of neurons in your brain.

Now imagine that each of those grains of sand could form 10,000 connections, and that these connections can shift and change over time. Our brains are a work in progress.

When you work out the total number of possible parallel processes in your brain, you get a number with fifteen zeroes – that is 5 quadrillion. The level of complexity is staggering.



# Overview

# Your Amazing Brain

## How Looking Up & Out Helps Us Grow New Brain

### The Importance of Daydreaming

+ Looking up and out and daydreaming is more than a pleasant way to pass the time. It is actually our natural cognitive state, technically called our default mode.
+ This is the state of abstraction, a state of mind that is essential for deep thinking, creative concept building, new insights and is the basis of the Aha! moment. Rather than a linear, hierarchical thought process driven by task, it enables our brains to network and cross-reference disparate nodes of knowledge, critical to problem solving.
+ That is what the human brain is built to do brilliantly – to riff, and to reconstruct ideas and enhance areas of knowledge. The more we do it, the better we get at it, so not only is daydreaming good for problem solving, it also builds a more creative brain.

### Our Wonderful Plastic Brains

+ We build up our cognitive complexity by laying down information in rich neural networks like 3D spider webs, and these get richer and larger and more cross-connected as we add new information.
+ The more curious, open to new information, or skilled we become, the richer the information we take in and the wider the sources we take it from.
+ When we take in information we fractionate it into tiny fragments we encode and store in various parts of our brain, only to round them up again in order to reconstruct them each time we recall them. This is why our memory is described as plastic.
+ The brain loves novelty and the chance to make non-linear connections, so when we are in an engaged or abstractive state, we are neurally nimble with a more flexible, abstractive neural structure.

## Getting Better at Thinking

+ While we think we may be giving our brains a rest when we're scrolling on our devices, this sort of distraction kills abstraction, rather than giving it the type of space that daydreaming does. It is estimated that our attention span has shortened by around one third over the last fifteen years.
+ We are built to register novel stimuli, especially in our peripheral vision, and the brighter and faster moving that stimuli the quicker we attend to it. This served us well when running from predators, but the constant stream of stimuli today increases inattention and distraction, and actively blocks abstraction.
+ Looking up not only lets our brains improvise and play, but it improves our capacity to maintain a focused state of mind – with less effort – so we actually get better at thinking.

## Building New Brain

+ Our brain moves, grows, prunes and changes continually in response to external and internal stimuli. We sculpt our brain depending on what we reinforce and pay attention to. It is a work in progress.
+ While there are peak times in our younger years when the brain grows and prunes more significantly, under the right conditions we can grow new brain at any stage of our lives – through adequate exercise and sleep, healthy eating, continued learning, looking up to enter the state of abstraction, and out to engage in direct human interaction.
+ As we synchronise and resonate, we spark into action the neurons and dendrites that connect up, shape and differentiate our brain. This stimulates systems that create new brain – our own and someone else's – simply by interacting in certain positive ways.

# Overview

## Light Up Your Brain & Each Others'

### The Magic of Electrochemical Resonance

### Synchronising With Each Other

+ Humans are designed to synchronise mentally, physically and emotionally, as soon as we are within range – this is the neurophysiological sonar of live human interaction. We are human radar.
+ Even before we look at each other or start to talk, we have begun to connect on a physiological level. Without being aware of it, we have set off intricate neural activity involved in developing a bond, and begun to synchronise our actions and intent.
+ We give off and pick up a huge amount of electrochemical information from each other when we engage – when we look at each other, speak, or even just share the same space. We are hardwired to connect, increasingly attuning in complex and little understood ways that have a profound impact on both ourselves and each other when we interact.

### Sparking Face-to-Face

+ One of the most powerful human interactions we can have is face-to-face contact involving eye gaze.
+ Our brains are built to pick up a huge amount of information about another human face, especially direct eye gaze, and with lightning speed. From the instant we first lock eyes with another person, specialised brain cells spark into action.
+ When we meet face-to-face, our brain begins to resonate at specific frequencies, and is awash in oxytocin, dopamine and vasopressin, all with positive effects.
+ When we interact face-to-face, we are constantly learning to read non-verbal cues. We get better and better at picking up a rich picture through our plasticity, honing our radar through visual signals, synchronisation, and chemical resonance.

## Lighting Up Each Other's Brains

+ Meeting someone face-to-face turns on different parts of our brain than meeting virtually, creating a more personal connection that lasts longer and feels different.
+ It is something that can't be replicated through a screen.
+ A different part of the brain lights up face-to-face and we can watch individuals wearing EEG caps neurally synchronising as they interact in person rather than over screens.
+ Due to the chemical cocktail we create when we connect, not only do we light up each other's brains but we each possess the power to rewire both our own brains and those of the people we interact with. It is like an in-built super power that we are hardly aware of, but we see and feel the results.

## Transferring Meaningful Messages

+ When we actively engage, we synchronise the social and emotional networks in our brains. This state, which we call interpersonal neural synchronisation (INS) or neural coupling, allows us to transfer not just information, but meaning, delight, fear and aspiration.
+ Neural coupling happens in positive face-to-face interactions when we're paying attention and trying to engage the other person in what we're seeing, thinking, feeling or imagining. Effective leaders, inspiring teachers, storytellers and engaging friends all demonstrate this capacity.
+ The more we look up and out to engage, the more we read both the affect and effect we have on people, and the keener our radar becomes.

# Overview

## What Fires Together Wires Together

### Humans are Hardwired to Connect

#### Building Trust & Hope

+ There is something humans instinctively do when we are worried or stressed and we see someone we love or trust – we seek reassurance via direct, prolonged eye gaze, be it a child looking at their parent or an adult their partner or friend.
+ We do this because the chemicals released in response include oxytocin and vasopressin which, along with increasing serotonin uptake, help promote a feeling of connection between us, lowering our body's stress response, and boosting healing and growth.
+ Hope is a related facet of human connection, that is becoming better understood. In medical and care environments, hope has been shown to grow when a person has a high trust relationship and warm, face-to-face interaction.

#### Expanding Our Horizons

+ When we engage, in under a second, mirror and spindle neurons start to fire and oxytocin and dopamine start to flow pre-empting the beginnings of empathy and trust.
+ Engaging in face-to-face contact is one of the major ways we elicit emotion and empathy.
+ Empathy allows us to identify feelings in others, and to an extent to feel what they feel, depending on our own experience. We can watch human brains innately light up when they see someone else in need.
+ Empathy has another critical role – it lengthens and deepens our view switching us into discernment mode – thus shifting our perspective, changing the criteria by which we judge problems and build solutions. It minimises short-termism, forming different neural pathways which nurture foresight and wisdom.

## Firing & Wiring Together

+ When we look up, directly interact and lock eyes we are connecting physically with each other's brains and bodies – synchronising and resonating with each other electrochemically.
+ The more we get to know each other, the stronger that synchronisation is and the shorter the lag time between sender and receiver as we tune in our radar.
+ We can also synchronise at scale, with a contagion effect that can be wonderful in a trusting and positive environment as it can lead to building shared neural networks of possibility. In a negative environment it also changes us, but not for the better.
+ As a result, a group of connected people can change how we see an issue, alter our priorities as a group, and create a capacity to collaborate around shared values.

## Being Human

+ Real live connections and interactions are at the very heart of what makes us human. It is what we are hardwired for.
+ A strong sense of our surroundings and real human connection can give us a greater sense of identity and a feeling and experience of belonging, both of which are fundamental to trust and a sense of hope.
+ Looking up and out to engage directly with the world around us, and who we share it with, unlocks a cascade of resultant neurological effects and measurable chemical and physiological changes that profoundly influence our bodies, our behaviour, our capacity to make decisions – the very nature of our humanity. It is critical to our individual mental and physical wellbeing, and in turn, our societies' health and life together.

**The last time you stood in a line waiting for your coffee what did you do?**

**Did you stare off into the distance lost in thought?**

**Did you chat to someone else?**

**Or did you look down at your phone?**

**Interestingly, two of those choices are fantastic for your brain and body, and can have a significant impact on the rest of your day – and your life.**

# The Aha! Moment

Our Free-Wheeling Brain & the Daydreaming State of Abstraction

**Looking up and out and daydreaming is more than a pleasant way to pass the time. It is actually our natural cognitive state, technically called our default mode.**

When we are not distracting our brains with technology or pushing them down the rabbit hole of trying to work on a specific task or problem, we enter a daydreaming state called abstraction, where we begin to think in a different, more complex way.

**Abstraction is turned on when we look up and out. When we are gazing out of that window or at the horizon, we allow our brain to cut loose. But at the same time, our free-wheeling brain is working hard, busy making all sorts of abstract connections between 'chunks' of knowledge and data filed away in their own separate compartments, and putting information together in new ways.**

Instead of goal-directed cognition that deactivates abstraction with cognitively demanding, externally focused, tasks and goals,[1] daydreaming allows our brain to spontaneously wander, engaging independently of goals or cues in the external environment.

The self-generated nature of such thoughts is important as it supports our capacity to focus on goals that extend beyond the present, and to combine different types of thinking. This is because the salience network that is normally the policeman of our brain that controls what is on and what is off, allows multiple networks to fire.

Rather than a linear, hierarchical thought process, we are more able to network and cross-reference as our brain is making connections between disparate nodes of information. Specifically, when placed in an MRI machine to watch what happens during this state of abstraction, studies consistently show activation of the whole default mode network which is a large group of brain regions that include the prefrontal, medial and lateral areas, the cerebellum and striatum. Not only do multiple areas fire, but there is coherence in the patterns, and the brain is very busy, consuming up to 80% of all brain energy whilst in this state.

