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Reinforcement in the Information Revolution

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INTRODUCTION

Marcia took a long look at the backpack. She immediately noticed the integrated rain cover and adjustable water bottle holders, two features that were a must for her through-trek of the Pacific Crest Trail she was planning for next year. She had seen review after review of packs on Instagram by long-trek influencers. This was the one, and $387 later, the pack was set to arrive on her doorstep in two days. This is by all accounts an innocuous story. And it may seem that what is being hinted at is a story about consumption and the role of multimodal advertising in pitching products to us. To be sure, AI has a role in the facilitation of identifying, segmenting, and targeting adds to potential consumers, but if we reflect on this scenario further, a larger reality also becomes clear.

Consider, for example, the rapid emergence of through-trekking more generally. Since the first through trek of the Pacific Crest Trail in 1952, fewer than one hundred people per year have completed the trek into the mid-2000s. Coinciding with the advent of social media and the age of the internet, that number has rapidly increased to more than five thousand permits issued in 2019.[1] Suddenly, a culture of long-distance hiking emerged that coincided with the internet age. Similar statistics can be found for all sorts of formerly niche activities including long-distance running, open water swimming, and ownership of stationary bikes, such as Peloton.

Behind targeted advertising more generally is the ability to create social realities that formerly did not exist. Humans are a social species and will readily change beliefs, hobbies, and even political parties to conform to the group in which they find themselves.[2] The digital age has facilitated the creation of online communities that allow us to congregate with others who share our community values, further refine our beliefs, and even reflect our fitness obsessions. Because these communities occur online, it presents a closed frame of variables under which AI learning algorithms can aggregate our data and build a predictive model of how we might behave when presented given variables.[3] While this ability is perhaps neither good nor ill, it does represent an incredibly powerful tool for those that wield it to influence the behavior of humans at a scale far beyond anything prior.

Opportunities for AI to identify and predict our behavior is only increasing. Adolescents and young adults spend between twenty and twenty-four hours per week in front of screens.[4] Data from screen time apps report a wider range for adults, between nine hours per week to much higher estimates, some exceeding an average of five hours per day.[5]

Collection and aggregation across platforms of our data, including our credit cards, social media, internet searches, location data, and more, allows learning algorithms to better understand our motivations and place

1. Pacific Crest Trail Association, "PCT Visitor Use Statistics."

2. See Gennaioli and Tabellini, "Identity, Beliefs, and Political Conflict"; Rydgren, "Beliefs."

3. For a further discussion of this, Luciano Floridi presents the case that the move to the information environment represents a fourth revolution in how humans conceive of themselves after the Copernican, Darwinian, and Psychological/Freudian revolutions. See Floridi, *Fourth Revolution*. As a consequence, we make it easier for AI to operate because we reduce the number of variables in a given situation to their native digital environment. In the analogue world, the number of variables and their transient nature overwhelms the computational power of predictive algorithms to render them ineffective. However, we are continually integrating them into our analogue world with, thus far, mixed success.

4. See Abdel Magid et al., "Disentangling Individual, School, and Neighborhood Effects on Screen Time among Adolescents and Young Adults in the United States."

5. See Hodes and Thomas, "Smartphone Screen Time"; Vizcaino et al., "Reliability of a New Measure to Assess Modern Screen Time in Adults."

realities in front of us that will influence the choices we make. The realities placed in front of us operate on our internal systems of reinforcement. Simply defined, reinforcement is a consequence of our actions that motivates us to seek rewarding things and avoid unpleasant ones. Reinforcement is arguably *the* most important aspect of shaping one's behavior, and perhaps even one's self in the holistic sense, as anyone who has been responsible for raising another human or an animal can attest to.

This chapter will outline what it means to be a behaving human and how AI makes sense of these concepts. It will then explore possible near-future implications of our remarkable progress in understanding how human behavior works with the assistance of AI from a neurobiological basis. A focus on understanding the reinforcement mechanisms of the brain will reveal the consequences of ceding control of so much of our brain-environment interactions to AI. It will conclude by offering a potential Christian response to this digital reality from a uniquely Anabaptist perspective.

DEFINING A HUMAN WITH FAITH AND NEUROSCIENCE

Much has been said about what it is that defines a human. Debate over things such as what it means to be created in the image of God, whether we have a non-corporeal soul, or whether we have free will all have critical importance on the definition of humanity, our relationship with other aspects of creation, and our relation to the eternal. However, many of these issues stretch far beyond what can be reasonably expected in a conversation between neuroscience and theology, such as is being attempted in this chapter. However, others have argued that the definition of what it means to be human is an inflection point where neuroscience and theology can productively interact.[6] As neuroscience has accumulated examples of how brain alterations can reliably affect everything from emotional regulation to the ability to sing, it has become clear that at least much of what we consider to be ourselves—our behaviors and even internal states—is produced by interactions among neurons.

