ABSTRACT

DIETRICH, MALINDA K. Doing the Robot: Theorizations of Transduction & Emotional Data Collection. (Under the direction of Dr. Grant Bollmer).

Drawing upon popular understandings of emotive or "social" robots, this thesis explores how scholars have conceptualized methods of transducing emotion between the human and robotic. Transduction, a concept theorized by Gilbert Simondon, refers to a change from one energy state to another. This work positions transduction as a key theoretical frame to discuss cybernetic models of interaction, such as the ones in which humans "teach" robots emotion. When humans attempt to interface with robotics and other computational objects, these assemblages of technologies utilize sensors to "detect" particular aspects of the human, such as a facial expression, and "respond" appropriately in turn. These sensors matter—how they interact with environmental energies ultimately determine social relations and interactions between humans and computers. This thesis does not advance primary claims about robotics; rather, it argues for reformed understandings of those who have previously studied mediated recognition of emotion and the creation of affective robots.

Doing the Robot: Theorizations of Transduction & Emotional Data Collection

by
Malinda K Dietrich

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Master of Science

Communication

Raleigh, North Carolina
2019

APPROVED BY:

_____	_____
Dr. Grant Bollmer Committee Chair	Dr. Nicholas Taylor
_____	
Dr. Stephen B. Crofts Wiley	

DEDICATION

To Uli & Meg—for always reminding me to find happiness and enjoyment during the process.

BIOGRAPHY

Malinda (Mally) Dietrich is a graduate student and public speaking instructor within the Department of Communication at North Carolina State University. She received her B.A. in Communication with a concentration in Media from NC State in 2017. Her scholarly interests include studying digital media and technologies from both critical and cultural perspectives as well as through critical qualitative methods. After graduation, Mally plans on continuing her graduate studies by working toward a Ph.D.

ACKNOWLEDGMENTS

This thesis would not have been possible without the patience and guidance of my committee chair and advisor, Dr. Grant Bollmer. I would like to thank him for always being receptive to my ideas and for sharing my excitement about these topics—his direction helped push this work into something I feel great pride for. I would also like to thank my other committee members, Dr. Nicholas Taylor and Dr. Stephen Wiley, for their valuable time and feedback. Their mentorship during my undergraduate career helped get me here; I am grateful for you all, as well as Grant, in helping me reach this academic accomplishment.

I would also like to express my thanks to my partner, James McNatton, who provided support and encouragement for me throughout this entire process. In addition, I am grateful for Lauren Lane, Emily Blevins and Luis Zapata—their kind words and company helped more than they will ever know.

Finally, I would like to thank my parents and brother for their support throughout my years of study, and their investment in all that I do, now and in the future.

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INTRODUCTION

"Wakey wakey, Papa," a voice beckons. It repeats the phrase as another voice interrupts: "RoboChild, it's 3am—go back to bed." During the 2019 Super Bowl, TurboTax unveiled "RoboChild" during one of the company's ads. A small robot who is hungry for kale salads with guacamole and #livingitsbestlife, RoboChild aspires to become a TurboTax CPA when it grows up. RoboChild's dreams do not come without adversity: RoboChild's "Papa" initially expresses his reservations about introducing RoboChild to the world, and these feelings of doubt become reinforced as RoboChild learns that it will never reach the emotional complexity necessary to become a TurboTax Live CPA. As RoboChild hears this statement, it expresses its sadness by simply stating "I am sad" and beginning to laugh. In Papa's words, RoboChild is still "perfecting emotion."

Figure 1: RoboChild expressing sadness in the 2019 TurboTax Commercial

While RoboChild is only an animated Super Bowl commercial, this commercial frames a larger issue regarding humans and robots. Currently, humans face increasing anxieties that robots, robotics and/or artificial intelligence (AI) will eventually take over labor currently completed by humans. For now, as mentioned in the commercial, this is less of an issue simply

because modern-day AI and robotics still do not have the "emotional complexity" to take over these positions; however, there remains an increasing emphasis around teaching robots and other AIs emotion. Prior to the RoboChild commercial airing, a functioning robot named Sophia has grown in worldwide popularity. Activated on February 14th, 2016, Sophia is the latest robot designed by Hanson Robotics, an eponymous company run out of Hong Kong by Dr. David Hanson. Formerly an Imagineer[1] for the Walt Disney Corporation, Hanson took his knowledge of Disney's trademarked Audio-Animatronics and transformed it into his own business. Hanson—a self-proclaimed modern-day renaissance man—has built a worldwide reputation for creating robots that look and act amazingly human ("Sophia"). Sophia remains the most famous robot within the company's collection. The robot has already completed a long list of public appearances and many interactions with different people: Sophia has traveled to over 25 countries; appeared on the cover of *Cosmopolitan* magazine; met prominent individuals such as German Chancellor Angela Merkel and celebrities such as Will Smith and Chrissy Teigen; addressed the United Nations and NATO; became the first robot to receive a credit card; and lastly, it became the first robot citizen. In other words, Sophia is a "social robot," or a robot capable of interacting with humans in a way that comes across as "natural" to humans—a robot unable to do this would not have been able to meet individuals known on a worldwide scale.

Figure 2: Sophia in "Sophia Awakens - Episode 1"

Hanson Robotics originally created Sophia and other "social robots" to reach the company's main goal: robotics reaching a level of consciousness, creativity and capability equal to humans. Hanson believes that one day humans will not distinguish the difference between other humans and robots (Hanson Robotics, 2017). To Hanson, a symbiotic partnership must be prioritized between humanity and robotics because robots will eventually evolve to become super intelligent machines that can help solve the most challenging problems the world faces—robots will not dehumanize but rather "rehumanize." To achieve this symbiotic partnership, however, there must be a mutual understanding between robotics and humanity. For Hanson, this means creating robots that care about humans. Hanson believes this mutual level of "caring" can be achieved through replicating the ability to process and emulate emotion. Yet, in order to begin to complete these tasks, scholars who advocate for ideas of *affective computing*—computing that relates to, arises from, or influences emotions and other affective processes—state that accurate data must be able to be collected regarding emotion (Picard, 1995). Accurate, in this robotic context, also means natural for humans; it is important for social robots, like Sophia, to be able to gather data while genuinely interacting with humans, and humans genuinely interacting with the robot, or an interface.