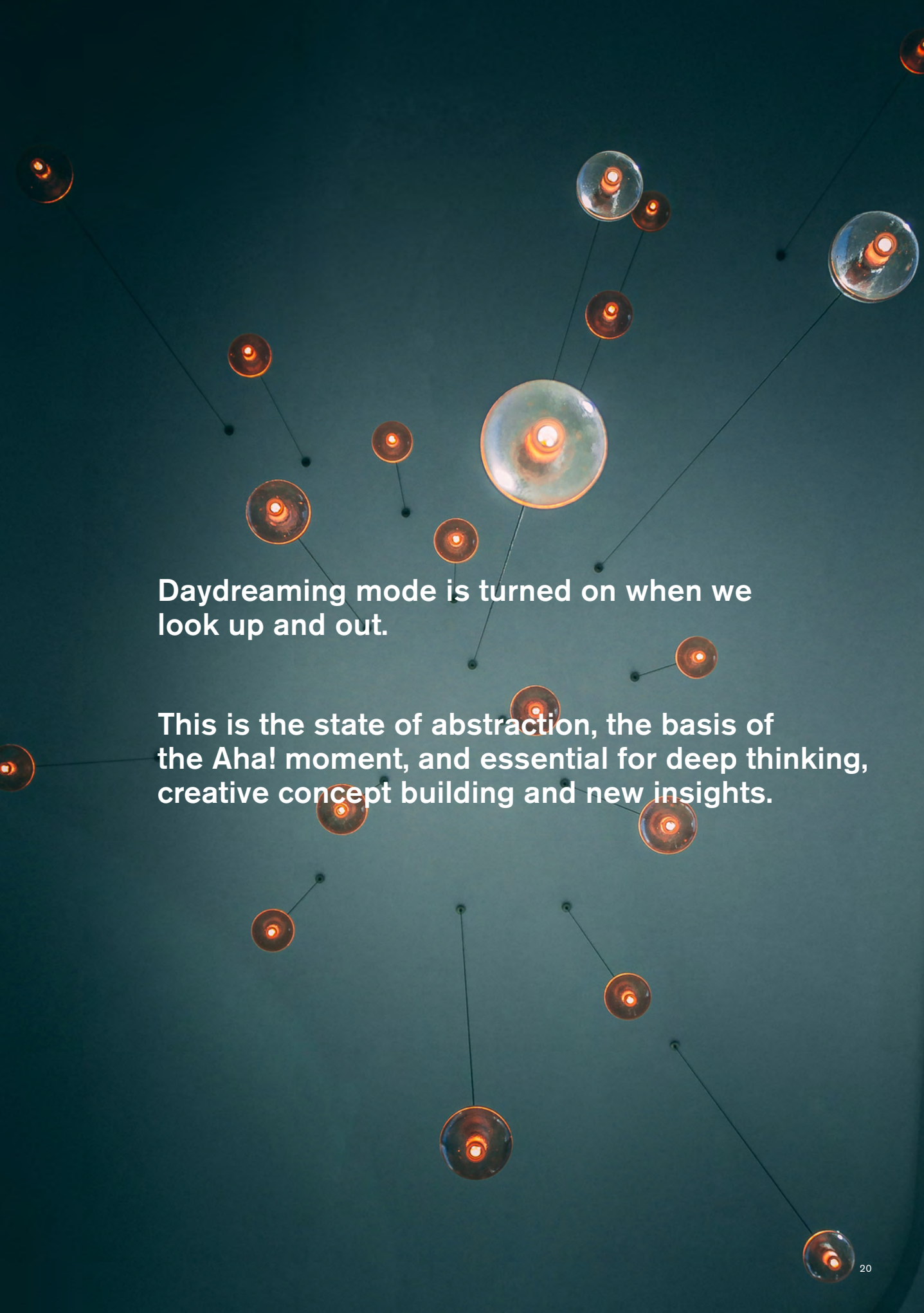
**This is the basis of the Aha! moment, a state of mind that is essential for deep thinking, creative concept building and new insights brought about from the novel connections being made.**

Think of it in the same way as Einstein's quote of not being able to solve a problem by using the same kind of thinking we used when we created it. We have filed the information regarding an experience or a problem in a certain way, and only when we allow this filed information to be connected in new ways do we create a different picture, and come up with new solutions.

**That is what the human brain is built to do brilliantly – to riff, and to reconstruct ideas and enhance areas of knowledge. And the more we do it, the better we get at it, so not only is daydreaming good for problem solving, it also builds a more creative brain.**

In contrast, when we are in task mode, we go down that rabbit hole, and can find ourselves sitting there looking down at the project we are trying to finish and getting nowhere, or worse still distracting our brains with our devices to get our dopamine spikes. We may think we are giving our brain a rest by this type of distraction, but instead of giving it the type of space that daydreaming does, this sort of distraction kills abstraction. Immediately.

One of the reasons for this is that it interrupts or completely blocks that process of allowing our brain to go about accessing all of the different pieces of disparately filed information that may be relevant while the multiple areas of our brain are turned on during daydreaming mode. And this is largely due to the way our memory works – how our brain collects, deconstructs, files and recombines information, and then hands us it back when we recall it.



**Daydreaming mode is turned on when we look up and out.**

**This is the state of abstraction, the basis of the Aha! moment, and essential for deep thinking, creative concept building and new insights.**

# The Magic of Memory

Building Cognitive Complexity by Being More Curious

**When we take in information we fractionate it into tiny fragments we encode and store in various parts of our brain,[2] only to round them up again in order to reconstruct them each time we recall them. This is why our memory is described as plastic.**

Even as you sit and read this text, you are filing such features as straight lines, curves, font, colour, meaning and gist and when you recall a word or line, the brain has to round the fragments up again, pass them through an emotional filter and give them back to you as recalled information. This takes cognitive effort, and it can be hard work depending on how much we have to make an effort to pay attention or how many parts of the puzzle there are to find and rebuild.

Interestingly, when we are excited and emotionally engaged in creative ideation we use different memory processes, linked to automatic memory which embeds faster and more richly through emotional pathways. So although it may feel like we are shifting between activities during a creative process by pausing, mulling over an idea, or gazing out of the window, this is not the same as having to make ourselves concentrate in task mode, or switching and scrolling between multiple screens – both of which are mentally depletive in nature due to cognitive fatigue. Instead, dealing with things that interest us, or entering a dynamic creative process is restorative for neural networks.

The brain loves novelty and the chance to make non-linear connections, so when we are in this engaged or abstractive state we are also rewarded with chemicals including dopamine – a neurotransmitter which signals a predicted reward, and acetylcholine – a neurotransmitter/ neuromodulator associated with attention and arousal. These days people are so used to multi-stimulatory devices that they sometimes report feeling less productive when they switch off all distractions and deep dive, but once they are in the zone, and the outcome is regularly a higher level of achievement and a higher quality to their work.[3]

A good way to think about it is to ponder the way our brain builds knowledge through 'chunking' information. We shape those chunks via how we take information in, what our brain does with it and how we retrieve it – all aspects which shape the view or idea we end up with.

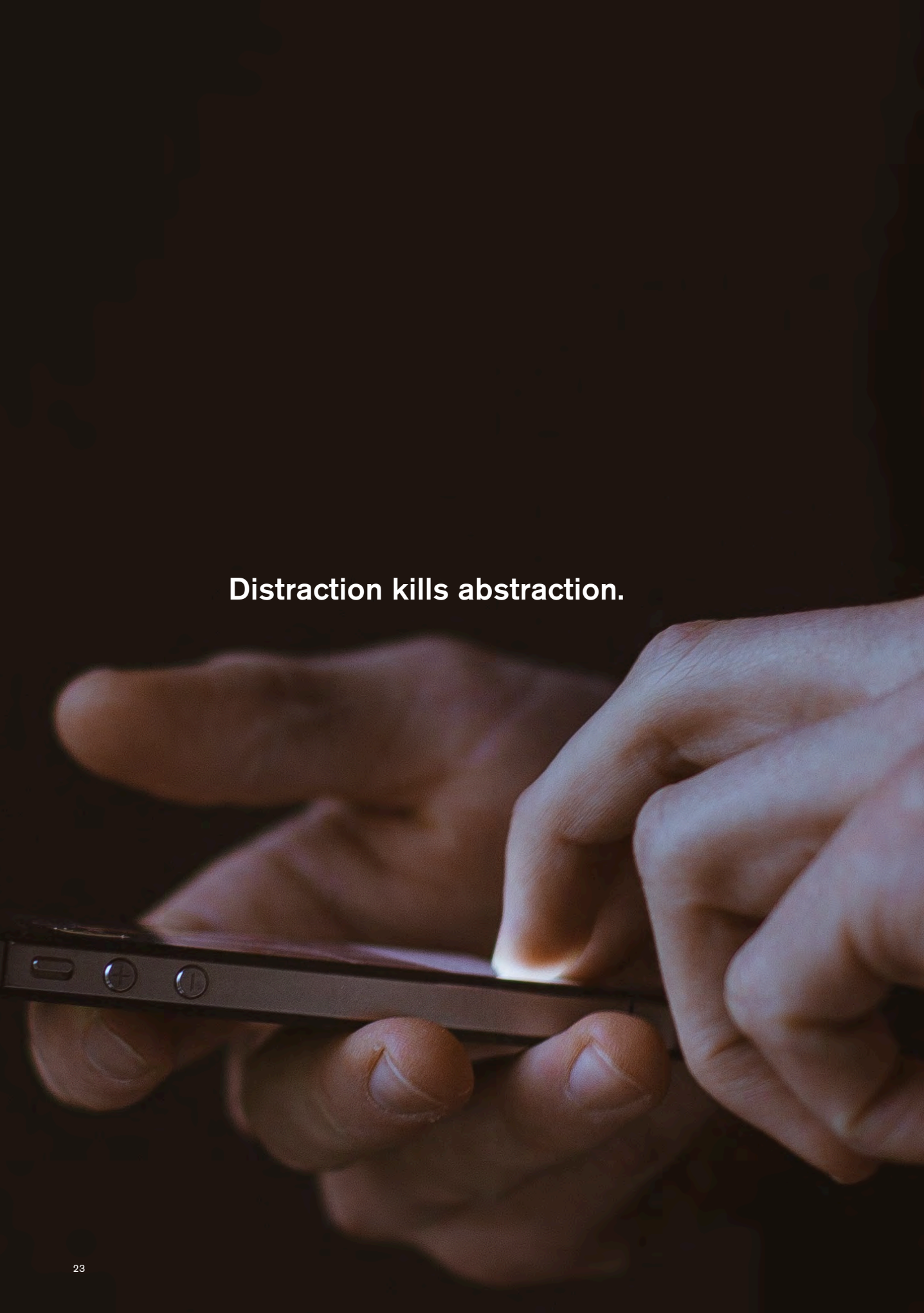
We build up our cognitive complexity via laying down information in rich neural networks like lovely 3D spider webs, and these get richer, larger and more cross-connected as we add new information. We add information via curiosity, practice, learning, observation and noticing more nuanced detail as we become better skilled.

**The more curious, open to new information, or skilled we become, the richer the information we take in and the wider the sources we take it from.**

**Our brain does wonderful things with it – seeing patterns and building networked 'chunks' connected in all sorts of abstract ways instead of being filed via neat hierarchical rules. These messy networks allow things to be grouped and clustered in more ambiguous and undefined ways, and retrieving information is richer and more flexible. This well suits the emergent nature of complex problems.**

When we allow ourselves to be, we are neurally nimble, and this unique quality of the human brain is a mix of both nature and nurture.

There is evidence that complex thinkers may do this more easily through having built a more flexible, abstractive neural structure.[4] We can also be impacted, both positively and negatively by culture, gender and practices which help to build new capabilities and new habits in regard to the way we think. On the other hand the narrow or linear thinker has a more fixed set of rules or heuristics that shape both information gathering and also the sources of information seen as relevant, so though they may deep dive into their speciality, there is less opportunity for abstraction.


Distraction kills abstraction.

## The average consistent estimate of how much our attention span has shortened is by around one third over the last fifteen years.

Understanding how we create habits is critical to how we live, learn and make better choices.

Simply put, the brain loves patterns, and so the more we do something in a certain way, the more often we repeat the pattern, the better the brain learns it and the more strongly a habit is formed.