Indeed, the discipline of behavioral neuroscience seeks to understand the neural circuits, chemical interactions, and brain states that ultimately select a single behavior from any variety of possibilities. In the quest to discover neural representations of choices, neuroscience has increasingly reached further and further into other disciplines including sociology, philosophy, and psychology to integrate the nearly innumerable variables

6. See Clayton, "Neuroscience, the Person, and God."

that might ultimately influence our choices. For example, the pioneering work of figures such as Joseph LeDoux in understanding the contributions of fear-related processes to decision-making, or Patricia Goldman-Rakic in understanding how the cortex represents goals, has allowed neuroscientists to observe and manipulate decisions in real time. Neuroscientists, building on the knowledge of how the brain represents everything from hunger to stress, have now built tools that allow them to causally influence behaviors across a variety of species including humans. *Casual attribution of brain processes to behaviors, and the correlated ability to manipulate those processes, may turn out to be the most consequential contribution of science to the nature of humanity.* With this knowledge, if desired, we could perhaps in the near future erase depressive thoughts from the brain through using the brain's own learning mechanisms.

As early as the dawn of the twentieth century, scientists were beginning to realize just how important the causal loop between behavior and internal states or thoughts was. This led to incredible optimism about the power to shape an individual. This movement is best characterized by the radical behaviorists who claimed that, if you allowed them control of the environment and sources of reward and punishment for a child, they could turn that child into anything from a doctor to a thief.[7] Ultimately, they underestimated the power of social structures and genetic influences on aspects of how humans make decisions. But with the rise of algorithmic methods of analyzing genetic and sociological data with AI, these contributions are becoming increasingly understood.

The crucial point here is that algorithms, as they are currently designed, don't attempt to be 100 percent accurate in predicting a single individual's behavior because, on average, they are built to make excellent predictions across large chunks of the population.[8] I would argue that these averages are what will largely shape development in society whether they be toward or away from justice, inclusivity, equity, and other critical aspects of ethical life. For some time, we have known that mental states are created by imitation of social phenomena.[9] This process of forming our emotional and social content, even from early in life (eighteen months at least), is critical to any social species if group dynamics are to function properly. This, in effect, is a

7. See Watson, *Behaviorism*.

8. This represents a shift in priorities in the field of AI from a quest to understand humanity to a quest to predict human behavior. This is evidenced by the large-scale shift in methodology from logical or expert systems to statistical approaches. In the end, the goal is not to understand how the human mind works, but to predict its outputs to a high degree of accuracy.

9. See Jeannerod, "Are There Limits to the Naturalization of Mental States?"

back door to understanding the human mind. Instead of attempting to build a model of what the mind is, you can instead input specific information to shape its output. Thus, if we cede social time to digital platforms, the AI algorithms that moderate them will be major players in the social realities we experience and by which we are informed. While this may not be particularly surprising to anyone, the implications of how this might develop as we gain access to additional computational power and tools to manipulate the brain needs to be better appreciated. To do this, we must be clear on what we talk about concerning the connection between behavior and humanity.

WHAT IS A BEHAVIOR?

If the hypothesis for this chapter is that we are increasingly ceding social time to experiences guided by AI algorithms, and AI's use of human behavioral prediction is rapidly altering human society, then one must be able to accurately describe what is meant by behavior. Human behavior can be thought of as an interaction between an individual and their environment. The environment presents a set of sensory stimuli that the individual can respond to with an action aimed at accomplishing some goal. The terms "behavior" and "action" at this point become important and are discussed elsewhere in this book.[10]

For present purposes, I will operationally define a behavior as a combination of overt (movements themselves) and/or covert (neural activity, e.g., thinking) processes that result when goals of an individual are represented internally, and then acted upon (or not) in the external world. This operational definition attempts to cover those actions that involve considered or intentional goal-directed behaviors rather than "mere behaviors" or, perhaps more accurately, reflexes that are innate to an organism. However, what is conscious (intentional) and what is unconscious (a reaction) in a behavior so defined remains uncertain. For this reason, as a neuroscientist I prefer to use the term "behaviors" to cover a range of what philosophers might consider both actions and behaviors. What is certain, however, is that these behaviors are learned through constant interactions with the external world and modified every time they are performed. This facet of human behavior is recognized across many disciplines. From engineers working on jobsite safety to early-life educators, the critical importance of how the environment, or everything "outside" of the brain, shapes the behaviors of the individual is utilized to ensure those behaviors are appropriate for their context.[11]

10. See Rice, "What's so *Artificial* and *Intelligent* about Artificial Intelligence?"

11. See Jiang et al., "Understanding the Causation of Construction Workers' Unsafe

What is perhaps generally underappreciated is the ability of the environment to profoundly alter the very structure of the brain itself. Returning to the example at the beginning of the chapter of the avid backpacker, neuroscientists can predict areas of the brain that become engaged when presented with stimuli associated with backpacking that would differ from someone without such interests. In fact, if one were to ignore ethical constraints on experiments, they could even take someone uninterested in backpacking and, by stimulation of specific brain areas involved in reward processing, turn them into someone that "enjoys" backpacking as well.[12]

Classic studies on the environment in which individuals are raised demonstrate the profound impact that environments can have. A famous example from psychology is the case of infants neglected in orphanages in Romania following the fall of the dictatorship in 1989.[13] Namely, profound and long-lasting changes in the size of the brain, neural activity, and cognitive function were found even after children were removed from the impoverished environments.[14] These findings matched well-validated models of neglect in rat models of development. These studies compared rats allowed to play and live with other rats and toys versus rats left in relative isolation. Such environmental enrichment led to an increase in the size and shape of neurons and neural circuits, and altered behavioral responses to stress, cognitive abilities, and a host of other adaptive behaviors.[15]

Similar findings have been confirmed across species, including humans, and have been extended to include a range of biochemical, anatomical, and psychological effects. For example, one major proposal for reducing the risk of cognitive decline in aging is the reserve hypothesis.[16] As you age, decline in cognitive functions—including creativity in problem solving, finding your way using memory, and susceptibility to distraction—are closely accompanied by neurobiological changes such as decreased plasticity in neurons, reduction in interconnections between neurons in memory-related

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Behaviors Based on System Dynamics Modeling"; Rushton and Larkin, "Shaping the Learning Environment."