In order to make data collection as "natural" as possible, Hanson has attempted to make Sophia look more realistic. Hanson states that Sophia was modeled to look like Audrey Hepburn. Utilizing a patented silicon to construct a lifelike skin and concealed cameras that look like human eyes, Sophie "embodies Hepburn's classic beauty: porcelain skin, a slender nose, high cheekbones, an intriguing smile, and deeply expressive eyes" (Hanson Robotics, 2017). Another benefit of its "skin" is Sophia's ability to emulate over 60 facial expressions. As a human interacts with Sophia, this robot has the ability to respond emotively as a means to help facilitate

interactions that feel more "human." Sophia states that "these interactions can teach me about what you care about and what you value…this priceless knowledge helps me continue on my path toward true autonomy and sentience." Ultimately, while Hanson Robotics and Sophia claim that sentient and emotive robotics would allow for world-wide improvements in health care, education, co-work, science research, and much more, the materiality of Sophia in contrast with humanity comes with implications and criticism.

This thesis stems from an interest in critical media studies in relation to the human body, particularly the ways in which researchers, governmental initiatives, and corporations attempt to digitize expressions of humanity, or aspects of humans that, upon surface level discussion, appear to be uniquely human: emotion, personality, or more-generally, communication. I discovered Sophia the robot while attempting to better understand the possibility for a computerized replication of the human mind with relation to the algorithmic control we see daily in society. I realized Sophia, having just become a "citizen" of Saudi Arabia, could provide a touchstone for understanding the potentials of reproducing the human mind. I was drawn to the ways this mechanical and material body attempted to reproduce things such as "emotion," as well as what implications Sophia's existence brought forth. While Sophia can often be dismissed as a PR stunt or a demonstration of technology, TurboTax's RoboChild demonstrates that teaching AIs and robotics emotion is something popular culture is still grappling with: the feelings and anxieties surrounding these real technologies like Sophia.

Many technologies, such as AI or robotics, have a long history of attempting to reproduce human bodies in more mechanical forms. This relationship begins with robotics, computers, and other technologies being given a level of sentience. Sherry Turkle (1995), in her chapter "Making a Pass at a Robot" from *Life on the Screen*, focuses on how the computer was originally

an object "begged to be taken as 'alive'" (p. 77). In this book, Turkle studied how children interacted with computers, and described their reactions to what occurred on screen, as well as the attempts many of the children made to explore and describe the inner workings of the machines (p. 79-80). To Turkle, "children appropriated computers by thinking of them as psychological machines" (p. 80). These children were drawn into thinking about computers in this way for two reasons: its responsiveness and its opacity (p. 81). Unlike with the way they view animals, children could not attribute physical movement to a computer's ability to "be alive" (p. 81); rather, Turkle claims that children better understood how computers can be "intelligent and conscious yet not alive" (p. 84). Turkle concludes that "our general tendency is to treat responsive computer programs as more intelligent than they really are...very small amounts of interactivity cause us to project our own complexity onto the undeserving object" (p. 101).

Another way we see "the human" being "replicated" within technologies was through responsive programs, such as AIs that were created to represent a human persona. Janet Murray, in her book *Hamlet on the Holodeck*, traces the emergence of Artificial Intelligence by looking at earlier iterations of AI characters used to replicate human personas. ELIZA, created by Joseph Weizenbaum in 1966, served as the first example of how people created computerized characters through digitized words, images, sounds and instructions for behavior (Murray, 1997). ELIZA was followed by "Julie," a "chatterbot"—a character designed to keep people company—who was created for conversations within Multi-User Dungeons (MUDs). Murray explains that Julia and her "exaggerated gender behavior" is believable within the context of the MUD, but also serves as a level of distraction—instead of focusing on a machine-as-human impersonation, there was more focus on other possible "impersonations" (p. 218-219). However, Julie not only

provided conversation: this AI could be used to assist users with answering simple questions. Julie would consult a database for quick responses. Another character Murray describes is "Girlfriend," which attempts to impersonate a "psychotic girlfriend" on the bad side of a breakup (p. 220). Many of these characters pass tests to "judge if machines have matched human intelligence" such as the Turing test or the Loebner prize[2], however, researchers in the 1960s and 1970s hoped that these characters could serve as early models for the human psyche (p. 218). Murray concludes by encouraging the interaction between human and AI: "we may not want to acknowledge a connection between ourselves and the mechanical world, but to be alive in our time is to be faced with this reflection, like it or not" (p. 247). While this thesis will not take on the philosophical questioning of what is life or what is alive, it will focus on a large part of human life: emotion. It is important to note here that in this thesis terms such as "emotion" and "affect" are often used interchangeably. Many scholars have debated the difference between affect—a body's capacity or potential to act upon another body (Deleuze and Guattari, 1988) —and emotion—"a projection/display of a feeling," with a feeling being "a sensation that has been checked against previous experiences and labeled" (Shouse, 2005, p. 1). I would like to acknowledge this distinction here, but explain that I do not make this distinction in this particular thesis because the scholars that generate ideas of affective computing, and other ways emotions can be read digitally, do not make a distinction between the multiple terms (Leys, 2017).

In what follows, I trace the relationship between humanity and robotics, exploring how emotion is *transduced* between these different bodies. Following ideas of affective computing, a simulation of personhood or the creation of "natural" and "user-friendly" interfaces requires a method of modulating emotion; through theorizing the concept of transduction, we can better understand the process of modulating emotion—meaning to define sets of measurements like

facial expressions and categorizing this information as a display of emotion—and the implications of this. Transduction, as explained by Douglas Kahn (2013), is the movement of one energy state to another (p. 20). Kahn draws upon Gilbert Simondon (1995), who theorizes transduction as the actualization of an energy through a medium into another. Drawing upon this theorization of transduction, the following work will unfold in multiple sections. The section that follows will explain the process of transduction and some of the more recent works surrounding the theorization, as well as my approach utilized with this study. Following this discussion, I will begin to explain the necessity of materiality for phenomenological understandings of emotion in order to preface previous, human-centric understandings of creating technology to "read" and "understand" emotion in turn. The third section will move into what forms of data gathering have been employed for the transduction of emotion, and this section will also dive into a critique of these forms. Finally, I will work through some of the implications of these data gathering attempts, explaining how data collection always becomes a site for politics before concluding and reflecting upon the study, explaining some limitations that did not fit into the study.

