THE EMOTION ORGANON

THE EMOTION ORGANON

Dr. C. Mason



Webster: **ORGANON (Greek/Latin)** is an instrument for acquiring knowledge; specifically : a body of principles of scientific or philosophical investigation. Ancient Greek: Ὄργανον, meaning "instrument, tool, organ"

Copyright 2024 Cindy Mason

First Edition 2024

San Francisco, California

ISBN 979-8-851933400

Library of Congress Control Number: 2024900138

THE EMOTION ORGANON

by Dr. C. Mason

KDP Independent Publishing Platform

Amazon Publishing Seattle Washington USA

Cover Image Art by Ariangga

Image Previous Page: adapted from Fragment of Frontispiece by Jan Wandelaar (1690–1759) of Linnaeus, C. (1738), Hortus Cliffortianus.

Outer Cover Design: Cindy, Tony, V., Feng and Raphael and Ariangga

Other books by C. Mason include:

Artificial Intelligence and the Environment

Designing Artificial Compassion Technology

This book is dedicated to the pioneers and healers of our future, and the people who support them.

Table of Contents

INTRODUCTION.....1
Soft Super Powers.....5
What is an Emotion Organon?.....8
The Rising Star of Human Science.....13
The Invisible Knowledge All Around Us.....14
The Emotion Organon.....17
About the Book.....18
OLD KNOWLEDGE NEW DISCOVERIES...23
Old Knowledge.....27
New Discoveries.....29
THE ORGANONS.....35
Aristotle's Organon.....35
Francis Bacon's New Organon.....37
The Emotion Organon.....39
The Emotion Organon and Technology.....43
Artificial Compassion Technology.....45
THE MEDICAL RENAISSANCE.....49
The Rescuing Hug.....50
The New Science of Compassion.....51
Compassion, Stress and Resilience.....53

Stanford Hospital Stem Cell Transplants.....57
Negativity - Your Health on Stilts 58
The Twitter (X) Study.....60
OXYTOCIN: NEUROTRANSMITTER, CATALYST, CARDIOVASCULAR HORMONE.....65
A Fresh Look At Oxytocin.....66
Under My Skin 67
Now What?.....70
The Heart.....71
Resilience and Stress 73
Cognition and The Brain.....74
Immunity, Nerves and Psychology 75
Glucose Metabolism.....76
Trust 76
MUSIC SCIENCE 83
Music and the Brain 85
SCULPTING CYBERSPACE 91
Digital Fury 93
The Antidote is Compassion.....93
Emergent Cultural Transformation 95

Survival of the Kindest?.....100
Compassion Centered Design Process 104
Compassion Centered Design Thinking 105
Positivity, Optimism and People 108
Making It Real.....109
REFLECTIONS.....121
About The Author.....121
Thanks and Acknowledgements.....134
The Glossary of Big Words and Acronyms ...135

Chapter 1

INTRODUCTION

If we treat people as if they were what they ought to be, we help them become what they are capable of becoming.
Johann Wolfgang von Goethe

In this book we explore the newly discovered knowledge of human science. And we unveil how it will impact our world, our tools and ourselves. Over the past three decades we have learned more about human science than in our entire history. While technology and space exploration have been racing outward into our collective futures, it is with the assumption that our current laws of nature and thinking are sufficient for this task. Meanwhile, at the same time, and without any fanfare, human and medical science researchers have been relentlessly digging inward, into our human nature and our reflections of self. What they found matters to everything that we do next. By fusing brain science and psychology with almost every other field of medical science, human science revealed something astonishing: human life is fueled by positivity. *What makes our biology tick is positive emotion.*

This is an important development because when it comes to serious thinking, emotion is usually left on the sidelines. Here are just a few of these remarkable human science discoveries. First, chronic exposure to positive social and emotional experiences heals wounds faster. Second, it increases our resistance to disease. Third, it helps us metabolize glucose. And fourth, it improves our brain functions [1-6]. There's something else that was very unexpected: Positive emotions such as love, kindness and compassion grow heart tissue [7, 8]. The heart generates

and receives important life giving signals and fluids when we experience love and kindness. The emotions of love and kindness also fuel human flourishing and happiness [9-11]. The same body of science also shows the opposite is true: chronic exposure to negative social and emotional experiences actually harms us, not just psychologically but biologically. This is especially true in cultures where we are expected to cope with such negative emotions on our own [12]. These discoveries on positivity (and negativity) are just the tip of the iceberg in this ocean of new knowledge.

We will be exploring more of these discoveries in the upcoming pages, but you can already see that the wisdom gained through these human science discoveries is very powerful. What may not be so obvious is that it changes the nature of knowledge. Imagine what happens when we apply this new human science to technology, drug trials, education and law.

The interdisciplinary human science revelations represent a new kind of knowledge unlike anything we have learned so far in science and they have important implications for how we design, administer, conduct healthcare and view the world. The insights are also deeply personal. They weave into the very fabric of our selves, our families, our relationships, our institutions and our societies. They are also important for how we regard ourselves. The important meaning of these medical advancements is that our quality of life, longevity and so many other things, are also connected to positivity. So, basically, what you're going to find out here is that all of the good things we instinctively

love in life are the exact things that turn on the biology of our cells and organs to keep us healthy and alive. They also keep us happy, resilient and creative. I'm talking about things like affection, sex, friendship, love, trust, belonging, caring, laughing, compassion, kindness and so on.

In these pages, we venture into the heart of human science, where three decades of unsung research have uncovered a profound connection between our body's functions and positive emotions like love, kindness and compassion. This is an important topic to study now because this kind of knowledge is not yet reflected in the structures and social norms of our modern world. While we are erecting our future of medicine, technology and laws on what should be a certainty of mind, the core ideas and philosophies of our cyber structures contain nothing designed to support our natural vitality or even, an awareness that there is a need to do so. What the human science and medical researchers have found is profound, very powerful and something no one could have imagined. And it needs to be part of our future as well.

The attitude with which we approach this new wisdom in this book is not to despise or disregard our past thinking, but to combine it with these new discoveries. Consider what happens when we combine these advancements of human science with drug research, law, education or technology, especially AI.

In the *Emotion Organon*, we dive into the renaissance of discoveries creating a new class of knowledge involving human science and emotion. The scale of innovation and

discovery happening in human science is profound, perhaps beyond anyone's ability to catalog. These interdisciplinary investigations are happening across all areas of medicine. So what you will see here is but a fraction of what's out there. Here we show you the key areas that impact health, technology and society. For example, there are extraordinary discoveries happening in the new field of compassion science.

Compassion science gives us a wide range of biological and neurological insights on compassion's importance and its impact on us. It upends century-old beliefs and validates compassionate intelligence as a new kind of knowledge, bringing it to the center stage of education, science and technology. As one of the new interdisciplinary fields in medical science, compassion science has delved deeply into understanding the neuroscience and cardiology around oxytocin. For over a century, oxytocin was believed to be *just a birthing hormone*. But it has been revealed to be a versatile powerhouse: it is a neuropeptide, a cardiopeptide, a hormone and more [5-8], orchestrating over 50% of our body functions [9].

Oxytocin is generated by our experiences with positive emotions such as love, compassion and kindness. It's magic happens not just when we are infants still attached to our mothers, but for all of our lives. Even mere fragments of oxytocin have been documented to have profound impact on catalytic processes in our body [13]. Instead of seeing loving attachment as a weakness we now know it is a strength.

Knowing about this is going to make every aspect of our lives better.

The adventure into human science in *The Emotion Organon* doesn't stop there. In the chapters to come you will also learn how the new knowledge you see here is already being applied in technologies like virtual reality, gaming, AI and so on. You will find out why a compassionate worldview is so important for our communication and for modern institutions such as our hospitals and schools. Hopefully as you read this, you will be inspired to apply it in your own way. If the only thing that happens from reading this book is that you make a happier life for yourself and those around you, then it has been a success.

Soft Super Powers

Tapping into these human science discoveries on positivity gives you a *soft super power*. What is that? *Soft* super power? Usually when we think about power in the United States, we think about the fierce winds in Chicago, the force of the Colorado river or huge space engines. In medicine we might think of power in terms of life saving high tech surgical instruments, pharmaceutical drugs or the medical insurance lobby in Washington D.C. These things are truly a powerful part of our world and we spend a great deal of time and resources learning how to create such power. But this is only one part of the world. There is another kind of power internal to us that is just as strong and mighty: love, kindness and compassion. These are soft super powers.

Why do I say this? What makes these positive experiences so powerful? The first reason is because they

help us succeed in difficult circumstances. Two examples of this include The Chicago Cubs baseball team and the U.S. military. The Chicago Cubs, well known for their long losing streak, credit meditation on loving kindness (mindfulness) as the key to their turn around and winning the World Series [14]. The U.S. military are seeing mindfulness meditation optimize performance and mental skills during operations and as a buffer for post-mission stress [15, 16].

The second reason I say that love, kindness and compassion are superpowers has to do with trust. Trust is the foundation of *everything* social. Positive behaviors, attitudes and emotions are the basis for trust and they impact our relationships, families, governments, businesses and society.

Surprisingly, positive emotions, attitudes and behaviors are also the source of power in the body's organs and functions. For instance, as I mentioned earlier, the experience of love and compassion can grow heart tissue. This phenomenon has been developed into a patented process for generating heart tissue by using the same heart fluids we produce while experiencing these positive emotions [7]. And there's something else: love, care and compassion reduce the impact and recovery time of a heart attack [8]. If that's not a super power, I don't know what is.

So while exercise and diet are still very important, the soft positive emotional stuff is like a superpower inside of us. It is a form of power that comes from the inside (yin) and is just as important as external power (yang). We need both. Yin power has been overlooked in the west, and it is far more

important than anyone realized. Now that we are able to see and measure the significant effects of this internal power with human science, it is time we reveal these secrets. I call them secrets not because we need to whisper about them, or because we need to restrict the people who can find out about them, but because if I told a room full of 100 people about these ideas, only a few will deeply understand their real meaning and significance. So, in essence, this knowledge is like a secret. Combining this new instrument of knowledge, or *organon*, with our current technologies, institutions and social structures will lead us to a new world, one that is designed to protect us and care for us. You will find the details on how this is happening here in this book.

The physical effects of emotion on the human body was previously uncharted territory. It was invisible to us. But now we know that a sympathetic and kind voice can objectively and subjectively reduce our pain [17]. And when that voice is coming from your physician, it increases your natural immunity [18]. During the COVID-19 pandemic, self compassion training gave healthcare workers more resilience and reduced fatigue and burnout [19]. Pioneering breakthrough discoveries like these and the ones about the heart are occurring across all areas of medical science and, in effect, are making the secret biophysical world of emotion both visible and measurable.

While soft super powers reside inside of us, we also find them in the relationships and environments where we spend our time. It follows that if we want our cyber environments to be healthy for us then we need to shape

them in a way that supports and encourages our better selves, our positive selves. The electrifying breakthroughs in human science establish a foundation for this. But AI technologies such as machine learning, robotics, generative, hybrid and traditional AI, are based on knowledge. The human science knowledge that establishes the biology of our soft super powers, documented here in this book, is not yet part of mainstream AI, virtual reality or gaming. But it needs to be. An environment created with caring, compassionate technology or with technology that will encourage caring, compassionate behaviors and attitudes in those who use it, will spread that goodness to the rest of us. This happens through something called machine rub off. To find out more about infusing human science with technology design, check out the ideas on Compassion Centered Design found in the book *Designing Artificial Compassion Technology* [20].

What is an Emotion Organon?

In Greek, the word *Organon* means "instrument"[21]. Over time, the word organon has come to mean *an instrument of knowledge*. We are living through an era of great discovery around emotion and that is changing how we define knowledge. The human science of emotion is an emotion organon. I believe the wisdom of this emotion organon will touch every aspect of life because they impact our core perception of knowledge and this will cause a ripple effect.

For example, when we pair this human science knowledge with technology, we find technology can amplify and reflect the positivity in us through our interactions with

virtual reality, games, software agents and so on. When we intentionally design technology to support people using advanced human science, what it amplifies about us is our positive human nature and this impacts the environment around us. Since these technologies are available online, when we build them they will be available globally.

Unlike most other types of technology, the aim of a compassion-centered approach to design is to create technology that has a stake in us—in our positive humanity and our biology—rather than selling us more goods or gathering more information about us. Consequently, as our interactions with devices, systems and environments become a more positive experience, we become more positive ourselves. In this book we call this process *machine rub off*. As revealed by the biology of emotion, positivity supports our mind and body. And when we are positively supported, our own positivity is contagious with those around us.

This rub off phenomenon can also work the other way around. If our interactions with technology (or people) make us chronically angry, that is also contagious and together, we become *un*healthier. So, what is the state of our current technology? There are reported instances of people shouting at, hitting and even shooting their computers [22, 23, 24]. I call this *digital fury*. So we need to ask, What is rubbing off on us? Has anyone thought about this question? I can tell you it is not based on the human science in this book (yet).

The Apple Watch feature that calls for help if we need it is definitely pretty cool. And smart defibrillators are awesome. But I believe that once you understand the human

science wisdom presented here, you will come to the same conclusion that I did: we need to, and can, do a lot more. In fact, some pretty incredible things are already taking place, as you will soon learn in this book. As to the question, What is rubbing off on us? And, What kind of knowledge is in our devices now? We will explore the answers to these questions in Chapters 2 and 3. Here is the short version.

The ideas that make up the foundation of knowledge for our present AI technology, modern society and institutions, date back hundreds of years to Aristotle (around 50 BC) and Francis Bacon (in the early 1600's). AI, machine learning, generative and hybrid AI, as well as robotics, depend entirely on knowledge. Let's be very clear. Without knowledge, they just don't exist. So as far as the question about how well our knowledge and technology support us, as biological creatures subject to machine rub off, right now I'd say we're standing on stilts. It is a shaky position. Our positive human nature is not well supported. This includes the kind of data we collect. And as AI technologies continue to play an increasingly closer role in our lives and institutions, we find ourselves in an unsustainable position, biologically speaking.

The reason for this is, essentially, when the foundations of knowledge were laid for AI, machine learning, Generative AI and robotics, these human science discoveries described in this book simply did not yet exist. The goals of most our our currently existing modern technologies, including AI technologies, center around automation and efficiency. But *people just aren't like that*.

We need to design our tools, systems and environments to support our biology and our positive humanity. We can do that with insights from advanced human sciences. By using an emotion organon, we build a foundation of knowledge and design that includes human science discoveries. As a consequence, the worlds, tools and systems we design with that knowledge have a stake in us.

In this book, you not only find out about human science, but also how our world view of knowledge has been shaped. You will see how the wisdom of these new human science discoveries, especially those related to compassion, can be applied to almost anything through design. In the upcoming chapters, you will learn why these human science insights are important to you when you interact with people *and technology*. You will also see how our lives and societies are impacted by knowing about them.

The goal of investing in science can be purely to advance basic science. But the knowledge gained from these human science discoveries is already being put to good use. For example, the Virtual Human Interaction Lab at Stanford University has developed a to way teach people, such as NFL football players, to display empathy and other soft skills, which is beneficial for many of life's situations, including relationships [25, 26]. This is accomplished through role-playing with virtual reality scenarios and other VR applications.

But what about the rest of us? Not everyone is a superstar football player who can afford to train in a cutting edge laboratory. That's where every day technologies come

in. Commonly used apps and tools can also benefit from these breakthroughs. The knowledge we need to get started on this is in this book.

Two of the most crucial ideas discussed here are *bioplasticity* and *machine rub off*. You will learn about these in depth, but the main idea is this: the people, places and things we experience literally change us. That's bioplasticity. We grow and change in response to what we experience each day. This includes the way we interact with our devices, systems, games and immersive environments. That is machine rub off. Human science tells us that our biology is critically dependent upon positivity. This means we can intentionally design tools, devices, systems and environments for a positive device-mind-body effect. Now consider how this might scale up.

We are already in a social cyber culture where we spend much of our time with gadgets, systems, and environments. By understanding bioplasticity, machine rub off and these new human science developments, we can coalesce these ideas with technology and intentionally sculpt a cyber society that has the quality of positive rub off. Realizing that machine rub off can happen en masse, however, we must again ask: What is rubbing off on us, en masse, through our current devices? We find the answer to this by looking at the link between our devices and the knowledge they currently contain. The characteristics and limitations of that knowledge, as well as the culture it comes from, effectively shapes the devices we now use. Technology

is a reflection of the knowledge of those who imagine it. This book is going to change what you can imagine.

The human science discoveries contained in this book change the way we have seen knowledge for hundreds of years. This has tremendous implications for any technology that relies on knowledge, especially those used in sensitive areas of people's lives. The advancements also give a new scientific validation for our basic human need for a constant and steady supply of sincere kindness and compassion. You will find out that these needs are not secondary, nor can they be considered inessential. They are, in fact, biological. As you are about to learn, this need is embedded in our cells and under our skin.

The Rising Star of Human Science

The human science discoveries of the past three decades are as astounding as the galaxies and nebulae discovered by the James Webb Deep Space Telescope. Instead of looking outward to space through a lens, we look inward at our lives, relationships and biology. The intense rate of human science discoveries is the result of two strategic shifts in the way medical science is conducted. And the two shifts are related. The first involves a new approach to investigating phenomena by bringing multiple fields of study together. The second shift involves the integration of neuroscience and psychology with every other field of medicine. This fundamental change in how we conduct medical science gave rise to potent new fields such as psychoneuroimmunology, psychoneuroendocrinology and psychoneurocardiology. These are big words for some very cool ideas. We will learn

more about them in Chapters 4 and 5. I encourage you to check out the glossary of big words at the end of the book.

The new world of human science knowledge revealed through these medical discoveries has tremendous implications for healthcare, technology and also for our institutions, work places, social interactions, and more. Perhaps the discoveries will eventually affect everything, even our music. As a former AI and Medicine Fellow at the Stanford School of Medicine, I am especially interested in how these human science discoveries are going to influence the design of technology [27, 28, 29]. Here's why.

From a 30,000 foot view, when you gaze down at the modern world, you realize it is essentially constructed on, about, and because of knowledge. This is partly due to the fact that we have filled our world with tools that rely on knowledge. Automated systems, immersive environments, software agents and other technologies populate our world and grow increasingly closer to our lives every day. What kind of knowledge are they built on? Does it include human science? It's an important question for ourselves, our children and for future generations. Especially if you consider that by the time a child turns 21 now, he has spent 10,000 hours, on average, gaming [30].

The Invisible Knowledge All Around Us

Because AI, machine learning, generative AI, robotics, and so on depend *entirely* on knowledge, the way we define knowledge for technologies like this should not be taken lightly. These systems influence our lives through their presence in banking, justice, employment, healthcare, taxes

and other institutions. But their view of knowledge left out the human sciences. So what knowledge does it include? Does it have positive regard for us? Few people think about how knowledge is defined. But it matters, profoundly. Because our worlds, including our technologies, systems, and environments, depend on it. It surrounds us now. Does the knowledge in our technology have a stake in us? We need to design it so that it does, and the human science knowledge you find here stirs the imagination for exactly this kind of design.

For all but a few inventors and programmers, the qualities of the knowledge all around us are invisible, in the same way water is invisible to a fish. We are living in it and we don't see it, but we need it. The insights in this book are going to help us see it. In fact, I would wager you won't be able to look. Because it is the scientific confirmation of what is already inside of us. The biophysical effects of emotion and social experience is something that has long been invisible and immeasurable, so seeing this now is positively mesmerizing. Once we embrace these discoveries, the knowledge embodied in our tools, systems and environments *will* have a stake in us.

Objectively, we're seeing this now, not just because of science, but because *AI technology amplifies and reflects us*. Our understanding of the significance of our emotions and social relationships has long been underrated, and sometimes left out all together. In fact, we've actually had this all wrong. They are a priority, biologically speaking. We just didn't have the whole story until now.

Historically, the science of our every day emotional experiences was of little interest to great thinkers like Euclid, Aristotle, and so on. In the modern world of technology and in the face of human science, however, it has become a blind spot. How did that happen? Was it, as Viktor Frankl, psychiatrist and Holocaust survivor described, "man's inhumanity to man"[31]? Certainly, in societies that inflicted genocide or used slaves, concern for someone's emotions or social experience was often nonexistent. But what modern human science has revealed to us is that compassion gives health benefits not only to those who give and receive it but also to those who witness it [32, 9]. Clearly, these discoveries can change our worldview.

The Emotion Organon is not about a philosophy or even one or two people's experiments. It is about hundreds of experiments happening across all areas of medicine. There are now more than three decades of hard core medical science, including brain science, cardiology, immunology and endocrinology, that show the need for love and belonging actually supports our physical needs.

But now that we have all this human science knowledge, what do we do? It is time to apply this knowledge to our daily lives and the world around us. It is clear that we can personally benefit from understanding more about the developments in human science, but the field of medicine stands to gain tremendously. It will happen not from a single project or person but from collaborative efforts that build upon each other, as when enough medical staff become educated about these

advancements. It will also happen through the use of everyday technical tools, environments, algorithms and systems founded on human science knowledge. Tools like this can help us all benefit from these breakthroughs. The knowledge we need to get started on this is in this book.

The Emotion Organon

As mentioned earlier, the word "organon" means instrument of knowledge [21]. *The Emotion Organon* is an emotional instrument of knowledge that shines a light on the kinds of human science knowledge we need in order to build a modern world that supports our biology. Although the work has been happening for a few decades, not many people are aware of it yet. Certainly, not many people who work in technology are aware of it.

I'm an AI researcher with an unusual background because, in addition to my work on software agents at U.C. Berkeley and Stanford, and robotics at NASA, I've also worked with people in hospitals, clinics, and other places as a trained compassion therapist. I saw with my own eyes how people benefit from care and compassion in even the darkest of circumstances. It helped me when I fell ill after my father died. Its what drove me, my uncle Earl, an MD, and his wife Eileen, to search for the science described here. The point of this book is to share those scientific breakthroughs more widely and get us going in the right direction as we build solutions to the new challenges that lie ahead. I believe the scale and pace of discovery here provides evidence of a new era in medical science. In the book, we call this the Medical Renaissance of Emotion (MRE). Knowledge like this

influences everything we think and do. My hope is that some of you will look further into the discoveries you see here and perhaps be inspired by them.

About the Book

The first thing to know is there is glossary of BIG WORDS at the back of the book. There are a lot of big words here, so the glossary should help with that. The heart of the book details three decades of human science discoveries. You will also learn more about some of the remarkable projects already under way. They can be the inspiration for your own projects or motivate you to bring more health, love or happiness into your life. Perhaps all three.

But before we jump into the heart of things, I believe we owe it to ourselves to find out about the kind of knowledge *already* in our world and already in the technology that surrounds us. This will tell us a lot about the way computers currently "think" (it's not just about data) and explain why emotions and social experiences were left out of so many things, including our technology. So there are two chapters related to finding out about this (Chapters 2 and 3). I believe taking this time to understand our history will help us appreciate human science and guide us in knowing what we need to do next. The approach taken here is not to throw away what we already know but to combine it with valuable new human science. That science is in Chapters 4 and 5. Chapter 6 looks at human science and music. Finally, Chapter 7 applies the knowledge of the Emotion Organon to technology, covering ideas such as device-mind-bioplasticity and Compassion Centered Design.