12. These experiments have been done in animals, although what is meant by "enjoys" in the human context would require additional consideration. Specifically, a rat or monkey may increase a behavior or response to a reinforced picture, but we are unable to ask them whether they "enjoy" the experience. See Wise, "Addictive Drugs and Brain Stimulation Reward."

13. See Weir, "Lasting Impact of Neglect."

14. See Nelson, *Romania's Abandoned Children*.

15. See Diamond et al., "Effects of an Enriched Environment on the Histology of the Rat Cerebral Cortex."

16. See Leal and Yassa, "Normal Cognitive and Brain Aging"; Stern, "What Is Cognitive Reserve?"

structures, and more.[17] Thus, how the environment is shaped around you, whether rich with interaction or more isolated, can have a profound impact on the development of dementia later in life, impacting whether neurons have the resources to remain healthy.

EXTERNAL INFLUENCES ON BEHAVIOR

Broadly speaking, while perhaps underappreciated in society, the interaction between brain and environments is not a new revelation. Indeed, daily practices to shape one's life and mind are a cornerstone of Christianity. Discipline of mind and bodily practices are hallmarks of many of Paul's letters to the early church (e.g., Rom 12:2). The more profound point here is that neuroscience is beginning to identify the neural components of these processes. This is significant because, concurrent with this understanding, a toolkit to alter the brain based on these data is rapidly growing. In more detail below, I will lay out some of the specifics of this progress as it relates to our ability to understand the conscious and unconscious processes that lead from making sense of the external environment to deciding how to respond to it.

To illustrate this point, an examination of the relationship between the brain and muscles is particularly useful. The connection between neural activity and movements in muscles is based on trial-and-error movement feedback since before birth. In the frontal parts of our brains, there is a map of our bodies owing to direct connections between the motor area of the cerebral cortex and the spinal cord. These "topographic" maps of the cortex detailing fine control of muscle movements were identified by the mid-nineteenth century.[18] In those with missing limbs, representation of the missing limb is absent. In cases of amputation, these areas transition and are "invaded" by other body areas to utilize the unused brain real estate.

Significantly, the representation of the body goes beyond a one-to-one relationship between neurons in the motor cortex and skeletal muscles.[19] Instead, these neuron groups in the motor cortex control distinct skilled movements that have been shaped through experience. A single finger muscle might receive input from any of several areas of the motor cortex due to its involvement in various skilled hand movements.[20] These learned

17. See Leal and Yassa, "Normal Cognitive and Brain Aging."

18. See Ferrier, "Localization of Function in the Brain."

19. See Grünbaum and Sherrington, "Observations on the Physiology of the Cerebral Cortex of the Anthropoid Apes."

20. See Schieber and Hibbard, "How Somatotopic Is the Motor Cortex Hand Area?"

action sequences are taught to the cortex through thousands of iterative experiences as an individual moves and interacts with the world. More specifically, the cortex interacts with important "lower brain" areas including the basal ganglia (more on this below) to select movement sequences that have resulted in goals and decrease movement sequences that failed to obtain goals.[21] Recently, neuroscientists have discovered that with implants these movement sequences or skills can be reinforced through existing brain mechanisms to shape even the movements of robots external to the brain, thus raising the possibility of extending skilled movements to include external devices.[22]

So, through many times out on the trail, our backpacker Marcia has developed the skills to shift her conscious effort away from not twisting her ankle, hiking too quickly, or losing track of where she is, and toward being able enjoy the experience. Unconscious processes guide her behaviors through the execution of skilled movement with little need for reflection on what she is doing. The learning of these skilled behaviors continues in response to feedback from the external world as she accomplishes her goals and learns from mistakes. In short, reinforcement actively shapes the behaviors Marcia will perform, often in the absence of conscious reflection. Perhaps even more exciting is recent data showing us that, in addition to behaviors, emotional and cognitive states are also subject to these same reinforcement processes.[23] This indicates that our thoughts and emotions are also subject to the environmental shapers of our lives, including AI.

UNDERSTANDING REINFORCEMENT

Recent work in the neural basis of learning and memory is also exploring whether we can avoid having to rely on the traditional time-consuming iterative processes of reinforcement of behaviors in the natural world. Specifically, this research seeks to understand whether we can short-cut learning by creating artificial or more efficient forms of reinforcement than would otherwise be required. This raises the need to understand how reinforcement of particular behaviors is accomplished. Closely related, of course, is how AI utilizes reinforcement to "learn" in an artificial manner. Understanding the similarities and differences between these will help make sense of the implications for AI on human behavior.