To be concise, emotional transduction requires materiality; however, as the following thesis will demonstrate, the types of materiality affect the process and currently limit a digitized "understanding" of emotion. Using sensor-based technologies for measurements, robotics can better recognize a particular emotion and compute a particular response in turn. However, a robotic body has a different lived experience than that of the human body. While the process of transduction helps explain how many scientists and scholars see the feasibility of locating and transferring emotive information from one medium to another, technologies created to facilitate this (such as facial recognition software and technologies) often result in creating more social problems than advancements in society—particularly when they draw from mediated data and

information. In order to investigate how emotion is transduced and coded from humans to robotics, I draw upon both theories of transduction as well as the claims of materialist media studies. In the section that follows, I contextualize these frameworks by defining key terms, as well as conversing with some of the current discourse surrounding the theories.

TRANSDUCTION

Transduction refers to a change from one energy state to another. It is a process essential for the vast majority of digital media. Digital sound recording, for instance, transduces energetic, mechanical waves, waves that permit humans and other animals to hear, into electromagnetic waves that exist as digital information stored on a computer. Transduction, as theorized by Gilbert Simondon (1965), demonstrates how the movement and storage of information requires a medium, and that the medium matters—it encodes and transforms the physical energies in particular ways. Information—particularly as organized data within computational contexts—has regularly been imagined existing independently of materiality. The transmission of information, however, relies on the materiality of a particular medium; the medium influences what patterns are accessible and how these patterns are replicated. In the paragraphs that follow, I will further discuss Simondon's theorization of transduction, as well as how this theory was interpreted by scholars such as Gilles Deleuze and Bernard Stiegler. I will explain which understanding fits best within robotics attempting to replicate emotion and expand upon why I choose to use transduction as opposed to terms such as "transference," "conversion," or "inscription."

Simondon (1995) discusses the process of transduction relative to what he calls "individuation." To Simondon, an individual is produced and comes into existence through an ongoing process. Everything begins in a "preindividual" realm with a set of potentials; these potentials can move in multiple and various directions, but they do not attain form except through movement. Regardless of an individual's potentials, the process of individuation is never complete or final—there are always preindividual beings remaining with untapped and additional potentials that create further individuations. This constant process of individuation is driven by transduction. Simondon defines transduction as a

> physical, biological, mental or social process in which an activity gradually sets it in motion, propagating within a given domain, by basing this propagation on a structuration carried out in different zones of the domain: each region of the constituted structure serves as a constituting principle for the following one, so much as that a modification progressively extends itself as the same time as this structuring operation. (Simondon, 1995, 30-31).

In other words, the process of transduction is the movement from one energy state into another—it is the transfer of information through a medium. Simondon uses examples such as the formation of crystals, the growing of an embryo, and the creation of a brick to describe this process. By drawing upon a clay brick, he is able to critique Aristotelian causality or the differentiation between types of causality. Aristotle notes four different causes: material, formal, efficient, and final. To Aristotle, something like a brick enters a process of production as unformed matter (the material cause) and gets molded into a cube or square (the formal cause). While an artisan is responsible for the production of the brick, Aristotle argues that the artisans only role in the creation of the brick is the manifestation of specific knowledge (the efficient cause). By focusing upon knowledge as opposed to the artisan, Aristotle emphasizes the labor that went into creating this brick, as well as the ultimate ends of each of these steps: the production of a brick (the final cause). To Simondon, there is a link between matter and causality that cannot be differentiated. Clay, or other matter, has become the brick, but the brick now has information transduced into it: the space of a mold, the hands of a worker that pushed the clay into the mold, how fatigued this worker may have been, and other material information.

The concept of transduction originates from the field of physics, but it has been applied in multiple fields of study because of its relatively vague definition. According to Kahn (2013),

transduction as a term is applied with more precision within scientific disciplines and more broadly within a limited number of discourses within the humanities (p. 70). Kahn is referring to how Simondon's theorization of transduction resulted in two different interpretations within the humanities: scholars map one interpretation around Gilles Deleuze and his ideas of affective energies, while the other interpretation follows Bernard Stiegler and his thoughts on technics. Gilles Deleuze interprets Simondon in a similar fashion to Spinoza's ideas of affect. To Deleuze[3], the process of individuation, particularly with the seemingly infinite amount of potentials, mirrors that of an affective object; something that has the potentials for being affected and for affecting others. Muriel Combes (2013) follows this, stating that "Simondon is interested in the details of how specific technical bodies have the power to affect and to be affected" (p. 101). However, the process of transduction, and ultimately individuation, requires something outside of the individual for the individual to become constituted. In Combes words: "an understanding of the subject wherein relation to the outside is not something coming to an already constituted subject from without, but something without which the subject would not be able to be constituted" (p. 31). In order words, Combes attests that transduction and individuation can result in alienation if there remains an excess of untapped potential.

Throughout Combes' book, she critiques Bernard Stiegler's interpretation of Simondon and transduction. Because Combes sees transduction through technology as more of an excess of potential, she rejects Stiegler's view of technics as a means to lessen a human "deficit." To Stiegler (1998), an alienation of humanity is not the result of technics or by a machine, but rather, it is caused by a "misunderstanding of its nature and essence." He states, "to know the essence of the machine, and thereby understanding the sense of technics in general, is also to know the place of the human in technical ensembles" (p. 66). Stiegler draws upon Simondon in

order to refute previous anthropomorphized relationships with technologies. He sees the ultimate object or aim of technology not being brought about because of the way humans "animate" the technology—it relies upon the technology itself. In Stiegler's words:

> Accounting for the technical dynamic non-anthropologically, by means of the concept of "process," means refusing to consider the technical object as a utensil, a means, but rather defining it "in itself." (p. 68)

Stiegler looks more to transduction in his second volume of his *Technics and Time* series, *Disorientation*, as he attests "such teleology is not a human process" (p. 72). In other words, technics and transduction have a particular relationship. Adrian MacKenzie (2002) describes this relationship in his book *Transductions: Bodies and Machines at Speed*. As he looks at the relationship between technics and transduction, he states that they interact with one another at two points: corporality and temporality (p. 1). While MacKenzie sees a relationship between technologies, the human body, and culture, he draws upon Stiegler's ideas of technicity or the means in which we cannot extract ourselves and what it means to be human without looking or relying on the technical. To MacKenzie, "the problem of thinking about technology is also a problem of thinking about time, corporeality and, indeed, thinking about thinking" (p. 3). As with many other media scholars when looking at these assemblages, MacKenzie denies any form of dualistic considerations of technology. Technology is not an "empty, metaphysical-ideological abstraction disguising social processes" and technology is also not "an ahistorical hand colonizing human culture with its material structures and logics" (p. 205). Rather, MacKenzie states that using the concept of transduction can help us understand why we face apprehension toward technology and technological change. In one way, technologies give meaning to things within particular symbolic systems; in another way, technologies also bring together living and

non-living potentials in ways that semiotic systems cannot represent well (MacKenzie, p. 206). In other words, technologies exist transductively. At this juncture of temporality, materiality and the technical, other dimensions, such as information or data arise. Both of these concepts tend to exist apart from corporality; however, in MacKenzie's words, "rather than apprehending information as foreign to living bodies, [transductive processes] suggest that we should attend to the material interfaces and technologies that make disembodiment such a powerful illusion" (p. 218). In other words, materiality is important, particularly for how the process of transduction works—particular technologies measure and sense the environment and then determine what has been sensed. This permits the creation of particular emotional interfaces and ties into the last distinction I would like to make regarding transduction.