Chapter 7 then relates these ideas to intentionally sculpting cyber cultures that support us. This topic is also covered in the companion book, *Designing Artificial Compassion Technology* [*20*]. Chapter 8 concludes the book by summarizing its basic points.

REFERENCES FOR CHAPTER 1

[1] Gouin, J. and Kiecolt-Glaser, J. 2011. The impact of psychological stress on wound healing: methods and mechanisms. *Immun. and Allergy Clinics of North America*. 31(1):81–93. https://doi.org/10.1016/j.iac.2010.09.010

[2] Barak,Y. 2006. The immune system and happiness. *Autoimmunity Reviews*. 5(8):523-527. ISSN 1568-9972.

[3] Tausk, F., Elenkov, I. and Moynihan, J. 2008. Psychoneuroimmunology. *Dermatol. Ther*. 21(1):22-31. doi: 10.1111/j.1529-8019.2008.00166.x.

[4] Kern, S., Oakes, T., Stone, C., McAuliff, E., Kirschbaum, C. and Davidson, R. 2008. Glucose metabolic changes in the prefrontal cortex are associated with HPA axis response to a psychosocial stressor. *Psychoneuroendocrinology*. 33: 517–29.

[5] Young-Kuchenbecker, S., Pressman, S. D., Celniker, J., Grewen, K. M., Sumida, K. D., Jonathan, N., Everett, B. and Slavich, G. M. 2021. Oxytocin, cortisol, and cognitive control during acute and naturalistic stress. *Stress*. 24(4):370-383. doi: 10.1080/10253890.2021.1876658.

[6] Lin, Y., Chen, C., Huang, C., Nishimori, K. and Hsu, K. 2017. Oxytocin stimulates hippocampal neurogenesis via oxytocin receptor expressed in CA3 pyramidal neurons. *Nat. Commun.* 8(1):537. doi: 10.1038/s41467-017-00675-5.

[7] Jankowski, M., Gonzalez-Reyes, A., Noiseux, N. and Gutkowska, J. 2012. Oxytocin in heart regeneration. *Recent Patents on Cardiovascular Drug Discovery*. 7(2):81-87. doi: 10.2174/157489012801227210

[8] Jankowski, M., Broderick, T. and Gutkowska, J. 2020. The role of oxytocin in cardiovascular protection. *Frontiers in Psychology*. 11: 2139. doi:10.3389/fpsyg.2020.02139

[9]Mason, C. 2021. Oxytocin and Compassion. *Film*. www.academia.edu/video/lePZ51

[10] Briggs, A. and Michael J. Reiss, M. 2021. *Human Flourishing: Scientific insight and spiritual wisdom in uncertain times.* Oxford Academic. 21 Oct. https://doi.org/10.1093/oso/9780198850267.003.0011.

[11] Rahe, M and Jansen, P. 2023. A closer look at the relationships between aspects of connectedness and flourishing. *Frontiers in Psychology*. 14:1137752. doi: 10.3389/fpsyg.2023.1137752.

[12] Pressman, S., Gallagher, M. and Lopez, S. 2013. Is the emotion-health connection a "First-World Problem"? *Psych. Sci.* 24(4):544–549.

[13] Uvnäs, K., Handlin, L., Kendall, K. and Petersson, M. 2019. Oxytocin is a principal hormone that exerts part of its effects by active fragments. *Med. Hypotheses*. 12(133):109394. doi: 10.1016/j.mehy.2019.109394.

[14] Simons, K. 2021. Mindfulness, Meditation, and Inspiration from World Series Winning Cubs. June 24. https://apbpa.org/mindfulness-meditation-and-inspiration-from-cubs-mental-skills-coach-darnell-mcdonald-hosted-by-apbpa-ambassador-matthew-repplinger/

[15] Nassif, T., Adrian, A., Gutierrez, I., Dixon, A., Rogers, S., Jha, A. and Adler, A. 2023. Optimizing performance and mental skills with mindfulness-based attention training. *Military Medicine.* 188 (3-4):e761–e770. https://doi.org/10.1093/milmed/usab380

[16] Bonura, K. and Fountain, D. 2020. From "hooah" to "om": Mindfulness practices for a military population. Journal of Social, Behavioral, and Health Sciences, 14, 183–194. https://doi.org/10.5590/JSBHS.2020.14.1.13

[17] Filippa, M., Monaci, M., Spagnuolo, C., Serravalle, P., Daniele, R. and Grandjean, D. 2021. Maternal speech decreases pain scores and increases oxytocin levels in preterm infants during painful procedures. *Science*. 11(1):17301. doi: 10.1038/s41598-021-96840-4.

[18] Yang, N., Xiao, H., Wang, W., Li, S., Yan, H., and Wang, Y. 2018. Effects of doctors' empathy abilities on the cellular immunity of patients with advanced prostate cancer treated by orchiectomy. *Patient Preference and Adherence*. 12*:* 1305–1314.

[19] Asl, E., Boostani, H., Behrouzian, F. and Rostami, H. 2021. The mediating role of compassion in the relationship between COVID-19 anxiety syndrome and COVID-19 burnout. *Journal of Education and Health Promotion*. 10*:*413.

[20] Mason, C. 2023. *Designing Artificial Compassion Technology*. Amazon Kindle Independent Publishing Platform. *In-press.*

[21] Organon. In wikipedia. https://en.wikipedia.org/wiki/Organon

[22] Wardrop, M. 2009. “ 'Computer rage' affects more than half of Britons". April. *Telegraph.co.uk*.

[23] Micron Technology. 2013. Survey: Over A Third of Americans Confess to Verbal or Physical Abuse of Their Computers. *Business Wire*.

[24] Grenoble, Ryan. 2015. Colorado Springs Man Shoots Malfunctioning Computer Eight Times, Calls It ‘Glorious’ The Huffington Post. May 22. https://www.huffpost.com/entry/man-shoots-computer-eight-times_n_7119246.

[25] VHIR. 2023. Stanford University’s Virtual Human Interaction Lab. https://stanfordvr.com/

[26] Fedotin, J. 2016. In Someone Else's Skin: NFL Considers VR To Give Players Empathy Training. http://www.thepostgame.com/nfl-virtual-reality-empathy-training-tolerance-stanford

[27] Mason, C. 2015. Engineering Kindness. *International Journal of Synthetic Emotions*. 6: 1–23.

[28] Mason, C. 2023. The Faces of Compassion Data Collection Project – Creating Positive Device Bioplasticity. www.thefacesofcompassion.org

[29] Mason, C. 2008. Human-level AI requires compassionate intelligence. AAAI Workshop on Meta Cognition at 23rd AAAI Artificial Intelligence Conference. Chicago.USA.

[30] McGonigal, J. 2015. Reality is Broken. Penguin Press. NY, USA.

[31] Frankl, V. 1959. *Man’s Search For Meaning*. Beacon Press, 2006, ISBN 978-0807014264 and 978-0807014295.

[32] Piper, W. and Saturn, S. 2016. Social neuropeptides and behavior. *Encyclopedia of Mental Health, Second Edition*. 184-188. Ed. Friedman, H. Academic Press. 10.1016/B978-0-12-397045-9.00046-X.

Chapter 2

OLD KNOWLEDGE NEW DISCOVERIES

From his ancient text, we can learn a great deal about what is happening today and what's coming next.

McGonigal on Herodotus
Reality is Broken

In order to best apply the knowledge of *The Emotional Organon*, it will be useful to understand some of the things that have driven us to our current view of knowledge. In this and the next chapter we dive deep into the fundamental questions about what knowledge is and how we define it. As mentioned earlier in the introduction, very few people consider or question how we define knowledge. However, because the very technology we use rests on it, entirely, we will look directly at these questions. In the search for answers to these questions about knowledge, what you find is that the modern world rests on two primary conceptions of knowledge. The first conception of knowledge comes from Aristotle and dates back to ancient Greece. Aristotle's ideas are captured in a collection of volumes called *The Organon* and focus on ideas of logic, rationality, organized systems and the durable quality of knowable objects [1]. These concepts of knowledge have formed the bedrock of AI since its inception.

The other concept of knowledge that plays a big role in our modern world (and in AI) comes from Sir Francis Bacon, a scientist and philosopher from the 1600s. Bacon's work was entitled *The New Organon* [2] in order to distinguish it from that of Aristotle's *Organon*. Bacon's views of knowledge and his *new* organon were a response to two

ground-breaking inventions that happened in his lifetime: the telescope and the microscope. These two inventions unleashed an incredible new era of scientific discovery.

Understandably, Bacon thought Aristotle had been wrong and believed that knowledge should now be defined through observation, counting and the discovery of patterns [3]. Today, Bacon's views of knowledge are the foundation of machine learning and Generative AI. They are especially significant for Generative AI, the technology behind the current generation of face recognition, large language models (e.g. Chat GPT), image analysis, etc. [4, 5].

Bacon's and Aristotle's organons form a battlefield in AI, dividing the people in AI into two camps: those who see the need for psychologically valid models and those who are data purists. These polarized positions affect not only how people in the AI community organize themselves, but also deeply held beliefs, funding, culture, education and industry. The reality is we need both, and we need more.

What we will be doing here is not throwing out either of Aristotle's or Bacon's world views, but adding to them, by infusing them with the insights brought to the world through the new human science of the Medical Renaissance of Emotion, which is happening in *our* lifetime. Right now, what you need to know is this: the ideas of Bacon and Aristotle form not only the deep foundation of AI, they are embedded in the architectures and institutions in much of the western world.

By infusing the core of this new human science knowledge with technology (and society) it gives us a way to

ring out the science of a positive humanity to people through the very tools, systems and environments where we are spending so much of our time today. Until the MRE, science and technology have largely ignored emotion and relationships. This influences our world view. In some cultures, such as in the U.S., emotion and social relationships are rarely discussed publicly. In fact, they have been an almost taboo subject in public, or sign of weakness in American and other cultures, which partly explains why a diagnosis or discussion of mental health issues can often bring whispered discussions and shame instead of support and healing.

So it may seem strange to some of you that there is a renaissance involving these topics. Or that they would have such important implications for our worldview and technology. The human science discoveries will impact the way we "see" knowledge from the definitions of Francis Bacon and Aristotle. In the coming chapters, some of you may cringe, because the medical advancements will make us wonder if we've been flying blind all this time. They have crucial implications for not just AI, but also the pharmaceutical and healthcare industries, the justice, education, and other systems of our modern lives.

In the same way that Bacon's concept of knowledge was influenced by the lenses of the telescope and microscope, our new concept of knowledge is influenced by the discoveries of this Medical Renaissance of Emotion. The MRE is the basis for a new world view that brings with it the depth of these

advances in human science. This is essential for us as we co-evolve with technology.

In effect, the discoveries impact how we conceptualize old knowledge now because historically, emotion has been separate from knowledge. Emotions and relationships were not seen as worthy of the term "knowledge" because they were not considered "rational" or "enduring." What we now know about emotion and social relationships tells a different story about their place in the world and in our lives.

In essence, the biology of positive emotion is both life sustaining and life giving. And the opposite is also true: negative emotions, or a lack of positive emotions, can lead to illness or even death. The new discoveries of the past few decades of human science also touch on the biological importance of our social lives and social structures.

They have implications not just for the technology that is increasingly surrounding us, but for the way we treat our fellow human beings. Together, the breakthroughs show that our current view of knowledge is unsuitable for the tools and technology used in close proximity to people's lives. This is especially true for tools and technology we use often, or when immersed in cyber worlds such as virtual reality or gaming environments. Now that we know of such human science treasures, we don't have to wait any longer, we can bring them to others in *our* life time. To do this, however, requires that we re-visit our ideas about knowledge.

Old Knowledge

Neither Aristotle nor Bacon viewed knowledge as related to human experiences. They looked outward from themselves to represent and create knowledge. While the concept of our existential concerns, or self, is universal, its representation is generally unspoken and unacknowledged in American culture. As a result, the applications of such knowledge, such as in AI, Generative AI, etc., remain absent. When technology does not reflect this aspect of self back to us, it reinforces its absence in our culture. This may, in part, explain the sense of digital depersonalization that some individuals experience [6].

In Japan, you will find that this type of knowledge is described by the philosophical concept of "fudo" [7]; in Germany, it is "dasein" [8, 9]; and in India, it is captured by the notion of "suchness". To be clear, these unrepresented aspects of self are precisely the concerns of the Medical Renaissance and *The Emotion Organon*. The reason they are so important is because now we know the direct impact they have on our biology. Our bodies are not separate from but *part of* knowledge. Our bodies are no longer *observers of* knowledge, they are part of it.

Our experiences as social selves, i.e., relations, societal or moral regard, culture and community, have a crucial impact on our organs and body functions [10, 11, 12, 13]. Much of the AI world has yet to notice this aspect of ourselves. The reasons for this lie in the next chapter. The philosophical concepts of self just weren't, and still aren't, part of our western world view of knowledge.

In some cultures, social experience is seen with indifference because it relates to emotion, or can be viewed as a distraction from more rational kinds of knowledge. Some might see it as weakness due to sentimentality. Similarly, there is often a lack of tender regard for or representation of the mental or emotional state of those whose data was collected or the person doing the collecting. This may relate to technology's focus on automation and efficiency or to the need to "move fast and break things". The bottom line of these 30 years of multi-disciplinary science is this: for our world and tools to have a stake in our human biology, our views and priorities need to change.

The exact kind of knowledge Aristotle and Bacon omitted, i.e., the human experience, has proven to be essential to maintaining healthy body functions and societal norms. For example, we now understand that psychosocial stressors affect brain glucose metabolism [14] and unhappily married couples who continually bicker and fight have slower wound healing [15].

But just as we can't totally blame the psychologists for getting it wrong, we can't totally blame Aristotle and Bacon for this omission of knowledge. We are now well into the 21st century, and these breakthroughs occurred long after Aristotle and Bacon's lives were over (RIP). In fact, most of the MRE discoveries we will see here have happened in the past three decades.

The idea of including human experiences and "fudo" as a kind of knowledge presents a significant addition to Aristotle's and Bacon's long-held views for two closely

related reasons. First, because this view of knowledge is in harmony with our mental, physical and emotional health. Second, because at this juncture in time, AI systems and their decisions are increasingly affecting our lives and there is a close relationship between AI and the way we define knowledge.

New Discoveries

The new discoveries of the Emotion Organon can be divided into three key areas: A) The Medical Renaissance of Emotion B) Machine Rub Off and C) Bioplasticity. These three areas are deeply interconnected. Although we will dive into them in depth later in the book, they are summarized here.

A. *Medical Renaissance of Emotion (MRE)* Approximately 30 years ago, the U.S. government created a new multi-disciplinary research program. The Decade of the Brain research program was also created about this time [16]. Pioneering medical scientists combined advanced emotion research in psychology and brain sciences with traditional fields of medicine, such as immunology, endocrinology, cardiology, and so on. This allowed medical scientists to answer questions such as "How does the immune system react to sadness?", "How does persistent positivity (or negativity) influence the function of the heart?", etc. Once a previously noteless and unmeasurable phenomenon, we can now look deeply into how emotions influence our body's functions. While this important moment of discovery in human science will continue to grow for many years to come, the knowledge gained from these discoveries has brought

crucial insights for the tools and institutions we create but also for the importance of our relationships and our positive regard for one another.

B. *Machine Rub Off* (*MRO*) The discovery of *Machine Rub Off* began with the work of Clifford Nass and his students in Stanford University's user experience laboratory [17, 18], where they discovered people changed by interacting with machines. The changes people experienced were then carried with them into their relationships and whatever else they did next – driving, working, decision-making , etc. *Machines don't just rub off, they rub off on all of us.* MRO has significant implications for how we design our systems and technologies now because our lives are growing increasingly closer to our devices every day. Some rub off is linked to another breakthrough called *bioplasticity*

C. *Bioplasticity* A newly reconized biological phenomena where human bodies change biologically and anatomically in response to experiences, behaviors and interactions. The bioplasticity phenomenon was first documented in the brain using MRI and fMRI. Aptly named neuroplasticity, the phenomenon was originally believed to occur only in our brain and during the first five years of life [19, 20, 21]. Remarkably, bioplasticity has been observed throughout our body tissues as well as in our fluids and biological functions such as our immune system and glucose metabolism [14, 22]. In addition, the phenomena occur not just when we are children but throughout all of our lives by our activities and what we experience [23].

These discoveries have consequential implications for our social world and our technical design. Our understanding of machine rub off and bioplasticity's importance to us deepens considerably when we link them to the Medical Renaissance of Emotion.

Up Next: In the next chapter (3) we expand on some of the ideas introduced here. Following that, chapters 4 and 5 cover the MRE.

REFERENCES FOR CHAPTER 2

[1] Aristotle. 2015. Translated Owen, O. 1853. *The Organon, Complete Edition*. ISBN-13: 9783849648367. JazzyBee Verlag Publishers. Bavaria, Germany.

[2] Bacon, F. 2000. *The New Organon*. Edited by Jardine, L. and Silverthorne, M. Cambridge University Press. Cambridge, UK.

[3] Turner, W. 1903. *History of Philosophy*. Ginn and Co. Boston, USA.

[4] Krizhevsky, A., Sutskever, I. and Hinton, G. 2012. ImageNet classification with deep Convolutional neural networks. *Advances in Neural Information Processing 25*. MIT Press, Cambridge, MA.

[5] Langley, P. 1995. *The Elements of Machine Learning*. Elsevier Science and Technology. San Francisco, USA.

[6] Ciaunica, A., McEllin, L., Kiverstein, J., Gallese, V., Hohwy, J. And Woźniak, M. 2022. Zoomed out: digital media use and depersonalization experiences during the COVID-19 lockdown. *Sci Rep*. 12(1):3888. https://doi.org/10.1038/s41598-022-07657-8

[7] Watsuji T. 1961. *Climate and Culture: A Philosophical Study*. Geoffrey Bownas (trans.). Ministry of Education and Hokuseido Press. Japan. https://monoskop.org/images/9/90/Tetsuro_Watsuji_A_Climate_A_Philosophical_Study.pdf

[8] Gross, D. and Kemmann, A. 2005. *Heidegger and Rhetoric*. State University of New York Press. New York, USA.

[9] Heidegger, M. 1962. *Being and Time*. Harper and Row. NY.

[10] DeVries, C., Craft, T., Glasper, E., Neigh, G. and Alexander, J. 2007. 2006 Curt P Richter award winner: social influences on stress responses and health. *Psychoneuroendocrin*. 32: 587–603.

[11] Eichstaedt, J., Schwartz, H., Kern, M., Park, G., Darwin, L., Merchant, R., Jha, S., Agrawal, M, Dziurzynski., L., Sap, M., Weeg, C., Larson, E., Ungar, L. and Seligman, M. 2015. Psychological language on twitter predicts county-level heart disease. *Psychological Science*. 26: 159–69.

[12] Filippa, M., Monaci, M., Spagnuolo, C., Serravalle, P., Daniele, R. and Grandjean, D. 2021. Maternal speech decreases pain scores and increases oxytocin levels in preterm infants during painful procedures. *Science*. 11(1):17301. doi: 10.1038/s41598-021-96840-4.

[13] Grewen, K., Girdler, S., Amico, J. and Light, K. 2005. Effects of partner support on resting oxytocin, cortisol, norepinephrine, and blood pressure before and after warm partner contact. *Psychosomatic medicine*. 67(4):531–538. https://doi.org/10.1097/01.psy.0000170341.88395.47

[14] Kern, S., Oakes, T., Stone, C., McAuliff, E., Kirschbaum, C. and Davidson, R. 2008. Glucose metabolic changes in the prefrontal cortex are associated with HPA axis response to a psychosocial stressor. *Psychoneuroendocrinology*. 33: 517–29.

[15] Gouin, J. and Kiecolt-Glaser, J. 2011. The impact of psychological stress on wound healing: methods and mechanisms. *Immunology and Allergy Clinics of North America*. *31*(1): 81–93. *https://doi.org/10.1016/j.iac.2010.09.010*

[16] Library of Congress. 1999. Project on the Decade of the Brain Research. https://www.loc.gov/loc/brain/

[17] Nass, C. and Moon, Y. 2000. Machines and Mindlessness: Social Response to Computers. *J. Social Issues*. 56:81–103. doi:10.1111/0022-4537.00153. ISSN 1540-4560.

[18] Reeves, B. and Nass, C. 1996. *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places*. Cambridge University Press. New York, USA.

[19] Fuchs, E. and Flügge, G. 2014. Adult neuroplasticity: more than 40 years of research. *Neural Plasticity*. 541870. doi:10.1155/2014/541870.

[20] Ganguly, K. and Poo, M. 2013. Activity-dependent neural plasticity from bench to bedside. *Neuron*. 80:729–741. *doi:10.1016/j.neuron.2013.10.028*

[21] Mateos-Aparicio, P. and Rodríguez-Moreno, A. 2019. The impact of studying brain plasticity. *Frontiers in Cellular Neuroscience*. 13:66. doi:10.3389/fncel.2019.00066

[22] Danese, A. and Lewis, S. 2016. Psychoneuroimmunology of early-life stress: the hidden wounds of childhood trauma. *Neuropsychopharm*. 4299–114. https://doi.org/10.1038/npp.2016.198

[23] Fuchs, E. and Flügge, G. 2014. Adult neuroplasticity: more than 40 years of research. *Neural Plast*. 2014:541870. doi: 10.1155/2014/541870.

Chapter 3

THE ORGANONS

One withstands the invasion of armies; One does not withstand the invasion of ideas.

Victor Hugo

As sometimes happens in the course of history, there are moments of change. Sometimes these moments are the result of inventions and discoveries. For example, the invention of the microscope and telescope gave us a new instrument of knowledge, a new organon. It literally changed people's world view because, for the first time, people could explore the details of things near and far. In the last chapter, we saw how the presence of the new MRE discoveries in our lives means that our old ideas of knowledge will change. The confluence of discoveries around the MRE, machine rub off, and bioplasticity are an organon. Their arrival in our lives creates a pivotal moment that is happening in our own life time.

To understand the significance of this moment and to appreciate the value these new discoveries bring to old knowledge, in this chapter we go back in time and explore the organons of Aristotle and Francis Bacon. In doing this, we also see how our definition of knowledge has such deep ties to AI and machine learning.

Aristotle's Organon

Aristotle created a collection of teachings on logic and analytical thinking called *The Organon* [1]. He taught that knowledge is centered on objects with permanence, such as the angles of an isosceles triangle, a configuration of stars, or the lines of a geometric proof. Anything without this

essential property he considered *not knowledge*. He also organized knowledge into systems, systems of systems, and so on. These ancient foundational ideas about what knowledge is, and is not, permeate western culture today. They form the foundation of our laws, language, medicine, education and culture, with implications for an AI system's internal knowledge representation and AI cultural norms.

This early history of knowledge is another explanation for why complex temporal things such as emotions, mood, relationships, and expressions of maternal caring (as well as our reactions to these experiences) are *not* part of AI's present knowledge foundation. This is not the only reason, but it may help explain why it has been so difficult to shift this perspective. To be fair, western medicine also did not have an easy time recognizing their importance.