21. See Graybiel, "Habits, Rituals, and the Evaluative Brain."

22. See Rajangam et al., "Wireless Cortical Brain-Machine Interface for Whole-Body Navigation in Primates."

23. See Floresco, "Nucleus Accumbens."

The basic method of iterative learning in both artificial and biological systems is explained by a classic model of reinforcement learning, the Rescorla-Wagner equation.[24] At its base, the Rescorla-Wagner equation states that the value of a stimulus or event is a product of how much reinforcement a subject has encountered both in prior experiences with it, and based on what happens in the current trial. It is formalized with the equation:

$$\Delta V = \beta(\lambda - Vn)$$

where ΔV is the change in the associative strength between a stimulus and an outcome. This change corresponds to the learning rate (β) multiplied by the maximum amount of learning that could occur given the event (λ) minus the connection that currently exists between the stimulus and outcome for a subject for that particular occurrence (Vn). For example, if, by chance, your dog sits quietly near the door in an attempt to go outside and you open it, that action is reinforced and the dog learns a lot because the potential to learn (λ) was high and the current expectation (Vn) was low. As your dog continues to be reinforced for sitting quietly, the change in associative strength ΔV will decrease to the point that, even if the dog sits for quite for some time without being let out, the potential to change the associative strength is low because the long history of reinforcement has lowered the potential for new learning (λ) to such a large extent. Because of a long history of reinforcement learning and built associations between stimuli and behaviors, it is indeed harder to teach an old dog new tricks!

Neural correlates of reinforcement learning, including modified forms of the Rescorla-Wagner equation, are now well understood. Prominent among these contributors to behavior is a group of highly evolutionarily conserved neural circuits known collectively as the basal ganglia. The basal ganglia are a group of subcortical neural structures that have evolved to select optimal motor and internal brain sequences between competing possibilities. This circuit is so critical to effective selection of behaviors that it is recognizable in every vertebrate brain ranging from ancient jawed fish to humans.[25] In humans, input from higher cortical regions that control executive functions are combined with sensory information from the thalamus and reinforcement-related brain areas to select a response based on the available context.

What is meant by context here needs elaboration. Context can be everything from the time of day, to social cues from others, to how hungry you happen to be. Both actions that are goal-directed in nature and those that

24. See Rescorla and Wagner, "Theory of Pavlovian Conditioning."

25. See Reiner, "You Cannot Have a Vertebrate Brain without a Basal Ganglia."

appear as habits compete within the basal ganglia circuitry to ultimately influence motor and internal cognitive pathways, otherwise two thoughts or behaviors would be attempted simultaneously.[26]

Simply put, the basal ganglia is offered competing motor plans that are voted on in one way or another by the context of the environment and internal processes related to goals and, ultimately, a single behavior is executed. For example, at a stream crossing our hiker Marcia decides to jump to a wet rock rather than step into the stream because she doesn't want to get her shoe wet. If the executed behavior is successful, it is reinforced (more on this below). If unsuccessful, it will be disincentivized in that particular context and less likely to be selected in the future. Because the rock was wet and slippery, next time Marcia will opt for the wet shoe rather than the bruised bottom. In this way, we can rapidly refine our behaviors to be the most appropriate to reaching our goals in a given context.

One issue to be raised here is how much of this occurs at non-conscious levels. The range of brain regions and sensory input that is received in the basal ganglia far exceeds what enters the conscious mind. Some have argued that this likely means that decisions happen at an unconscious level and have found behavioral psychology experiments that seem to support the conclusion that conscious control of our behaviors is an illusion.[27] A closer look at the neural basis of goal-directed activity, however, points to behavior being a complicated mix of both top-down consciously-driven goals being maintained and updated by many more ongoing non-conscious process that have a profound influence on behavior.[28]

What this reveals for the purposes of understanding behaviors is that much of our goal-directed behavior is influenced by factors that do not reach our conscious mind and therefore are influenced instead by past experiences in similar contexts. All the prior reinforcement history, ongoing sensory stimuli, learned action sequences, expected outcome information, and emotional context are rapidly combined to change synaptic weights on neurons to bias the selection of a behavior automatically, and continuously. The key question then is, what are the neural processes that facilitate both implicit and explicit forms of reinforcement learning? Clarification of this question will go some way in answering whether an AI algorithm with access to a massive data set of contextual factors is able generally to shape the behaviors that will result from them.

26. See Redgrave et al., "Goal-Directed and Habitual Control in the Basal Ganglia."

27. See Doris, "Persons, Situations, and Virtue Ethics."

28. See Suhler and Churchland, "Control"; Berkman and Lieberman, "Neuroscience of Goal Pursuit"; Maoz et al., "Neural Precursors of Decisions That Matter."

REINFORCEMENT AND THE CONTROL OF BEHAVIOR

The study of the neuroscience of reinforcement learning took a great leap forward with the discovery that the neurotransmitter dopamine acted as a feedback signal.[29] In 1997, Wolfram Shultz performed a now classic study in monkeys that showed how reinforcement in the brain can be mediated by responses recorded from dopamine neurons. When a monkey was sitting quietly and juice was administered via a tube into its mouth, dopamine neurons responded by increasing their activity, marking as a reward the feeling of pleasure that the juice created. However, crucially, when the juice reward was preceded by a cue that indicated the juice reward was about to be delivered, the pleasurable juice no longer resulted in dopamine activity. Instead, the predictor of the reward (the cue) now resulted in dopamine activity. Finally, when the cue that predicted the juice reward was given, but the juice unexpectedly withheld, dopamine neurons decreased their activity and signaled that the outcome (the juice) was less than expected. This is commonly termed a reward prediction error, or RPE.[30]

Subsequent research has extended these crucial initial findings across many species to demonstrate that dopamine acts as a teacher in the brain to help modify expectations based on an outcome of an event, whether that outcome is some external event or a behavior of the subject. If the outcome was better than expected, an increase in dopamine is observed. If the outcome was worse than expected, a decrease in dopamine activity occurs. Thus dopamine is now thought of as a signaler of salience rather than as a reward or pleasure *per se*. Salience in this case can be thought of as events that draw attention due to their potential to serve as predictors of future outcomes. This means that the neural signal of dopamine can be detected in the brain and utilized to shape behaviors. Identification and manipulation of this signal of salience has been employed in many contexts, including as the basis for maladaptive behaviors such as substance abuse, gambling, and internet addiction.