With attention we can change habits – by doing things differently and sticking at it, our wonderful plastic brains can also change the pattern and incorporate the new one. The important element here is willpower – we need the stickability to keep at it until a new behaviour becomes the norm. Willpower takes effort, but like a muscle the more we use it the stronger it gets and the more effort we train our brain to make.

We can also increase our attention span by minimising distractions – switching off alerts or making a list to clear our mind of unimportant decisions as these take as much cognitive effort as decisions relevant to task performance.

Instead, we are freed up to immerse ourselves in the ever-more abstractive practice of looking up… and daydreaming.

# The Role of Intuition

The Hard Science Behind an Abstract Concept

**Another aspect of the Aha! moment is feeling that we know something through intuition. That gut feel when we just 'know' what to do means that many people think it is the same as an educated guess, but it isn't.**

Instead, intuition is the fascinatingly fast retrieval of rich chunks of knowledge that we have built up over our lifetime, and the more expertise we have in an area, the richer that chunk we open.

How do we build up these intuitive chunks of knowledge?

When we learn – to play chess, ride a bike, play an instrument, speak a language, drive a car – at first our real working memory, which is allowing us to function dynamically in real time, is bombarded with hundreds of thousands of pieces of data about all aspects of our new pursuit. Each piece has to be retrieved and dealt with separately.

Our brain loves patterns and aggregates very efficiently, so the more we practice, the more the brain chunks up information into like areas, creating packages that can be retrieved by the real working memory as one, instead of bits at a time, thereby greatly lowering cognitive effort.

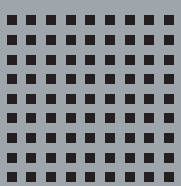
Eventually our chunked mastery is dense with packed networks that take up less working memory, need less attention, and leave us to concentrate on more abstract ideas or further improvement. It also minimises the brain searching through irrelevant data, freeing us up to find innovative solutions,[5] and allowing us to be more flexible in dealing with conflicting information.[6]

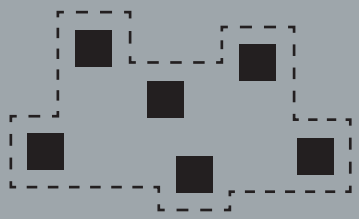
This 'compressed expertise' that we have developed over long experience,[7] is a rich resource we can tap into when we allow our brain the opportunity to do it. We are then able to combine this knowledge with analysing data in real time – blending intuited knowledge and analysis for the most accurate complex or strategic decisions.

Who would have thought we can tap into all this by looking up?

**Figure 1.0**

This picture in the New York Times shows eight year old Samuel Reshevsky, one of the greatest chess child prodigies ever, simultaneously playing a number of chess masters, and winning.



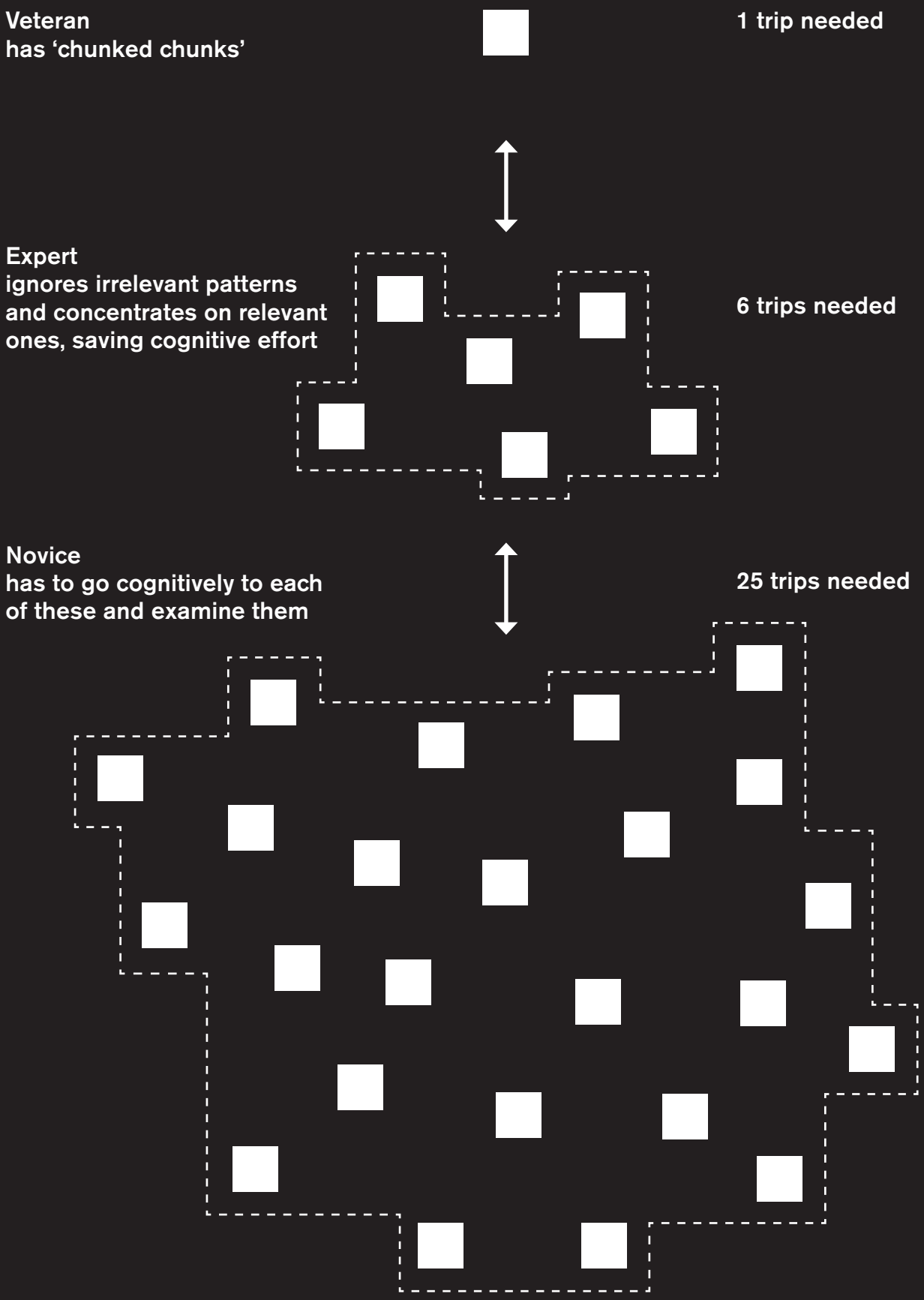


**A chess master can recognise 50,000 configurations on sight, minimising the cognitive effort they expend on any one game and allowing them to concentrate on multiple games at once.**

**Our brain does this is by grouping and chunking related pieces of information into huge, rich chunks of knowledge that open in under a second and present all of the information to our real working memory.**

**Thus that feeling of just knowing is not guesswork, but a robust font of knowledge built over time and experience.**

Figure 2.0


Veteran
has ‘chunked chunks’
1 trip needed
Expert
ignores irrelevant patterns
and concentrates on relevant
ones, saving cognitive effort
6 trips needed
Novice
has to go cognitively to each
of these and examine them
25 trips needed

Linked pattern is now a single unit, taking up less working memory and attention.

Whole patterns are grouped as a chunk of understanding, which can be linked to other chunks.

A chunk can hold several thousands of pieces of information.

Neural receptors recognise patterns in the pieces of information and they are chunked – grouped together as single chunks of understanding.

The initial information collected is often 100s of 1000s of pieces, all of which need to be collected individually.

# Focus & Attention

Inner, Outer & Other Focus

**Looking up not only lets the brain improvise and play, but it improves our capacity to maintain a focused state of mind with less effort so we actually get better at thinking.**

Focus is complex. It is a bricolage of vigilance, alertness, concentration, selective attention, open awareness, self awareness, self management and empathy. Focus shapes our criteria of relevance and meaning and informs how we build an idea. Goleman describes a mix of inner, outer and other focus, connecting each to self-awareness, systems awareness and empathy.[8] We need a mix of all three to deep dive into a complex problem or idea.

**When we really focus we can deep dive into something instead of getting distracted and this requires paying active attention.**

Attention is fascinating – it is the way to turn on chemicals that speed up our brain, and even increase plasticity or neurogenesis. When we pay attention to something, we also put it into our memories more efficiently and retain it for longer.

Unlike the first few years of life when we are human sponges, with our brains awash with BDNF and other chemicals that build new neurons and encode new information very rapidly, as we age we have to activate that capability to absorb, map and retain information.

Paying attention lets us do this. It is a wonderful resource. It creates the capacity to take in more information, more rapidly, because neurons synchronise and selectively focus, increasing both firing efficiency and absorption capacity (as can be seen in the diagram, the firing pattern moves from A to B). This creates expectation resonance, which means we notice more and predict more accurately what is coming, readying our brain to act like a sponge. It is also why if you have just bought a red car you suddenly see them everywhere.

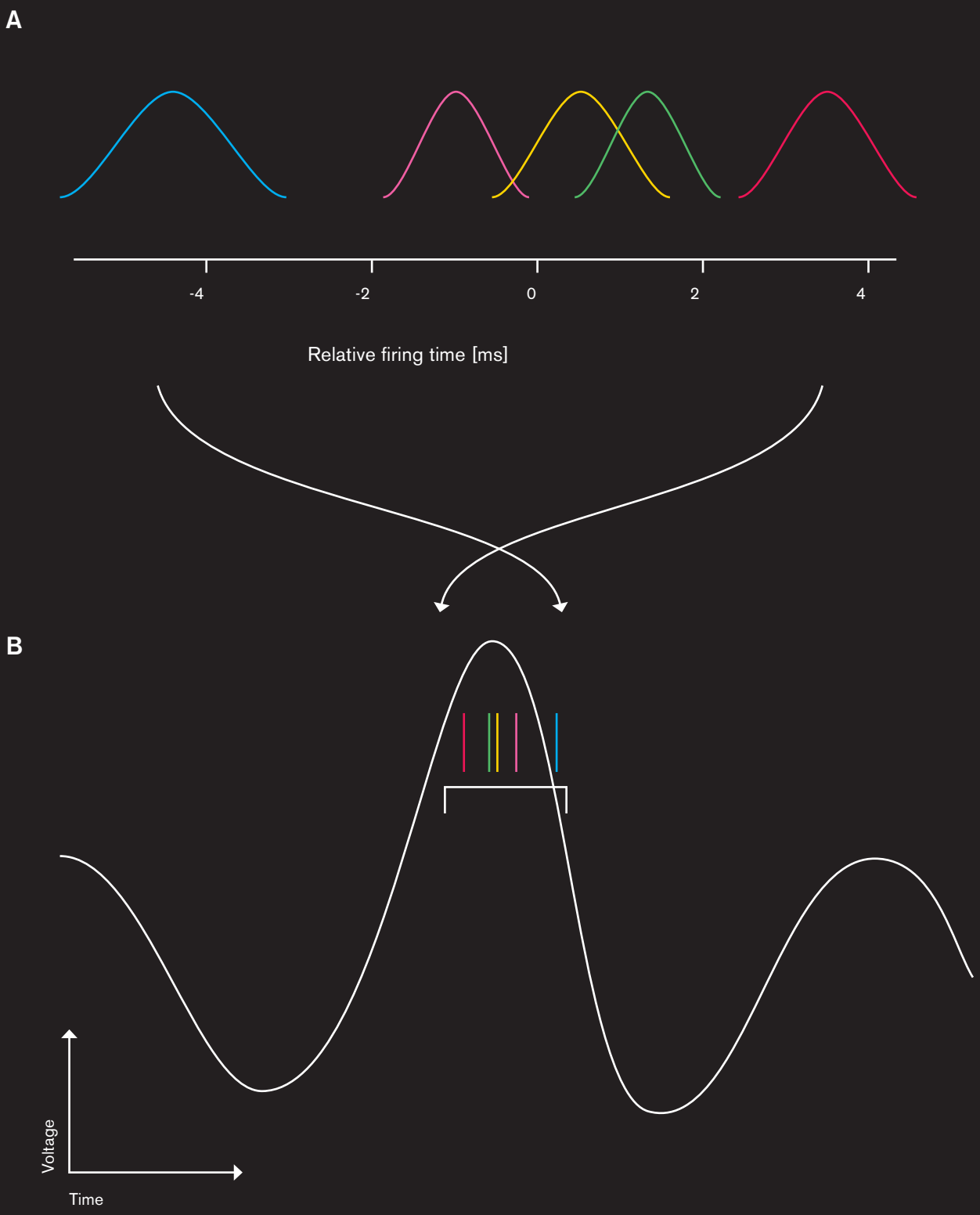
On the down side of things, anything can grab our attention as we are built to register anything novel, and the brighter and faster moving the stimuli in our peripheral vision the quicker we attend to it. This served us well when rapidly observing a stimulus helped us to survive, but now it serves to distract us easily.

