Spring 2017

Empathy and the Role of Mirror Neurons

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EMPATHY AND THE ROLE OF MIRROR NEURONS

A thesis submitted to

Regis College

The Honors Program

in partial fulfillment of the requirements

for Graduation with Honors

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May 2017

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TABLE OF CONTENTS

Acknowledgements

I would like to thank Dr. Fricks-Gleason and Dr. Matlock for advising me throughout this project. Also, I would like to thank Dr. Howe and Dr. Kleier, as well as the whole Regis University Honors Program. Lastly, I must thank my family and friends, who, without their support this project would not have been possible.

Part I: The Role of Mirror Neurons in the Brain

Neuroscience is a relatively new field and only recently have technologies arisen that aid researchers in exploring fundamental questions of human behavior and the brain. Neuroscience melds together the examining of the mind through philosophical inquiry, and the ability to empirically test. Neuroscience has the power to carefully and methodically assay the workings of the mind and of the heart into explainable and nuanced definite parts. It has the potential to take that which is abstract and make it concrete. So concrete in fact, that it can be tested, it can be explained, and it can even be altered, if the proper understanding is met. Neuroscience takes that which can be inherently human and fluidly defined, such as the mind, and tries to understand and explain it through the tangible mechanisms and processes of the brain as a machine.

The American Philosopher John R. Searle observed “Because we do not understand the brain very well we are constantly tempted to use the latest technology as a model for trying to understand it. In my childhood we were always assured that the brain was a telephone switchboard. ('What else could it be?') I was amused to see that Sherrington, the great British neuroscientist, thought that the brain worked like a telegraph system. Freud often compared the brain to hydraulic and electro-magnetic systems. Leibniz compared it to a mill, and I am told some of the ancient Greeks thought the brain functions like a catapult. At present, obviously, the metaphor is the digital computer” (Searle, 1984, p. 44). As the scientific community discovers more extensively the physical functioning of the brain, leading to human behavior itself, it becomes clear that the brain is the most complex structure that humans have ever been tasked with deconstructing and analyzing. Therefore, the rationale that compares the workings of the brain to other complex and calculating technologies, such as the computer, seems to naturally follow.

However, blatantly absent from this mechanical, technological understanding of the brain, are integral components of human behavior that are more difficult to quantify and pinpoint mechanistically in the brain, such as emotions and cognition. These are concepts that we often associate with the more metaphysical notions of the mind. In a realm not yet touched by new technologies and computers lies a mélange of complex and fundamentally human behaviors in which human warmth and nuance cannot be encapsulated or demonstrated, through even the newest and most advanced of technologies. Of these human behaviors that cannot be accounted for in our cold technologic comparisons, one is uniquely compelling, centering itself at the core of our humanity— empathy. One cannot understand humanity as a whole without understanding the empathy innate in a single individual. To reach an understanding of empathy we look to the brain for clues that hint at the neurophysiologic roots of this human instinct.

"Man is still the most extraordinary computer of all." ~John F. Kennedy

With the emergence and advancement of neuroscience, strengthened through technology, science has been able to understand and explain behaviors and cognitive processes that were once mysteries. In 1988, the renowned researcher Giacomo Rizzolatti stumbled upon an insight that catalyzed an expansive exploration into what might be a neural mechanism for one of these human behaviors—empathy. During this landmark study, Giacomo Rizzolatti and his team set out with the intention of mapping the motor cortex of macaque monkeys. The assumption was that the macaque and human brains are closely enough related structurally that there was high confidence that the findings concerning motor neurons could translate into applications concerning the human brain. The researchers identified the specific functions of various groups of neurons in the motor cortex through the single-cell recording of individual neurons. Through single cell neural recordings, they could record data specific to individual neurons that were activated as a result of the macaque's execution of various actions and movements. The study took a serendipitous turn one day when they instead discovered an unexpected pattern of neuronal firing in the macaque as the researchers themselves moved. As a part of the study's normal operation, Rizzolatti recorded an individual neuron that fired when the macaque physically moved to grab a peanut. Like clockwork, every time the macaque reached for this peanut, this specific neuron would fire. One day, while the monkey still had the microelectrode recording the firing of the peanut-grabbing neuron implanted in its brain, one of the researchers went to pick up the peanut. When viewing the researcher perform this same motion, the peanut-grabbing neuron fired, even without movement on the part of the macaque. This neuron, in effect, did not functionally distinguish between the actions of the self and the actions of an other. The macaque's neurons seemed to, within the motor neuron system, fire in a pattern that mirrored the actions of the observed. This phenomenon had never been seen before and was so unexpected that it is still, to this day, a source of avid contention in the field. Through this incidental observation, Rizzolatti happened upon what many today contend to be a neural basis for human empathy— mirror neurons.