The ability to track salience in the brain and to track the brain's interpretations of salient events, whether positive or negative, has profound implications for predicting and shaping behavior. This is perhaps best

29. Although beyond the scope of this paper, it is worth pointing out that the role of dopamine in the brain is in fact not related to pleasure as is popularly assumed. Rather, as explained in this section, it is more accurately a reinforcement signal that is used to increase or decrease behaviors based on their relation to goals. Rather than pleasure, although that could be one such goal which dopamine reinforces, this is more accurately described as salience. For a further discussion see Berridge, "Debate over Dopamine's Role in Reward."

30. See Schultz et al., "Neural Substrate of Prediction and Reward."

exemplified by classic experiments by James Olds and Peter Milner in which electrodes were placed into various areas of the brain to enable the stimulation of neural activity.[31] To initiate brief neural activity in many brain areas associated with dopamine and opiate neural activity, rats would press a lever until the point of exhaustion, even forgoing food when on a restricted calorie diet. These and subsequent experiments showed that increasing brain activity in these reinforcement areas drives behavioral repetition based on keeping reward or salience high. Similarly, if dopamine and other associated neurotransmitters are increased pharmacologically, as is the case with many drugs of abuse such as methamphetamines, behavior can become focused on seeking and obtaining those drugs. The ability of these pharmacological agents to push reinforcement systems well beyond normal operating conditions can lead to a singular focus on obtaining that form of reinforcement (i.e., addiction).

As the technology to both monitor and manipulate the brain has continued to advance, the ability to gain precise control over both the perception of salient stimuli and the ongoing internal state of the subject has advanced significantly. For example, circuits in the brain that control the consumption of food have been identified and can now be manipulated in real time to both initiate and cease eating in mice.[32] Specifically, using a technology known as optogenetics, scientists can implant, using an engineered virus, a channel that responds to photons of light by opening and causing neurons to become active, or other channels that cause them to become inactive.[33] With this bidirectional control of part of the feeding circuitry in the brain, Joshua Jennings and colleagues were able to cause either otherwise sated animals to eat, or hungry animals to cease the consumption of food. While this example of the control of behavior or reinforcement may seem as yet far-fetched in humans, we need only think of ongoing experiments aimed at the control of impulsive or depressive behaviors using implantable devices to realize the proximity of this form of brain control to reality.[34] Where is the line in attempting to control the impulse to consume drugs or to control sad thoughts—or even thoughts that society decides are deviant?

31. See Olds and Milner, "Positive Reinforcement Produced by Electrical Stimulation of Septal Area and Other Regions of Rat Brain."

32. See Jennings et al., "Inhibitory Circuit Architecture of the Lateral Hypothalamus Orchestrates Feeding."

33. See Deisseroth, "Optogenetics."

34. These devices are known as deep brain stimulators (DBS) and are already commonly used to reduce the symptoms of Parkinson's Disease, but are also being implanted to treat conditions ranging from depression to chronic pain.

Even now, companies that have the resources to develop AI algorithms aimed at connecting passively collected brain patterns to overt behaviors are beginning to brag about their ability to shape experiences to get a desired behavioral output. This is accomplished through learning algorithms that analyze brain states, looking for known responses that relate to the learning and decision-making circuits that were outlined above (namely salience). For example, Neilson has invested significant resources into their consumer neuroscience institute. This has led to over five hundred published peer-reviewed articles with the overall goal of better targeting advertising to consumers by understanding how the brain responds to everything from fonts to color schemes and to objects that appear in videos. For example, data analytics provider NielsenIQ states:

> We've always known a significant part of advertising spending is wasted. Now, neuroscience can identify the exact moments in an ad that activate memory, draw attention, or prompt an emotional response, and determine on a second-by-second basis which parts are and are not effective in engaging viewers. By including only the most effective elements in your ads, significant savings can be realized from shortening their length while also maintaining or improving their overall impact.[35]

AI has given companies and other well-resourced entities the ability to analyze vast amounts of brain data, eye movement, and online clicks to generate the ability—with significantly improved accuracy—to predict the types of interactions that drive salience and, in turn, human behavior.

Where is the limit to this move to utilize brain data to predict human behavior? Neuroscience continues to increase rapidly its toolset to both measure and manipulate the brain using non-invasive techniques. Direct-to-consumer products are being bought up by technology companies including Facebook, Google, and others that aim to passively read brain data either directly, through head-worn devices, or indirectly, through technology that can be worn on the wrist.[36] The latter in particular might be especially useful for companies given the ubiquity of devices that measure physiology for tracking runs and day-to-day activity. Who is to say what these companies that primarily earn their income from advertising will do with this potential treasure trove of data about our internal neural processes and their related behaviors? Again, here it must be pointed out that the goal is not to predict every individual choice at this point. It currently remains far beyond our ability to use individual brain state examples to predict

35. NielsenIQ, "Discover More of Your Business."

36. *BBC*, "Facebook Buys 'Mind-Reading Wristband' Firm CTRL-Labs."

behavioral outcomes. Rather, the strength of AI is to aggregate signals to look for signatures of desired responses and use those signatures to shape behaviors of individuals on average. What needs to be more clearly understood, however, is that *these averages belong to our societies* and thus are sufficient to the goals of profit generation whether we seek to sell serious backpacking equipment or sway public opinion in an election.