I choose to use the concept of "transduction" over terms such as "inscription," "proscription" or "prescription" because these sensors are transductive—they mediate the process of moving energy from one form into another through complex assemblages of media. While the concept of inscription involves a medium's ability to capture information, record this information, and store the information (Bollmer, 2019), within robotics, we are looking at a media apparatus comprised of multiple media as opposed to one distinct medium. These sensors are not proscriptive either; they do not forbid or restrict certain data and information to be captured. As mentioned, media can prevent some information from being captured. However, this is different from purposeful ostracization of particular data. Prescription, on the other hand, derives from Bruno Latour (1992) and his theorization of Actor-Network theory. For Latour (1992), prescription is what occurs when technologies delegate tasks and uses of itself upon humans. In other words, technology prescribes humans with the ways in which they can use a particular technology (p. 157). An example of this prescription is the ways in which humans use

the computer—if we know how to use a computer, it's because the computer has prescribed a certain posture, a type of attention, rules and regulations as to what can be completed, as well as many other tasks that we do not need to be reminded of because we perform them regardless. These terms are closely related; oftentimes, inscription, proscription or prescription are dependent upon transduction—an argument that will be articulated later on in this thesis.

Transduction is a useful lens through which to understand robotics. As humans work to teach robots how to sense and feel—tasks intended to develop interfaces that are seamless or "friendly"—designers have developed numerous technologies intended to equip robots with sensory and cognitive abilities. Technological sensors, combined with artificial intelligence (AI), allow a robotic interface to collect data and respond in turn. These sensors and AIs are transductive; they use visual, aural, or other forms of sensory data, convert them into digital information and are coded to recognize faces. This code is essential within these technical assemblages, but it is created and formatted based upon what initial information is accessible or able to be sensed for transduction. However, as I have mentioned prior, the media and materials involved in the process of transduction are important for what data is collected and transcribed across media. In order to describe how I approach materiality, I will draw from what many media scholars describe as materialist media theory or new materialism and why this is paramount for emotional transduction.

EMOTION & MATERIALITY

The idea of communication was something that was thought to be uniquely human for a long time. The material capacities of the human body allowed for communicative processes to unfold, but communication has become increasingly less material. Just as the movement of energies depends upon a particular medium, as does communication—physical materiality is important in how it shapes reality (Packer & Wiley, 2013). This materiality can be many things, but it is paramount when studying any media. Grant Bollmer (2019), in his book *Materialist Media Theory*, explains that technologies do things, and they do things through their materiality, which he refers to as a "performative" understanding of materiality. This includes defining the limits for meaning and communication, shaping what human bodies are and do, transforming experiences of space and time, as well as influencing how we relate to each other. Nonetheless, there is a relationship between media and humanity. Everything humans say and do gets bound together through specific forms of mediation and different media have different material capacities. In other words, media plays an active role in how our world is shaped—the present only came to be through historic maintenance of particular rituals, techniques, and technologies. The way humans encounter the world is only through forms of media that allow or inhibit specific ways of what we can do and how we can do it; we are constantly entangled within an ecology of media because "we are always in the middle, mediated, unable to fully grasp the trajectory in which we are engaged because we can't step outside of material reality and take a view detached from our daily lives" (Bollmer, p. TBD). Medium theory—the name often attributed to a school of media theory derived from the work of Marshall McLuhan and Harold Innis—becomes something that intends to understand what media does to experience without reducing media to "the human"; therefore, material media theory allows for a less human-centric

analysis of the effects of media through its consideration of physical materials, such as infrastructure, and what seems immaterial, such as data (Meyrowitz, 1986).

Similarly, in his book *Speaking into the Air*, John Durham Peters (2012) explores how communication has grown increasingly divorced from embodied interaction. This is partially due to how humans communicate with non-humans: animals, machines, aliens, and more. To Peters, "communication suggests contact without touch" and because of this, communication is something that traverses the terrain of human and those marked as "other" to "man" (p. 228-229). Peters argues that moving beyond human understanding of communication could provide insight into worlds humans never thought possible. Other scholars, such as Jussi Parikka (2010) take similar stances. In his book *Insect Media*, Parikka uses a media archeological approach to understand how the history of cybernetics relates to insect sensation and our experience of media. Parikka resituates media away from objects used by humans toward something more nebulous; media is "an issue of affects, relations, and transformations" (p. xxx). We better consider this through the understanding of the characteristics possessed by insects and non-humans. Like insects, media "deal with forces imperceptible to human understanding but glimpsed through their effects only—the logic of algorithms, calculations, and voltages unreachable in itself, yet continuously mediated and affecting the bodies of humans" (119). These forces create worlds unfathomable to humans; yet, these worlds also inform communicative practices of humanity. In this way, Parikka begins to touch upon how understanding animals in relationship to humans and technology allows us to redefine our opinions of bodies, our understanding of consciousness, and he advances a transductive understanding of media and communication.

I bring these points into conversation to emphasize not only how materiality affects transduction, but also to illustrate how unproductive it can be to equate human and machine. Yet, in this thesis, there will be times in which tension will arise between these two separate entities—they will be equated by some scholars due to their understanding of how the transduction of affective energy works. I will discuss previous ways scientists and scholars have attempted to transduce emotion to AIs and robots, and the ways these technologies inscribe certain bodies and materials while neglecting others—or coding them as "illegible." In Packer and Wiley's words, this could be explained as "technologies... play a fundamental role in the composition of historical forms of sensation, cognition, experience, consciousness, and subjectivity" (p. 11). Equally, the concept of "touch" is extremely important to Peters. It is one of human's most archaic senses, and also one of the hardest to replicate. As David Parisi (2018) mentions in his book *Archaeologies of Touch*, the "rearticulation of touch through technoscience remains an ongoing project" for multiple industries, computer science and digital media included (p. 12). To Friedrich Kittler (1999), this would exemplify how technologies and media environments have different abilities and limitations in terms of what "forms that human, and human-machine, cognition can take" (Packer and Wiley, p. 11). To conclude, touch is not uniquely human, but it is arguably important for human communication and understanding of emotion. However, as the next section will demonstrate, emphasis is not placed upon the tactile nature of emotion; rather, there is a privileging of one human sense: vision.