As we will see in the upcoming chapters, what was formally intangible and temporal, has now been shown to be important in hundreds upon hundreds of studies. But it's not just any knowledge, it is a crucial kind of knowledge, because it pertains to our biological health and survival.

"Everyone has a worldview. If you think you do not have a worldview then probably your view is the default one of your society, which in the UK's case is a form of agnostic, capitalist, scientific materialism." [4]

Dr. Alison Gray,
MRCPsych MMedSci

The medical discoveries about kindness and compassion are going to change our worldview again. This is significant because our world view informs our every thought and

action. Our worldview is our “attitudes, values, stories and expectations about the world around us” [4].

These Aristotelian views of knowledge are pervasive and can be found throughout our advanced education systems. The universities and institutions of the United States stem from those in England, which were founded on Aristotle's teachings and way of thinking. The institutions and those who train in them have, unknowingly and unquestioningly, supported this oblivious stance, which spills over to a lack of integral regard for the importance of people's welfare in our social and corporate institutions, engineering and problem solving. In the U.S., attention to a product’s effects on people is often considered more deeply, as an after thought to law suits. Naturally, this view of knowledge and corporate culture rubs off on the design of AI systems. But this antique view of knowledge has a blind spot.

The new human science discoveries of our lifetime shine an important light on this blind spot. MRE knowledge is significant for the generation of artifacts and creations we make now, including AI tools and products. But the impact of the MRE is bigger than that: it affects our culture.

Francis Bacon's New Organon

At the beginning of the 17th century, the world experienced its first telescope and microscope. Consequently, these inventions changed our ideas about knowledge and everything we thought we knew about the world. The first compound microscope combined the use of an eyepiece and a magnifying lens to reveal *micrographia*, a newfound world

of small creatures and exquisitely detailed patterns [16]. Around the same time period, the first telescopes appeared, allowing the world to probe objects in the sky like never before. They also allowed us to gaze at distant lands and find features in horizons that were previously incomprehensible. And, if you had one, it gave you a distinct advantage because you could see the shine off your adversary's belt buckle, long before they could see you.

These inventions revealed a new kind of knowledge that was observed and counted. As a society, we began collecting data about the world. These new instruments not only allowed us to count and catalog things in new ways, they fundamentally changed how we thought and what we defined as knowledge. They changed us. And much later, they influenced AI [6, 7]. This was a shift in everyone's worldview.

"In the history which we seek and intend, we must be sure above all that it is extensive and made to the measure of the universe. The world must not be contracted to the narrow limits of the understanding (as it has been heretofore), but of the world as it is found to be." [2]

Sir Francis Bacon
The New Organon

In *The New Organon* [2], Francis Bacon created and documented this new way of seeing, with lenses, that allows us to "know" based on what we can observe. He laid the foundation for describing a new kind of knowledge based on data collection. This is the knowledge view of machine learning and Generative AI [6, 7]. This view of knowledge

has led us to invent some very useful technology. But we need to consider these technologies *together with people*. This should be common sense.

The Emotion Organon

The definitions of knowledge in both AI (The Organon) and machine learning (The New Organon) are both person-less and emotion-less. There is no concept of society, person or emotion, in an isosceles triangle or in the lines of a mathematical proof. Nor do the lines of a proof represent, acknowledge or show us anything about the person who did the work*. The patterns of bacteria and ocean waves can be counted, described and catalogued, but the person who did the counting will always be invisible. At this point in time, we find ourselves increasingly surrounded by devices that can count, catalogue and analyze us, but that have been designed with a very limited awareness of humanity or human science. The number of algorithms, systems and immersive environments in our lives is expected to increase dramatically. In effect, together with these devices, we have developed a cyber world that does not have a stake in us. Therefore, if we wish to influence how it is shaped, it is time to rethink this approach to knowledge.

Let me give you some specific examples. Consider our present machine learning algorithms. They can be used to arrive at a decision that affects a mortgage, an employee contract, a tax fraud investigation and so on. Now consider these decisions happen not for just one person, but for millions or hundreds of millions of people. The Australian system, Robodebt, is an unsupervised algorithm trained to

automatically determine who owes the government money and automatically withholds funds from those people. Robodebt made many errors, affecting all of Australian society with devastating consequences among the most vulnerable. Human managers did not respond to the complaints made by the people affected and there were no features designed into the system for those affected to give feedback or consideration for how deeply its decisions negatively impacted their lives. It ruined lives and some people actually took their own lives [5, 14].

According to the Robodebt Royal Commission, the algorithm continued to operate despite the fact people's lives were severely ruined and in spite of numerous complaints [14]. The system itself was unable to take these concerns into consideration during problem solving and it was left to the human administrators to correct the problem. What I am suggesting here is that the system itself should look out for our well being during its decision making. The reason this is an important way to design is that unfortunately, this kind of issue is not an isolated incident.

Similar problems have arisen, due to bias with face recognition systems. According to research by the Algorithmic Justice League, Scotland Yard misidentified over 2300 people using face recognition [3]. The power to correct these 2300 mistakes is left to people who have no stake in us. They are simply part of a system that relies on face recognition to make decisions further up the chain on whether or not to arrest someone.

We can reasonably call this period of technological design (and society) *The Oblivatronix Era*. By infusing devices with the knowledge of caring, by building from designs that are influenced by the human science described here, we begin to move towards the *Post-Oblivatronix Era*. When we do this at scale, the result is a positive device rub off en masse, ultimately moving us towards a more compassionate society.

When design is founded on a view of knowledge that is oblivious to us, the limitations we create for ourselves (and our tools) are far more than our algorithms or devices. It limits us. What I'm proposing we do about this is to introduce the idea of *compassionate design*. Positive humanity and the human spirit have great potential and have overcome many "impossible" things. When Bacon said, "The world as it is found to be," that is not what he meant. Because the world of knowledge and learning is not limited to what we see through a lens. *It includes us*. *We* also need to be part of the world that Bacon described. It is not *the* world, but *our* world. To do this the tools and systems reflect us through the knowledge architectures that we use.

The MRE will refine knowledge and the technology that depends on that knowledge (e.g. AI), precisely because compassionate design represents us: it has a stake in us and reflects our higher selves. It is not enough to say we are bringing humanity back to technology because it is really our *positive* humanity. This shifts our perspective. "I think therefore I am" becomes "I feel and care, therefore I am," or alternatively, "I am because I know you and care for you." In

the context of the MRE, this change in perspective is not philosophical but tangible and visceral *because it supports our biology* in a physical, living way that cannot be ignored. The MRE reveals both the scientific and living proof we need to transform ourselves with a knowledge architecture that is also a biologically supportive organon.

Like compound microscopes and telescopes, the new medical and human science reveals a crucial new world of knowledge where impermanent and seemingly invisible phenomena like emotions and social relationships are, in fact, essential knowledge. This knowledge can change our tools *for the better* We ourselves also change because of machine rub off. Since we are already living in a social cyber world today, this brings up the question, what is it that is rubbing off on us?

There is one more thing. In a cyber society, using an advanced form of knowledge like this means that many dimensions of our personhood can be computationally represented. And the act of giving it explicit representation in our data, languages and code means we can expressly design a capability for positive regard for people into the knowledge architectures of our tools. Consequently, our personhood can be positively represented and regarded in such systems. This will impact any situation where our personhood is at stake, i.e., within the law, government agencies, healthcare, employment, etc. These are applications of knowledge and technology unimagined by either Aristotle or Bacon.

In order to design Artificial Compassion Technology, that is, to intentionally design a social cyber world with a positive device rub off, including Compassionate AI, Compassionate machine learning, etc., we use an emotion organon to change how we think about knowledge and pivot us to a worldview that includes compassion. This is made possible because of compassion science, one of the most remarkable new fields to emerge from the MRE [17]. Compassion has been linked to more than 50% of our body functions through its ability to influence oxytocin [18].

I believe that because of bioplasticity, designing for compassion is not optional, but essential. We are already constructing social cyber environments. Our designs, whatever they may be, shape us through bioplasticity and machine rub off. Because of our biology, the systems closest to our lives necessarily need to meet us on the grounds of our positive humanity. Right now, we are already co-evolving with our devices, algorithms, systems and environments through our co-existence with them. But these devices were created *before* compassion science and before these 30 years of human science insights. Because of the significant impact compassion has on us, physically, if something or someone is devoid of compassion, it simply does not support our biology.

The Emotion Organon and Technology

Once you connect the dots between MRO, MRE, bioplasticity and our dependence on knowledge (personal, systemic and societal), you see there is a lot to be gained by fusing this

new knowledge about ourselves with things that are closest to the sensitive areas of people's lives.

At present our tools, devices and systems embrace a view of problem solving and technology design that is one part automation and efficiency, one part profit and one part ignorance. You could say the tools and devices we live with today are *oblivious* to us. The word "oblivious" applies in this context because the devices and systems themselves are not designed to have our welfare in mind, but also because the programmers, engineers, governments, and even the general public are still unaware its importance. That is another big reason for this book - to share the information more widely. People in technology are generally unaware of the advancements in medical or human science.

It is the position of this author that, because of the tsunami of proof showing why caring for people is so critical for our biology (ours and theirs), we simply cannot persist with technologies and world views that do not support us. That is not to say ALL technologies and tools need this, but right now, we don't have much option. Remember that caring is linked to oxytocin and not only can we grow human heart tissue with oxytocin, people recover faster from heart attacks in caring environments and relationships [19, 20].

As the COVID-19 pandemic showed us, human caregivers are often underpaid, mistreated, sleep deprived and, they can get burned out with compassion fatigue. Robotics and AI systems can help. But their impact is limited due to the way they are designed right now. And we

keep running into the consequences of these limitations, e.g., Robot Debt, biased human resources, etc.

Although the focus of this book is about the human science breakthroughs, it is pointless to talk about them, or a new world view, without thinking about how we can apply this knowledge. Being an AI researcher, I believe the knowledge of The Emotion Organon compels us to apply it to our tools and technologies. This is not only because of the human science but also because of the machine rub off and bioplasticity discoveries. When positive device plasticity happens not just for one person, but for hundreds of millions of people, this positive device plasticity has the potential to uplift all of us. In effect, we increase resistance to stress and illness at a population level by sculpting a positive social cyber world. After the pandemic, this is the obvious next step. How can we NOT do this? In fact, the transition to the *Post-Oblivatronix Era* has already begun.

Artificial Compassion Technology

In addition to my own projects on Engineering Kindness, Giving Robots Compassion, the Faces of Compassion data archive, and Compassionate AI [8-13], there are a growing number of Artificial Compassion Technology (ACT) systems already in use or in development. ACT is not just about AI. A very simple example of the idea of Artificial Compassion Technology is the smart watch that can detect if you have fallen. It asks if you are ok and would you like it to call someone to help. It also has a panic button. A more sophisticated example of ACT is robotic nursing [15]. We will hear about more ACT applications in Chapter 7. The

interested reader may want to check out *Designing Artificial Compassion Technology*[13].

Up Next: In the next two chapters we dive not the main material of the book - the medical research. It is valuable to us as a society but it also has relevance to our own lives at a personal level.

**Although for certain texts, such as the Bible and Euclid's Elements, much has been written about the situations and trustworthiness of translators who occasionally make alternations [21].*

REFERENCES FOR CHAPTER 3

[1] Aristotle. 2015. Translated Owen, O. 1853. *The Organon, Complete Edition*. ISBN-13: 9783849648367. JazzyBee Verlag Publishers. Bavaria, Germany.

[2] Bacon, F. 2000. *The New Organon*. Edited by Jardine, L. and Silverthorne, M. Cambridge University Press. Cambridge, UK.

[3] Buolamwini, J. 2021. Technology Should Serve All of Us and Not Just the Privileged Few. Algorithmic Justice League. https://www.ajl.org.

[4] Gray, A. 2011. Worldviews. *International Psychiatry:Bulletin of the Board of International Affairs of the Royal College of Psychiatrists*. 8(3):58–60.

[5] Henriques-Gomes, L. 2023. Robodebt: five years of lies, mistakes and failures that caused a $1.8bn scandal. Mar 10 and July 6. The Guardian.

[6] Krizhevsky, A., Sutskever, I. and Hinton, G. 2012. ImageNet classification with deep convolutional neural networks. *Advances in Neural Information Processing 25*. MIT Press. Cambridge, USA.

[7] Langley, P. 1995. *The Elements of Machine Learning*. Elsevier Science and Technology. San Francisco, USA.

[8] Mason, C. 2008. Human-level AI requires compassionate intelligence. *Proc. of the Assoc. for the Advancement of Artificial Intelligence Workshop on Meta-Cognition*. 147-150. Chicago, USA.

[9] Mason, C. 2012. Giving robots compassion. *First Stanford CCARE Conference on Science and Compassion*. Telluride, USA.

[10] Mason, C. 2015. Engineering Kindness. *International Journal of Synthetic Emotions*. 6: 1–23.

[11] Mason, C. 2021. Artificial Compassion From An AI Scholar. https://www.academia.edu/50341134 Artificial_Compassion_From_An_AI_Scholar_Draft_for_comm.

[12] Mason, C. 2023. The Faces of Compassion Data Collection Project – Creating Positive Device Bioplasticity. www.thefacesofcompassion.org

[13]Mason, C. 2023. *Designing Artificial Compassion Technology*. Amazon Kindle Independent Publishing Platform. *in-press*.

[14] Robodebt Royal Commission. Royal Commission into the Robodebt scheme. https://Robotdebt.royalcommission.gov.au

[15] Soriano, G., Yasuhara, Y., Ito, H., Matsumoto, K., Osaka, K., Kai, Y., Locsin, R., Schoenhofer, S. and Tanioka, T. 2022. Robots and Robotics in Nursing. *Healthcare (Basel)*. 10 (8):1571

[16] Hooke, R. 1665. *Micrographia: Some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries made thereupon*. Martin and Allestry Royal Society Printers. London, England.

[17] Seppälä, Simon-Thomas, E., Brown, S., Worline, M., Cameron, D. and Doty, J. (Eds.). *The Oxford Handbook of Compassion Science*. 121:132. doi:10.1093/oxfordhb/9780190464684.013.1

[18] Mason, C. 2022. Oxytocin and Compassion. *Film*. https:// www.academia.edu/video/lePZ51

[19] Jankowski, M., Gonzalez-Reyes, A., Noiseux, N. and Gutkowska, J. 2012. Oxytocin in heart regeneration. *Recent Patents on Cardiovascular Drug Discovery*. 7 (2):81-87. DOI : 10.2174/157489012801227210

[20] Jankowski, M., Broderick, T. and Gutkowska, J. 2020. The role of oxytocin in cardiovascular protection. *Frontiers in Psychology*. 11: 2139. doi:10.3389/fpsyg.2020.02139

[21] Heath, T. 1956. *The Thirteen Books of Euclid's Elements*. Cambridge University Press and Dover Publications. New York, USA.

Chapter 4

THE MEDICAL RENAISSANCE

The existing scientific concepts always cover only a very limited part of reality, and the other part that has not yet been understood is infinite.

Werner Heisenberg
Physicist

This chapter examines some of the key scientific discoveries around emotion that are having an extraordinary impact on the field of medicine. Multi-disciplinary research can lead to large strategic pivots in the way we currently do things because information is combined in new ways, altering perspective and giving rise to innovations across many areas of our lives. The fundamental discoveries here are a result of combining psychology, neurology and other areas of medical science. What they show is that our needs for positive emotional and social experiences are so deeply embedded in us that we find evidence for them at a cellular, organ and systemic level. In essence, they are linked to *our survival.*

Positive social and emotional experiences are linked to the brain, immune function, glucose metabolism, stress and resilience, thermal regulation, cardio function and rehabilitation, wound healing, and more. The insights in this chapter have implications beyond medical science, particularly for positive emotions such as compassion. In effect, the amount of compassion a society has sculpts the kind of world we live in and whether or not we feel safe. As you will discover here, feeling safe and having trust also impacts biology. It is much more important for people than we have acknowledged.

In essence, what all these studies show is that little things in life, like a smile or just a friendly interaction, *undeniably matter*. They also show that when someone kisses your boo-boo, it actually *does* make it better (thanks, mom!). In this and the next chapter, we find out exactly how and why this happens.

We begin this exploration with the amazing human story of *The Rescuing Hug*. It is an important story not only for its biological significance, but because it also demonstrates the reason we need to bring *heart intelligence* into our core idea of knowledge. The focus on cerebral intelligence occurs throughout engineering, mechanical design, machine learning, AI and robotics. This chapter reminds us that there are many types of intelligence, even some that are beyond words.

The Rescuing Hug

The newborn twins shown in Figure 4.1 spent their first week of life in separate incubators [1]. This is standard hospital policy for premature births. One of the twins was struggling for her life with a fluctuating temperature and heartbeat. The specially trained nurses had tried everything, but the ailing baby was not responding to standard treatment. One of the nurses, following her intuition, placed the two twins together in the same incubator, violating standard hospital policy and risking her job. Immediately, the stronger twin reached out her arm to hold and comfort her sibling. The endearing embrace stabilized the struggling twin's heart rate and normalized her body temperature.



Figure 4.1. Premature twins thrive with a "Rescuing Hug." Image with permission: Townsend [2].

These two babies seemed to know instinctively what scientists are now discovering and documenting. Today, the twins are healthy adults.

This example shows the naturally occurring and deeply fundamental connection between our biology and emotion, affection, and compassion. The compassionate embrace had a definite biological impact on these premature twins.

Next, we explore the medical science discoveries that relate to the intelligence shown in this small but extraordinary moment of human connection.

The New Science of Compassion

The science of compassion is a growing new field full of discoveries about compassion and how it (or the lack of it) affects us. Although new discoveries continue to unfold, there are already so many that they will blow your socks off. For instance, did you know that when we witness tenderness

or generosity, like when someone stops their car to help an animal or give money to the poor, and then we have this good, warm feeling inside of us, those feelings are actually something biological happening inside of us? During these good feelings, or "awww" moments, so named by research scientists Walter Piper and Serina Saturn [3], you are actually experiencing a wonderful cascade of neuropeptide and neurohormonal reactions that support your health.

The neuropeptides and neurohormones created in this "awww" moment interact with a body wide system that supports our immune system, heart, memory, wound healing, and so much more. The same peptides and hormones help us form social bonds, express positive emotional experiences through caring and intimate behaviors. In turn, these social and emotional experiences provide us with a steady supply of neurohormones and peptides. These are what make us more resilient and resistant to the impact of stress and infections. Our lives depend on positive reactions and experiences.

The studies in this section detail the biological impact of compassion and warm, positive relationships. They also show that if we are deprived of them or experience chronically negative psychological events, it is extremely detrimental to our lives. In fact, chronically stressful and conflicting relationships have been shown to have ill effects on our health in a variety of studies across many different fields of medical science.

The main reason for the link between warm positive experiences and good health concerns remarkable new

discoveries about oxytocin, such as its key role in the health of our cardiovascular and neuroendocrine systems. You will discover in the next chapter that fundamental beliefs about oxytocin, held by the medical science community since 1902, have been shattered by these discoveries. Essentially, oxytocin is the key to a wide range of important body functions without which we could not survive. Our ability to create it depends on the loving kindness of our actions, thoughts, and environment. We go into greater detail on oxytocin later on in the next chapter.

Compassion, Stress and Resilience

During the COVID-19 pandemic, every level of healthcare worker experienced physical and emotional burnout [4, 5]. A number of studies conducted on compassion during this time showed that when educators, physicians and other healthcare workers used compassion generating methods such as mindfulness meditation, they experienced more resilience, better mental health and social capacities [6].

For example, in a study of 250 healthcare workers conducted during the COVID-19 pandemic, compassion was shown to play a mediating role in the relationship between COVID-19 anxiety syndrome and COVID-19 burnout [7]. These types of effects can also be seen with online activities. In a study involving frontline COVID-19 pandemic healthcare workers, a number of positive effects were achieved from online compassion centered meditation including capacities for mental health, resilience and social adaptation [8]. This is important because of the role these folks play in our society. Remember the idea of machine rub

off and how it can happen en masse? Rub off happens between people, too.

Compassion centered meditation might include the practice of paying non-judgmental, supportive attention to (becoming aware of) our breath, our attitudes, emotions, body posture, comfort or discomfort, etc. [9]. In a 1600 person study, these mental practices were shown to be protective for healthcare, education and other workers who experienced compassion fatigue and burnout during the pandemic. The impact of compassion fatigue and burnout (as measured by the Maslach Burnout Inventory) is accompanied by a reduction in sensory sensitivity according to Highly Sensitive Person Scale measures, a sense of depersonalization and a lowered quality of life. The researchers found compassion awareness and sensory training support were confirmed as protective against these effects [10]. The findings of this study demonstrate "the importance of incorporating adequate management strategies for high sensitivity, empathy and compassion satisfaction in prevention programs" [10].

There is also much to say about what helps. Grandi and team found that the practice of self-compassion helped reduce exhaustion [11] and Saarinin and team found that compassion practices help protect against exhaustion and negative attitudes and emotions [12]. This is important because, as you will find out in detail later on in this section, *our immunity is affected by stress.*

In studies related to parental resilience, Cousineau and team discovered that compassion and mindfulness helped

parents when caring for children with chronic conditions [13]. Another study by Heym and team showed a relationship between the microbiology and inflammation of the gut and self-criticism and empathy [14]. In 1999, Fogarty and team uncovered the remarkable discovery that a mere 40 seconds of compassion can reduce patient anxiety [15]. In 2019, Weingartner and team found compassion training enhanced medical student clinical care [16]. This type of research continues to expand.

In 2021, Sahi and team found an immediate and long lasting reduction in pain from the effects of warm, comforting hand holding [17]. And Filippa and team saw decreased pain in infants who experienced soft motherly affection in speech [18]. This is why tenderness matters so much. It might just explain why mother's kisses on our boo-boos actually seem to help. It's not just psychological.

Some of the earliest and most innovative studies on positive relations and affection happened at McGill University in Canada, where neuroscientist Michael Meaney and his team showed that motherly affect positively impacts the expression of the human genes that regulate the stress response [19]. This finding is important because stress impacts all diseases and disease processes. Meaney and his team also showed that motherly affection positively impacts the creation of neural stem cells, which govern our short-term memory.

By contrast, aggressive behaviors inhibit the expression of affection. In response to Meaney's findings, the Canadian government awarded him the Royal Order of Quebec. His

research on motherly affection has also inspired the public health agencies in Canada to begin investigating more formally the role that affection and motherly nurturing have on human health. Knowing how important the expression of tenderness, motherly affection, and other forms of positive emotion are for human health and, just as importantly, that they are squashed by aggression and violence, the Canadian government launched a public education campaign specifically designed to reduce aggression and violence in families and other trusted social circles where the expression of affection and warmth is natural.

The kind of positive impacts Meaney and his team discovered are not limited to the mother-infant relationship. In two different research efforts, one by Kiecolt-Glaser and team and another by Grewen and team, it was shown that consistent, warm partner contact lowers cardiovascular reactivity [20, 21]. A number of researchers have found a link between our immune and cognitive systems: positive cognitive states influence positive immune responses and vice versa [22, 23, 24]. This effect is known as the immune-brain loop.