**So why isn't looking down at our busy screens doing the same to our brains as they deliver dopamine spikes from alerts and reminders? It certainly feels like we are paying attention. But it isn't – screens activate different parts of our brain, increasing inattention and distraction, and actively blocking abstraction.**

This is made worse by our nimble brain's capacity to reset neurons every six seconds or so, jumping to the next piece of information or shiny thing – and just like any other habit we can train our brain to get used to doing this. By acclimatising us to faster input and rapid switching through paying attention to lots of peripheral stimulation which makes screens more sticky, the average consistent estimate of how much our attention span has shortened is by around one third over the last fifteen years.

So although your brain is zipping around, it is not the same as attention's increase in speed through attentive synchronisation and rapid memory coding. Instead it causes cognitive fatigue, tiring us and driving us towards superficial problem solving. While AI may beat us at data aggregation and pattern matching, when actively attending, our brain is still great at this, and much faster at cross connective, contextual extrapolative activity.

## Figure 3.0




**Paying attention creates the capacity to take in more information, more rapidly. This happens because neurons synchronise and selectively focus, increasing both firing efficiency and absorption capacity and creating expectation resonance. This means we notice more and predict more accurately what is coming, readying our brain to act like a sponge.**

# Awareness & Insight

Why Looking Up & Out Let's Us Look In

**True focus melds the inner, outer and other, and we gain the capacity to shift between them and integrate, creating a more cohesive picture of the whole.**

Both reflection and awareness change the brain.

One of the key ways reflection does this is by increasing the level of self-awareness which can inform or lessen our individual biases. Our biases shape the lens through which we look at ourselves, others and the world, and can cause us to ignore relevant information, engage in negative self-talk and go into automatic pilot in thought or action. Reflection and contemplation help counteract this by allowing the brain's hippocampus to evaluate tacit learning and for multiple parts of the brain to connect, to better 'test' thoughts by integrating multimodal, non-linear information.

Meditation is the most well-known formal contemplative practice. Ricard et al, in their article Mind of the Meditator[9] describe meditation as:

**"the cultivation of basic human qualities, such as a more stable and clear mind, emotional balance, a sense of caring mindfulness, even love and compassion — qualities that remain latent as long as one does not make an effort to develop them. It is also a process of familiarization with a more serene and flexible way of being."**

Scientists who have taken up the Dalai Lama's offer to study brain activity in the Mind and Life Institute's contemplative neuroscience discipline, have developed some great work that has seen over 100 monastic and lay practicing Buddhists and early meditators as subjects taking part in experiments with more than 20 universities, and with startling results.

## Study 1.0

The study compared veteran versus novice meditators, and allowed researchers to watch through neuroimaging what happens during three major forms of Buddhist meditation.



**Focused Attention**

aims to tame and centre the mind while remaining vigilant and present, allowing the meditator to minimise mind wandering, and refocus quickly if it occurs.

The study showed different patterns of activity in the attention areas of the brain depending on the level of experience, with veteran meditators able to focus at will, with little effort.

**Mindfulness**

aims to improve attentiveness but lower emotional reactivity to internal emotions, thoughts and sensations.

With practice, meditators increased their ability to optimise attention but control and buffer physiological responses. Scientists observed such outcomes as moderating stress through lowering stress hormones, lowering pain and inflammation levels and depression, and improvement in a variety of activities including sleep, public speaking and maths calculations.

**Compassion & Loving Kindness**

fosters an altruistic perspective towards others, with an awareness of their needs and a sincere desire to help them.

Two groups meditated on empathy, with one also including meditation on love and compassion. It was found that just increasing empathy can lead to empathy fatigue, but including the second allowed the meditator to step back and contemplate how to help, which strengthened several cognitive areas linked to determination and emotional resilience, decreasing distress and emotional overload. Over time this is seen as leading to benevolent wisdom.

Amazingly, expert meditators could not only sustain a particular electrical brain pattern that allows temporary networks to be grown integrating cognitive and emotional functions during learning, but could then convert them into *new* brain circuitry.

# Contemplative Experience

How Meditation Changes Our Brains

**Contemplation, with its substantive impact on cognitive capacity, biological processes and wellbeing may just be the true fountain of youth.**

There are many studies that consistently show the power of meditation to create physiological changes in the brain and body of the practitioner.

This study, and others noted in the Mind of the Meditator article, have unearthed some startling results showing changes to the size and density of different parts of the brain depending on the type of meditation and how long the person has meditated, and amazingly these changes to their brain circuitry can be permanent.

There are increases to cortical thickness – the brain's real estate – the prefrontal cortex, which processes attention, sensory information and internal bodily sensations and the way the amygdala processes fear – both of which contribute to meditation increasingly being included in treatment for depression, chronic pain and wellbeing.

They also found that long-term Buddhist practitioners can switch brain oscillations and change EEG patterns at will depending on what the situation requires, such as maintaining emotional calm, regulating pain or diving into creative ideation mode and even facilitating neurogenesis, as noted in the study described. This is because meditators are able to increase density of both grey matter and axons (that connect neurons together into networks), and quickly build temporary schema that become permanent cognitive and affective networks critical to learning.

Experienced meditators can stay calmer, maintaining emotional balance, regulating stress and anxiety, boosting focus and plasticity. And over time, they acquire these abilities with less effort, whether they want vigilance or sleep, as they can mindfully monitor both external stimuli and internal bodily sensations.[10]
The increase in compassion includes compassion for an individual's own faults and foibles. This combined with the rise in emotional resilience and determination can help enable examination and acceptance of the self and others, and strengthens the ability to change if required. Mindfulness was also found to enable better control of stress, anxiety and depression, and improvement in sleep patterns.

One of the most fascinating areas is the mounting evidence of enhanced wellbeing through physically diminishing inflammation. A study by Kaliman found that experienced meditators can turn down inflammation-related genes and alter their enzyme activators,[11] and even regulate telomerase, the enzyme that lengthens DNA segments to enable slower cellular ageing, which is also associated with decreased psychological stress. Contemplation, with its substantive impact on cognitive capacity, biological processes and wellbeing may just be the true fountain of youth.

In the space offered by the contemplation of looking up we are not only able to learn and create faster, but through emotional regulation we are also able to get in touch with who we are and what is important to us. It can allow us to get to know and accept ourselves in a way that can bring an inner stillness, and a level of self-compassion mixed with emotional resilience that can release us from sculpting what we think we should be in our own, or other's eyes. It can allow us a powerful shift in perspective, inviting us to change who and what we value, and where our priorities lie. It can offer us an increased capacity to be comfortable in our own skin. This is not only important for our own self-acceptance, but also, just like the notion that we have to love and accept ourselves in order to be able to love and accept others, it is only when we are comfortable with our authentic self that we also accept the authenticity of others.

**Such compassion is a critical basis for the compassion that drives a kinder us and helps us to build a kinder, more connected and contented world.**

True focus then melds the inner, outer and other, and we gain the capacity to shift between them and integrate, creating a more cohesive picture of the whole. We can look upwards and outwards and open the door to our inner selves, whilst also grappling with bigger questions around what a good world looks like and our place in it. All in that quiet time of contemplation.