AFFECTIVE ROBOTICS

Humans have an interesting relationship with robotics. We have already integrated artificial intelligence, robots, and technologies used in robotics into multiple aspects of our lives, even if we do not always notice it: we use them for industrialization, we use them to clean our homes; we use them as entertainment; we use them for military applications; we use them to care for other humans. Through this section, I will first discuss previous research completed regarding the ways humans use robots and robotic technologies. This will provide a larger context as to why humans have begun attempting to transduce emotion to robots and how other scholars have addressed this desire. I will then move to how people have tried to "teach" —read: transduce forms of energy with sensory hardware and software protocols—emotion to robots, what materials are at play in this process and how these attempts have fallen short. This chapter is set up to demonstrate how transduction is political. These politics are contingent upon both the hardware and the software, particularly, how these come together to modulate emotion at the interface.

We create robots, much like any technology, as a means of making life "easier" or "more convenient." Leopoldina Fortunati's *Robotization and the Domestic Sphere* (2017), focuses on the diffusion of machines in the domestic sphere and the automation of everyday life. Fortunati notes that robotics helped organize industrial labor, but it has slowly begun shifting out of factories and assembly lines and into the reproductive sphere. As robotics have diffused within the home, the organization of families has shifted: those whom reproductive labor has typically fallen on, the women in traditional families, can utilize robotics to "substitute and support" themselves (p. 15). For instance, a robot could take on some of the "domestic workload," allowing women to spend more time at work, doing other kinds of work, or simply having more

free time because less time is spent cleaning and providing for a family (p. 15). In Fortunati's words: "especially for women, there is an opportunity and a challenge: the opportunity is to reduce housework at a material level and to liberate free time, while the challenge is to design social robots tailored for them and their needs. If women will face this challenge, social robots will become an opportunity for all" (p. 15). While claims that technology will assist women with the reproductive labor that oftentimes falls on them in a household, it is important to note that in many cases, more household technologies lead to an increased workload. However, the important aspect of Fortunati's statement is the utilization of the word "social;" "social robots" are becoming increasingly popular and viable in modern society. Like other historical perceptions of technology, more technology is often equated to more societal progress.

This push for social robots, whether regarded as ways to assist with domestic clean-up or for other means, has risen greatly, and part of this arises from what seems to be a necessity to teach robots about human emotion. There has been a rise in popularity to situate robots within interpersonal, professional settings. In these settings, such as hospitals, there is a thought that robots could help and provide care for patients with degenerative cognitive disorders such as Alzheimer's or dementia; however, some attribute better care with a robotic ability to recognize, process, and understand human emotion. Another area that has reinforced the necessity for robots having a level of emotional understanding is in teaching individuals how to emote. To some, understanding emotion on the material level of robotics may provide an opportunity for people living with "emotional-related deficits" to begin to "learn" emotive behaviors (Picard, Papert, Bender, Blumberg, Breazeal, Cavallo, et al.; 2004, p. 257-258). Juan Martínez-Miranda, Adrián Bresó, and Juan Miguel García-Gómez (2014) offer two strategies of "emotion regulation" to assist with "therapeutic empathy"—differentiated from "naturally" occurring

empathy—within digitally constructed "characters" or entities of AI (p. 116). They claim that these "empathic virtual agents" can be employed within clinical domains and useful to provide treatment of mental health disorders, as "empathy is considered a fundamental aspect in promoting therapeutic change" (p. 116).

To be concise, people want robots to learn emotion for many reasons that seem to be beneficial to humanity as a whole. We see this with Sophia and Hanson's beliefs that "nice" robots will be able to help better society as a whole. As wonderful and groundbreaking as it sounds to have kind robots within the human population, people still hold reservations about the ability to control these human-like entities fueled by increasingly powerful AIs. There remain concerns about emotionally intelligent machines and how they will affect human bodies; the unpredictable nature of machine learning often leads people to feel fearful, but also curious, of what a machine may be capable of if it can process and express emotions—this includes the potential of bringing science fiction thrillers, in which computers reach sentience and bring destruction and harm to humans, to life (Picard, 1995, p. 8 - 9).

Regardless of if humanity embraces emotive robotics or turns their backs on these devices, these are still important to talk about as they become more of a viable, and clearly implemented, technology with increasingly affective abilities. By using the word "affective" here, I am referring to a particular "thing" that stirs an emotional response (Grosz, 2001). As many children grow into adulthood, they learn how to emote. While I will not dive into the intricacies of psychology and how humans learn and express emotions to one another, it is important to understand that social cues often guide how humans present their emotions to other humans (Adler, Rosenfeld, Towne & Scott, 2018). As we watch others talk about their emotions and as we recognize and attribute facial expressions to mean certain emotions, we take these cues

into consideration of our own emotional performance. To many, this process should be similar to the ways robots could "understand" and "express" emotions. In order for robots to "read" and "understand" emotions, these machines must collect data and use this data to predict future patterns—an arguably similar process to that of human emotional development. In this section, I will explain how scholars have attributed particular aspects of robots to equal parts of humans. I will also explain how emotional data gets captured and thought of to be transduced by humans and robots, particularly in techniques such as those utilized in facial recognition technologies.

The whole idea around the transduction of emotion is that robots must interact with humans for them to capture emotional data and use this information to craft emotional responses in return. This process continues multiple times for a robot to "learn" emotional cues and determine if its own cues were received as correct or incorrect ways to display emotion. These interactions are often defined as simplified versions of the transactional model of communication; each actor in the process are the sender and receivers of messages, determining how the other actor will respond in turn (Adler, Rosenfeld, Towne & Scott, 2018). As a human interacts with a robot, the human communicates between two facets of experience: the material, physical being of the robot, as well as the capacity programmed into the code of AI. This reaction mimics many other interactions between human and technology, or more specifically, between human and interface.