In a related pioneering prostate cancer study [25], Yang and team discovered that when we encounter empathy in our doctors, it increases our natural killer cell immunity. Similarly Yang's team also found a lack of empathy was associated with a reduction of natural killer cells and negative emotions such as stigma, anxiety and a lack of self efficiency. Insurance companies take note: it appears that

the empathy our physicians show us is related to our health outcomes.

Stanford Hospital Stem Cell Transplants

Closely related to Yang's work and to the Rescuing Hug is another story about a Japanese compassion therapy called Jin Shin Jyutsu, or psychophysiophilosophy [26]. Jin Shin Jyutsu is an ancient healing art from Japan founded on the idea that if you *help the body smile*, you help the natural healing process. By harmonizing negative emotions that impede our body's innate healing capacity, it supports our body's natural healing ability. I saw how effective this approach was with my own eyes from working with patients in a variety of challenging health situations including stroke recovery, advanced cancer and multiple heart surgeries.

These next two paragraphs involve details of an invasive medical scenario. You may wish to skip to the next paragraph.

At Stanford Hospital's stem cell transplant unit I organized and worked as part of a team of psychophysiology practitioners (Jin Shin Jyutsu) with patients who were undergoing bone marrow stem cell transplants. This is a grueling, lengthy, and invasive medical process that begins with radiation and chemotherapy. It involves destroying existing bone marrow and then "rebooting" the bone marrow, as well as every other kind of cell in the body, with a new stem cell infusion, often drawn from the patient's own body. At the time, the mortality rate of this procedure was anywhere from 50 to 70 percent.

Patients receiving the compassion centered therapy twice daily experienced fewer fevers and side effects, used less pain medication, smiled more, and reduced their length of hospital stay on average by twenty-one days [27, 26]. One patient left the hospital without the need for a home caregiver. As with the Rescuing Hug, these experiences with compassion centered therapies show us how important compassion is to the process of human healing. It also shows that because each person's emotional and mental story is unique, each person's path to healing is unique. It is not a one size fits all production line activity.

Negativity - Your Health on Stilts

In addition to documenting the physical impact of positive emotions, the effects of negative emotions are also well documented. What you find is that negative emotions such as anger, aggression, hatred and so on, put our health in a precarious perch: negative emotions have the opposite impact on us that kindness does. For example, psychosocial stressors affect brain glucose metabolism [28], something that exacerbates many brain diseases [29]. A stressful relationship also has an impact on our healing process. Research by Karen Grewen at the University of North Carolina established a connection between warm relationships and positive cardiac health [30, 20, 21].

Soon after Grewen's early work was published, neuroendocrinology researchers found a correlation between wound healing and positive social relations. Initially working with hamsters, Ohio State researchers DeVries,

Craft, Kiecolt-Glaser and others, found acute stress levels in the hamsters (as measured by cortisol levels in plasma) as a result of social isolation [31, 21]. In the wound healing study, the hamsters that were paired with siblings healed at twice the rate. "These animals also produced less of the stress hormone cortisol than unpaired hamsters" [32, 31]. Kiecolt-Glaser and team found related results in human studies: hostile marital relationships resulted in delayed wound healing [33]. It would appear that social relationships in both humans and animals modulate our stress responses and therefore are key to our body's healthy healing response.

In particular, in the studies by Devries and team at Ohio State on social modulation of stress response, they found that social relationships which are enforced by displays of aggression are negatively associated with a healing response. Conversely, they found that where social relationships kept together through high levels of pro-social behavior have improved health outcomes. This research received the international Curt P. Richter award in psychoneuroendocrinology [31]. In a related study on empathy between physicians and patients, women with acute myocardial infarction, i.e., heart attacks, have a greater survival rate with same-sex physicians [34].

For the many people who feel stuck in various kinds of toxic situations, there is hope. Kindness meditation (also known as "insight" or "mindfulness") can help. The effects of kindness-centered meditation extend to our neuroendocrine, immune and behavioral reactions to psychosocial stress [35]. This explains why we crave

trusting, loving relationships, including those with our pets. The bottom line is this: A steady and predictable source of love and affection insulates us from harm, inside and out. There is much more research like this, but due to space limitations it is impossible to include it all here.

The Twitter (X) Study

So far, the research discussed here shows the impacts of real and concrete social settings but similar observations have been found to occur when we are on social media. For example, analysis on hate speech show it is worse for cardiovascular health than smoking. Researcher J.C. Eichstaedt and team looked at Twitter (now called X) language patterns in a large-scale study (country-level) [36]. They discovered that negative language patterns used on Twitter (X) are a significant predictor of age-adjusted mortality in atherosclerotic heart disease. The predictor is more than ten other well-known risk factors, such as smoking, obesity, and high blood pressure. The Twitter (X) study further showed that positive emotions and engagements appear protective even online.

Up Next: In the next chapter, we discover there is so much more to know about love and compassion as we dive deep into the world of oxytocin. It is not what we thought.

REFERENCES FOR CHAPTER 4

[1] McDonald, C. 1997. Miracle babies. *Worcester Telegram & Gazette*.21 December.

[2] Townsend, L. 2001. Premature twins thrive with a Rescuing Hug. Cal State University Northridge. https://www.csun.edu/~vcoa00el/webct/de361s52_folder/tactilepower.html

[3] Piper, W. and Saturn, S. 2016. Social neuropeptides and behavior. *Encyclopedia of Mental Health, Second Edition*. 184-188. Ed. Friedman, H. Academic Press. 10.1016/B978-0-12-397045-9.00046-X.

[4] Leo, C. , Sabina, S., Tumolo, M., Bodini, A., Ponzini, G., Sabato, E. and Mincarone, P. 2021. Burnout among healthcare workers in the COVID 19 era: a review of the existing literature. *Frontiers in Public Health*. 9:750529. https://doi.org/10.3389/fpubh.2021.750529

[5] Tan, B., Kanneganti, A., Lim, L., Tan, M., Chua, Y., Tan, L., Sia, C., Denning, M., Goh, E., Purkayastha, S., Kinross, J., Sim, K., Chan, Y. and Ooi, S. 2020. Burnout and associated factors among health care workers in Singapore during the COVID-19 pandemic. *J. American Med. Dir. Assoc*. 21(12):1751–1758.e5. https://doi.org/10.1016/j.jamda.2020.09.035

[6] Weingartner, L., Sawning, S., Shaw, M. and Klein, J. 2019. Compassion cultivation training promotes medical student wellness and enhanced clinical care. *BMC Medical Education*. 19(1):139. doi: 10.1186/s12909-019-1546-6.

[7] Asl, E., Boostani, H., Behrouzian, F. and Rostami, H. 2021. The mediating role of compassion in the relationship between COVID-19 anxiety syndrome and COVID-19 burnout. *Journal of Education and Health Promotion*. 10:413.

[8] Godara, M., Silveira, S., Matthäus, H., Heim, C., Voelkle, M., Hecht, M., Binder, E. and Singer, T. 2021. Investigating differential effects of socio-emotional and mindfulness-based online interventions on mental health, resilience and social capacities during the COVID-19 pandemic: The study protocol. *PLoS One*. 16(11):e0256323. doi: 10.1371/journal.pone.0256323.

[9] Fronsdale, G. 2023. *Mindful speaking*. Insight Meditation Center. https://www.insightmeditationcenter.org

[10] Pérez-Chacón, M., Chacón, A., Borda-Mas, M. and Avargues-Navarro, M.. 2021. Sensory processing sensitivity and compassion satisfaction as risk/protective factors from burnout and compassion fatigue in healthcare and education professionals. *International Journal of Environmental Research and Public Health*. 18(2): 611. https://doi.org/10.3390/ijerph18020611

[11] Grandi, A., Zito, M., Sist, L., Martoni, M., Russo, V. and Colombo, L.. 2022. Wellbeing in workers during COVID-19 pandemic: the mediating role of self-compassion in the relationship between personal resources and exhaustion. *Int J Environ Res Public Health*. 19(3):1714. doi: 10.3390/ijerph19031714.

[12] Saarinen, A., Keltikangas-Järvinen, L., Viding, E., Dobewall, H., Kaseva, K., Lehtimäki, T., Raitakari, O. and Hintsanen, M. 2021. Compassion protects against vital exhaustion and negative emotionality. *Motivation and Emotion*. 45(4):506-517. doi: 10.1007/s11031-021-09878-2.

[13] Cousineau, T., Hobbs, L. and Arthur, K. 2019. The role of compassion and mindfulness in building parental resilience when caring for children with chronic conditions: a conceptual model. *Front Psychol*. 10:1602. doi: 10.3389/fpsyg.2019.01602.

[14] Heym, N., Heasman, B., Hunter, K., Blanco, S., Wang, G., Siegert, R., Cleare, A., Gibson, G., Kumari, V. and Sumich, A. 2019. The role of microbiota and inflammation in self-judgement and empathy: implications for understanding the brain-gut-microbiome axis in depression. *Psychopharmacology Berlin*. 236(5):1459-1470. doi: 10.1007/s00213-019-05230-2.

[15] Fogarty, L., Curbow, B., Wingard, J., McDonnell, K. and Somerfield, M. 1999. Can 40 seconds of compassion reduce patient anxiety? *Journal of Clinical Oncology*. 17:371-379.

[16] Wager, T., Davidson, M., Hughes, B., Lindquist, M. and Ochsner, K. 2008. Prefrontal-subcortical pathways mediating successful emotion regulation. *Neuron*. 50:1037-1050.

[17] Sahi, R., Dieffenbach, M., Gan, S., Lee, M., Hazlett, L., Burns, S., Lieberman, M., Shamay-Tsoory, S. and Eisenberger, N. 2021. The comfort in touch: immediate and lasting effects of handholding on emotional pain. *PLoS One*. 16(2):e0246753. doi: 10.1371/journal.pone.0246753.

[18] Filippa, M., Monaci, M., Spagnuolo, C., Serravalle, P., Daniele, R. and Grandjean, D. 2021. Maternal speech decreases pain scores and increases oxytocin levels in preterm infants during painful procedures. *Science*. 11(1):17301. doi: 10.1038/s41598-021-96840-4.

[19] Meaney, Michael. 2001. Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annual Review of Neuroscience*. 24:1161–92. doi:10.1146/annurev.neuro.24.1.1161

[20] Grewen, K., Girdler, S., Amico, J. and Light, K. 2005. Effects of partner support on resting oxytocin, cortisol, norepinephrine, and blood pressure before and after warm partner contact. *Psychosomatic Medicine*. *67*(4):531–538. https://doi.org/10.1097/01.psy.0000170341.88395.47

[21] Grewen, K. and Light K. 2011. Plasma oxytocin is related to lower cardiovascular and sympathetic reactivity to stress. *Biological Psychology*. *87*(3):340–349. 10.1016/j.biopsycho.2011.04.003

[22] Azar, B.. 2001. A new take on psychoneuroimmunology. *Monitor on Psychology*. 32: 34–36.

[23] Boomershine, C., Wang, T., and Zwilling, B. 2001. Neuroendocrine regulation of macrophage and neutrophil function. In Ader, R., Felten, D. and Cohen, N. *Psychoneuroimmunology*, *3rd Ed.* (Eds.) Academic Press. Cambridge, USA. 289–300.

[24] Davidson, R., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S., Urbanowski, F., Harrington, A., Bonus, K. and Sheridan, J. 2003. Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine*. 65(4): 564–570.

[25] Yang, N., Xiao, H., Wang, W., Li, S., Yan, H., and Wang, Y. 2018. Effects of doctors' empathy abilities on the cellular immunity of patients with advanced prostate cancer treated by orchiectomy: the mediating role of patients' stigma, self-efficacy, and anxiety. *Patient Preference and Adherence*. 12*:* 1305–1314.

[26] Mason, C. and Mason, E. 2009. Haptic medicine. *Studies in Health Technology and Informatics*. 149: 368–85. Pub.Med. PMID19745495.

[27] Shannon, A. 2002. Jin Shin Jyutsu outcomes in a patient with multiple myeloma. *Alternative Therapies* 8: 128.

[28] Kern, S., Oakes, T., Stone, C., McAuliff, E., Kirschbaum, C. and Davidson, R. 2008. Glucose metabolic changes in the prefrontal cortex are associated with HPA axis response to a psychosocial stressor. *Psychoneuroendocrinology*. 33: 517–29.

[29] Mergenthaler, P., Lindauer, U., Dienel, G. and Meisel, A. 2013. Sugar for the brain: the role of glucose in physiological and pathological brain function. *Trends in Neuroscience*. 36(10):587-597. doi:10.1016/j.tins.2013.07.001.

[30] Grewen, K., Anderson, B., Girdler, S., and Light, K.. 2003. Warm partner contact is related to lower cardiovascular reactivity. *Behavioral Medicine*. 29: 123–30.

[31] DeVries, C., Craft, T., Glasper, E., Neigh, G. and Alexander, J. 2007. Curt P Richter award winner: social influences on stress responses and health. *Psychoneuroendocrinology*. 32: 587–603.

[32] Gouin, J. and Kiecolt-Glaser, J. 2011. The impact of psychological stress on wound healing: methods and mechanisms. *Immunology and Allergy Clinics of North America*. 31(1): 81–93. https://doi.org/10.1016/j.iac.2010.09.010

[33] Kiecolt-Glaser, J., Loving, T., Stowell, J., Malarkey, W., Lemeshow, S., Dickinson, S. and Glaser, R.. 2005. Hostile marital interactions, proinflammatory cytokine production, and wound healing. *Archives of General Psychiatry*. 62: 1377–84.

[34] Greenwood, B., Carnahan, S. and Huang, L. 2018. Patient–physician gender concordance and increased mortality among female heart attack patients. *Proceedings of the National Academy of Sciences*. 115(34)*:*8569-8574 https://doi.org/10.1073/pnas.1800097115

[35] Pace, T., Negi, L., Adame, D., Cole, S., Sivilli, T., Brown, T., Issa, M., and Raison, C. 2009. Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. *Psychoneuroendocrinology*. 34(1): 87–98. https://doi.org/10.1016/j.psyneuen.2008.08.011

[36] Eichstaedt, J., Schwartz, H., Kern, M., Park, G., Darwin, L., Merchant, R., Jha, S., Agrawal, M., Dziurzynski., L., Sap, M., Weeg, C., Larson, E., Ungar, L. and Seligman, M. 2015. Psychological language on twitter predicts county-level heart disease. *Psychological Science* 26: 159–69.

Chapter 5

OXYTOCIN: NEUROTRANSMITTER, CATALYST, CARDIOVASCULAR HORMONE

It is impossible for a man to learn what he thinks he already knows.
Epictetus

This chapter explains the transformative research on oxytocin (OXY) that is shattering established beliefs across all areas of medicine. OXY is now recognized to positively impact almost every aspect of medical research from brain science and cardiology to our immune system and metabolism. The supportive conditions for its healthy secretion and absorption involve love, kindness and compassion. As you will learn in this chapter, this happens not just as infants or children, but all of our lives.

These breakthroughs alter our understanding of the importance that kindness, compassion, and love play in human health and survival. While there are many other body secretions to consider, OXY has been the most investigated in the past few decades not only because of a tsunami of surprising anatomical discoveries but also because, the prevailing beliefs we have held about for over 100 years have now turned out to be dead wrong. There are not just one or two isolated discoveries, but hundreds. You will learn about some of the key discoveries in this chapter, but they are only representative of this new frontier in knowledge. In the last 5 years more than 500 articles with the word oxytocin in their title have been published on the National Library of Medicine website.

First the chapter discusses some of the fresh medical understandings of the nature and function of OXY. The

remainder and the bulk of the chapter then documents how specific organs, such as the brain, heart, skin, etc., and body processes, like our immune and thermal regulation, secure their healthy functioning through socioemotional behaviors that are now documented to produce and absorb this liquid gold. These findings are crucial to our lives because they show us that our social and emotional environments affect us more than we first thought. When you bring them together with bioplasticity and machine rub off they show the need to create technology that considers and supports us in this way, because it impacts our emotional and social environment.

A Fresh Look At Oxytocin

Most of us have heard about oxytocin (OXY). The name "oxytocin" literally means "rapid birth" [1]. For more than a century, it was believed to be a hormone whose function was limited to women's reproduction. This idea has now been thoroughly debunked. In fact, oxytocin acts as both hormone and neurotransmitter with receptor sites throughout the body and nervous system.

Oxytocin is the captain regulator and influencer of a body wide collection of *systems,* including thermal regulation, fluid balance, pain thresholds, glucose metabolism and digestion, bone formation, blood pressure, cardiovascular health, social bonding and care giving. Initially it was believed to be restricted to functions related only to child birthing and feeding, and that it was only found in the pituitary gland and womb. As the first hormone

discovered in 1906, this belief held until the discovery and mapping of neuropeptides during "The Decade of the Brain" research [2, 3]. The neuropeptide mapping has had a significant scientific impact, much like that of human genome mapping.

An especially significant finding was the discovery of neuropeptide receptor sites for oxytocin (OXYR). Receptor sites for oxytocin were found throughout our entire body, including in the heart, skin, kidneys, glands, etc. Consequently, the discovery of all these different sites for OXYR means it is not just a birthing hormone, as was long believed. Its effects are systemic and even some of its fragments can act as a catalyst both directly and indirectly for many of the body processes, crossing the blood brain barrier [4].

In addition to these receptor sites, new creation sites for oxytocin have also been discovered in the heart [5, 6], the skin [7, 8] and numerous other places in the body. Furthermore, OXY creation and receptor sites are often co-located in the same, explaining its ability to have local effects in those areas.

Under My Skin

These discoveries give medical and human science researchers a deeper understanding of the significance and vastly expanded range of impacts the oxytocin system has on maintaining health. For instance, our understanding of the skin has changed dramatically. Figure 5.1 shows a cross section of skin similar to the ones portrayed on a website for skin cancer and hospitals such as the Cleveland Clinic, Johns

Hopkins, and so on. This is a common portrayal of skin anatomy that is widely recognized. Now look at a cross section of the skin in Figure 5.2 which shows more recent discoveries of the skin that allow us to zoom in around the

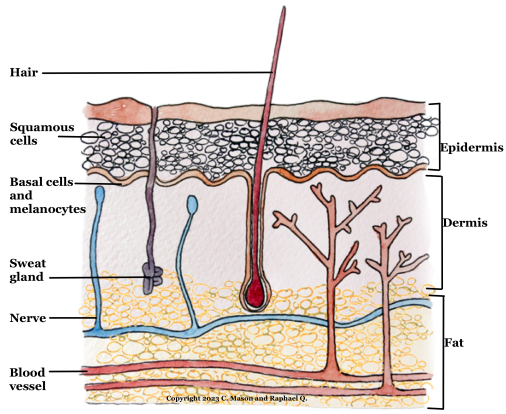


Figure 5.1 A widely used skin cross section in 2023. Illustration: C. Mason and Raphael Q.

oxytocin. It appears *very* different from the skin shown in Figure 5.1. You can see there are a variety of immune cells, including stem cells, as well as generators and receivers for the OXY neuropeptide. The density and distribution of these cells vary depending on the location in the body, but as you can see in the image, the cells that generate OXY lie near many different kinds of immune cells, such as macrophages,

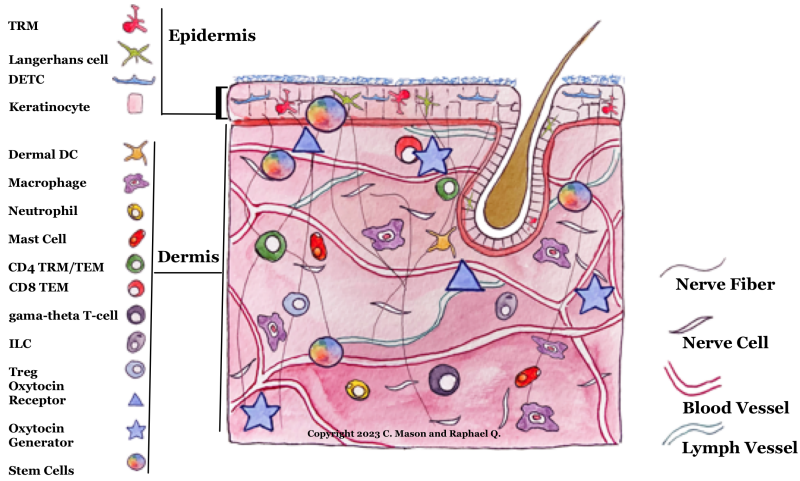


Figure 5.2. Updated cross section of skin shows important new cells discovered. Illustration: C. Mason and Raphael Q.

neutrophils, mast cells, and T-cells, as well as our lymph,blood and nerves. The discovery of these new details of the skin is largely due to the work of pioneering virologists and cancer researchers looking to find the link between our exposure to the sun, our immunity and skin cancer [9].

Similarly, OXY receptor cells lie close to immune cells, lymph, blood and nerves. In effect, the influence OXY exerts on our bodies from the skin is not only local but distal, reaching across the body far from where we are touched.

Figure 5.2 is a particularly interesting image because it can help explain how a 3000-year-old healing art called acupressure, as well as many other forms of compassionate

touch therapies, work. While touch therapies have been helpful to people for centuries, it is only through these new discoveries that they can be explained from a western science perspective. OXY's influence on our social lives could also be explained this way because many expressions of love, sex, kindness and compassion occur through touch.

In addition to mapping the variety and locations of our neuropeptide generators and receptor sites, neuroscientists have also been studying oxytocin's pharmaceutical action in the brain. The initial goal of the neuropeptide mapping studies was to uncover the region in the brain associated with addiction. Although a specific location for addiction was never found, in the process of hunting for it, the neuroscientists discovered many other surprising things. For example, the regions of the brain where our emotions live are super loaded with receptor sites for the OXY neuropeptide [10, 3]. This area of the brain lights up like a neon sign in the presence of compassion and other positive emotions. In effect, such positive emotions are vital to us.

Now What?

While there is still more to discover about the complex interactions among various other neurohormones and peptides, what we have learned at this point is extremely valuable to us. For example, some of the studies in this chapter show that oxytocin buffers us from exhaustion and mental stress. It increases our capacity for resilience and squashes the psychological and physical effects of stress. This is important because too much stress exacerbates many

disease processes. A number of factors can inhibit oxytocin release, such as aggression and chronic or acute stress. How does this happen?

According to research at Colorado State, oxytocin neurons are repressed by catecholamine, a substance released from the adrenal gland in response to many types of stress, including fright [11].

This brings us to a fundamental question: Is it possible to develop technology to help support this aspect of ourselves? The answer is: Absolutely. And as we enter a new era of lengthy crewed space travel, where people will be socially isolated for extended periods of time, e.g., NASA's project Artemis, such tools can be used in space to reduce stress and support us psychologically and physically. Because we know that our tools rub off on us, we can use this rub off to our advantage by designing technology with these new oxytocin discoveries in mind.

Your Body On Oxytocin

The key medical discoveries around oxytocin are described in the remaining sections of this chapter. As much as possible, the work is grouped together around body functions, although many of the discoveries relate to multiple body functions. Each section summarizes the work in that area.