# Figure 4.0

### Focused Attention

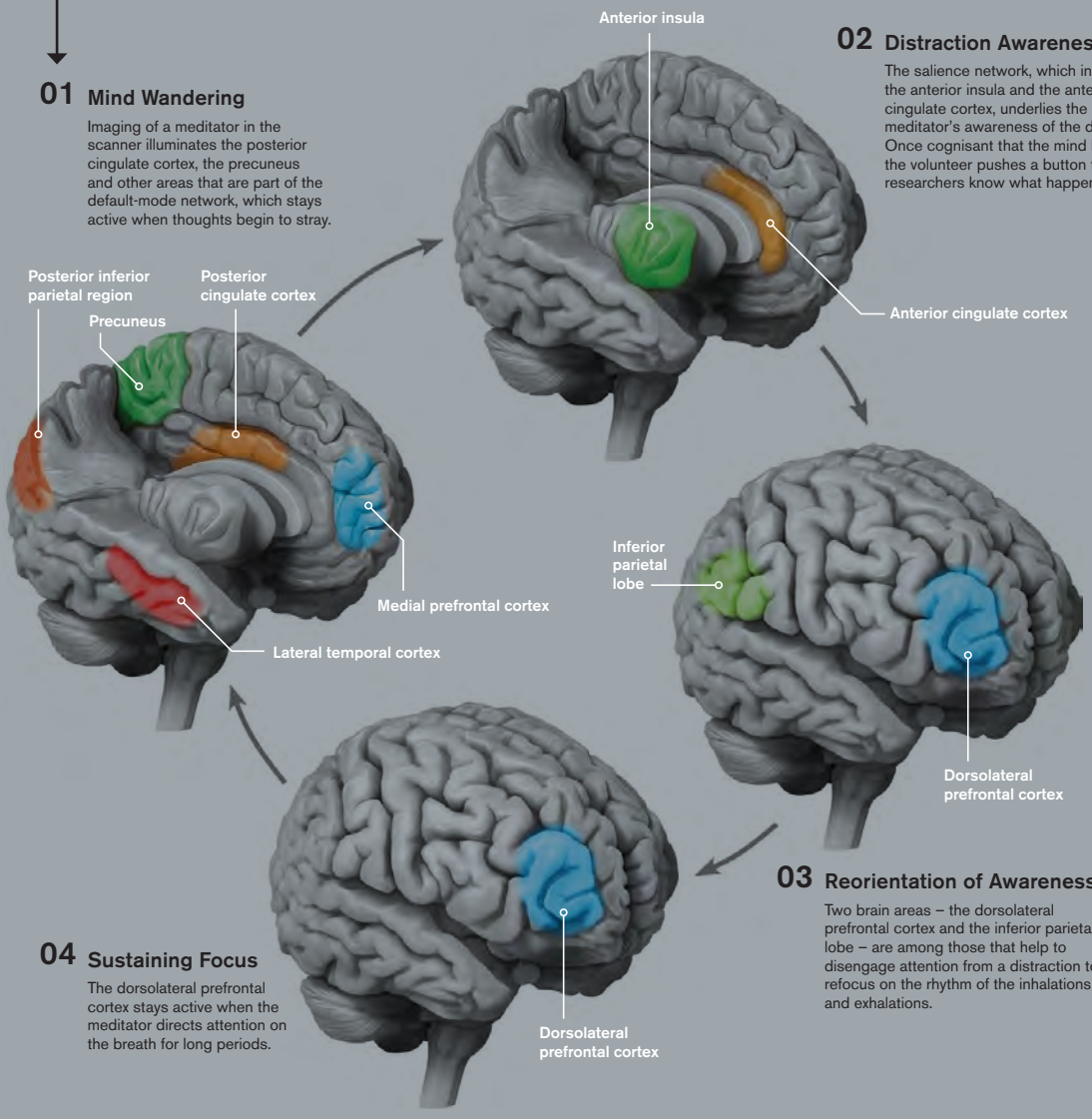
This practice typically directs the meditator to concentrate on the in-and-out cycle of breathing. Even for the expert, the mind wanders, and the object of focus must be restored. A brain-scanning study at Emory University has pinpointed distinct brain areas that become involved as attention shifts.

### Mindfulness

Also called open-monitoring meditation, mindfulness entails observing sights, sounds and other sensations, including internal bodily sensations and thoughts, without being carried away by them. Expert meditators have diminished activity in anxiety-related areas, such as the insular cortex and the amygdala.

### Compassion & Loving Kindness

In this practice, the meditator cultivates a feeling of benevolence directed toward other people, whether friend or enemy. Brain regions that fire up when putting oneself in the place of another – the temporoparietal junction, for instance – show an increase in activity.




### 01 Mind Wandering

Imaging of a meditator in the scanner illuminates the posterior cingulate cortex, the precuneus and other areas that are part of the default-mode network, which stays active when thoughts begin to stray.

### 02 Distraction Awareness

The salience network, which includes the anterior insula and the anterior cingulate cortex, underlies the meditator's awareness of the distraction. Once cognisant that the mind has roved, the volunteer pushes a button to let researchers know what happened.

### 03 Reorientation of Awareness

Two brain areas – the dorsolateral prefrontal cortex and the inferior parietal lobe – are among those that help to disengage attention from a distraction to refocus on the rhythm of the inhalations and exhalations.

### 04 Sustaining Focus

The dorsolateral prefrontal cortex stays active when the meditator directs attention on the breath for long periods.

# Hardwired to Connect

## The Neurophysiological Sonar of Dynamic Resonance

**When John Donne wrote that no man is an island entire of itself, he was touching on a deep truth that we as humans understand intuitively, and science is now beginning to explain.**

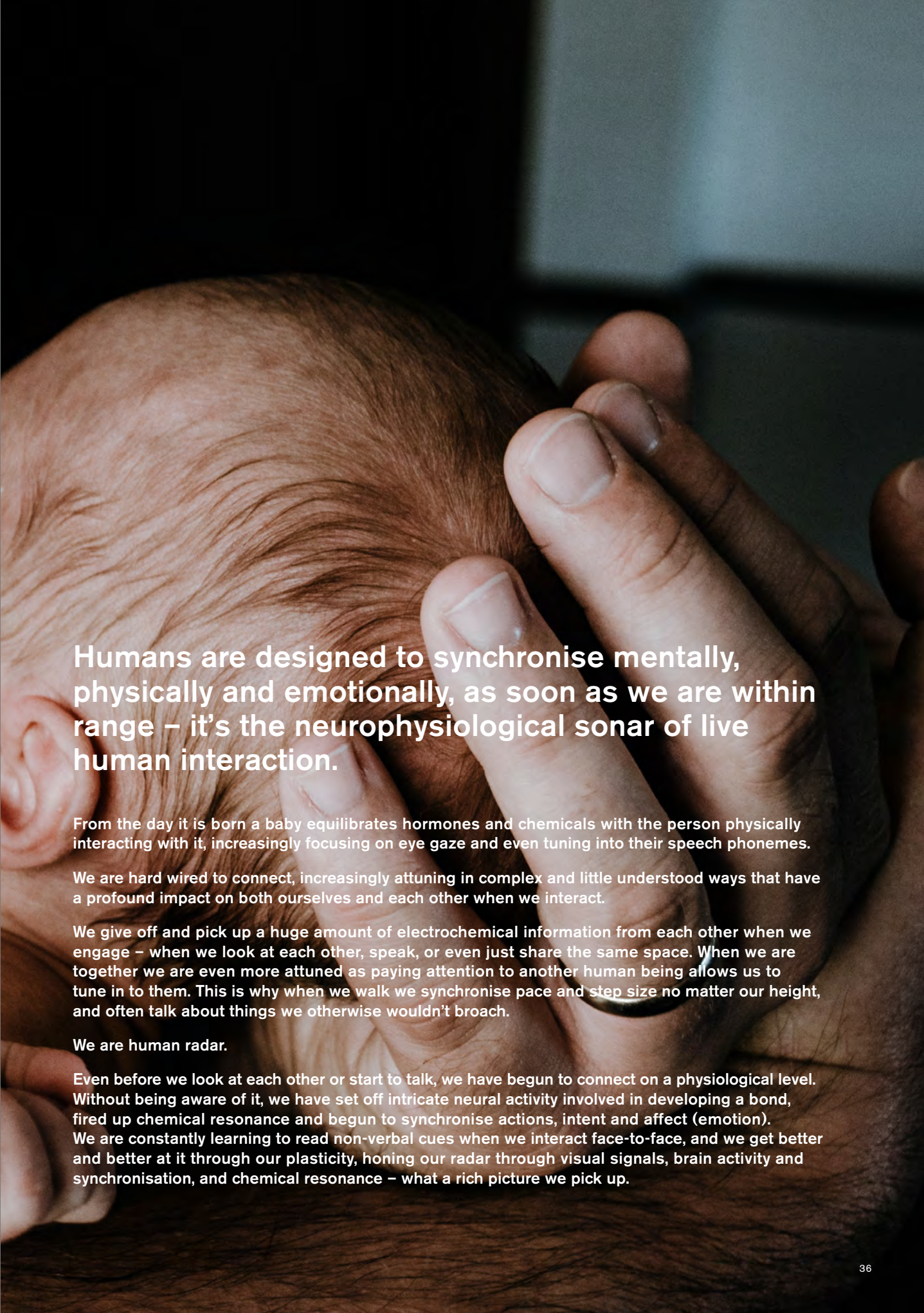
**Our brains and bodies are a work in progress, dynamically changing through an incredible mix of nature and nurture that keeps shaping us throughout our whole lives. And we not only shape ourselves, we shape each other, and we do this every time we interact.**

**We are hardwired to connect, with an ability to chemically and electrically synchronise our brains and bodies that is akin to a super power that we hardly know we possess. Yet we are somehow instinctually aware that live connection changes how we feel about ourselves, each other, and the world we live in.**

**We have explored some of the wonder of looking up on our own, but now we come to the magic of connection – that electrochemical dance of looking up and at each other, of seeing and being seen by another person, and of being in the same space or proximity.**

**Just sharing space we create dynamic resonance. When we sit in cafes, trains and movie theatres, when we move in a shared space, attend live events, or walk together down a street, we resonate in various ways, synchronising and firing up our motor neuron systems.**

**And when we deliberately synchronise, dancing or moving together, we release dopamine, oxytocin, and all sorts of other chemicals in a wondrous electrochemical resonance that only happens when we are connecting with each other.**



## Humans are designed to synchronise mentally, physically and emotionally, as soon as we are within range – it's the neurophysiological sonar of live human interaction.

From the day it is born a baby equilibrates hormones and chemicals with the person physically interacting with it, increasingly focusing on eye gaze and even tuning into their speech phonemes.

We are hard wired to connect, increasingly attuning in complex and little understood ways that have a profound impact on both ourselves and each other when we interact.

We give off and pick up a huge amount of electrochemical information from each other when we engage – when we look at each other, speak, or even just share the same space. When we are together we are even more attuned as paying attention to another human being allows us to tune in to them. This is why when we walk we synchronise pace and step size no matter our height, and often talk about things we otherwise wouldn't broach.

We are human radar.

Even before we look at each other or start to talk, we have begun to connect on a physiological level. Without being aware of it, we have set off intricate neural activity involved in developing a bond, fired up chemical resonance and begun to synchronise actions, intent and affect (emotion). We are constantly learning to read non-verbal cues when we interact face-to-face, and we get better and better at it through our plasticity, honing our radar through visual signals, brain activity and synchronisation, and chemical resonance – what a rich picture we pick up.

# Up Close & Personal

The Power of Face-to-Face Interaction

**Our brains are built to pick up a huge amount of information about another human face, especially direct eye gaze, and with lightning speed.**

We have explored the capacity for our brain to become active even from a distance as soon as we register another human, and this activity greatly increases as soon as we look into each other's eyes.

Everyone has experienced locking eyes with a stranger across a crowded room or when walking down the street – the brain feels like it physically 'kicks-in' – and that is because it does.

When we look straight at someone the left frontal area in the brain fires asymmetrically which alerts social networks and motivates us to approach the other person – the brain is preparing for a highly probable social interaction.

When you are looking very slightly past someone, the indirect gaze fires up the right frontal area, which motivates us to avoid the person as we have identified subconsciously that they are not interested in a direct social interaction. This is why we can feel slightly resentful when we realise the person we thought was looking at us was looking behind us even if we don't know them, as the brain switches from approach to avoidance.

This phenomena is also a major reason why we don't feel at ease with someone who cannot meet our gaze, and it is also why we often cannot talk about things which are important to us if someone is looking away or is distracted or checking their phone. In turn it is why we often reveal much to someone who is really present, attentive and empathic.