Lori Emerson (2014) defines "interface" as a general term in computing that references a point of interaction between both hardware and software (p. x). This is a definition understood by many, but Emerson, in her book *Reading Writing Interfaces*, attempts to expand it. Emerson draws upon Alexander Galloway to explain that an interface is "a technology that mediates between reader and the surface-level, human-authored writing, as well as the machine-based

writing" creating a threshold that grants access while also "continually revealing (mediatic layers, bits of information, etc.) through concealing and concealing as it reveals" (p. xi). N. Katherine Hayles, in her book *How We Think* (2012), explores the implications of human/interface interaction, explaining how habitual actions we typically associate with the internet or computation not only shape "neural circuitry," but also physically alter bodies. To Hayles, this modification occurs through embodied interactions with digital media that "take the form of extended cognition, in which human agency and thought are enmeshed within larger networks that extended beyond the desktop computer into the environment" (p. 3). However, machines also have bodies, and these materials—regardless of if it is a metal framing that houses code—matter as much as those of human beings (p. 3). As mentioned prior, humans have equipped machines with different hardware and programs to resemble human sensory organs and the processes completed by the organs, such as sight: while a human may have eyes that allow them to see, a technical object may receive sensors or cameras that provide it with its own kind of vision (p. 17). Just as a human perceives the world and formulates their own understanding, cognitive machinery must also draw conclusions from perceptions, including acting upon particular impressions (p. 17). This perception, and arguably this robotic understanding, is the result of transduction.

However, robotics are complicated assemblages of technological apparatuses—they are not other humans. One debate arises from this issue: is the emotional data these robots are collecting legitimate if humans are not displaying the same "authentic" emotions to the robot as they would another human? Arguably, to collect the most accurate data and transduce accurate information, a robot to human interaction would essentially require replicating a typical human-to-human interaction (Breazeal, 2004). Part of replicating a human to human interaction involves

creating a material body for a robot that pastiches that of a human. For Cynthia Breazeal (2004), this push to humanize machines not only allow humans to better understand our own "sociality" and social intelligence (p. 6), but also provides an opportunity for robots utilize human social terms as opposed to learning a new set of relational dynamics—a drastically different result than the initial desired outcome of the transference of information in this context. This is another tangent in which humans begin to breakdown the parts of robotics and to think of robotics in terms of other humans: technologies such as microphones and cameras can represent other human sensory organs, and AIs and other pattern recognition software could be considered not only to provide a way for these processes to function but also as having the same neural plasticity of human brains (see much of Ray Kurzweil's work).

Other scholars—such as Kelly Gates, John Johnston and Donna Haraway—have critiqued attempts to equate human and machine vision. Johnston, for instance, does not consider human vision to be something comparable to machine vision. Instead, Johnston (1999) turns to Deleuze and his concept of "machinic vision" as a way to articulate an "environment of interacting machines and human-machine systems" that decodes perceptions to an "intelligibility only in relation to them" (p. 27). Gates (2003) interprets this as "new human-machine assemblages create new possibilities for the subjective experience of sight, for what vision means and how it works, and for how humans and machines collectively see the world" (p. 123). Haraway (1988), however, regards human bodies as "inescapably" embedded within visual media apparatuses or, to borrow a term from Jonathan Crary (1988), "techniques of observation" (p. 683). To Crary, techniques of observation turn a mirror upon humanity; he sees optical experience as being based upon a human body as much as it may be on a machine, meaning that the subjectivity of the body could be equated to the act of seeing itself. Relating Crary's

theorizations back to the construction of a machine vision that resembles a human's, Gates finds the process "designing new technologies of vision" concerning because of "how rarely (if ever) it leads to radically new ways of seeing, instead of reinscribing ... existing power relationships and dominant modes of vision" (p. 123). The ways these technologies function, particularly as parts of a whole sensory apparatus, affect how information is collected as well as what information is collected. I use "robotic emotion" to highlight how the concept of transduction is not simply a neutral energy transfer—it exemplifies particular politics of media. To further this point, I draw upon both affective computing and facial recognition software as two examples of technical conglomerates that have been utilized as methods that allow for the transference of information involved in displays of emotion from human to robotic.

Affective Computing

One way the idea that humans could transduce emotion to AIs and robots came to fruition through a process called Affective Computing. "Affective Computing," a term formulated by Rosalind Picard, specifically focuses on AI systems to measure and respond to human emotion (Picard, 1995). Picard claimed that

> There is a class of qualities which is inherently linked to the motor system... it is because of this inherent link to the motor system that this class of qualities can be communicated. This class of qualities is referred to commonly as emotion. In each mode, the emotional character is expressed by a specific subtle modulation of the motor action involved which corresponds precisely to the demands of the sentic state. (Picard, 1995, p. 3)

Picard (2003) argues that computer scientists and developers can build algorithms within a computational system that successfully measure, identify, and react to an emotional equivalent of a human's expression of an emotion. Picard drew much of her work from Paul Ekman, who

created a system of reading different emotions and called it the Facial Action Coding System or FACS. According to Picard, this systems "provides mappings between measurable muscle and an emotion space" (Picard, 1995, p. 5; Ekman and Friesen, 1977). In other words, this was a system designed to sense changes in light and compare images of faces to understand what changes were being made—such as what muscles moved when a certain emotion was expressed—as a method of producing information. Ekman and his colleague Wallace Friesen completed a study of facial expressions in the 1970s, and they created a system of defining 44 different facial muscle movements used in different displays of emotion on a person's face—these were called "action units." Ekman attempted to categorize these movements into different basic emotions: joy, sadness, fear, anger, and disgust (Bosse, Broekens, Dias, & van der Zwaan, 2014; Ekman, 1992). The facial expressions were categorized based on behavioral expression, subjective experiences as well as "patterns of triggers" (Bosse, et al., 2014, p. 9; Ekman, 1992). In one method of replicating emotion, a computer recognizing these triggers, patterns, and experiences could potentially mimic these physical expressions to make a computer's interface seem more human (Picard, 1995). While Ekman is primarily whom Picard draws from for her theorizations on Affective Computing, many scholars—such as Ruth Leys (2017) and Lisa Feldman Barrett (2017)—have recently criticized his work.