The Heart

The heart is truly one of the most remarkable areas of research when it comes to love and compassion. Two

scientists named Gutkowska and Jankowski (as well as others) have uncovered the fact that the heart not only has receptors for the OXY neuropeptide but it also *generates* oxytocin [5,6]. So in addition to OXY being a neurohormone, it is now also seen as a cardiovascular hormone. So far, their research shows it is generated in the aorta and the vena cava.

Oxytocin has been shown to regenerate damaged heart tissue [12]. It also plays a helpful role in reducing the size of a cardiomyopathy and in our recovery [13, 12]. Oxytocin has also been demonstrated to decrease blood pressure [14]. So how do we cultivate it? Where is the social and psychological link?

When we give, receive, or witness love or compassion we create oxytocin, and it is both created and utilized in the heart [15]. Typically, we secrete oxytocin through the experience of positive social and emotional connections with behaviors such as compassion, tenderness and kindness. Heart surgeon, Dean Ornish has written widely on this aspect of heart health in his book, *Love and Survival.* The book documents his expanded experiences of the heart following his own cardiac incident [16]. His words of wisdom parallel what the scientists have also seen.

"Anything that promotes feelings of love and intimacy is healing; anything that promotes isolation, separation, loneliness, loss, hostility, anger, cynicism, depression, alienation, and related feelings often leads to suffering, disease, and premature death from all causes." [16]

Dean Ornish, M.D.
Love and Survival

Resilience and Stress

One of the most important things that has been discovered is that there is a relationship between stress, resilience and compassion. What do stress and resilience have to do with compassion? The first thing to know is that the amount of cortisol in our blood can be used to gauge how stressed we are. Cortisol is a key catalyst in the chemistry of stress. Oxytocin, the crucial catalyst of numerous bodily functions produced in the presence of love and kindness, "cancels out" cortisol[17, 18, 19, 20, 21]. So the antidote to stress is love and kindness. This discovery is huge.

Stress makes just about everything seem worse, and it is related to our disease processes. Recently, studies have linked psychological stress to the initial stage of cancer [22], lowered cardiovascular response [23], resilience of our skin's protective barrier [24] and even the blood brain barrier [25]. If oxytocin can counter the effects of stress, then we need to be sure to support this aspect of ourselves in the devices we are spending so much time with.

Positive social and psychological interactions also create more oxytocin. This creates a buffer against the effects of stress and cortisol, helping us to be more resilient, improving our happiness in life, and strengthening the quality of our relationships. In a world where we are constantly surrounded by technology, we can use our tools not just to do our jobs and send texts but also to increase the positive emotional support in our lives. It is especially important for mental health when positive emotional support is scarce or not available.

A great low-tech example of this is a project to emotionally support new mothers. Using mobile messages of support and positive encouragement it helps reduce the experience of isolation, depression, and a lack of family or other support [26]. Creating technology so that it reduces rather than causes stress is a huge win.

Cognition and The Brain

Many of us know from personal experience that stressful emotions affect our memory, but now science can explain it. Fear impacts memory retrieval and stress affects our ability to focus our attention [15, 27]. In two separate research studies, one led by Micheal Meaney at McGill University and the other by Lin and team at National Cheng Kung University, oxytocin was proven to help not only because it squashes stress and neutralizes the effects of fear, but also because it stimulates the creation of new neurons (neurogenesis) in the hippocampus, a region of the brain known to be where new memories are formed [28, 29].

In our cognitive processes, research by both the Guastella and the Wagner teams showed positive emotions associated with oxytocin play a role both in social memories and facial recognition [30, 31]. Oxytocin can also help the diseased mind. Significantly, Fisher and team showed that positive emotions associated with oxytocin help with the executive function of the brain in individuals with Huntington's disease [32]. Positive social and emotional experiences can even affect brain structure. Using MRI, Klemecki and team showed positive changes in brain tissue when individuals were trained to cultivate compassion [33].

Using fMRI, Wignton showed a reduction in amelioration using positive affect training to increase oxytocin [34].

Immunity, Nerves and Psychology

There is a complex interaction between our psychological experiences, our nervous system, and our immune system. This is sometimes called the brain-mind-immune loop. Oxytocin is important to our immune system because it has a direct impact on our defense against viruses. This was shown in studies involving the 3 most important inflammatory cytokines that happen during an infection: IL-6, IL-1 beta and TNF-alpha [35, 36, 37]. Oxytocin *also* controls the regulation of immune system functions associated with the thymus gland, B and T cells, bone marrow, and even wound healing [38, 5, 39, 40, 41].

However, when we are chronically or acutely under stress, including psychological stress, the immune system can be repressed due to the action of cortisol [42, 43]. During chronic or sudden, acute stress, cortisol is expressed by the adrenals and adversely impacts oxytocin production. If the rise in cortisol is not countered with oxytocin by means of compassion, affection, rest, or other care, the effects of chronic or acute stress injure our immune response. Our nervous system evolved to handle stress, but not without periods of relief. If stress is chronic or acute and there is little (or no) opportunity to recover between stressful events, eventually our bodies and our adrenals grow tired, setting the scene for disease [44, 45].

Glucose Metabolism

In fact, medical researchers Kern and team showed that psychosocial stressors affect brain glucose metabolism [46]. The impact of stress also affects the body's neuroendocrine system and our ability to keep blood sugar stable [47, 48]. This is important because many brain disorders are caused by the disruption of normal brain glucose metabolism [49]. Importantly, in a study involving pregnant Hispanic women, perceived psychosocial stress was correlated with glucose intolerance [50]. In general, psychosocial stress was seen to be a predictor of abnormal glucose metabolism, obesity and disability [51]. By contrast, in a study reported in JAMA, the Journal of the American Medical Association, it was found that women in high-quality marriages are at lower risk of developing the metabolic syndrome [52].

Trust

Human trust plays a key role in our health and underlies all human relationships, whether in business, school, family or work [53, 54, 11]. Oxytocin also plays a role here [55, 56, 57]. The research in this area is primarily due to neuroeconomist Paul Zak, who has studied oxytocin and the neuroscience of trust [11, 58, 59]. Zak's research links oxytocin levels to healthy organizational culture and productivity. If you feel unsafe, physically or psychologically, there is an impact on our balance of stress hormones and oxytocin [57, 11, 58, 59].

Zak's neuroscience findings are backed up by corporate studies. In a project at Google, researchers set out to discover what made "the perfect team," [60]. What they found was surprising. The key factors were not the skill sets

people possessed, as they had predicted. What mattered the most was psychological safety and dependability [60, 61].

Up Next: In the next chapter we find links between music science and the amazing discoveries of Chapters 4 and 5.

REFERENCES FOR CHAPTER 5

[1] Gimpl, G., and Fahrenholz, F. 2001. The oxytocin receptor system: Structure, function, and regulation. *Phys. Reviews.* 81(2):629-683. http://physrev.physiology.org/cgi/content/full/81/2/629.

[2] Library of Congress. 1999. Project on the Decade of the Brain Research. https://www.loc.gov/loc/brain/

[3] Pert, C., Dreher, H. and Ruff, M. 1998. The psychosomatic network: foundations of mind-body medicine. *Alternative Therapy Health Medicine.* 4(4):30-41.

[4] Uvnäs Moberg, K., Handlin, L., Kendall-Tackett, K. and Petersson, M. 2019. Oxytocin is a principal hormone that exerts part of its effects by active fragments. *Medical Hypotheses.* 133:109394. ISSN 0306-9877. https://doi.org/10.1016/j.mehy.2019.109394.

[5] Gutkowska, J. and Jankowski, M. 2008. Oxytocin revisited: It is also a cardiovascular hormone. *Journal of the American Society of Hypertension.* 2 (5): 318–325.

[6] Gutkowska, J., Jankowski, M., Mukaddam-Daher, S. and McCann, S. 2000. Oxytocin is a cardiovascular hormone. *Brazilian Journal of Medical Biological Research. 33*(6):625-633. https://doi.org/10.1590/S0100-879X2000000600003.

[7] Nejati, R., Kovacic, D. and Slominski, A. 2013. Neuro-immune-endocrine functions of the skin: an overview. *Expert Rev. Dermatol.* 28(6):581-583. doi: 10.1586/17469872.2013.856690.

[8] Ramot, Y., Böhm, M. and Paus, R. 2021. Translational Neuroendocrinology of Human Skin: Concepts and Perspectives. *Trends in Molecular Medicine*. 27(1):60-74. doi: 10.1016/j.molmed.2020.09.002.

[9] Mueller, S., Zaid, A. and Carbone, F. 2014. Tissue resident t-cells dynamic players in skin immunity. Frontiers in Immunology 5 (2):332. doi:10.3389/fimmu.2014.00332

[10] Triana-Del Rio, R., Ranade, S., Guardado, J., LeDoux, J., Klann, E. and Shrestha, P. 2022. The modulation of emotional and social behaviors by oxytocin signaling in limbic network. Front Molecular Neurosci. 15:1002846. doi: 10.3389/fnmol.2022.1002846.

[11] Kosfeld, M., Heinrichs, M., Zak, P., Fischbacher, U. and Fehr, E. 2005. Oxytocin increases trust in humans. *Nature*. 435(7042):673-676.

[12] Jankowski, M., Gonzalez-Reyes, A., Noiseux, N. and Gutkowska, J. 2012. Oxytocin in heart regeneration. *Recent Patents on Cardiovascular Drug Discovery*. 7 (2):81-87. DOI : 10.2174/157489012801227210

[13] Alizadeh, A. and Mirzabeglo, P. 2013. Is oxytocin a therapeutic factor for ischemic heart disease? *Peptides*. *45*: 66-72. https://doi.org/10.1016/j.peptides.2013.04.016

[14] Petersson, M., Lundeberg, T. and Uvnas-Moberg, K. 1997. Oxytocin decreases blood pressure in male but not in female spontaneously hypertensive rats. *Journal of the Autonomic Nervous System*. *66*:15-18.

[15] Baldi, E., Costa, A., Rani, B., Passani, M., Blandina, P., Romano, A. and Provensi, G. 2021. Oxytocin and fear memory extinction: possible implications for the therapy of fear disorders? *International Journal of Molecular Science*. 22 (18):10000. doi: 10.3390/ijms221810000.

[16] Ornish, D. 1998. *Love and Survival*. Harper Collins Publishers. New York, USA.

[17] Kirschbaum, C., Wolf, O., May, M., Wippich, W. and Hellhammer, D. 1996. Stress- and Treatment-induced Elevations of Cortisol Levels Associated with Impaired Declarative Memory in Healthy Adults. *Life Sciences*. 58:1475–83.

[18] Quirin, M., Kuhl, J. and Düsing, R. 2011. Oxytocin Buffers Cortisol Responses to Stress in individuals with impaired Emotion Regulation Abilities. *Psychoneuroendocrinology*. 36: 898–904.

[19] Smith, A and Wang, Z. 2014. Hypothalamic oxytocin mediates social buffering of the stress response. *Biological Psychiatry*. 76: 281–88.

[20] Uvnas-Moberg, K. and Maria, P. 2005. Oxytocin, a mediator of anti-stress, well-being, social interaction, growth, and healing. *Zeitschrift fur Psychosomatische Medizin und Psychotherapie*. 51: 57–80.

[21] Uvnäs-Moberg, K. 1998. Antistress Pattern Induced by Oxytocin. *Physiology*. 22:25. https://doi.org/10.1152/physiologyonline.1998.13.1.22

[22] Falcinelli, M., Thaker, P., Lutgendorf, S., Flaherty, R., Conzen, S. and Flint, M. 2021. The role of psychologic stress in cancer initiation:

clinical relevance and potential molecular mechanisms. *Cancer Research*. 81(20): 5131-5140. doi:10.1158/0008-5472.CAN-21-0684

[23]Grewen, K. and Light, K. 2011. Plasma oxytocin is related to lower cardiovascular and sympathetic reactivity to stress. *Biological Psychology*. 87(3):340–349. 10.1016/j.biopsycho.2011.04.003

[24] Choe, S., Kim, D., Kim, E., Ahn, J., Choi, E., Son, E., Lee, T. and Choi, E. 2018. Psychological stress deteriorates skin barrier function by activating 11β-hydroxysteroid dehydrogenase 1 and the HPA axis. *Scientific Reports*. 8(1): 6334. https://doi.org/10.1038/s41598-018-24653-z

[25] Kertser, A., Baruch, K., Deczkowska, A., Weiner, A., Croese, T., Kenigsbuch, M., Cooper, I., Tsoory, M., Ben-Hamo, S., Amit, I., and Schwartz, M. 2019. Corticosteroid signaling at the brain-immune interface impedes coping with severe psychological stress. *Science Advances*. 5 (5):eaav4111. https://doi.org/10.1126/sciadv.aav4111

[26] Trude, A., Martins, R. C., Martins-Silva, T., Blumenberg, C., Carpena, M. X., Del-Ponte, B. and Loret de Mola, C. 2021. A whatsapp-based intervention to improve maternal social support and maternal-child health in southern Brazil: the Text-message Intervention to Enhance Social support (TIES) feasibility study. *Inquiry : A Journal of Medical Care Organization, Provision and Financing*. 58. 469580211048701. https://doi.org/10.1177/00469580211048701.

[27] Young-Kuchenbecker, S., Pressman, S., Celniker, J., Grewen, K., Sumida, K., Jonathan, N., Everett, B. and Slavich, G. 2021. Oxytocin, cortisol, and cognitive control during acute and naturalistic stress. *Stress*. 24(4):370-383. doi: 10.1080/10253890.2021.1876658.

[28] Lin, Y., Chen, C., Huang, C., Nishimori, K. and Hsu, K. 2017. Oxytocin stimulates hippocampal neurogenesis via oxytocin receptor expressed in CA3 pyramidal neurons. *Nature Communications*. 8(1):537. doi: 10.1038/s41467-017-00675-5.

[29] Meaney, M. 2001. Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annual Review Neuroscience*. 24:1161-92. doi: 10.1146/annurev.neuro.24.1.1161.

[30] Guastella, A., Mitchell, P. and Mathews, F. 2008. Oxytocin enhances the encoding of positive social memories in humans. *Biological Psychiatry*. 64(3):256–258. 10.1016/j.biopsych.2008.02.008.

[31] Wagner, U. and Echterhoff, G. 2018. When does oxytocin affect human memory encoding? The role of social context and individual

attachment style. *Frontiers in Human Neuroscience*. 12:349. PMID: 30294265

[32] Fisher E., Rocha N., Morales-Scheihing, D., Venna, V., Furr-Stimming, E., Teixeira, A. and Rossetti, M. 2021. The relationship between plasma oxytocin and executive functioning in huntington's disease: A pilot study. *Journal of Huntington's Disease*. 10(3):349–354. 10.3233/JHD-210467

[33] Klimecki, O., Leiberg, S., Lamm, C. and Singer, T. 2013. Functional neural plasticity and associated changes in positive affect after compassion training. *Cerebral Cortex*. 23(7):1552-61. doi: 10.1093/cercor/bhs142.

[34] Wigton R., Tracy D., Verneuil T., Johns M., White T., Michalopoulou P., Averbeck B. and Shergill S. 2022. The importance of pro-social processing, and ameliorating dysfunction in schizophrenia. An FMRI study of oxytocin. *Schizophrenia Research Cognition*. 27. 100221. 10.1016/j.scog.2021.100221

[35] Borges, A., O'Connor, J., Phillips, A., Ronsholt, F., Pett, S. and Vjecha, M. 2015. Factors associated with plasma IL-6 levels during HIV infection. *J. Infectious Disease*. 212:585–595. doi: 10.1093/infdis/jiv123

[36] Cohen, S., Tyrrell, D. and Smith, A. 1991. Psychological stress and susceptibility to the common cold. *New England Journal of Medicine*. 325(9):606-12. doi: 10.1056/NEJM199108293250903.

[37] Thakur, P., Shrivastava, R. and Shrivastava, V. 2021. Oxytocin as a Potential Adjuvant Against COVID-19 Infection. *Endocrine, Metabolic & Immune Disorders Drug Targets*. 21(7):1155–1162. https://doi.org/10.2174/1871530320666200910114259

[38] Gouin, J. and Kiecolt-Glaser, J. 2011. The impact of psychological stress on wound healing: methods and mechanisms. *Immunology and Allergy Clinics of North America*. 31(1): 81–93. https://doi.org/10.1016/j.iac.2010.09.010

[39] Sofroniew, M., Weindl, A., Schrell, U. and Wetzstein, R. 1981. Immunohistochemistry of vasopressin, oxytocin and neurophysin in the hypothalamus and extrahypothalamic regions of the human and primate brain. *Acta Histochemistry Suppl*. 24:79-95.

[40] Wang, P., Yang, H., Tian, S., Wang, L., Wang, S., Zhang, F. And Wang, Y. 2015. Oxytocin-secreting system: A major part of the neuroendocrine center regulating immunologic activity. *Journal Neuroimmunology*. *289*:152-61.

[41] Yan, T., Yao, S., Yifei, G., Xiaomeng, X., Ting, H., Jingxin, L. and Chuanyong, L. 2019. Oxytocin system alleviates intestinal inflammation by regulating macrophages polarization in experimental colitis. *Clinical Science*. 133(18):1977–1992. doi: https://doi.org/10.1042/CS20190756

[42] Janicki-Deverts, D., Cohen, S., Turner, R. and Doyle W. 2016. Basal salivary cortisol secretion and susceptibility to upper respiratory infection. *Brain Behavior and Immunity*. 53:255-261.

[43] Li, T., Wang, P., Wang, S. and Wang, Y. 2017. Approaches mediating oxytocin regulation of the immune system. *Frontiers in Immunology*. *7:*693. https://doi.org/10.3389/fimmu.2016.00693

[44] Uvnas-Moberg, K., Handlin, L. and Petersson, M. 2015. Self-soothing behaviors with particular reference to oxytocin release induced by non-noxious sensory stimulation. *Frontiers in Psychology*. 1:1529. doi: 10.3389/fpsyg.2014.01529.

[45] Zefferino R., DiGioia, S. and Conese, M. 2021. Molecular links between endocrine, nervous and immune system during chronic stress. *Brain Behavior*. 11(2):e01960. doi: 10.1002/brb3.1960.

[46] Kern, S., Oakes, R., Stone, K., McAuliff, M., Kirschbaum, C. and Davidson, R. J. 2008. Glucose metabolic changes in the prefrontal cortex are associated with HPA axis response to a psychosocial stressor. *Psychoneuroendocrinology*. 33(4):517–529. https://doi.org/10.1016/j.psyneuen.2008.01.010

[47] Lawson, E., Olszewski, P., Weller, A. and Blevins, J. 2020. The role of oxytocin in regulation of appetitive behaviour, body weight and glucose homeostasis. *J. Neuroendocrinology*. 32(4):e12805. doi: 10.1111/jne.12805.

[48] Wiesli, P., Schmid, C., Kerwer,O., Nigg-Koch, C., Klaghofer, R., Seifert, B., Giatgen, A., Spinas, G. and Schwegler, K. 2005. Acute psychological stress affects glucose concentrations in patients with Type 1 diabetes following food intake but not in the fasting state. *Diabetes Care*. 28 (8): 1910–1915. https://doi.org/10.2337/diacare.28.8.1910

[49] Mergenthaler, P., Lindauer, U., Dienel, A., and Meisel, A. 2013. Sugar for the brain: the role of glucose in physiological and pathological brain function. *Trends in Neurosciences*. 36 (10):587–597. https://doi.org/10.1016/j.tins.2013.07.001

[50] Silveira, M., Whitcomb, B., Pekow, P., Braun, B., Markenson, G., Dole, N., Manson, J., Solomon, C., Carbone, E. and Chasan-Taber, L. 2014. Perceived psychosocial stress and glucose intolerance among

pregnant Hispanic women. *Diabetes Metab.* 40 (6):466-75. doi: 10.1016/j.diabet.2014.05.002.

[51] Williams, E., Magliano, D., Tapp, R., Oldenburg, B. and Shaw, J. 2013. Psychosocial stress predicts abnormal glucose metabolism. *Annals of Behavioral Medicine*. 46(1):62–72. https://doi.org/10.1007/s12160-013-9473-y

[52] Troxel, W., Matthews, K., Gallo, L. and Kuller, L. 2005. Marital quality and occurrence of the metabolic syndrome in women. *Archives in Internal Medicine*. 165 (9):1022–1027. doi:10.1001/archinte.165.9.1022

[53] Edmondson, A. and Bransby., D. 2023. Psychological safety comes of age:observed themes in an established literature. *Annual Review of Organizational Psychology and Organizational Behavior*. 1(10): 55–78.

[54] Jenson, M. 2010. *Moral markets: The Critical Role of Values in the Economy*. Princeton University Press. Princeton, USA.

[55] Delgado, M. 2008. To trust or not to trust: ask oxytocin. *Scientific American Mind and Brain*. July. https://www.scientificamerican.com/article/to-trust-or-not-to-trust/

[56] Fuxe, K., Borroto-Escuela, D., Romero-Fernandez, W., Ciruela, F., Manger, P., Leo, G., Díaz-Cabiale, Z. and Agnati, L. 2012. On the role of volume transmission and receptor-receptor interactions in social behaviour. *Brain Research*. 1476:119-31. doi: 10.1016/j.brainres.2012.01.062

[57] Kennedy, J. 2020. Why Your Brain Needs to Feel More Trust. Psychology Today. https://www.psychologytoday.com/us/blog/brain-reboot/202011/why-your-brain-needs-feel-more-trust

[58] Zak, P., Kurzban, R. and Matzner, W. 2004. The neurobiology of trust. *Annals of the New York Academy of Science*. 1032:224-227.

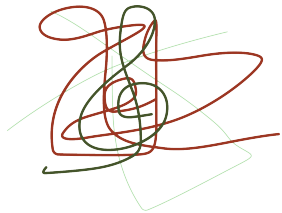
[59] Zak, P. 2017. The neuroscience of trust. *Harvard Bus. Rev.* 95 (1):84-90

[60] Duhigg, C. 2016. What Google learned from its quest to build the perfect team. *The New York Times Magazine*. February.

[61] reWork. 2023. Tool: Foster psychological safety.https://rework.withgoogle.com/guides/understanding-team-effectiveness/steps/foster-psychological-safety/

Chapter 6

MUSIC SCIENCE



It would be impossible to talk about emotion without including music, so this chapter is about the science of music. As humans we are already aware of the power of words and sound. But music is another soft superpower. It can make us smile, cry or want to dance. It can soothe a broken heart, raise our spirits, and transport us to times gone by. Today, something unusual and remarkable is happening with music because scientists have begun to understand the biological effects of music.

Using brain scans and clinical trials, *music scientists* have discovered that the music we listen to triggers biological changes in us along the same neural channels as our natural emotions. As we learned in earlier chapters on the MRE, our emotions make a tremendous impact on health. Although the idea of music is not mentioned in these three decades of MRE discoveries, it belongs there because music is both emotional and social. While music science is still in its infancy, there is believed to be a link between the neurobiology of oxytocin and our experience of music [1]. One can't help but consider what it would mean if we partnered music science with what we have learned from the

Medical Renaissance of Emotion. And when we consider the phenomena of bioplasticity, we realize what a very potent medical tool it can be.