**One of the most powerful human interactions we can have is face-to-face contact involving eye gaze.**

**From the instant we first lock eyes with another person, specialised brain cells spark into action and if that gaze is warm or even neutral, our brain is flooded with lovely chemicals as we start to form a connection that is as much neural and physiological as it is social.**

There are many views on why this is the case, including the need to rear young who take years to be self-sufficient. These amazing human brains take years to develop. Added to this the advantages of nuanced social structures for long-lived species like primates and elephants. As we are increasingly able to identify the effects of chemicals we release such as oxytocin, vasopressin, dopamine and serotonin, it is becoming evident that this is more neurobiologically important than individuation and dominance.

Understanding intuitively the power of face-to-face interactions is what keeps us flying across the world to meet in the same room.

**When we meet face-to-face various parts of our brain activate, we begin to resonate at specific electrical frequencies,[12] dedicated neurons begin firing and our brain is awash in chemicals like oxytocin, dopamine and vasopressin, all of which have particularly positive effects.**

Oxytocin, often referred to as the love hormone, is best known for its role during and after childbirth, when it helps to create the strong bond between mother and baby. It kicks in when we orgasm, helping to cement the bond between lovers, but it also plays an important part in all sorts of everyday interactions by increasing our drive and ability to connect.

## Figure 5.0

**In under a second mirror and spindle (von-economo) neurons start to fire and oxytocin and dopamine start to flow, pre-empting the beginnings of empathy and trust.**

**In under 1/20th of a second spindle neurons drive our intuition about the other person through ultra-rapid connection of emotions, beliefs and judgements that help us discriminate their mental state and allow rapid adjustment of behaviour in this new human interaction. Interestingly, all animals that have long term, complex social networks – humans, primates, elephants and dolphins – possess spindle neurons as they allow us to work out the nuance of different relationships which mature and change over time. No wonder they are termed the trust neuron.[13]**

**By 1/6th of a second various subsets of our mirror neurons are also firing. We have many different types and they are especially active when people are bonding. These neurons allow us to read intent and pick up signals that help to form a direct link between them that allow messages to be understood at a faster pace than conscious thought (cognitive mediation[14]), so they get in first before our conscious biases kick in.**

# Lighting Up Each Other's Brains

The Magic of Electrochemical Resonance

**Meeting someone face-to-face is different to meeting virtually. It creates a more personal connection that lasts longer and feels different.**

Part of the explanation as to why this occurs comes from a number of studies from Finland where researchers like Jari Hietenan are interested in watching the difference in people's brains when they looked at each other in real life, and over a screen.

**Wiring up people with EEG caps showed that when someone looked at another person in real life, a different part of their brain lights up than when they look at that person over a screen.[15]**

Experts building better technology interfaces tend to think this will lessen as technologies give us richer data streams across digital mediums, but technology is also helping us to find increasing evidence for the sort of physical synchronisation and resonance caused by direct engagement and interaction which leads to constant electrochemical information-trading.

There is another fascinating part of the puzzle connected to our socially wired brain being both lazy and hugely efficient. We know that specific neurons such as spindle neurons (von-economo) are involved in creating a social network map in the brain of animals with long term, nuanced social structures, and that these fire within one twentieth of a second.

**We know that there is different brain activity when we meet face-to-face rather than over screens and we can now watch individuals wearing EEG caps neurally synchronising as they interact.**

It is intriguing to look at what is happening during the intricate neural activity involved in connecting, and how it develops over time, and my current work is investigating the possibility that direct positive interaction begins to build a small fragment of the other person inside our brain, just as there's a small fragment of new brain being built in them just to contain us.

**For the lazy, efficient brain this means that if we ever meet again, instead of the brain having to start all over again this fragment can light up and connect to emotional pathways, reinforcing the bond we've formed simply by engaging and paying attention to each other. This also explains why even a phone call or skype is different once we have connected directly, as there is an immediate physical network available in the brain to fire up and connect.**

In looking up at each other, that first encounter can tap into something we as a species value above all else – an enduring physical connection with another human being.

**In looking up at each other, that first encounter can tap in to something we as a species value above all else – an enduring physical connection with another human being.**

# Building New Brain

The Work in Progress of Neurogenesis

**Gone are the days when we thought our brain was set after a few years, and we couldn't change it. We now know that the brain moves, grows, prunes and changes continually in response to external and internal stimuli.**

In short we sculpt our brain depending on what we reinforce and pay attention to.

There are peak times in life such as early childhood and adolescence during which the brain grows in size and complexity, but under the right conditions we can grow new brain at any stage of our lives. The ways to do this include adequate exercise and sleep, learning new things, eating the right foods to keep our microbiome healthy, and last but not least, direct human interaction.

Due to the chemical cocktail we create when we connect, not only do we light up each other's brains but we each possess the power to rewire both our own brains and those of the people we interact with. It is like an in-built super power that we are hardly aware of, but we see and feel the results.

**As we synchronise and resonate, we start chemicals flowing, sparking into action the neurons and dendrites that connect up, shape and differentiate our brain.**

**One of the results of this is to stimulate various systems that literally create new brain in both our own and someone else's brain simply by interacting in certain positive ways.**

Changes in positive affect can help to heal us when we're sick, face the unknown with courage and compassion,[16] and come up with new ideas, new solutions, and new ways of doing things.

Change happens when the interaction is negative too, often with longstanding results. Boyatzis et al. studied the brains of those who had either resonant or dissonant leaders while they recalled the experience, often years later. The brains of those with resonant leaders activated areas associated with mirror neurons, the default mode and social and affective networks, while those with dissonant leaders showed a pattern of quite different mirror neurons – avoidance, narrowed attention, decreased compassion and negative affect.

**Neural activation between people takes many forms, depending on the nature of our interaction.**

**Figure 6.0**

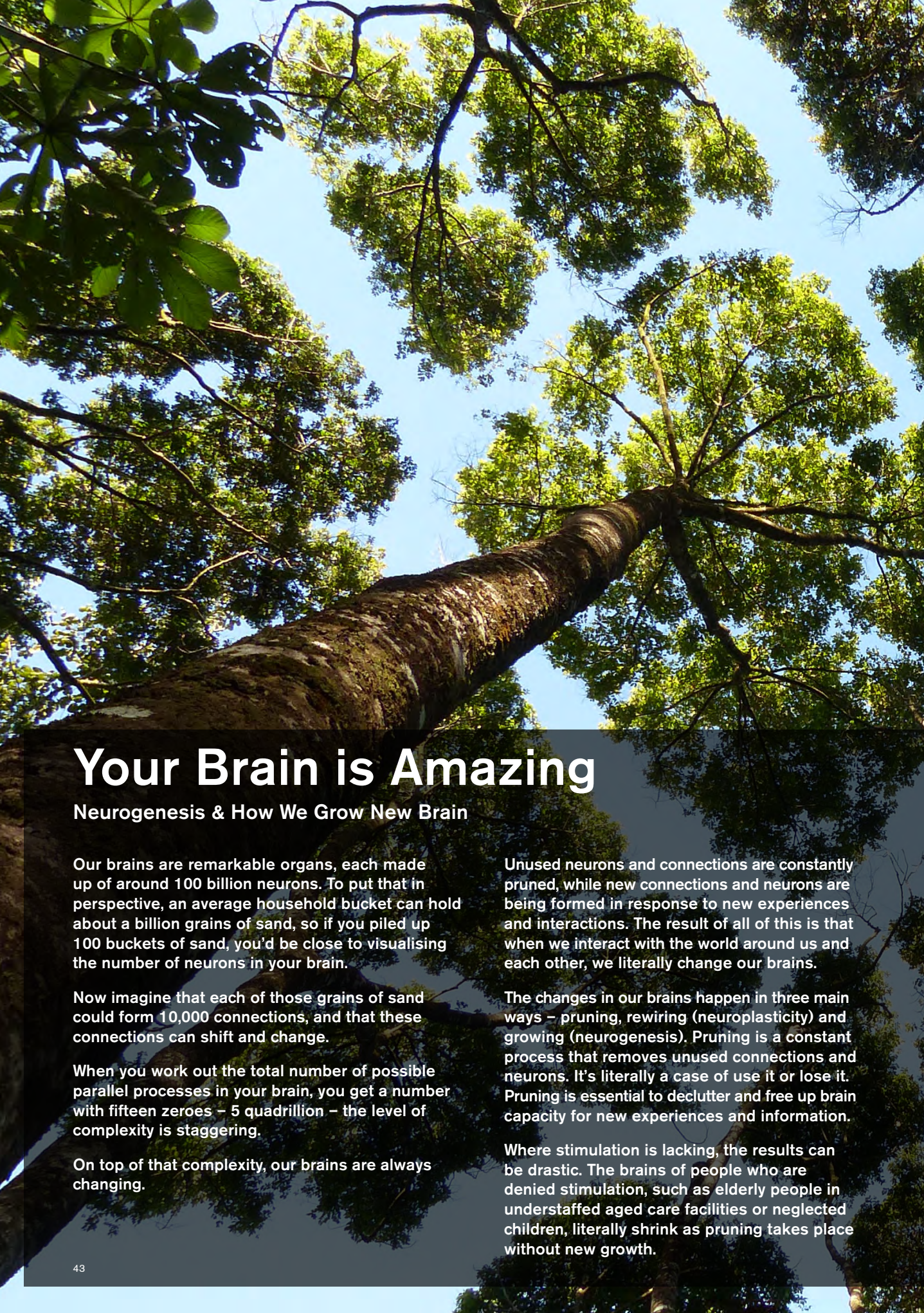
A Quick Glance
lights up neurons in specific parts of our brain with direct gaze, automatically evoking a positive affective (emotional) reaction.[17]

Ongoing Gaze
has advantageous effects on things like memory, pro-social behaviour, and individual perception.[18]

More Intense Engagement
such as collaborating, storytelling or sharing jokes, makes chemical changes that create deeper and wider connections and changes, many of which are long term.

**Due to the chemical cocktail we create when we connect, not only do we light up each other's brains but we each possess the power to rewire both our own brains and those of the people we interact with.**

**It is like an in-built super power that we are hardly aware of, but we see and feel the results.**



# Your Brain is Amazing

## Neurogenesis & How We Grow New Brain

Our brains are remarkable organs, each made up of around 100 billion neurons. To put that in perspective, an average household bucket can hold about a billion grains of sand, so if you piled up 100 buckets of sand, you'd be close to visualising the number of neurons in your brain.

Now imagine that each of those grains of sand could form 10,000 connections, and that these connections can shift and change.

When you work out the total number of possible parallel processes in your brain, you get a number with fifteen zeroes – 5 quadrillion – the level of complexity is staggering.

On top of that complexity, our brains are always changing.

Unused neurons and connections are constantly pruned, while new connections and neurons are being formed in response to new experiences and interactions. The result of all of this is that when we interact with the world around us and each other, we literally change our brains.

The changes in our brains happen in three main ways – pruning, rewiring (neuroplasticity) and growing (neurogenesis). Pruning is a constant process that removes unused connections and neurons. It's literally a case of use it or lose it. Pruning is essential to declutter and free up brain capacity for new experiences and information.