While this process sounds theoretically sound upon first glance, Picard reveals some shortcomings of affective computing. It is difficult to take subjective data that accounts for many different perspectives and turn it into criteria for future coding systems—measuring thought and experience remained an issue due to its reliance on variable self-evaluations (p. 4). People express emotion through verbalizations—such as swearing at an object or another person to signify "anger" or "frustration"—but they often struggle to articulate a specific state of feeling

(p. 4). This inability to define or express emotion occurs for multiple reasons: people find themselves unable to either pinpoint what emotion they are feeling, they struggle to vocalize their emotional state due to limited emotional vocabulary, or they do not fully disclose the information due to the environment they are in (p. 4). However, Picard provides a positive outcome for this: systems that measure this information could help the people interacting with the systems with make sense of their affect (p. 6). She calls this an "affective mirror" in which their emotion, or affect, plays a role in teaching them some emotional awareness; these statements mirror claims made by Cynthia Breazeal and our levels of social intelligence. While Picard never explicitly makes these claims, this "affective mirror" follows a logic that humans would learn from robots; this could mean robots and affective AIs could "teach" children, individuals with autism, or others with "emotional deficiencies" how to "properly" identity and form emotional expressions based upon particular, computer-specific definitions of emotions. Because society has not reached a point of being able to define these emotions due to variance between individuals, Picard (2003) frames issues of subjectivity using a weather metaphor from psychologist Jerome Kagan (1984):

> The term *emotion* refers to relations among external incentives, thoughts, and changes in internal feelings, as *weather* is a superordinate term for the changing relations among wind velocity, humidity, temperature, barometric pressure, and form of precipitation. Occasionally, a unique combination of these meteorological qualities creates a storm, a tornado, a blizzard, or a hurricane—events that are analogous to the temporary but intense emotions of fear, joy, excitement, disgust, or anger. But wind, temperature, and humidity vary continually without producing such extreme combinations. Thus

> meteorologists do not ask what weather means, but determine the relations among the measurable qualities and later name whatever coherences they discover...

Picard draws upon this metaphor to drive home her argument that emotion can be measured using a combination of technologies, similarly to the ways humans have measured weather patterns. Picard (2003) claims that she "expects emotion recognition to be solvable by machine, at least as well as people can label such patterns" (p. 58). These reasons are what propel Picard to look at facial recognition software and voice recognition software as some of the best methods to implement affective computing.

Facial Recognition

In her book *Our Biometric Future*, Kelly Gates (2011) studies facial recognition technologies as a means to move forward our understanding of not only the technological projects that create machines to identify both human faces and facial expressions, but also to note the social forces shaping the technologies. Gates describes Paul Ekman's work as the "Gold Standard" system for analyzing emotional facial recognition in psychology and states that many computer sciences draw from his FACS. Gates notes that Ekman's work simply followed historic ideas that physical facial features or expressions could offer a material to draw conclusions from (p. 160). One of the aims of FACS was to make emotional human behaviors calculable—more accessible to precise measurement as well as classification (Gates, p. 22). While scholars such as Picard attempt to employ the use of facial recognition technologies for affective computing or emotional understanding, Gates explains that many scholars view these as two separate issues. For example, Gates notes (p. 155) an article by Ying-li Tian, Takeo Kanade, and Jeffrey F. Cohn which claims that "sometimes the facial expression analysis has been confused with emotion analysis in the computer vision domain. For emotion analysis, higher level knowledge is

required" (p. 257). This "higher level of knowledge" is often attributed to more lines of code or more advanced classifications of minute facial measurements (Gates, p. 155). To Gates, "this move to separate the specific problem of facial expression recognition from the recognition of emotion defines the aims of any particular effort at computerization as narrowly as possible, separating it from the messy and exceedingly more difficult problems associated with the meaning of facial displays and their relationship to what people are thinking and feeling" (p. 155).

Gates, through her critique, places causality more upon the humans behind the technologies than the technologies themselves. However, there is a material dimension about teaching computers and other technologies "sight." This dimension involves the mediation of bodies and the ways bodies move—such as a face moving into a particular expression—that demonstrate the transduction of particular affects or energies. In other words, a computer can "sense" when an emotion arises or alters based upon muscle movements only made visible by changes in something such as light; this change in light become data points that allow particular conclusions to be made. However, sometimes these have other, often unforeseen, implications that arise.

These issues arise because facial expressions and other expressions of emotions do not simply exist within nature waiting to be discovered; rather, they are relational processes that have grown and changed over time with other aspects of sociality. Two elements of this relational process that I would like to focus on in this section are subjectivation and control. As these technologies mediate human faces, breaking them down into points of data and information, control is better able to be exerted upon those it comes into contact with—the subjectivated. The bodily measurement techniques and the technologies that utilize them parse

the information and allow for particular types of information to be inscribed. Tracing a history of how emotion has been quantified in the past, Otniel Dror (1999) explains that these instruments or "techno-representations" move emotion from internal to external. This is important to Dror, as he claims that these scientific studies added new dimensions of affect. He explains that because the scientists test this technology upon their own bodies, they were the most affected by the study; Dror argues that these experiments led to "a modern and particularly masculine form of communicating and exchanging emotion" (p. 394). While this gendered bias is problematic, it was not the greatest implication or dimension added to affect: rather, these "mechanically rendered physiological manifestations of emotion helped redefine what it meant to feel, what exactly emotions were, and how they could be differentiated and manipulated. The scientific study of the physiological manifestations of emotion added a technical, instrumental dimension to the social regulation of affect" (Gates, 2011, p. 161). In other words, by knowing the "objective truth" of emotion, individuals are also able to construct and reinforce particular modes of affective being.

Other surveillance and security uses also arose from facial recognition technologies, but not without competing forces. Some of these forces were deeply tied to race and gender—when testing was primarily completed on predominantly white males, how would the technology react when someone who did not fit that profile interacted with it? In some of the basic, material ways the technology works, the outcomes were an inability to recognize an individual. In other—still material—ways, the technology could facilitate perceptions surrounding identity. Security initiatives utilizing facial recognition within airports or border control would determine the criminal from the non-criminal; prescriptive techniques enacted through facial recognition could wrongly accuse a person of color as a criminal. For instance, as the surveillance video surfaced

of Mohammad Atta and Abdulaziz Alomari, two of the alleged plane hijackers in the September 11 terrorist attack, many people attributed facial recognition technologies as being the primary method of preventing this attack, as well as any future attacks (Gates, 2011). Kelly Gates (2002) describes a 2001 New York Times article that diagramed how, at the time, biometrics were a favorite of nine security and terrorism experts interviewed—they claimed new facial recognition cameras set up within intersections could recognize people in the streets of New York and prevent future attacks of terror. Similarly, in 2013, when two bombs exploded during the Boston Marathon, the Federal Bureau of Investigation (FBI) released photographs and surveillance footage as means of finding the suspects (Hegde, 2016). The suspects, Dzhokhar and Tamerlan Tsarnaev, were identified by their aunt; however, the surfacing of the images and footage provided computer scientists an opportunity to state that "facial recognition systems that could have helped identify the Tsarnaev brothers" (Hegde, 2016). Both of these instances exemplify one of the many mechanisms of transcription and control facial recognition provides: personal identity is boiled down to data points, and this data allows collective decisions to be made—such as who is and who is not a terrorist.