The discoveries in the musical sciences show a striking correlation to the biophysical discoveries of emotion (described in Chapters 4 and 5). Although music and our natural socio-emotional lives are two distinct kinds of experiences in life, they impact common locations of neural tissue and brain functionality. Understandably, this is an exciting and hot new research area in music science. although so far, modern medicine has shown comparatively limited investigations into this avenue of health.

"Music does evoke a sense of wonder and awe for lots of people. Some of it is still mysterious to us. But what we can talk about are some neural circuits or networks involved in the experience of pleasure and reward. It modulates levels of dopamine, as well as opioids in the brain. Your brain makes opioids."[2]

Daniel Levitin
Neuroscientist at McGill University

After exploring the discoveries of the MRE, it seems reasonable to suggest that, regarding music, if the brain is affected then there are most likely bodily effects, possibly through circulating neuropeptides and hormones.

Along with these new insights in music science, an exciting new modality of healthcare has emerged called *music therapy*. Music therapy applies the scientific understanding of how music impacts us biologically to treat patients' issues, in a medical therapeutic setting. Like music science, music therapy is still in its infancy, so there is still

much is left to be discovered: how often and when to listen, what volume should the music be, when is it better to play an instrument rather than listen, and so on. Imagine if music therapy could bring the knowledge from the medical renaissance together with existing music science. Not only might there be a new way to address health concerns, music therapy could also potentially be useful in the design of technologies as a form of Artificial Compassion [3].

As humans, we instinctively know, for instance, that the right music can lighten our step and our mood, while other music can help us release deeply held feelings [4]. It is all subjective, of course. Or is it? The science of what is happening inside of us when we listen to music is slowly being revealed [5]. So far, the experts in this area believe that aside from listening to dissonance, it appears music can do no wrong. I am guessing there are exceptions to this, such as the deeply sad music of Leonard Cohen or the uncomfortable depressive emotion of Alban Berg. Modern studies are still documenting some of the specific effects of music with clinical trials and innovative diagnostics such as fMRI. They reveal new knowledge about listening to and playing music that can be useful in treating various human ailments, from depression and pain to disease.

Music and the Brain

When it comes to the brain, music is king. When listening to music, the areas of the brain associated with emotion are activated. In fact, it activates just about all of the brain. According to a report from Harvard Medicine, the only other activity shown to have such a positive influence on our brain and emotions is social activity [6].

In a study by Koelsch and team [7], there is a correlation between the areas of the brain associated or influenced by our emotions and those with music, both pleasant and unpleasant. While observing patients undergoing contrast fMRI, regions of the brain associated with processing positive emotion are activated when pleasant music is experienced.

MRI studies by Mitterschiffthaler confirm music's correlation with emotion in neuroanatomy [8]. In fact, blood oxygen is also positively correlated with pleasant music. The inverse is also true [7, 9]. When dissonant and unpleasant music was played, structures of the brain associated with processing negative emotions were activated. The activations also increase over time.

Similar to the discoveries presented earlier in the book, the link between music and emotion has broad implications for health: Mitterschiffthaler's findings suggest an emotional processing network is activated in response to music [8]. In a meta-analysis project on music's ability to alleviate pain, music therapist Dr. Lee found that music has had a significant impact not only pain's intensity but also on our vital signs and the amount of pain medicine we take [10].

In related research, Wang and team found music to be helpful in relieving pain during cardiac procedures [11]. Music has also been shown to be helpful for depression [12], improving outcomes in cancer patients (physical and psychological) [13], pre-surgery anxiety [14] and Parkinson's disease [15, 16].

The musical treasures that scientists hope to dig up, such as how the precise ways different music and styles of

listening impact us and whether learning and playing interact, will undoubtedly reveal another new world of knowledge. Before closing this subject, it is important to acknowledge that sound and music have, in fact, been used as a healing modality for hundreds, if not thousands, of years. This occurs primarily in cultures where the wisdom of traditional or ancient medicines have been preserved. At this point, it is not clear how to translate the knowledge of sound between such ancient cultural wisdom and modern medicine, although a friend of mine has been trying to do just that in India. He first had to learn Sanskrit in order to study ancient texts on this subject. What is clear is that in both ancient and modern cultures, musically induced affect is a way to impact the body's healing processes. The science of the MRE and bioplasticity phenomena may help explain how this happens.

Up Next: In the next chapter we explore machine rub off and the intentional design of social cyber worlds.

REFERENCES FOR CHAPTER 6

[1] Harvey, A. 2020. Links between the neurobiology of oxytocin and human musicality. *Frontiers in Human Neuroscience*. 14:350. doi: 10.3389/fnhum.2020.00350.

[2] Stein, R. 2023. These scientists explain the power of music to spark awe. NPR Weekly Dose of Wonder. https://www.npr.org/sections/health-shots/2023/07/29/1190374074/these-scientists-explain-the-power-of-music-to-spark-awe

[3] Mason, C. 2008. Human-level AI requires compassionate intelligence. Workshop on Meta-Cognition with the 23rd AAAI Conference on Artificial Intelligence. Chicago, USA.

[4] Bogert, B., Numminen-Kontti, T., Gold, B., Sams, M., Numminen, J., Burunat, I., Lampinen, J. and Brattico, E. 2016. Hidden sources of joy, fear, and sadness: Explicit versus implicit neural processing of musical

emotions. *Neuropsychologia*. 89:393–402.https://doi.org/10.1016/j.neuropsychologia.2016.07.005

[5] National Center for Complementary and Integrative Health. 2023. Music and Health: What You Need to Know. https://www.nccih.nih.gov/health/music-and-health-what-you-need-to-know

[6] Harvard Health. 2020. Why is Music Good For the Brain? https://www.health.harvard.edu/blog/why-is-music-good-for-the-brain-2020100721062

[7] Koelsch, S., Fritz, T., Cramon, D., Müller, K. and Friederici, A.. 2006. Investigating emotion with music: an fMRI study. *Human Brain Mapping*. 27 (3):239–250. https://doi.org/10.1002/hbm.20180

[8] Mitterschiffthaler, M., Fu, C., Dalton, J., Andrew, C. and Williams, S. 2007. A functional MRI study of happy and sad affective states induced by classical music. *Human Brain Mapping*. 28 (11):1150–1162. https://doi.org/10.1002/hbm.20337

[9] Lee, S., Han, Y. And Park, H. 2016. Neural activations of guided imagery and music in negative emotional processing: a functional MRI study. *Journal of Music Therapy*. 53(3):257–278. https://doi.org/10.1093/jmt/thw007

[10] Lee, J.. 2016. The effects of music on pain: a meta-analysis. *Journal of Music Therapy*. 53(4):430–477. https://doi.org/10.1093/jmt/thw012

[11] Wang, Y., Wei, J., Guan, X., Zhang, Y., Zhang, Y., Zhang, N., Mao, M., Du, W., Ren, Y., Shen, H. and Liu, P. 2020. Music intervention in pain relief of cardiovascular patients in cardiac procedures: a systematic review and meta-analysis. *Pain Medicine*. 21(11):3055-3065. doi: 10.1093/pm/pnaa148. PMID: 324721

[12] Aalbers, S., Fusar-Poli, L., Freeman, R., Spreen, M., Ket, J. , Vink, A., Maratos, A., Crawford, M., Chen, X. and Gold, C. 2017. Music therapy for depression. *The Cochrane Database of Systematic Reviews:11*(11). CD004517. https://doi.org/10.1002/14651858.CD004517.pub3

[13] Bradt, J., Dileo, C., Grocke, D. and Magill, L. 2011. Music interventions for improving psychological and physical outcomes in cancer patients. *The Cochrane Database of Systematic Reviews 8*. CD006911. https://doi.org/10.1002/14651858.CD006911.pub2

[14] Giordano, F., Giglio, M., Sorrentino, I., Dell'Olio, F., Lorusso, P., Massaro, M., Tempesta, A., Limongelli, L., Selicato, L., Favia, G., Varrassi, G. and Puntillo, F. 2023. Effect of preoperative music therapy versus intravenous midazolam on anxiety, sedation and stress in stomatology surgery: A Randomized Controlled Study. *Journal of Clinical Medicine*. 12 (9):3215. https://doi.org/10.3390/jcm12093215

[15] Sotomayor, M., Arufe-Giráldez, V., Ruíz-Rico, G. and Navarro-Patón, R. 2021. Music therapy and parkinson's disease: a systematic review from 2015-2020. *International Journal of Environmental Research and Public Health.* 18(21):11618. https://doi.org/10.3390/ijerph182111618

[16] Pacchetti, C., Mancini, F., Aglieri, R., Fundarò, C., Martignoni, E. and Nappi, G. 2000. Active music therapy in Parkinson's disease: an integrative method for motor and emotional rehabilitation. *Psychosomatic Medicine*. 62(3):386–393. https://doi.org 10.1097/00006842-200005000-00012

Chapter 7

SCULPTING CYBERSPACE

We must design a new way of living… we need to design how we behave… the design of our time is the design of our life.

Bruce Mau
Multi-award winning Canadian designer

It is the year 2023. Our daily lives are filled with interactions with personalized tools and technology. Cell phones, tablets, laptops, gaming consoles, smart watches, head phones, smart glasses and other devices surround us. As illustrated by Figure 7.1, we exist in a social cyber environment like never before, and it can influence us like never before. So in the context of all the science presented in the previous chapters, it is important to consider how devices, software and immersive environments might be shaping us, not just as individuals but also as a society.

Social media software systems allow us to express ourselves to one another in cyberspace, staying connected with friends, near and far, via tools like Instagram, Tic-Tok, Facebook, X (Twitter), etc. We are also connecting in real time, visually, to anyone anywhere in the world with tools like Zoom, Skype, Snapchat, Signal, and FaceTime. Virtual reality and gaming environments allow people to be continually immersed.

But although we are surrounded by these kinds of automation systems and devices, they are not always something we *want* to live with, e.g., robo calls, Robodebt [1, 2], flickering pop-up ads, and so on. The concern about this situation that my Japanese friend, Professor Ikura,

raises, is the connection between our mental health, spirituality and society. Because we are *not made of silicon*



Figure 7.1. We are surrounded by technology. Today this includes cell phones, tablets, computers, cars, smart home interfaces, virtual reality (VR) and other immersive environments, robots, softbots, e-readers and more. All of these are currently designed with founding assumptions revolving around automation and efficiency. Image source:Mason [3].

and metal, but are flesh and blood social creatures, we experience machine and social rub off. What we see and experience through our gadgets, and the way we regard, speak, type, and relate to our gadgets, spills over into how we treat one another [4, 5]. Simply put, our digital lives

affect our non-digital lives. It is a *device-mind-body* and *device-mind-society* phenomenon.

Digital Fury

I would like to draw your attention to a particular aspect of machine rub off I call *digital fury*. Many people experience extreme frustration when dealing with a computer. In fact, people have become so furious that they have shouted at, hit, or thrown their gadgets [6, 7]. There have even been extreme cases where people shot their computers [8]. These instances demonstrate that there are many people whose interactions with computers create caged emotions and frustrations. They can spill over into their interactions with other people. Unleashing our fury, digital or otherwise, upon those around us should be avoided wherever and whenever possible.

The Antidote is Compassion

One of the biggest lessons to come from the Medical Renaissance of Emotion is that *compassion is an antidote for many of our stresses* [9, 10, 11]. Compassion, whatever its origins, is a well-established notion found across various social and spiritual traditions. Social and spiritual traditions teach the notion of compassion in different terms. Often, spiritual entities show spiritual love or spiritual compassion for us. In other situations, people are taught to show compassion toward others with altruistic manners. These kinds of traditional and spiritual

teachings are shared by many communities throughout the world.

Despite all its incredible achievements, technological involvement in our lives has provided new avenues to harm us and our social relationships. This comes in the form of anonymous bullying, doxxing, revenge porn, public shaming and attacking, and even criminal activities. All of these disrupt human relationships.

These technological challenges are in addition to the face recognition and image analysis problems mentioned earlier. The FBI in the United States named hate speech, trolling, porn, and drug use among the top five hate crimes online. To be fair, the internet has truly given us amazing things, and our lives are better for it. But it must also be said that the internet makes it easier for people to exhibit behaviors that can be wrong, immoral, or even illegal. These behaviors are far from the values of someone who seeks alignment with spiritual values or a community of compassion. This can be harmful.

People exposed to chronic inhumane internet behaviors can develop illnesses of the mind such as depression or PTSD. I believe that if we can take the science of this book and infuse it into our devices, tools, systems and other technologies, we can begin creating a new kind of cyberspace. We can sculpture it, or design it, into one that transforms our states of mind not into digital fury but into digital health by infusing technology design with the science of compassion.

Emergent Cultural Transformation

Without even thinking about it, we have been transforming our society and culture via device rub off (see Figure 7.2). It happens through the *device-mind-society* rub off phenomena. Here is how it happens. Each of us individually

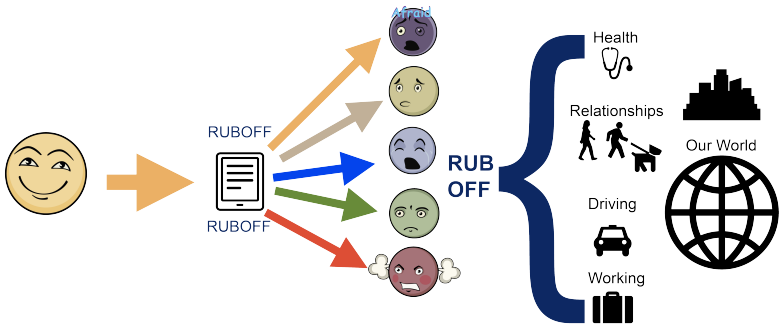


Figure 7.2 Emergent cultural transformation occurs when Device-mind-culture transference happens en mass. There is also en masse device bioplasticity rub off.

experiences machine rub off. But everyone around us is also experiencing machine rub off. So, the effect is happening *en masse*. It takes place at a group or social level. We did not anticipate nor design for this, at a group level, so it is an emergent cultural phenomenon. In effect, *en masse* rub off creates a *device-mind-culture* effect. Consider that with machine rub off, over time *device-mind-body* bioplasticity is also is occurring *en masse*. This process is what you might call an *emergent cultural transformation* (Figure 7.2). But if we didn't anticipate this or design for this effect, what

exactly is emerging and transforming us, *en masse?* We asked this question earlier.

In our present social cyber culture, we find ourselves spending time not only interacting with gadgets but also with web pages, videos, algorithms, gaming environments and so on. What we experience during this time matters much more than we realized. The tools and algorithms we use every day play a big role in creating our surrounding culture not only because so many of us experience device rub off, but because we then rub off on others. So even if you are somehow not using any devices, algorithms or games, it is changing the people in the world around you.

Some organizations have measured the time people spend in cyberspace and with devices. A group called Reviews.Org found that "On average, Americans have a screen time of 4 hours and 2 minutes each day on their mobile devices in 2023, compared to 2 hours and 54 minutes in 2022 [12], and according to Statista, another organization that measures things, in January 2023 there were 5.16 billion people on line, and 4.76 billion of those on social media [13]. Importantly, AI systems are poised to be involved in almost all areas of our lives: news, art, writing, work, education, banks, transportation, agriculture, supply chains, etc.

Right now, we are living *in response to* an emergent social cyber culture. But now that we understand about the link between rub off, bioplasticity and the Emotion Organon, we no longer need to live in an emergent social cyber world.

We can intentionally design our social cyber world for our benefit. Bruce Mau, a multi-award-winning designer from Canada, said, "You either leave it to chance or design what you want" [14]. In the remainder of this chapter, we look closer at Mau's idea.

So, if we can design the future through our devices, *what kind of future do we want for ourselves?* The pandemic has shown us that cooler, faster algorithms alone are just not enough anymore. The Emotion Organon suggests we need to design (and continually design) in favor of human science. The slogan among technology companies today is still "move fast and break things." But that slogan just doesn't work when it comes to people. In fact, we really don't want to break things (people, in this case); we want to fix things and make them better than they were, if possible.

A similar idea is reflected clearly in a statement called the *Safe Face Pledge*, crafted by the Algorithmic Justice League and the Center on Technology and Privacy at Georgetown Law: "We want to show value for human life, dignity and rights. Address harmful bias. Facilitate transparency. Embed commitments into business and healthcare practice." [15].

There is a recent history of apologies for some of the mistakes made with our current approach to designing tools, e.g., face recognition, Robodebt, insurance claim algorithms, etc. What if we intentionally designed device-mind-culture transference by founding it on the medical science of compassion? This could tilt the scales against our not so impressive human tendencies (and our history). This is precisely the point of ACT, Artificial Compassion Technology

[3]. If widely designed and widely adopted, it can change the world for the better. How do we get from here to there?

As far as our present tech culture goes, it is the questions we don't ask that are the most important. Is it possible to create a problem solving technology that also has a compassionate design stance, i.e., a stake in your welfare?

Will this be enough to create a biologically supportive social cyberspace? So far, we're not really thinking about, "What, or who, is rubbing off on us?" I say "who?", because there is a percentage of people who are not only unconcerned about people's welfare but who are nefarious [16, 17, 11]. This is one of those areas some people simply can't look at because it is too painful to contemplate. Fortunately, those who can look are now teaching how to recognize it and work to prevent it. The textbook is called *Wicked Entrepreneurship* [18].

To sculpt a social cyber world with our welfare in mind, we must face this reality or be doomed to talk nonsense. A very simple way nefarious behavior can happen is when there is a conflict of interest. As described by Steve Blank, Adjunct Professor in Management Science and Engineering at Stanford University, "technology is not being driven by research scientists, it's being driven by for-profit companies," [19]. The idea of ACT is to *use the rub off effect to our advantage.*

Rather than blindly allowing a random rub off effect to emerge in some unforeseen way, or worse, to leave it to those with nefarious purposes, an approach to design that purposefully creates systems, gadgets and algorithms that

reflects our more positive, higher states of mind will support our human nature and biology. As illustrated in Figure 7.3, the effect of using ACT devices creates a device-mind-society with positive bioplasticity. It happens as a consequence of many individuals, already living in a society, who experience the effects of systems, devices and environments where the

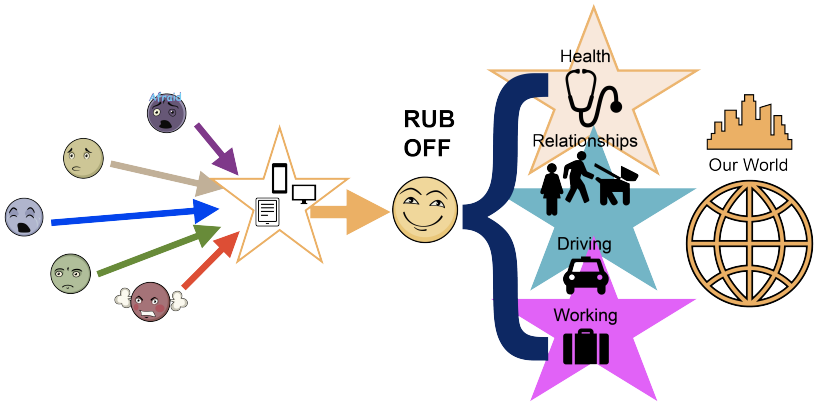


Figure 7.3. Devices created with Compassion-Centered Design reflect our Compassion Thinking. This process transforms us in a healthy way. Our interactions create positive device bioplasticity en masse.

rub off effect is intentionally designed with knowledge of the MRE. Namely, the human science and medical breakthroughs discussed in Chapters 4 and 5. In effect, by reflecting and supporting higher states of mind through technology design, it brings the best of our humanity back to

technology and, through rub off, returns it to us by reflecting it back at us.

"Isn't it possible we might have too much compassion and that people will get soft?" This question came up at a talk I gave at MIT while creating the final versions of this book. At the moment, the question is a bit like worrying about overpopulation on Mars. My Jewish grandmother would have answered this question: "we should HAVE such a problem!"

Survival of the Kindest?

Besides being important for our health, the science of the previous chapters also shows *the crucial importance of our positive regard for one another*. In fact, the devices and software in which we find ourselves immersed could potentially make or break our survival. The medical discoveries showing the link between our body and positive emotions, like kindness and compassion, shine a new light on the expression, "The survival of the fittest." Did Darwin actually say this?

The science presented here supports a slightly different view of the survival quote. A majority of our body functions depend on the biochemical effects of kindness and compassion. Perhaps that famous expression would be more apt as "the survival of the *kindest*." In fact, the original quote, which appears *everywhere*, is misquoted. It is so widely misquoted that, when U.C. Berkeley biology student Nicholas Matzke got to the bottom of the misquote, he was given the Darwin Correspondence Prize from Cambridge University [20].

"According to Darwin's Origin of Species, it is not the most intellectual of the species that survives; it is not the strongest that survives; but the species that survives is the one that is able best to adapt and adjust to the changing environment in which it finds itself." [21]

Leon C. Megginson
'Lessons from Europe for American Business'

So it would seem that Darwin understood the usefulness of coming to someone's aid, biologically speaking. His observations on survival certainly predicted all the compassion science findings of the 21st century. Consider, for example, the discovery that cardiac event recovery happens faster in people who cultivate compassion and that positivity has a strikingly positive impact on our immune health [22, 23, 24, 25]. Similarly, when individuals learn to cultivate compassion, it has positive effects on their brain tissue[26].

As we have seen earlier in the book, the recent advancements in medical science show an expanding number of ways that kindness and compassion are the antidote for life's toxic experiences. The medical breakthroughs show that compassion is life's most sustaining and enabling emotion [27]. And, as we have also learned, the opposite is also true. Chronic exposure to negative emotions can makes us ill, unhappy and anti-social, especially if we live in a culture that expects us to cope with those negative emotions on our own.

Perhaps evolutionary fitness is not exactly about

physical strength or overtaking another in competition, but about having the internal capacity for positive relationships through compassion and cooperation. These behaviors would enable us to adapt and adjust to a changing environment because we assist one another.

In fact, we have the capability to infuse our tools with the knowledge of the Emotion Organon. In this chapter, we consider how the Emotion Organon can sculpt society through the design of our tools and technology. *It is through these devices that we are designing our future.* Doug Englebart, a futurist and inventor of the computer mouse and many other innovations, predicted the co-evolution of humanity with technology [28].

If we don't create ACT, what will we evolve into?

We have accomplished many amazing things with a foundation of automation, efficiency, logic and reason. If you believe in logic, then clearly the next reasonable and logical evolutionary step is to build a foundation of compassion for technology. Even if we didn't have all the science, you can see why this is a good idea when you consider a *Then and Now* scenario.

In the early days of computing, back *then*, our computational systems were not designed for human-computer interaction. But *now* interactions with systems are required. They happen daily, frequently, and some of us find ourselves immersed. The interactions are both verbal and non-verbal. *Now* our faces are planted in front of a

screen. With the invention of smart glasses, some companies want to practically glue the screen to our faces.

This observation concerns not only our personal interactions but also the business world, where most customer interactions now take place digitally. The effects of the recent COVID-19 pandemic are propelling us even faster in the direction of our machines and our screens. This is a particularly important trend to recognize because it relates to *device-mind-body* bioplasticity.