Where stimulation is lacking, the results can be drastic. The brains of people who are denied stimulation, such as elderly people in understaffed aged care facilities or neglected children, literally shrink as pruning takes place without new growth.

The old notion many of us learned in school about having a fixed brain structure by adulthood has been shown to be quite wrong. Our brains continually move, grow, prune and change.

It's well known that our brains grow in size and complexity during early childhood and adolescence, but what is less widely understood is that under the right conditions we can grow new brain at any age.

Neurogenesis – the growth of new neurons – takes place throughout our lives.

It's at its most frenzied during our ninth month of gestation, when 250,000 new brain cells are formed every second. This incredible growth continues until our brains contain one trillion neurons, most of which are then pruned away, leaving us with the 100 billion we're born with.

As we grow, we produce fewer new neurons, but vastly more dendrites – the connections between them which shape and differentiate our brain into dedicated areas. This is why babies sleep so much, as they're making enormous amounts of new connections, a vital function of sleep. Most of us die with a similar number of neurons that we were born with – about 100 billion – but, significantly, they are not the same ones.

We have the ability to influence neurogenesis in the people around us simply by interacting with them.

# Brain WIFI

Interpersonal Neural Synchronisation

**When we interact, we synchronise the social and emotional networks in our brains. This state, which we call interpersonal neural synchronisation (INS), allows us to transfer not just information, but such things as meaning, delight, fear and aspiration.**

**Sometimes called neural coupling, INS happens in positive face-to-face interactions when we're paying attention and trying to engage the other person in what we're seeing, feeling, thinking or imagining.**

During such active engagement our brain is busy activating socio-emotional pathways, choosing and framing the information we need to deliver our idea or story, and at the same time reading the other person, to observe what registers with them, what delights, shocks or angers them; whether they're still with us or are losing interest.

**It's a live, two-way engagement, not just a one-way broadcast.**

It is one of the reasons why we love storytellers – they are skilled in synchronising not only the auditory sound waves between us but the socio-emotional areas in our brains.

Synchronisation also helps us to read communicative intent accurately. Think of an experience where you have had a growing misunderstanding with someone over text or email, only to have it cleared up very quickly once you go and see the person face-to-face. Our brains expertly discern sincerity, and the fact that no offence was meant. We also discern the opposite and are quite accurate at picking up the wordsmith who is insincere.

**Effective leaders, inspiring teachers, engaging friends – all have a high capacity for INS.**

**If we use EEG or fNIRS caps to scan such people when they are engaging someone through sharing a story or idea, we can see that they have highly active social and emotional areas that light up while they engage, as well as other parts of their brain involved in both communicating information out, and sub-consciously taking information in at the same time to read how the other person is attending.**

By doing this they win our hearts through effortlessly shifting emphasis, picking up signals with their socio-emotional radar and changing pace or direction depending on our reactions, all at great speed.

Through a technique called hyperscanning, we can watch more than one brain at once as we interact, and can also observe that the listeners brain is lighting up the same way.

One 2014 study (by Jing et al.) used this technique to investigate leader emergence. They wired up teams of three people, gave them a topic to discuss and after 5 minutes a leader had to be chosen to present back.

They showed that INS was significantly higher between the chosen leaders and followers than between followers and followers, and postulate that leaders emerge by synchronising their brain effectively with followers. This could potentially be a way to assist in identifying future leaders.

# Connection & Contagion

Interpersonal Neural Synchronisation

**When we interact with others, we change both ourselves and the other person. Our choice is not whether this will occur, but whether it will be positive or negative.**

**When we engage actively and positively with another – making eye contact, leaning in closer, talking, telling stories and jokes, many studies show both brains lighting up in the same regions.**

A large number of behavioural studies and increasing scanning studies, carried out in the workplace[19] and in schools, consistently show higher levels of interaction and shared attention around jointly understood goals leading to increased creativity, trust and shared values.[20]

There are an increasing number of studies that include hyperscanning methods to scan multiple brains whilst people are engaging directly with each other, and the huge improvements in technology have greatly improved the accuracy of this methodology.

**One consistent finding is that as soon as we scan two or more brains together while people interact, we see a physical change in both brains.**

What's more, as with any signal that is sent and received there is a lag time between sender and receiver, but fascinatingly our brains are so attuned to each other that the more we get to know each other the shorter the lag time between the sending brain and the receiving one – until when we are so in tune with each other we we get more efficient at synchronising and can anticipate what the other person is going to say by pre-emptive syncing. We almost feel like we can read their mind.

Some interesting research around mind reading found that this ability mostly develops before the age of five, as children are exposed to direct interaction and discussion about the emotions and motivations of others. These conversations hone the child's capacity to pick up and read the emotions of other people.

All is not lost after the age of five. Studies on 'mind reading' in humans by Domes et al. looked at the ability for an individual to infer the mental state and interpret subtle social cues[21] which are indispensable to human social interaction.

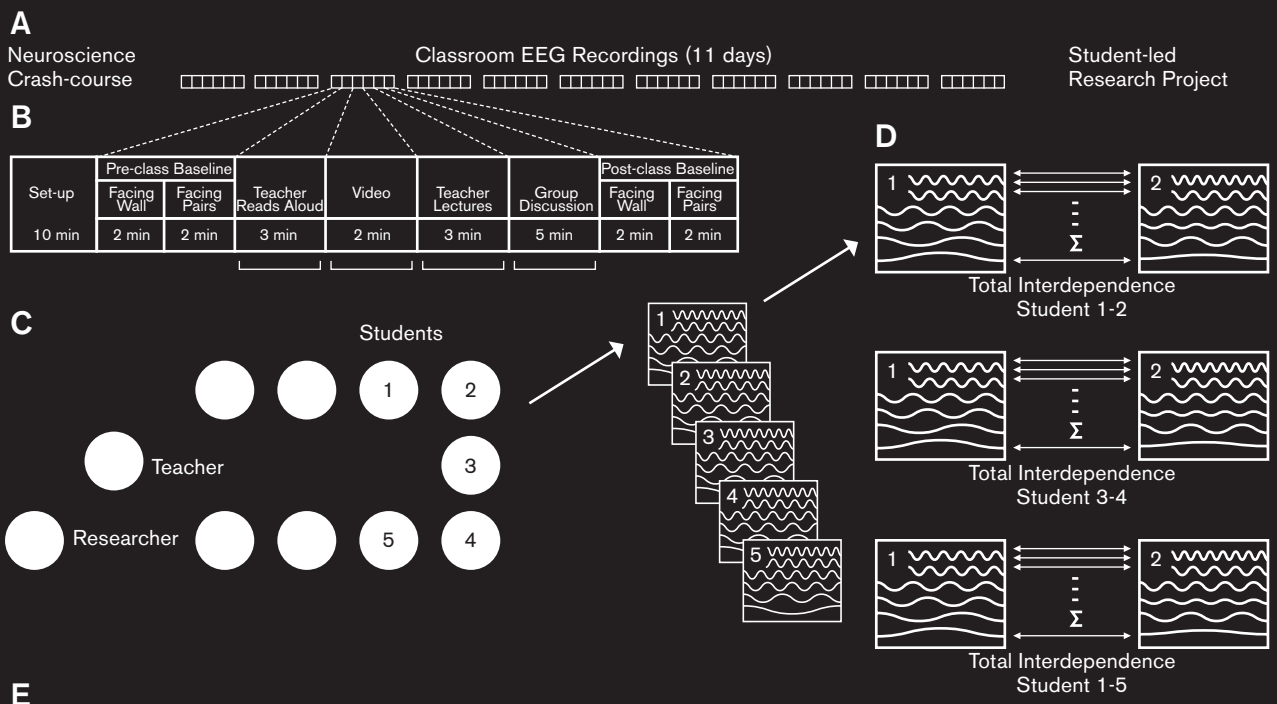
These studies found that the neuropeptide oxytocin played a central role in approach behaviour, reducing ambiguity in social situations and encouraging social approach, affiliation, and trusting behaviour. It potentially modulates emotional reactivity of the amygdala, and assists in processing emotional facial stimuli. This is why administered oxytocin is increasingly considered in the treatment of autism.

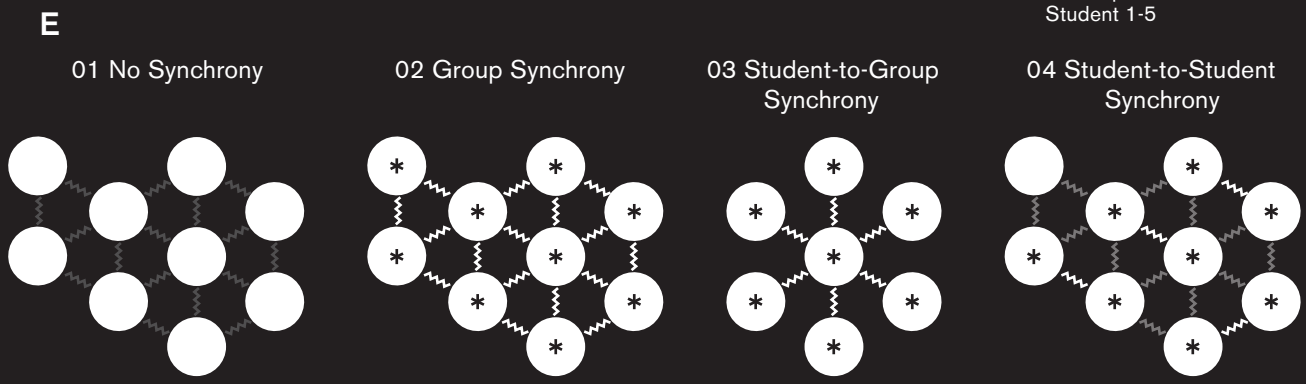
Oxytocin is thought to enhance reward of social encounters, and highly social species have high densities of oxytocin receptors in reward circuits. As we have explored, a major activator of oxytocin is direct, positive eye gaze. And we can continue to improve our capacity to pick up and read the emotions of others with direct, positive engagement which activates empathic pathways.