Another way of putting this, to paraphrase economic theory, is that those who control the means of salience control the direction of society. As long as access is actively or passively granted to aggregate and analyze our behavior or indeed our neural data, the means by which we make those choices can be strategically adjusted. This can happen under the guise of directing purchases, as is currently done in the United States and elsewhere—or, in the case of more authoritarian states, it can be used to shape the direction of society. Perhaps the first attempt at the latter is the Chinese social credit system currently in development to evaluate individuals and companies based on the goals set out by the Communist Party.[37] Time will tell how systems such as these integrate potential neural data obtained by various means to further incentivize behavior.

Of immediate concern, however, is that the rise of brain-reading and manipulating devices has far outpaced our legislative infrastructure to deal with the ethical and sociological implications these technologies have raised. This gap has led many prominent figures to call for increased awareness of these implications, resources aimed at understanding them better, and creating the means by which to legislate the use of various technologies. Among those leading this call has been Nita Farahany, who has urged the creation of a cognitive bill of rights. In a TED Talk that has garnered nearly two million views, in her keynote speech at the 2019 annual meeting of the Society for Neuroscience, and in other appearances at places such as the World Economic Forum, Farahany has stated, "The time has come for us to call for a cognitive liberty revolution to make sure that we responsibly advance technology that could enable us to embrace the future while fiercely protecting all of us from any person, company, or government that attempts to unlawfully access or alter our innermost lives."[38]

Devices that can infer mental states such as attention or emotional arousal already exist and will only become more advanced as companies or governments with billions of dollars in resources continue to invest in research and development. Restricting information flow is likely a losing

37. See Chorzempa et al., "China's Social Credit System."

38. Farahany, "When Technology Can Read Minds, How Will We Protect Our Privacy?," https://www.ted.com/talks/nita_farahany_when_technology_can_read_minds_how_will_we_protect_our_privacy.

battle. Therefore, it seems prudent instead to develop a framework for how to engage with this technology in ways that increase human thriving, equity, and inclusion. With so much at stake, interested Christians might ask themselves, "What role can we as a body of faith play in shaping how we engage this technology that aligns with the values of the Bible?" Certainly, many groups may come to different conclusions when faced with this question based on prior engagement with ethical considerations around technological concerns. In the following, I offer a uniquely Anabaptist approach as a model for how this response may look in a Christian context.

REINFORCING COMMUNITIES OF CHRIST: AN ANABAPTIST PERSPECTIVE

The question of what is to be done about AI and how we ought to shape its development is beginning to fill libraries with commentary. What this section hopes to suggest is what the neuroscientist might have to offer to a church community that seeks to make sense of how AI interacts with lived experience. How should we understand what has already been done and where might we highlight areas of potential communal action? Based on what was outlined above, it will be particularly important to understand what the models of reinforcement are that underlie the AI algorithms with which we interact. We need to reflect on who AI is currently for—its aims, goals, and what it considers reinforcement—to better grasp what it has already done and what it can potentially do. The context in which we make our decisions and respond to reinforcers is inexorably linked as we increasingly are becoming part of an information-driven future.

Philosophical development has been key in understanding the ramifications of the circular effect of environment and behavior on what it means to be human in the context of the information revolution. Luciano Floridi even goes so far to describe the development of environment-shaping technologies as the fourth revolution in human development following the Copernican, Darwinian, and Freudian revolutions.[39] Specifically, one way to understand what makes the information revolution so important is technology's ability to autonomously shape the environment following an initial set of inputs from programmers. This in essence breaks, or perhaps exponentially increases, the feedback loop between us and the environment we create. In other words, we have the potential to delegate, and perhaps in some ways already have delegated, our influence on our environment

39. See Floridi, *Fourth Revolution*.

(and vice versa) to autonomous algorithms created by companies or governments that shape our world and ourselves in their desired image.

This happens in many ways, in both online experiences and in the real world. For example, when Marcia spends more time on a post about hiking as she scrolls social media, the algorithm doesn't need to learn, through a process of trial and error, what it was about the post that made her pause on it. Instead, it can take the aggregated data from millions of others and compare models of Marcia to it. In the world, too, AI can examine her practices, location data, purchases, and other traces left in her digital footprint to discern patterns of predictable behavior based on models of people with similar features. Further, what you interact with—the advertisements, article suggestions, interest groups, etc.—will shape your preferences through targeted reinforcement. In view of this reality, the Christian neuroscientist can help us clarify both what contexts we inhabit and what reinforcers exist in those contexts to shape our behavior. More specifically, an Anabaptist perspective on technological discernment can serve as an example for how communities of faith can then move forward.