Technological progress up to this point has been accomplished primarily with cerebral intelligence. Cerebral intelligence has been a great inspiration for creating our algorithms, immersive environments and systems, including AI, machine learning and robotics. But imagine opening up our world to other kinds of intelligence, such as compassionate intelligence. This is a natural and logical next step. Even if the scientific advancements of the Medical Renaissance had not been revealed to us, the way we interact with devices *now* is so different from back *then* (when the founding ideas of efficiency and automation were being laid), that it compels us to create a new foundation for technology. By foundation, I mean a ground level assumption, one we begin with, rather than think about later. A Post-Oblivatronix technical foundation is where technology is not based solely on automation and efficiency, but also on what might be most helpful to our flesh and blood lives and what is compassionate *to us*.

Compassion Centered Design Process

As illustrated in Figure 7.4, the transformation to the Post-Oblivatronix era begins by becoming aware of the human science (The Emotion Organon) and the importance of integrating care awareness into design. This is the foundation for building Compassion Literacy. Compassion

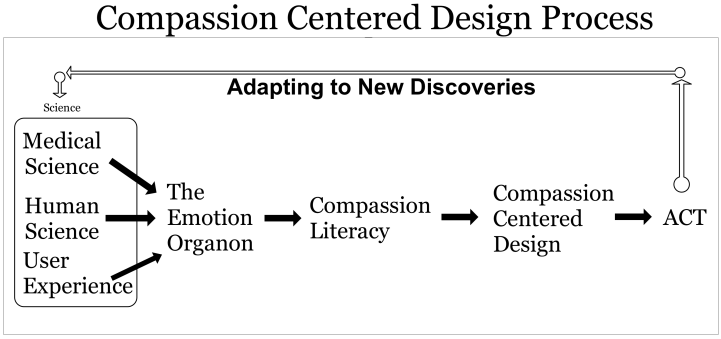


Fig. 7.4 The process of Compassion Centered Design leads to Compassion Thinking and Transformation

Literacy changes our thinking and imagination, giving rise to the creative design process called Compassion Centered Design. Tools, devices, systems and environments developed through this process can reasonably be called Artificial Compassion Technology (ACT). You will notice in Figure 7.4 there is a feedback loop. This is because as human science continues to grow, our thinking (and our foundation) also continually evolves. The key aspect of this design process is the inclusion of human science discoveries (The Emotion Organon). Ultimately the creation of ACT depends on this foundation. I encourage you to keep digging for human

science research as time goes on, because new insights continue to pour in.

Compassion Centered Design Thinking

Understanding the new advances in medical and human science is one way to develop an imagination for Compassion Centered Design Thinking. But it is not the only way. Sometimes we develop compassion literacy from difficult circumstances. Hospitals and history are filled people and the stories that stir us. They reveal the suffering of genocide, war, slavery, domestic violence, plagues and other horrors of human existence. There are too many.

While I was an AI researcher at U.C. Berkeley, I had what the French call *année horrible* - a horrible year. Everything was going fine, but then as if out of nowhere, over a 13 month period I experienced the death of 7 people. While each of these deaths felt tragic (my father was one of these, as was my grandmother), three of the deaths were students who committed suicide in the building where I lived on campus. The three deaths were not all at the same time, nor did the students know one another. What the suicides had in common was bullying. It was a tragic loss of young life. I joined efforts with my friend who was working on a White House task force on anti-cyber bullying at the time. It was healing to do that. But reflecting on how many devices and computers there are in our lives now, and seeing how close we live with technology, surely, I thought, we can use technology to help us with all of these difficult social and emotional problems. Easier said than done.

Coming to grips with suffering is not easy for anyone. Although some people feel a calling to relieve that suffering, there are many more who simply need to look away because it is too painful. Focusing on the science of compassion is a less painful way to stir the imagination of our minds and hearts. We can achieve a compassionate state of mind (heart) by learning about the incredible advancements around positive emotions and medicine.

When we work on these type of tools, and we become compassionate literate, by whatever means, it is important to take care that we do not become too sad by dwelling on all the world's suffering. I find that it helps to focus on the fact that it is possible to make things better and I believe ACT is a big way we can do this.

When we become Compassion Literate we can apply this knowledge to the design of technologies that reduce harm and suffering. When we become Compassion Literate, we also can benefit personally because it can help us with our own lives, relationships, health and happiness. We saw how this is possible from the science in Chapters 4 and 5.

Compassion Centered Design (CCD) aligns positive social values and experiences with our technological designs. As a consequence of this process, we end up with tools that have a stake in us. What was once mere 'problem solving' becomes *compassion centered* problem solving. And "Design Thinking" becomes "*Compassion Centered* Design Thinking" or just "Compassionate Centered Design". A Compassion Centered Design focus creates an important distinction from the past.

It changes everything about the way we view problem solving, immersive environments and user interfaces. Presently, most programmers and engineers (the ones building tools and technology) view problem solving as a kind of puzzle. But we're not in the puzzle and sometimes we need to be. CCD thinking brings a consideration of us into the puzzle. It includes a sympathetic awareness of the social interactions and reactions of people when they engage with a tool. CCD thinking also imparts an awareness of how, at a larger scale, designs sculpt or create a social cyber culture through our tools and technology.

We call this new perspective "*computational compassion"* or *Artificial Compassion*. It is an intentionally broad term because it includes much more than AI or technology. It is also about an outlook on life and in the attitude we carry about others. The point of saying this is not to harangue about morality or offer platitudes. Maintaining a positive attitude can be difficult, if not impossible, at times, especially when dealing with difficult situations. You can probably think of some - chronic illness, financial debt, death of a loved one, etc. There is a long list of life's challenging situations, and whether chronic or not, they can deplete our reserves for staying positive.

ACT is not just about developing compassion for others, it is also sometimes about recognizing our own need for compassion. Everyone from students to healthcare workers to judges can use CCD tools and systems. They can be especially helpful for the helpers and the tool makers themselves who may confront suffering on a daily basis.

Positivity, Optimism and People

To codify the values expressed through Compassionate Centered Design and Compassion Literacy, we need a guiding principle. It is this: Positivity, Optimism and People. POP represents the positive psychological values expressed through Compassionate Centered Design and Compassion Literacy. Having a guiding principle such as POP allows designers, makers and manufacturers to announce a perspective or an intention on technology design and use. It is also a system of values that drives the end product into the hands of consumers.

POP can be distinguished from the way we currently design technology, which is primarily based on a puzzle perspective. The values and goals for technology design focus solely on automation and efficiency. This efficiency and automation makes us more productive, but only focusing on automation and efficiency creates a blind spot when it comes to designing systems that affect people.

To metamorphose from the dominant puzzle perspective to a compassion centered perspective (POP), we need to get physical. This is not about theory or ethics. I'm talking about our physical bodies and our biology. This is where the rubber meets the road: our arms, legs, livers, brains, immune system and so on. This kind of conversation is possible because of the science of the Medical Renaissance (Chapters 4 and 5).

In effect, it compels us to a very logical and rational conclusion: we must strive to design technology not just for

automation and efficiency but also to support our biological human need for positivity and care. When we do this, we can begin to see our need for positivity and care as part of the puzzle. The principle of POP reflects this vision.

Making It Real

Having a principle (POP) and becoming aware of how important it is to infuse our every day tools with human compassion (CL) is not enough. Although design is often associated with finishing touches on a product or tool, Compassion Centered Design can be distinguished from this approach because it becomes part of a tool from its inception, through its foundation of compassion science. Another essential element of CCD is its need to be vetted by and for the public. In this way, it is very much in tune with Article 114 of the EU approach to technology oversight [29].

As Figure 7.5 illustrates, just as there are many different ways to express compassion in life, there are many ways to apply CCD. This book makes the case for using Compassion Centered Design (and infusing compassion) in all areas of technology, including user interfaces (fonts, media, gaming and web page design), communication, machine learning, decision making, bots and AI advisors, robotics, smart cities, game, VR, and so on.

This is especially important when it comes to immersive environments. CCD inspires technical designs with a broader reach than just solving a problem with automation, efficiency and intelligence. It infuses human

compassion based design principles into the delivery of technology devices and services. Consequently, we not only

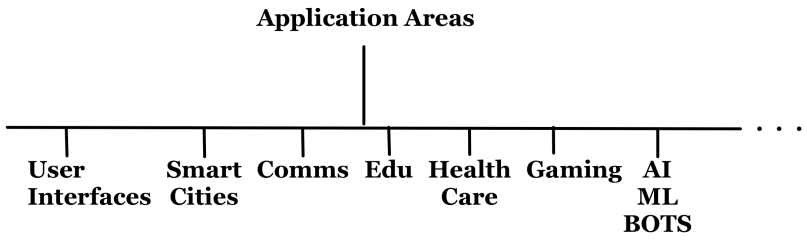


Figure 7.5. Artificial Compassion Technology is the result of CCD applied in many different technologies [29].

boost the sense of collective compassion in our social cyber society, but also guard our health with more positivity.

In addition to the projects described earlier, there are a variety of other active ACT projects involving technologies such as VR headsets, simulation environments, AI, chatbots, games, and more.

One of the coolest applications of ACT I've seen comes from Sydney, Australia. It is a smart city design for Mars. Pioneered by gifted school children concerned about our future, its design specifies all the computer systems in the city are based on Artificial Compassion Technology [30]. Another impressive type of ACT is robotic nursing [31]. In Japan, there is simultaneously a shortage of nurses and an increasingly large aging population, so there is a great need for this. Thankfully, there has been much progress. For

example, Robear, Japan's robot nurse bear, is soft to the touch but can lift patients [32].

In addition to these projects and products, you find ACT reflected in some of the advanced social and emotional applications developed using VR headsets and environments, games, and online education interfaces. I believe that, in general, because of the growing use of such technologies, when creating simulated characters and worlds, knowledge about the biological effects of psychosocial interactions is essential. It is unclear whether these tools have been designed with MRE knowledge, but so far, they seem quite helpful, especially among the medical community [33].

Gamification and role-playing games have been useful in health education technologies involving positive emotion. Ma and team have found that role-playing games that elicit empathy are effective with nursing students because they provide a way to create psychological immersion and alternative perspectives [34]. Professors Kovisto and Hamari from Finland have discovered that gamification, an approach to building user interfaces involving game-like elements such as awarding points and badges, using novel sounds and lights, and so on, is a successful method for improving and supporting motivation. However, Kovisto and Hamari's assessment of over 800 systems, they observe that there is a lack of coherent guidance or structure for designing these motivation applications [35].

Virtual reality, smart glasses and other related technologies are proving a useful way to inspire positive

emotions and behaviors in us as well. For example, by using a virtual reality education platform designed by Kim and Chun, nursing students were able to view the world from a patient's perspective in settings other than the hospital [36]. This is important because typically nurses are trained in hospital settings. According to the analytical findings of Kim and Chun, nursing students who virtually experienced patients' conditions through a combination of virtual reality and conventional learning showed A) an increase in empathy B) had more favorable attitudes toward patient safety C) increased clinical skill performance and D) felt a greater sense of confidence [36].

Similarly positive results have been achieved using virtual reality training systems to provide empathy support and training for caregivers [37, 38]. From these projects, it seems natural that a VR approach may be an important tool for preventing burnout and compassion fatigue. As we saw in the chapter on MRE, this is a serious issue that often plagues health care workers (see Chapter 4, pp. 64-65). But health care workers are not the only ones who can benefit from such applications. ACT holds potential for helping everyone single one of us as we age [39, 40].

Most of the studies on the social and cognitive effects of video games have been focused on the younger generations but pioneers Kovisto and Malik reviewed its impact on those aged 55 and above. Kovisto and Malik looked at 12 studies. "Positively oriented results were reported in 10 of 12 studies on visual attention rehabilitation, diabetes control, increasing positive emotions

for patients with sub threshold depression, cognitive training and memory tests, engagement in training program, perceptions of self-efficacy, motivation and positive emotions of social gameplay conditions, increased physical activity and balancing ability, and increased learning performance and autonomy experiences." [41].

Kovisto and Malik's results are consistent with the MRE insights and indicate that the use of games to inspire positivity in us holds great potential benefit to our health as does virtual reality. Another relatively new avenue for introducing positivity is through humanoid companions such as Replika and Caryn [42, 43]. I believe that, in general, because of the growing use of such technologies, when creating simulated characters and immersive games/worlds, knowledge about the biological effects of psychosocial interactions is essential. Although we have not yet mentioned affective computing, and it is not particularly focused on eliciting positivity or compassion, I believe it can reasonably be included as a type of ACT in the same way that smart watches can. When paired with illnesses or conditions such as autism, affective computing leads to caring innovative solutions, which is an act of compassion [44].

CCD design thinking can also influence machine learning. For example, suppose you have a machine learning algorithm that is trained to recognize not just voices, but *helpful* voices. And suppose you have another machine learning algorithm trained to spot not just faces, but *compassionate* faces. In both of these systems, the programmer's goal is not just to do pattern matching or

classify a voice or a face, but to protect and aid us as well. So the data collected is not simply voices or faces but voices and faces screened for helpfulness or traits linked to compassion.

Tools based on this kind of data can guide us to the voices and faces we may find most helpful in an unknown city, if we find ourselves in a crowded hospital or airport, or as a new student at school. In identifying voices and faces that are helpful or compassionate, we may also automatically find those voices and faces that are most likely not. This can help us minimize exposure to potential harm or may help us detect threats in our schools or other places.

Similarly, we could train an algorithm to recognize the voices or faces of people (and animals) in distress using a similar strategy. Those who are in nursing homes, orphanages, violent homes or rehab centers are our most vulnerable so an app with such capabilities would be of great assistance to them, possibly providing data and evidence useful in the justice system where such situations are particularly difficult to document.

"Positivity filters" that can be used to filter out negative content from online or other sources (e-mail, webpages, documents, etc.) so that we are only seeing positive content, would, in my opinion, also be of great interest. This is not to live in a bubble, but it would be beneficial for mental health, such as in cases of depression, grief, illness, bullying, etc.

Summary Although the point of the Emotion Organon is to shine a light on the medical advancements for the past 3 decades, progress also comes by applying this knowledge. The new discoveries on compassion and positivity that you

have seen here mean we can design the technological tools we use to support our biology *in our lifetime*.

Compassion-Centered tools are intentionally designed to extend, amplify, and reconnect us to the naturally positive human qualities in ourselves. This approach to design supports rather than ignores our natural underlying biological needs and our lives. All the science shows that we can clearly benefit from such new devices. Designing and thinking this way and becoming compassion literate is an act of hope for the future. Like art and music, our technology is a reflection of us.

As we ourselves become more compassion literate, this will be reflected in the technology we design. By cultivating compassion thinking awareness, programmers, engineers, designers and decision makers can infuse much needed positivity into the technologies we experience in our daily life. Through the act of using these algorithms, systems and devices every day, over time, as a society, we will collectively reflect the higher states of mind that are embodied by and reflected to us through the tools. In essence, by understanding that a transformation is occurring through our devices, it creates an opportunity to purposefully transform the emergent social cyber culture we have now into one based on a foundation of compassion. In effect, we are actually talking about a cyber culture design process that explicitly and intentionally contributes to our internal and external health.

This way of thinking also naturally acknowledges the need for care and protection that each of us requires as flesh

and blood human beings. Oddly, this is not currently part of the engineering design process or design thinking, even as we now teach design at the K-12 levels [45]. It needs to be. The MRE establishes with absolute certainty how critical this is for our biological and mental welfare. Applying MRE through Compassion-Thinking and Transformation, ACT, is not about applying behavior science to persuade people or manage customer experiences. It is about applying compassion science to support us in all areas of our lives. It is the secret to increasing our happiness.

Up Next: In the next and last chapter, Chapter 8, we summarize some of the key points covered and reflect on the way forward.

REFERENCES FOR CHAPTER 7

[1] Robodebt Royal Commission. 2023. Royal Commission on the Robodebt scheme. *https://Robotdebt.royalcommission.gov.au*

[2] Webb, A. 2020. The Big Nine: How The Tech Titans and Their Thinking Machines Could Warp Humanity. *Public Affairs*. NY, USA.

[3] Mason, C. 2023. *Designing Artificial Compassion Technology*. Amazon Kindle Independent Publishing Platform. *in-press*.

[4] Nass, C. and Moon, Y. 2000. Machines and Mindlessness: Social Response to Computers. *Journal of Social Issues*. 56: 81–103. doi:10.1111/0022-4537.00153.

[5] Reeves, B. and Nass, C. 1996. *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places*. Cambridge University Press. New York, USA.

[6] Carufel, R. 2013. Over a third of Americans confess to verbal or physical abuse—of their computers. July 30. Republished in Business Wire from Bulldog Reporter. https://www.businesswire.com/news/home/20130730005132/en/Survey-Over-A-Third-of-Americans-Confess-to-Verbal-or-Physical-Abuse-of-Their-Computers

[7] Wardrop, M. 2009. " 'Computer Rage' Affects More Than Half of Britons." The Telegraph. April 1. www.telegraph.co.uk

[8] Grenoble, R. 2015. Colorado Springs Man Shoots Malfunctioning Computer Eight Times, Calls It 'Glorious' The Huffington Post. May 22. Available online: https://www.huffpost.com/entry/man-shoots-computer-eight-times_n_7119246.

[9] Kuppusamy, T., Ramaswamy, P., Perumal, M., Silambanan, S. and Prabu, A. 2021. A short note on oxytocin and stress attenuation. *Bioinformation*. 30;17(11):921-923. doi: 10.6026/97320630017921.

[10] Uvnas-Moberg, K. and Maria, P. 2005. Oxytocin, a mediator of anti-stress, well-being, social interaction, growth, and healing. *Zeitschrift fur Psychosomatische Medizin und Psychotherapie*. 51: 57–80.

[11] Zefferino R., DiGioia, S. and Conese, M. 2021. Molecular links between endocrine, nervous and immune system during chronic stress. *Brain Behavior*. 11(2):e01960. doi: 10.1002/brb3.1960.

[12] Review.org. 2023. 2023 Cell Phone Usage Statistics. *www.reviews.org/mobile/cell-phone-addiction/*

[13] Statista.com. 2023. Number of internet and social media users worldwide January 2023. *www.statista.com/statistics/617136/digital-population-worldwide/*

[14] Mau, B. 2021. We must design a new way of living. Louisiana Channel. YouTube.com.

[15] Safe Face Pledge and Georgetown Law. 2022. Pledge to mitigate abuse of facial analysis technology. https://www.safefacepledge.org/pledge

[16] Broddy, C. 2011. *Corporate Psychopaths, Organizational Destroyers*. Palgrave McMillan. New York, USA.

[17] Ingram, B., Jones, D., Lewis, A., Richards, M., Rich, C. and Schachterle, L. 2010. A code of ethics for robot engineers. *Proc. ACM/IEEE International Conference on Human Robot Interaction*. Osaka, Japan.

[18] Arend, R. 2015. Wicked Entrepreneurship: Defining the Basics of Entreponerology. Palgrave MacMillan. New York, USA. DOI:10.1057/9781137503329.

[19] Baron, E. 2023. Chatbots and the new AI: what will AI unleash upon the world now? San Jose Mercury News. Apr. 25.

[20] Cambridge University. 2023. Darwin Correspondence Project Six Things Darwin Never Said. *https://www.darwinproject.ac.uk/people/about-darwin/six-things-darwin-never-said/evolution-misquotation*

[21] Megginson, C. 1963. Lessons from Europe for American business. *The Southwestern Social Science Quarterly*, *44*(1):4. http://www.jstor.org/stable/42866937

[22] Asl, E., Boostani, H., Behrouzian, F., and Rostami, H. 2021. The mediating role of compassion in the relationship between COVID-19 anxiety syndrome and COVID-19 burnout. *Journal of education and health promotion*. 10*:*413. https://doi.org/10.4103/jehp.jehp_1580_20

[23] Azar, B. 2001. A New Take on Psychoneuroimmunology. *Monitor on Psychology*. 32: 34–36.

[24] Bordt, E., Smith, C., Demarest, T., Bilbo, S. and Kingsbury, M. 2019. Mitochondria, oxytocin and vasopressin: unfolding the inflammatory protein response. *Neurotox Research*. *36*(2):239-256. doi: 10.1007/s12640-018-9962-7.

[25] Jankowski, M., Broderick, T. and Gutkowska, J. 2020. The role of oxytocin in cardiovascular protection. *Frontiers in Psychology*. *11*: 2139. doi:10.3389/fpsyg.2020.02139

[26] Klimecki, O., Leiberg, S., Lamm, C. and Singer, T. 2013 Functional neural plasticity and associated changes in positive affect after compassion training. *Cerebral Cortex*. *23*(7):1552-61. doi: 10.1093/cercor/bhs142.

[27] Mason, C. 2021. Oxytocin and Compassion. Film. www.academia.edu/video/lePZ51

[28] Engelbart, D. 1995 Toward augmenting the human intellect and boosting our collective IQ. Communications of the ACM. *38*(8):30-32. doi:10.1145/208344.208352.S2CID 8192136.

[29] EU Parliament and Council. 2021. Laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union legislative acts. Brussels 21.4.2021 com.2021. 206.final. https://artificialintelligenceact.eu

[30] Nolan, T., Nolan, E., Nolan, R. and Nolan, F. 2021. Modelling Smart Cities on Mars in Minecraft. World Automation Congress Proceedings. 222-227. DOI:10.23919/WAC50355.2021.9559579

[31] Soriano, G., Yasuhara, Y., Ito, H., Matsumoto, K., Osaka, K., Kai, Y., Locsin, R., Schoenhofer, S. and Tanioka, T. 2022. Robots and Robotics in Nursing. *Healthcare*. 10(8):1571.

[32] Robear 2023. Meet Robear, Japan's Latest Robot Creation for healthcare and elderly care. Press Reels Tyler Lee. https://pressreels.com/meet-robear-japans-latest-robot-creation-for-healthcare-and-elderly-care/26149

[33] Morrow, E., Zidaru, T., Ross, F., Mason, C., Patel, K., Ream, M. and Stockley, R. 2022. Artificial intelligence technologies and compassion in healthcare: A systemic scoping review. *Frontiers in Psychology*. https://doi.org/ 10.3389/fpsych.2022.971044

[34] Ma, Z., Huang, K. and Yao, L. 2021. Feasibility of a computer role-playing game to promote empathy in nursing students: the role of immersiveness and perspective. *Cyberpsychology, Behavior and Social Networking*. 24(11): 750–755. https://doi.org/10.1089/cyber.2020.0371

[35] Koivisto, J. and Hamari, J. 2019. The rise of motivational information systems: a review of gamification research. *International Journal of Information Management*. 45*:*191-210.

[36] Kim, H. and Chun, J. 2021. Effects of a patient experience–based virtual reality blended learning program on nursing students. *CIN: Comput. Inform. Nursing*. 40(7): 438 – 446. doi: 10.1097/CIN.0000000000000817

[37] Brydon, M., Kimber, J., Sponagle, M., MacLaine, J., Avery, J., Pyke, L. and Gilbert, R. 2021. Virtual reality as a tool for eliciting empathetic behaviour in carers: an integrative review. *J. Med. Imaging Radiat. Sci. 52*(3):466-477. doi: 10.1016/j.jmir.2021.04.005.

[38] Demarinis, S. 2022. Healthcare providers use virtual reality to elicit empathy. *Explore: The Journal of Science and Healing*. 18(1): 4-4. ISSN: 1550-8307.