**So nurture matters too – the more we look up and engage, the more we read both the affect and effect we have on people, and the keener our radar becomes. INS is a powerful part of this phenomenon, tuning in our connective hardwiring, but it only takes place when we interact face-to-face.**

**So when we look up and out to directly interact it creates neuronal firing, cognitive synchronisation and physical resonance – so that not only our brains and bodies, but the very space between us is alive with chemical and electrical data.**

## Study 2.0




**A study observing high school children interacting in a classroom setting showed the neural magic that happens when people engage warmly and share excitement. In the study by Dicker et al, EEG was recorded from 12 students simultaneously over 11 sessions, showing that the level of synchrony created consistently predicted both classroom engagement and the social dynamics seen in the class, suggesting that this relationship may be driven by shared attention within the group, and by the amount of eye contact face-to-face the students had.**

**Specifically, there was an increase in synchronisation between the students in an interactive, positive environment with shared attention – tying in with long standing behavioural evidence showing that people physically, and typically subconsciously, synchronise with each other when engaging in tasks that require joint attention (pupil dilation, gestures, walking vocal rhythm and emotional level). There are neural studies showing that brain rhythms lock to the rhythms of auditory and audiovisual input, and the higher the level of shared attention to the stimulus, the stronger the synchronisation. Shared student focus predicted student to group synchrony independent of teaching style, but the more the students liked the teacher, the greater the level of neural attention and subsequent group synchronisation.**

**Direct eye gaze made a difference. To test student interaction effects, some students had to engage in two minutes of direct eye contact just before class. The researchers then monitored three things – having had eye contact, sitting adjacent to each other and not sitting adjacent. The variable that made a difference was direct eye contact before class, which raised reported social closeness, directly increased brain-to-brain synchrony during class and served as an "activator" for actual joint attention, and not passive co-presence.**

# Trust & Hope

Retinal Eye Lock

**There is something humans instinctively do when we are worried or stressed and we see someone we love or trust – we seek reassurance via direct, prolonged eye gaze, be it a child looking at their parent or an adult their partner or friend.**

We do this because the chemicals released in response include oxytocin and vasopressin which, along with increasing serotonin uptake, contribute to promoting a feeling of connection between us, lowering our body's stress response, and boosting healing and growth. We have a wonderful capacity to connect and soothe.

We have talked about oxytocin's virtuous cycle of positive feedback encouraging even greater levels of gaze to the eye region of human faces, which further increases trust and empathy.

Retinal eye lock between an anxious person and someone they trust also assists in synchronisation of various brain hemispheres, quietening the sympathetic nervous system and amygdala. This reduces the person's agitation and increases their ability to deal with trauma.

**Amazingly, we have the power to soothe someone who is anxious or upset merely by looking at them with a level of warmth or empathy.[22]**

This is also reciprocal – we are responding through modulation of the socio-emotional centres in our brain that increase empathy and we receive many of the same chemicals.

**Hope is a unique facet of human connection, and it is becoming better understood as a robust phenomenon rather than a vague concept.**

Books such as Groopmans 'Anatomy of Hope' give us a wonderful insight into role this cancer specialist saw hope play in the survival and recovery of his patients, and Weinberg's hopeless, helpless mindset loop paints a physiological picture of the devastating physical effects that hopelessness can create.

Whilst undertaking the study on the neurophysiological impact of touch and eye gaze it was astounding to fully comprehend the power we have to give each other hope, and the impact it makes.

In medical practice and care roles, hope grows when a person has a high trust relationship and personal, face-to-face interaction with the carer or practitioner – as Groopman discusses it is so powerful that it changes the quality and potential for survival in critically ill patients.[23]

Hope was linked to a number of physical changes across many quantitative studies including a drop in cortisol and pro-inflammatory cytokines, assisting wound repair, changing depression pathways, and there is even early evidence of hope creating epigenetic changes in the patient.

Hope is connected to trust, and it is fostered through showing genuine empathy, and interaction such as direct eye contact and physical touch motivated by even a slight level of compassion.[24]

In some cultures where comforting touch is not appropriate, there is still much dynamic resonance and synchronisation during direct interaction and connection, and via the tone and modulation of our voice which entails a whole new avenue for neural synchronisation.

We have such a gift. And such a responsibility.

## Study 3.0

As part of a two year study on the neurophysiology of human touch and eye gaze in regard to therapeutic relationships and healing, myself and my co-authors reviewed hundreds of quantitative studies on the interaction between therapist/practitioners and their patients and also with strong, warm relationships like parents or partners. The study informed this illustrative story of the power of human interaction in the form of retinal eye lock.

Imagine yourself being admitted to hospital...

As the nurse chats to you and takes your details, the face-to-face interaction has already begun its electrochemical magic, activating mirror and spindle neurons and the release of various chemicals discussed above. If they take your hand to take a pulse, an additional synchrony begins as C-fibres in the skin go through emotional pathways before reaching the brain, further increasing the connection and assisting the formation of trust. You have your operation and as you see the nurse over the next few days the trust bond will strengthen with each small interaction.

Then something happens which causes worry or stress, kicking off a negative neurophysiological process which increases such chemicals as cortisol and adrenalin, dropping oxytocin, dopamine and serotonin uptake which can then harmfully impact your immune system and impair your ability to deal with pain and trauma.

Enter the trusted nurse. Five minutes of positive, direct eye gaze, especially if supported by the light, gentle touch of a hand can turn this around, stimulating the parasympathetic nervous system, altering hormonal, serotonin and neuroplasticity responses triggered by stress or pain, and boosting immune system strength for healing and resilience. And the nurse gets a lot of these same chemicals too via reciprocal feedback loops.

Allowing this precious time to engage directly and empathically helps people feel less vulnerable and more able to deal with trauma, and incredibly it decreases healing time through such mechanisms as modulating the interaction of lymphocytes which produce antibodies, and triggering hormone and neuropeptide changes which mediate emotions. It even impacts morbidity and mortality through increasing connection and hope.[25]

# Expanding Our Horizons

Empathy & Longer Term Thinking

**Empathy creates the capacity to tackle complex problems and think strategically by shifting our focus to think longer term about solutions. It lengthens and deepens our view, changing the problem-solving path which our brain takes.**

Empathy is much more complex than most people think, working on a number of levels and impacting multiple cognitive pathways.

Empathy allows us to identify feelings in others, and to an extent to feel what they feel depending on our own experience. We can watch human brains innately light up when they see someone in need, and our brain even registers social and physical pain in others in different ways in order to assist us to tailor our response accordingly. As with so many of the response loops we have discussed, there is a high level of reciprocal electrochemical activity when we help others – which is why it often feels good to do good.

Empathy shown to us can make us feel cared for, valued, and accepted for who we are, which builds trust and a sense of belonging – all critical to our individual mental and physical wellbeing and in turn, our societies' emotional health.

## Empathy physically changes our brains and our bodies, and is a key neurological response to direct eye gaze – to looking up and out.[26]

Looking up and out and engaging in face-to-face contact is one of the major ways we elicit emotion and empathy, creating the capacity to change our view and directly shaping how we engage, connect, decide and build a better world.

Empathy has another important role in humans – it creates the capacity to tackle complex problems and think strategically by shifting our focus to think longer term about solutions. It changes the problem-solving path which our brain takes when confronted by a complex problem – one with no easy answers but instead lots of messy, unknown elements with unseeable interactions that also change over time.

Simply put, linear problems often involve the application of known fixes, and the brain tends to be driven by habit by going back to the pattern of thought that worked last time.

## Complex problems are emergent and unpredictable and need our brain to develop novel solutions instead of engaging automatic pilot and applying known fixes.

This requires breaking the old patterns of connections which have been built up, taking in new information, then putting it together in new and creative ways. This pattern breaking requires emotional engagement which changes the electrochemical activity in our brain and makes it more plastic. It also changes the criteria we use to judge the relevance of information – our brain goes into discernment mode and trawls our memory with a different sieve, questions more and puts together solutions that focus on long-term consequences instead of short-term closure.[27] When we look up and out, our brain works differently, considers more and looks further.

Thus empathy and emotional engagement create strategic, longer term thinking and new ideas and are a critical neural pathway for foresight and wisdom. This is an example of why we need to be conscious of the changes that occur when we connect with each other, and not allow our interactions to be blocked or diminished.

On a larger scale, the genuine affection that empathic leaders have for people, and the strength of their core values, means that they inspire trust, and enable dynamic resonance in their groups. The positive feelings and humour elicited by such leaders increases the creativity and nimbleness of responses from those they lead, and builds a shared picture of purpose through neurogenesis.


When we look up and out, our brain works differently,
considers more and looks further.

# Firing & Wiring Together

Our Neural Duet Between Brains Individually & at Scale

**When we look up, directly interact and lock eyes we are connecting physically with each other's brains and bodies – synchronising and resonating with each other electrochemically.**

Social interaction thus becomes a shared process of positive feedback, a virtuous cycle whereby increased levels of oxytocin in turn encourage even greater levels of gaze to the eye region of human faces.

This dynamic in turn further increases the level of trust and empathy between us, and when we have a positive, trusting relationship this cycle can lead to the chemical high that lovers have when staring into each other's eyes.

## We can synchronise at scale, with a contagion effect that can be wonderful or problematic.

Imaging technology now allows us to watch the responses of multiple brains as people interact, observing the way we impact each other and even building shared neural nets – what Goleman describes as a "hitherto undreamed of neural duet between brains as people interact".[28]

The interaction between trusted individuals creates a cognitive coupling between brains as people interact, and this lovely dance has a powerful effect on building even greater levels of trust and empathy, and allows us to step into a positive attitudinal shift that comes about through both chemical changes and the courage that being connected creates in us.


What fires together wires together.

# Conclusion

Humans are Hardwired to Connect with Their Surroundings & Each Other

**As a group of connected people looking up and out we can change how we see an issue, alter our priorities as a group, and create a capacity to collaborate around shared values.**

The ripple effect that occurs when a positive effect spreads is powerful as it draws people in to engage. It acts like a neurophysiological safety net that supports us to step into the unknown and try new things, and in new ways.

And it so often begins when we look up at our surroundings and each other – with the small connection of interacting with where we are and who is there with us – spreading to the next person who looks up fleetingly, and is invited into the interaction with a smile or an inclusive word. For most of us, most of the time, that is all it takes to interact in a way that leaves us all walking away with a positive experience, and a feeling of connection and belonging.

**Real live connections and interactions are at the very heart of what makes us human.**

As we have seen throughout this paper, being part of a social group and a shared activity provides the empathic engagement and connections that allow us to synchronise and feel that we belong.

Science and technology help us to explain what we know from lived experience regarding how wondrous the outcomes are – how they affect us, and how they can escalate through individuals, course up through the group, accelerate through the community, and arrive the common humanity we all share.

A strong sense of our surroundings and real human connection gives us a greater sense of identity and a feeling and experience of belonging, both of which are fundamental to building trust and a sense of hope.

This paper has dived into the wonder of the resultant neurological effects, and measurable chemical and physiological changes that profoundly influence our behaviour, our mood, our bodies, our capacity to make decisions, the very nature of our humanity.

**The connection you make by looking up and out – at your streets, suburbs, and cities, at the sky, trees or horizon, and at each other with a glance, smile or short conversation – is more than a way to pass the time. It meets a fundamental human need in our hardwiring for connection. And now you know that the ramifications of this fleeting exchange can be enormous.**

In a complex, powerful and beautiful system such as the societies we live in, the power and beauty is in the connections between individuals. It is what shapes our social system and determines its health, and ours.

**So next time you're going for a walk, standing in a coffee line, on your way to work, or grappling with a complex problem, make the time to pause… and look up and out… and enjoy all the amazing benefits that brings.**

It is the best few minutes you will ever spend.

**In a complex, powerful and beautiful system such as the societies we live in, the power and beauty is in the connections between individuals.**

**It is what shapes our social system and determines its health, and ours.**


LOOK


UP

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