Sources of commentary on an Anabaptist approach to AI are rare. Therefore, to begin to answer these questions, I will use the example of Anabaptist engagement in bioethics and ontology as a framework for finding Christ in this fourth revolution of humanity. Further, I make no claims to be an authority on Anabaptist thought. Rather, mine is a lived experience within the tradition informed by reading and participation in conferences and forums where these issues have been discussed. In particular, Eastern Mennonite University held a conference on the meaning of biotechnology to faith in 2003 while I was a student there. Those discussions and the subsequent edited volume that resulted inform much of what follows concerning a possible response to yet another novel technology, AI.[40]

It must first be noted that Anabaptist morality is concerned with the creation of a human moral community. For example, in the Anabaptist tradition, sin is considered a communal act. Any action of an individual within a community has the potential to affect the whole body and, therefore, the responsibility for reconciliation is also communal. While capitalism seeks to enhance the individual pursuit of happiness or the "good," many Anabaptist scholars have sought to contrast this with the call of Christ to be a community that corporately seeks the good of the "least of these" through radical service.[41] The concern of technological advancement, then, is primarily about how we create and maintain these communities with technology.

40. See Miller et al., *Viewing New Creations with Anabaptist Eyes*.

41. See Kraybill, *Upside-Down Kingdom*.

How do we ameliorate human suffering with AI—not, crucially, increase the good? These are key differences.

For example, consider the possibility that through automation Marica is afforded more free time to do what she enjoys (long-distance trekking) by working from home. However, after moving across the country, her primary relationships are with coworkers and the Bible study that formed among Christians at her workplace. Because of less contact outside the office, the group eventually falls apart. In this case, the automation increased individual good but disrupted the interdependence of a given community. Anabaptists might consider the disruption of interdependence harm even if, by conventional methods, the wealth (or good) of everyone in the community increased. Even if the group members agreed to disband due to other interests, harm may have been done to God's call to live in community. This traditionally would have led to the rejection of the technology by some Anabaptist groups.

This approach of wholesale rejection of a technology could drum up "Luddite"-like imagery of the Amish "rejecting" all technology and separating themselves from society. However, this is a largely uninformed view that fails to understand the process of communal discernment that takes place in Anabaptist communities when considering what to do with new advances. Indeed, a general consensus is that technologies such as genetically modified organisms on their own are ethically neutral.[42] For Anabaptists, the consideration for the adoption of any technology takes place in communities where consensus can be built. Without communal action, no mutual accountability is established. So, in the example of automation in Marcia's workplace, it isn't the technology itself that is problematic; it is the consequences of its adoption that are of concern. How might this process look when thinking about such integrated technologies as algorithmic learning?

Indeed, the difference between decisions concerning automation at a corporate entity versus a technology from prior generations, such as whether tractors should be incorporated into farm work, certainly seems difficult to grasp. The globalization of many aspects of society has gone hand-in-hand with a globalization of decision making. How can we be held to make choices about our work when we are employees of a multinational corporation? In other words, how can one effectively reject a technology, even as a church community, when the jobs members have can range so widely and incorporate such a deep level of technology? I will argue that we must shift instead to think critically in these communities about how to cultivate accountability for behaviors rather than focusing on the technologies

42. See Miller et al., *Viewing New Creations with Anabaptist Eyes*.

themselves. Specifically, how do our individual behaviors reflect our patterns of preferred reinforcement and how can we hold one another accountable as we reflect on what our reinforcers say about our priorities? Underlying this is the need to develop shared communal priorities.

An Anabaptist response to the incorporation of new technologies is informed by three distinctive communal experiences. First, Anabaptists are informed by discipleship to Christ. Menno Simons, one of the key early leaders of the Anabaptist movement, prefaced his writings with his favorite verse, 1 Cor 3:11: "For no one can lay any foundation other than the one already laid, which is Jesus Christ." For early Anabaptists in particular, this commitment to discipleship led to a lived experience with an ethic of dissent. The belief in believer's baptism, fellowship of all believers in church communities rather than hierarchical distinctions, and other faith emphases led to clashes with church authorities of the day.

Non-conformity to dominant culture can often stand in direct contrast to forms of social reinforcement that act on the neural mechanisms outlined above. As interdependent primates, humans experience social belonging as a form of reinforcement.[43] What is considered community has rapidly changed with the digitization of society. It is very likely that a larger proportion of people now spend less time with their church communities than they do engaging in digital forms of interaction and entertainment. There's no doubt that your community is a function of those with whom you spend time. Christians must examine this critically if they hope to maintain a community at all, let alone one of dissent. Perhaps church communities will also move part of their existence online and a larger context of communal engagement will lead to more insightful ideas about how to order ourselves in society.

A second major principle of the Anabaptist ethical context is the experience of persecution as a function of being dissenting communities. Experiences related to conscientious objection to military service, or rejection of Catholicism and Lutheranism in Europe, led Anabaptists to emphasize the needs of persecuted minorities within a majority culture. In practice, this has resulted in the idea that if the adoption of a new technology is likely to increase suffering for the "least of these," then it must be communally rejected. Even if beneficial to individuals within the community, if any are made to suffer as a result of its use, it should be rejected. This is based on the teachings of Christ for the poor and the widow who lived outside of the community.