[39] Hirt, J. and Beer, T. 2020. Use and impact of virtual reality simulation in dementia care education: a scoping review. Nurse Educ Today. 84:104207. doi: 10.1016/j.nedt.2019.104207.

[40] Sung, H., Su, H., Lee, W., Yamakawa, M. and Wang, H. 2022. Effects of a dementia virtual reality-based training with peer support for home care workers: A cluster randomized controlled trial. *Intl. Journal of Geriatric Psychiatry*. 37(9):10.1002/gps.5799. *https://doi.org/10.1002/gps.5799*

[41] Koivisto, J. and Malik, A. 2020. Gamification for older adults: a systematic literature review. *The Gerontologist*. 61*:*e360 – e372.

[42] Marjorie, C. 2023. Caryn.ai:The first influencer transformed into AI. https://caryn.ai

[43] Pardes, A. 2018. Replika, the emotional chatbot, goes open-source. *Wired Magazine*. https://www.wired.com/story/replika-open-source/

[44] el Kaliouby, R., Picard, R. and Baron-Cohen, S. 2006. Affective computing and autism. *Annals of the New York Academy of Science*. 12(1093):228-48. doi: 10.1196/annals.1382.016.

[45] Markowitz, D. and Bailenson, J. 2020. Virtual reality and emotion: A 5-year systematic review of empirical research (2015-2019). In *Our Online Emotional Selves: The Link Between Digital Media and Emotional Experience*. Editors Nabi , R. and Myrick, J. Oxford University Press. UK. doi: https://doi.org/10.31234/osf.io/tpsmr

Chapter 8

REFLECTIONS

People who wonder if the glass is half empty or full miss the point. The glass is refillable.

Unknown

In this book we explored the science of life's most significant experiences: happiness and compassion. We dove into three decades of groundbreaking research in human science, resulting from the fusion of psychology, neuroscience and all areas of medical science. While we may never completely know what goes on inside someone, the explorations have uncovered something extraordinary. There is an intricate relationship between the positive social and emotional experiences in life and our body's biological functions, especially the positive emotions of love, kindness and compassion. It is the basis of our own human existence. Perhaps we need to deeply listen to this new wisdom: the very elements of human experience that evoke our deepest affections - sex, friendship, love, trust, compassion, and more - spur on the healthy functioning of our cells and organs, ensuring our health and life continue. This newfound knowledge is not yet widely known.

We also learned about an extraordinary new field called compassion science. The results from this field showed how compassion positively impacts our resilience and increases our resistance to disease and the effects of stress. We saw how positive emotions support wound healing, thermal regulation, glucose metabolism, cardiac function and so much more. We also explored how positivity is literally the biological glue of our social world. The potent

role that positive emotions have on our lives revealed that positivity is actually a superpower. If someone is ill or suffering, we need to address both their physical illness and their inner state of happiness, to power-up their healing.

One of the key ideas we learned from all the discoveries is that collectively, the wisdom of these insights represents a new kind of knowledge that impacts our world, our tools and our selves. We learned that the reason this knowledge about emotion is so important now is because knowledge is the foundation of our modern world and there is a crucial relationship between technology and the way we define and view what knowledge is (and is not). Without knowledge, advanced technologies such as AI, machine learning, robotics, generative AI and so on, simply would not exist. Their functions, decisions and behaviors rely entirely on the way we define and use knowledge.

We further saw that our view of knowledge includes limited and biased portraits of reality as well as blind spots, assumptions, and subjective perceptions. When new inventions and discoveries come along, they reveal our blind spots, assumptions and beliefs and change our world view. In essence, *our view of knowledge impacts how we design technology,* and this link between our view of knowledge and technology design is especially significant now. Because in addition to the breakthroughs in human science we have uncovered the phenomena of human bioplasticity and the impact of machine rub off.

We saw that techniques that cultivate positive emotions in ourselves, such as compassion therapies and

mindfulness meditation, are improving our resistance to stress and disease. They support mental health and encourage us to bring our best selves to the table each day. We explored the idea of applying the new human sciences insights into our tools through compassionate centered design, which creates positive device rub off.

We recognized that there is an evolving nature to our interaction with machines. We not only share our lives with nature and other living creatures, but also with devices, systems and virtual worlds. People are spending increasingly more time in a social cyber world. This trend shifted dramatically during the COVID-19 pandemic when more of our activities moved online. Game researcher McGonigal estimates that today, by the time a child reaches 21, they have gamed an average of 10,000 hours [1]. We connected these trends to the phenomena of machine rub off and bioplasticity and asked "What exactly is rubbing off on us?"

Because we co-exist with many knowledge centered technologies now, we recognized there is a need to take a closer look at the properties of the knowledge and assumptions upon which these systems are designed. Not many people are aware that knowledge surrounds us, nor of how that knowledge makes assumptions about us, or (mis)represents us. The breakthroughs of human science showed us it is crucial that our knowledge of the world should include compassion and human science.

We learned that compassion's role in our existence and survival is much greater than we ever imagined. It is so deeply embedded in our cells and tissues that our biology

benefits not only by giving or receiving compassion, but simply by witnessing it [2]. The discoveries in the new field of compassion science helped us understand that our biological need for compassion is important not only for reimagining our ideas of knowledge, but because also for designing technology that supports our biology. This is especially true for the areas of our lives that require sensitivity, such as the interactions with police, government, healthcare, military and so on, where advanced technologies are deeply involved in decisions.

When we dug into the history and character of knowledge used in AI systems, we learned that the foundation of knowledge originated centuries ago. By AI systems, I mean machine learning, generative AI, robotics, cognitive systems and so on. The knowledge foundation for these technologies originates with the ideas of knowledge shaped and taught by Aristotle (384 - 322 BC) and Francis Bacon (1561 - 1626). Today's technology designs (and the world) have benefitted greatly from their ideas. However, because their systems of knowledge (The Organon[3] and The New Organon[4]) were developed prior to the medical renaissance of emotion and before the advancements in human science, any technology designs based on their knowledge foundations are inherently oblivious to us. We saw that, historically, the ideas of compassion and care were simply not considered essential nor relevant to the definition of knowledge. Nor were other more temporal and subjective aspects of human experience represented as elements of knowledge.

Bacon's view of the world, which coincided with the invention of telescopes and microscopes, helped us describe, catalogue and understand the world as never before. But we looked out at the world and not inside ourselves, where soft power lies. Discoveries from the new James Webb space telescope are amazing but they don't guide us in designing technology for the most human problems: our inner lives and relationships, i.e., how to cope with difficult situations, how to get along, etc. The knowledge perspectives we live with now, that originated so long ago, no longer fit how we live with technology now. Access to technology was once limited to experts working on scientific and military projects, but now it's in the hands of people worldwide who use it to engage in business and in life.

In view of the new knowledge of the emotion organon, we can regard our present class of advanced technology systems, the ones that draw from a knowledge foundation based solely on Aristotle's or Bacon's work, as part of the Oblivatronix era of technology. We learned that this is because they prescribe a foundation of knowledge that is inherently oblivious to our human need for care, protection and compassion. Their ideas of knowledge lead to the design of technology that is oblivious to compassion. They certainly do not support our cultivation of soft superpowers. As we saw, this leads to a lack of biological support and that is unsustainable. Consequently, we recognized the need to have a new foundation of knowledge that includes human science. This expands the view of knowledge held by designers and gives us a world view that respects our need

for positive emotions like compassion and the need for care and protection of people.

To fully become literate about the knowledge of emotion, we also learned about the role that compassion has played in our lives and social institutions. We learned that without being shown human care and compassion as infants, we may pass away or endure illness and an inability to socialize or bond. We also learned that when our social institutions and groups lack attitudes and awareness of our need for care and compassion, we can experience brutality and death on a massive scale, such as happened in Nazi Germany. In conclusion, when humans are deprived of compassion it is not *humanity*.

A foundation of knowledge that includes compassion is also important for the creation of social worlds and institutions where we have frequent, long term or immersive use of devices, systems, games, etc. We learned that when machine rub off happens to many of us, it is called en masse machine rub off. We saw how this en masse device rub off can become device society rub off. Depending on our interactions, and the design of those devices, that en mass or society rub off can be a positive or a negative one.

We learned that our interactions put us in a certain "mood." We then take that mood with us when we drive, interact with co-workers, pets, family, and so on. This effect then spreads. When we examined what is rubbing off on us, we discovered that there are many instances of digital fury, where people have shouted, hit, thrown and even shot their computer. This is *negative* device rub off. We recognized

that this is important to learn about *now* because, in general, technology has introduced new avenues of harm (doxxing, hate speech, etc.), disrupting our trust in human relationships [5]. We learned from interdisciplinary medical science that our positivity and human relationships are protective of health and our survival. In effect, this is another reason that bringing the new human science insights to the knowledge foundation of our technology designs is essential. We looked at how this can be done with Compassion Centered Design, an approach to technology design that includes human sciences as part of the knowledge foundation [6].

Compassion Centered Design leads to the creation of devices, systems and algorithms that have a stake in us. This is Post-Oblivatronix era technology. Post-Oblivatronix social cyber environments have a broader foundation of knowledge that includes the new human science discoveries (as described here in *The Emotion Organon*).

We learned that we are already sculpting a rub-off effect and that it is emergent, occurring without thought. As to whether this emergent rub off is positive or negative, not many people are designing for it. The discoveries of human science over the past three decades showed us there is a need for intentional design that supports our biology. This is not just about technology, it is also about the world we want for ourselves. In recognizing that technology is now a part of modern society, its institutions and media, the technology we use has become a vector for influencing attitudes, decisions, regard, and beliefs about and toward each other.

We saw how this can help in healthcare when we looked at what happened not long ago in the UK's National Health System (NHS). They experienced what can only be called a crisis of compassion. This kind of thing can happen anywhere, but thankfully, it was recognized, investigated and documented. The investigation into the compassion crisis conducted by the British Parliament showed a lack of compassion was in the culture of the NHS, not simply in one hospital but throughout the country. The report on their crisis, *The Francis Report*, proposed solutions for how to create a social culture within the NHS that supported compassion [7]. In the studies we saw earlier on compassion, we now have the medical science explain the difference compassion can make in helping pain, wound healing, immune function, depression, etc. It is crucially important for us. Some of the suggestions in the Francis inquire are helpful for those of us who work in tech and design. The report makes 290 recommendations and there have been many policy developments, including a more careful inspection regime conducted by the newly created Care Quality Commission (CQC). Two recommendations from the report that may be useful in other areas of life are:

1) "openness, transparency and candour throughout the health care system (including a statutory duty of candour), fundamental standards for health care providers
2) improved support for compassionate caring and committed care and stronger health care leadership" [8].

Healthcare institutions are a social cyber world, littered with many devices, including those worn by staff and patients as well as those found throughout the offices and labs. When those devices provide, encourage and remind people of positive emotional behaviors and attitudes, when they are designed with knowledge of compassion, the rub off that occurs en masse, is the right one. Every interaction the staff has with a Post-Oblivatronix device can increase compassion levels. The positivity rub off is contagious and healing for staff and patients. Studies during the COVID-19 pandemic showed practicing self-compassion reduced staff burnout and increased resilience to stress. Our devices can help us build such positive environments.

We saw that it is possible to create Post-Oblivatronix devices through Compassion Centered Design. And that a knowledge foundation that includes these human science advancements makes this possible. But as we have seen with our current generation of Oblivatronix technology, there is little oversight to ensure that the technology that is closest to us and that affects the most sensitive areas of our lives is genuinely looking out for us. My personal view is that we must build this knowledge of care for us directly into the algorithms, devices and systems. This is because there are existing unresolved issues with technology such as face recognition, Robodebt, etc., which people continue to investigate. While governments and corporations struggle with how to balance freedom of expression, technology and ethical behaviors, there is often a gap of years between the

creation of technology and the creation of laws or policies regulating its appropriate use [9, 10].

While we are waiting for people to come to an agreement, the Post-Oblivatronix era is already happening. So what do we do while we wait (indefinitely?) for people to find answers? As engineers, designers, programmers and managers, we can intentionally program or design the tools, systems and environments that have a built-in regard for us. When designers, programmers, engineers or managers are compassion literate, that is, when they understand the implications of these new human science developments, this will happen naturally. We build into the systems not only knowledge of human science, but the boundaries of behavior that are a consequence of that human science.

Imagine for a moment that we ignore this. Suppose that for another decade, or maybe forever, the knowledge of the emotion organon is lost. Or that we are so attached to our way of doing things that we continue on without recognizing that the advancements in human science constitutes a crucial new knowledge. We will continue to design technology and live in a social cyber world without recognizing our most important kind of intelligence: *compassionate intelligence* [11].

This would be a great loss to our human potential and for our time on earth. It is not just our biology that benefits from compassionate behaviors. People accomplish more and have a higher quality of life through compassionate interactions that bring self esteem, words of hope and encouragement, empathy, and kindness. The

problems that lie ahead in our future require a renewed strength to face them together. Soft superpower can be a great ally.

There is one last question to address say before we end. Is technology *for me*, or *against me*? Our worldview is linked to technology and innovation. At this juncture in time, we are faced with a decision. Do we design technology for automation and efficiency, and allow ourselves to adapt to it, or do we design technology that supports to us? Human kind has always built tools to make our lives better. The presence of these human science insights means we can design this next generation of technology, the Post-Oblivatronix era, to have a stake in us. This can help us sustain the health, energy and optimism we need to build our future together.

We saw that many efforts to develop Artificial Compassion Technology are already in motion, from simple ideas such as an Apple Watch app and an intelligent defibrillator to more complex and sophisticated systems for empathic education in virtual reality or artificial companions. We saw an amazing aspect of the human science knowledge discoveries presented here that is connected to music. We learned music is a way to apply the knowledge insights of human science independently from technology because brain studies showed music is a promising avenue of activating the body's systems and creating positive emotion effects.

The Emotion Organon showed us that new human science is the redefining our worldview and our

foundation of knowledge. It is essential for building our future. The results presented in this book are enough to persuade us to build our lives and tools around positive emotion. We cannot completely rule out the possibility that they will not help everyone. And we will not always need them for every situation. But if we find ourselves in a situation where we lack the imagination or capacity to make our own positivity, these kinds of tools and environments can help us. Human kind has always made tools to make our lives better. Study these references. Dig deep. Listen to the lessons of the Francis Inquiry. And let your imaginations fly and your heart soar. Its our future. Design it.

REFERENCES FOR CHAPTER 8

[1] McGonigal, J. 2011. *Reality is Broken*. Penguin Press. NY, USA.

[2] Saturn, S. 2017. Two factors that fuel compassion: The oxytocin system and the social experience of moral elevation. In *The Oxford Handbook of Compassion Science*. Seppälä, E., Simon-Thomas, E., Brown, S., Worline, M., Cameron, C. and Doty, J. (Eds.) 121–131. Oxford University Press. Oxford, England.

[3] Aristotle. 2015. Translated Owen, O. 1853. *The Organon, Complete Edition*. ISBN-13: 9783849648367. JazzyBee Verlag Publishers. Bavaria, Germany.

[4] Bacon, F. 2000. *The New Organon*. Edited by Jardine, L. and Silverthorne, M. Cambridge University Press. Cambridge, England.

[5] Federal Bureau of Investigation. 2023. A supplement to the hate crime statistics 2021. *Uniform Crime Reporting Program. https://www.fbi.gov/news/press-releases/fbi-releases-supplemental-2021-hate-crime-statistics*

[6] UK National Health Service. 2013. Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry. *https://www.gov.uk/*

government/publications/report-of-the-mid-staffordshire-nhs-foundation-trust-public-inquiry

[7] The Health Foundation. 2023. https://www.health.org.uk/about-the-francis-inquiry

[8] Mason, C. 2023. *Designing Artificial Compassion Technology*. Amazon Kindle Independent Publishing Platform. *in-press*.

[9] Griffith, J. 2019. A losing game: The law is struggling to keep up with technology. *Journal of High Technology Law*. 12 April.

[10] Lessig, L. 2006. *Code. Version 2.0*. Basic Books. New York, USA.

[11] Mason, C. 2008. Human-Level AI Requires Compassionate Intelligence. *Proc. Association for the Advancement of Artificial Intelligence Workshop on Meta-Cognition*. Chicago, USA. 147-150.

About The Author

Dr. Cindy Mason is an AI researcher with an unusual background because her AI work is inspired by medical and multi-cultural studies of the mind. She holds a Ph.D. in Computer Science, specializing in AI, from the University of California. She was also a fellow in Stanford University's joint AI and Medicine program. While an AI researcher and Assistant Chair in U.C. Berkeley's BISC Technology and Philosophy group in the EECS Department, she began investigating models of the mind that connected mental state and emotion with physical health. She obtained her certification in psychophysiology and a state certification in health eduction, completing an internship in Chinese acupressure and psychophysiology at the Berkeley Primary Care Hospital, a mental health and addiction residential facility on the Berkeley-Oakland border. She also worked with the medical team of Tenzin Choedak, personal physician to HH Dalai Lama.

She later took up a research position as an AI researcher in the Computer Science Department at Stanford University, while also working with patients in critical care at Stanford Hospital, Lucille Packard Children's Hospital and other clinics in the Palo Alto community, collaborating with others, including Cheryl Gasner, RNCFNP, co-founder of Stanford Hospital's Integrative Mind Body Program.

Dr. Mason's work has received many awards, including from the AAAI and National Research Council, and she was a key researcher for the New York Times' Best Selling book, *How To Create A Mind*, by Ray Kurzweil. Among her accomplishments, she founded the first national (AAAI) and international (IJCAI) workshops bringing together scientists and AI researchers to collaborate on the environment and sustainability. The book from those meetings, *Artificial Intelligence and The Environment*, has sold in 31 countries. She is noted in the Computer History Museum in Mountain View, California, and in The Women's Museum of Australia, for starting a Computer Science Department at the College of Central Australia (now Charles Darwin University) in the Australian Outback with Anna Lichtenberg.

Thanks and Acknowledgements

I would like to thank all the people who supported the work leading up to this book. My curiosity about emotion and cognition began around the same time breakthroughs in neuropeptides and brain sciences were happening. Together with Earl Mason, Ph.D., M.D. and his wife Eileen, we tried to find research that would explain how love and compassion heal. The science just wasn't there yet, but we did not give up our quest to find answers. This volume is the final result of that initial curiosity. Over the next 3 decades, the science exploded across all areas of medicine, as documented here. I am grateful to each and every one of those scientists, and Earl and Penny, for believing in this work.

The book would not be possible without taking an unconventional career path with parallel studies in AI and human health science. There are people to thank in both of these worlds because it is through these multi-disciplinary experiences that the ideas behind this book have arisen. I would like to thank both of my bosses in the EECS Dept. at U.C. Berkeley and in the CS Dept. at Stanford because they never complained about the time I spent in the local hospitals. I would also like to thank my friends at MIT and Berkeley who were unable to understand the link between emotion and cognition. It was their lack of understanding that drove me to do more research so they could see what I did. I hope when they read this book, it will make sense to them. I would also like to thank those special individuals in Palo Alto who unconditionally believed in what I was doing.

I would also like to offer deep gratitude to the people from cultures other than my own who brought the gift of their knowledge to others. They have understood for generations that emotions and human health are inseparable. Their protection and preservation of that knowledge are now paying off, as modern science continues to prove the merits of their cultural wisdom.

I especially appreciate friends and colleagues in the US: Berkeley, Palo Alto, Livermore, Santa Cruz, and Cambridge as well as friends from France, England, Ireland, Spain, India, Australia and Japan. I could not have completed this work without their friendship and conversation. I would especially like to thank Curt Hall for the many discussions on editing and writing. If I have left anyone out, I apologize.

The Glossary of Big Words and Acronyms

It has been pointed out to me that there are some unusually big words in this book. These are relatively new words resulting from new multi-disciplinary research. For instance, when psychology, neurology and immunology were brought together, the multi-disciplinary field was called psychoneuroimmunology. It can be a mouth full, but I hope that this glossary will help! I also included some acronyms.

AI - An acronym for Artificial Intelligence that generally refers to a wide range of robotics, machine learning, cognitive systems and other kinds of AI.

Bioplasticity - first discovered by neuroscientists, it is a phenomena where our body systems and organs change in response to experiences.

Cardio neuropeptide - a peptide found in the neurons supplying the heart with its supporting nervous and vascular system.

Compassion-Centered Design (CCD) - the design of everyday objects inspired by compassion literacy (see *Compassion Literacy*).

Compassion Literacy (CL) - the state of being informed of the science about the crucial role of compassion in human biology.

Cyberspace - An emergent world created through online experiences, interactions with software agents, and other digital artifacts that can communicate with us.

Device-mind-body rub off - the phenomena where device rub off impacts the body functions via mental and emotional rub off (see *bioplasticity* and *Medical Renaissance of Emotion*).

fMRI (functional Magnetic Resonance Imaging) - fMRI is a non-invasive way to measure brain activity according to changes in blood flow in tissue. The brain "lights up" when it is active. Because it happens over time, it is considered more accurate than MRI (see MRI).

Generative AI - AI technologies that can generate and manipulate text, voice, and other media. Its output relies on training data.

Micrographia - Bodies made visible through a microscope.

Medical Renaissance of Emotion (MRE) - A period of time when medical research about the biology of emotion became prolific.

Machine Rub Off (MRO) - A phenomena where people are changed by interacting with a system, immersive environment, device or machine. Discovered by Cliff Nass and team at Stanford University.

MRI (Magnetic Resonance Imaging) - MRI is a non-invasive medical imaging technique used to measure brain and other kinds of soft tissue.

Neuroeconomist - Someone who applies neuroscience to the study of economics.

Negative-Device-Plasticity - A negative bioplasticity effect created by machine rub off with a system, immersive environment, social media, or device. It may occur through frustration, irritation, hate speech and so on.

Neuropeptides - A class of peptides (proteins) that act on or are essential to neurological synapses, cell functions, pathways or other neurological tissues throughout our body. They often act as a messenger or enable functions, sometimes in the presence of other peptides. An important example is oxytocin, which has also been discovered to be a cardiovascular peptide and important hormone with a wide range of influences on body function.

Organizational Psychopath - A psychopathic personality disorder that is focused on inflicting wide scale suffering by using a position of power within an organization.

Positive Psychology - A new branch of psychology concerned with the study of human flourishing and living a good life.

Positive-Device-Bioplasticity - A positive bioplasticity effect created by machine rub off with a device. It may occur through intentional design, such as with Compassion-Centered Design or by coincidence.

Psychoneuroimmunology - the study how our psychology and neurology affect the immune system.

Psychoneurocardiology - the study of how psychology and neurology influence the cardiovascular system.

Psychoneuroendocrinology - the study of how our psychology and neurology impact the endocrine system.

Psychoneurocardiology - the study of how our psychology and neurology impact our cardiovascular system.

Psychophysiology - the study of the relationship between our attitudes and mental state and our body and its processes.

Social-cyber-world - any world, virtual or natural that includes people and machines.

Social-cyber-environment - any environment with machines where we engage socially. This includes user interfaces (e.g. gaming, virtual reality, etc.).

VR - an acronym for Virtual Reality