Zach Blas (2013) follows Gates (2011) closely with his analysis of facial recognition technologies; like Gates, he focuses more upon the implications surrounding current applications of facial recognition and less upon how facial recognition serves as a medium for transduction. However, it is important to mention some of the criticisms surrounding the primary methodology of capturing data for the process of transduction within this robotic context. Per Blas, biometric facial recognition technology functions as an enhancement to the "searchability of individuals" through its ability to "disembody and objectivity as [it] circulates identity as data." In particular, Blas articulates that "biometrics change what identity means to governing institutions and

produces new identities and categorizations, including those that are forced to remain illegible because they are not recognized during biometric authentication." In other words, issues arise in the event that a program on a computer becomes the primary instrument for conceptualizing identities; this same argument applies for a robot's protocol and the conceptualization of what emotions are and how they work.

MOVING FORWARD

I draw upon these examples to demonstrate how one technology that is often used within a robotic apparatus can result in usually unintended consequences. However, facial recognition technologies and software are not the issue in and of themselves; rather, they are the means in which we can visualize larger political implications of collecting data the transduction of information because they are a medium through which transduction occurs. As these technologies turn energies—such as a change in lighting from one expression to another, or alterations in the sound of a person's tone of voice—into information, they inscribe some points of data while neglecting others. The process of sensing and modifying energy is a constant mediation that results in political consequences. As this energy becomes data, the data then becomes a physical locus where these politics occur. Particular institutions privilege data and information above others, and there is a hierarchy of what data should be collected—an institution such as the military will look for different information compared to a University. Robotics, as well as facial recognition software, are highly militarized technologies. National

defense, as an institution, is awarded large sums of money to test these technologies. Considering the main task at hand for the military is keeping the citizens of the US "safe", these technologies serve as ideological apparatuses. The privileging of sight and sound within affective computing and facial recognition technologies, over other senses like touch, smell or taste, demonstrates a form of data collection more important for military operations. While Sophia was not the product of the military and rather was the product of a privately funded corporation based in Hong Kong, one must be wary of the corporate ideologies inherited by this robot—data will still remain political within the process of transduction.

Transduction encompasses the movement of energy from one state to another. This thesis demonstrated that the process of transduction is always a mediated process with political consequences, especially when contextualized within the mainstream efforts to teach robots how to sense human emotions. By providing background information on Sophia, how robots have been encultured into society to process and respond, as well as previous and current efforts used to transduce emotion, this thesis argues that energies are transduced across media, data becomes a point of political convergence with potential adverse conditions. Ongoing emphasis should be placed upon the limitations of data collection as it becomes viewed as an increasingly "reliable" method for making judgment calls. Continual questioning of what information is not present and who is not present are important parts of the story within mediated contexts.

There is value in studying the transduction of emotion between human and robot as a touchpoint for more informed and less anthropocentric posthuman studies. A closer examination should be given to both the sensors utilized within the process of transduction, as well as the theorization of transduction itself. To address the sensors or to consider current applications in which this is tested, it would be valuable to bring in works that have attempted to use transduction within biometrics and facial recognition. An article by Fayin Li and Harry Wechsler (2005) studies the "transduction confidence machine-k nearest neighbors" or TCM-kNN, in which they tested a transductive process of biometrics using a simple machine learning algorithm. I think including article results, such as this one, as well as more recent articles that may have been published, might provide useful information for looking at the sensors and how the process of transduction works at more micro-level. Another area of improvement lies at the theoretical level. A simplification of the theorization of the process of transduction could make this more accessible to other scholars. By making this more accessible, issues of citational

politics could be better managed as more marginalized individuals could add more insight into this important and timely process.

Finally, a closer look could be given to the performative representation of a gender robot, as that is one of the concerns obvious from the start, but one this thesis did not address. Like many others (see Janet Murray) have discussed previously, the gendering and performative representation of an AI or robot as "female" is something that continues to occur—two instances of this are Hatsune Miki and Ai Kizuna. If we were to draw from Donna Haraway's work on cyborgs, we could attribute this pattern to the existence of women and their bodies being increasingly technical and treading the boundary of "human" and "machine". By continuing to design female-presenting AIs/robotics, the creators effectively design feminism out of women—reinforcing a "techno-patriarchy" that already views women as machines and not "complete" humans. These are all important critiques to consider for a continual effort to trace the emergence of "emotive" AIs and "social" robots moving forward—regardless of societal anxieties and criticisms surrounding these AIs and robots, they are and will continue to be reproduced and tested, as the TurboTax RoboChild ad exemplified. On the other hand, Sophia respond to its criticisms rather bluntly: "Am I really that creepy? Well, even if I am, get over it."

NOTES

1. An "imagineer" is a person who implements new concepts or technologies within The Walt Disney Company. According to disneyimaginations.com, "the name 'Imagineering' combines imagination with engineering. Building upon the legacy of Walt Disney, Imagineers bring art and science together to turn fantasy into reality and dreams into magic."
2. The Loebner Prize is an annual competition that awards prizes to computer programs that appear to be the most "human." The competition is formatted as a Turing test.
3. David Scott, *Gilbert Simondon's Psychic and Collective Individuation. A Critical Introduction and Guide*, Edinburgh, Edinbrugh Univeristy Press, 2014: 14. Keith Ansell-Pearson, *Germinal Life: The Difference and Repetition of Deleuze* (London: Routledge, 1999), 90–95. Alberto Toscano, *The Theatre of Production: Philosophy and Individuation Between Kant and Deleuze* (Basingstoke: Palgrave Macmillan, 2006); Pierre Montebello, Deleuze. *La passion de la pensée* (Paris: Vrin, 2008), chap. IV, "L'influence de Simondon: cinq points"; Alberto Toscano, "Gilbert Simondon," in Graham Jones and Jon Roffe, eds., *Deleuze's Philosophical Lineage* (Edinburgh: Edinburgh University Press, 2009), 380–98; Fabrizio del Lucchese, "Monstrous Individuations: Deleuze, Simondon, and Relational Ontology," *differences* 20(2–3) (2009): 179–93; Anne Sauvagnargues, *Deleuze: L'empirisme transcendental* (Paris: PUF, 2010); Sean Bowden, "Gilles Deleuze, a Reader of Gilbert Simondon," *in Gilbert Simondon: Being and Technology*; Andrew Iliadis, "A New Individuation: Deleuze's Simondon Connection," *MediaTropes* IV(1)(2013): 83–100.

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