43. See Jones et al., "Behavioral and Neural Properties of Social Reinforcement Learning."

In practice, what this might look like is asking moral questions about our everyday lives in community spaces, perhaps even in online chat groups. Questions such as "Who have my financial decisions benefitted this week?," "Who have they harmed?" and "Where did I devote my social energy?" can help us frame reflections on how the reinforcement mechanisms that surround us have led us to behave in certain ways. The consequences of our actions in modern society are notoriously difficult to discern due to the complex supply chains and labor practices that underlie economic activity.[44] However, using communal reflection and encouragement can bend us toward more just practices and move us away from the exploitative power dynamics of the haves against the have-nots.

This then relates to the third guiding Anabaptist principle, a commitment to non-violence. This is commonly interpreted as an intentional move away from the accumulation of power. Conrad Brunk summarizes this sentiment well: "The worldly virtues that Anabaptists often viewed as vices include a reliance on power and violence for social and environmental control, which is seen as a lack of trust in divine sovereignty over human affairs in history."[45]

I would argue that AI, as it stands, is primarily an agent of capitalism. We need only look to the rapid adaptations in response to the coronavirus crisis to see how large corporations at the fore of AI development increased their profits while those at the margins suffered. It is not a stretch to suggest that the growth in screen time during the pandemic relates to increased profits for these companies and those that advertise on digital platforms, as many suggest that screen time increases attained during the pandemic are likely to be sustained long term. This is based on the knowledge of human reinforcement systems outlined above and the remarkable ability of AI to model and coopt them to sustain engagement. This profound concentration of wealth and power should cause Christians to pause as they think about the effect that their actions have in relation to the digital environment. This is a profound alteration of the organization of everyday existence. With every hour of increased screen time, we have ceded additional control of our behavioral-environment loop, and indeed given power, to the companies that control that space.

44. The episode titled "The Book of Dougs" from NBC's *The Good Place* demonstrates this through a discussion of how even good intentions like buying flowers for someone can cause harm due to exploitative labor practices or harmful chemicals used in their production.

45. Brunk, "The Biotechnology Vision," in Miller, *Viewing New Creations with Anabaptist Eyes*, 106.

The use of AI to concentrate power has also been happening in the workplace. Initial concerns of labor being replaced by robots has been modified to include management. Companies have begun to adopt algorithms in workplaces that can track behaviors and notify workers when efficiency drops. They can even fire someone based on performance evaluations assessed automatically.[46] In ways such as this, the human connection is removed from the workplace and power further concentrated at the altar of efficient labor and profit generation. This wanton pursuit of wealth and power is in direct contrast to the call of Christ to build the community of God here on earth. Any such attempt to dehumanize work should be strongly resisted by the committed Christian.

The pursuit of wealth that leads to ceding time and labor to profit-driven algorithms represents an ethic of individual good in contrast to a communal consideration of how we ought to order our lives. Anabaptists have recognized this for many years and have sought to draw a sharp distinction between profit and the ethics of Christ due to the assumption that the desire for profit puts mammon above God.[47] Indeed, the economic models upon which we build the metrics to measure the betterment of society (e.g., gross domestic product) are based primarily on a hoped-for increase in consumption. In the rush to not miss out on the next technological advancement that generates trillions in tax revenue to redistribute (or not) among the populace, or to create the next advancement in human health and wellness, we must ask ourselves, is our hope in the economic outcomes or in what it does to us as the family of God?

In the secular space there are also a variety of voices openly questioning consumption as the primary means by which we might measure human thriving. Even within AI, high profile examples of this dissent, including the firing of Timnit Gerbru and Margaret Mitchell at Google, reveal an unease within AI companies to consider alternatives to the goal of increasing consumption.[48] Alternatives, including the environmental movement led by feminist voices, are offering creative alternatives to the search for good in profit.[49] I would argue, however, that the church has a long history of dissenting voices to this ideology, including prominently within the Anabaptist and Indigenous movements, among others. It will be imperative that the Western

46. See Dzieza, "Robots Aren't Taking Our Jobs—They're Becoming Our Bosses."

47. See Kraybill, *Upside-Down Kingdom*.

48. See "Margaret Mitchell."

49. For examples of this see the excellent *All We Can Save*, an anthology of essays and poems by leading female voices in the environmentalist movement.

church repent and center these long-dissenting but cooperative voices if we seek to harness our partially digital future rather than be harnessed by it.

So what does this look like? Neuroscience tells us that social reinforcement can directly compete with even strong biological reinforcers, including drugs of abuse.[50] Age-old practices within the church such as communion and gathering to worship are built on the idea of social reinforcement. Group singing is known to release endorphins, the body's own opiates, in addition to providing other positive benefits.[51] One thing I have always enjoyed in a majority of Mennonite services I have attended is the time of sharing praises and prayer concerns, either during Sunday school or during service. This moment of sharing and accountability can be a powerful form of social motivation that can shape behaviors. What if we cultivated communities of digital accountability? Shared our screen time from the previous week? Celebrated our ability to get off our phones and go to bed at a reasonable time? What if we found ways of increasing our connections with loved ones and could learn to trust one another enough to speak boldly in love rather than in jealousy or anger? These practices likely already exist across the wider church, but concerted effort is needed to build communities that demonstrate the power of a focus on the ethics of Christ in the digital age. Then we may be the salt and light to others who find themselves increasingly isolated, despite having thousands of followers in digital communities where they share so many "common interests."

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50. See Venniro et al., "Volitional Social Interaction Prevents Drug Addiction in Rat Models"; Heilig et al., "Time to Connect."

51. See Kang et al., "Review of the Physiological Effects and Mechanisms of Singing."

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