Excitement quickly built over this never before seen phenomenon which, in turn, brought a boom in mirror neuron research. Controversy over the implications of such neurons naturally followed as well. Before this discovery of what were later termed mirror neurons, the study of empathy had predominantly consisted of explorations in the application of empathy through social psychology or through the study of philosophy. Prior to the rapid increase in investigations brought on by the findings of Rizzolatti et al. (1988) concerning single neuron mirroring behaviors, there was no detailed and comprehensive explanation of the neural roots of empathy. Some today warn that conclusions as they relate to humans, regarding the expansive and spectacular implications of an empathetic mirroring system in the brain is not justified and is conceptually too far reaching given the current evidence. However, it is undeniable that the scientific community has made substantial progress in fleshing out the extent of the relationship of mirror neurons to empathy.

One aspect of this progress lies in illuminating the uniqueness of mirror neurons. The quality that is unique to mirror neurons is that the *observation* of motion fires these motor neurons as if the individual was performing that same motion him/herself. The larger, groundbreaking implication within this finding is that the actions of others influence not only neurons that fire when associated with an ‘other’ but fire a set of neurons that are tied specifically to a ‘self’ distinction. Empathy, as a concept, can be loosely defined as an experience or a moment when the ‘self’ and ‘other’ lines are blurred or discarded in such a way that the individual can intimately and personally relate to someone else, or, in other terms, when an individual has the capacity to know an experience of an ‘other’. What better way is there to know another’s experience than to have action-oriented, experiential neurons fire in a similar, if not identical, pattern as the other? Research in the area of vicarious neuronal activation has quickly progressed, yet the limits to these neuronal mechanisms as well as the specific pathways are still being discovered. In the next section, the progression of the understanding of mirror neurons will be examined, followed by a discussion of the limits of the findings in the context of empathy and areas for future study.

The Unique Quality of Mirror Neurons

Mirror neurons are similar to other neuronal brain cells in the vast majority of ways. They are like other neurons in that they are cells that are interconnected through synapses on their dendrites, soma and axons, communicating with one another through chemical signals and propagating information down the cell electrically, to form a complex network of information transfer. A regular, non-mirror motor neuron, for instance, might be activated specifically when we move our body in a particular way, receiving a mixture of chemical and electrical inputs that cause the neuron to fire. Another non-mirror neuron might fire action potentials specifically when an individual sees someone else move in a particular way. There are two distinct neurons, performing two separate functions in two different neural pathways. In contrast, the mirror neuron has one key difference. The same individual neuron fires similarly to both of the above non-mirror neurons, in their respective scenarios, however, a mirror neuron fires in both the self motor action *and* the observed motor action capacities simultaneously when only the observed action scenario is present. In the second scenario, when an individual observes a person's action, a single motor neuron will fire as if it has been given the signal that the observer moved in the exact same way as the observed. This leaves both a functional and conceptual differentiation of mirror neurons. The mirror neuron system complicates the old monkey see, monkey do adage. Mirror neurons can be likened to, monkey see, monkey’s neurons fire as if monkey did, but in reality, the monkey did not do.

A Motor Understanding of Mirror Neurons

These first understandings of mirror neurons stemmed from discoveries localized in the motor pathways. Motor mirror neurons provide a real time mapping of the physical actions of others, which are in turn, automatically internalized within the observer (Iacoboni, 2014). The founding mirror neuron study by Rizzolatti introduced previously was defined by this type of live action mapping. The first area examined for the presence of mirror neurons in macaques was area F5 of the ventral premotor cortex (di Pellegrino, Fadiga, Fogassi, Gallese & Rizzolatti, 1992; Gallese, Fadiga, Fogassi & Rizzolatti, 1996). The understanding of mirror neurons began by examining the self and the other’s mirroring relationship in the context of observing a physical action. However, in this space is not where the inquiries remained. Researchers soon began looking for mirror neurons beyond the confines of the motor system.

Expansion beyond Motor Functioning

It was suspected among select research groups that this mirroring function of individual neurons in the monkey brain was not localized and limited specifically to motor functions exclusively, but was instead likely to be adaptive to a variety of brain structures and functions. Thus far, mirror neurons have been found in the monkey brain with connections to a variety of systems including auditory, somatosensory and motor. However fundamentally, some emphasize that a broader interpretation of the concept of mirror neurons is most valuable when considering the implications of such a mechanism.

Christian Keysers and Valeria Gazzola (2009) proposed that these mirroring systems, existing throughout various parts of the brain, could be conceptualized as a system generally promoting social cognition through triggering somatosensory and emotional representations of the experience of others. If mirror neuron functions can be discussed in the terms of an individual experiencing vicariously through an other, then it logically follows that this vicarious activation of neurons would not differ from other functions of the brain; it is not isolated or localized, but instead is widely interconnected with dispersed pathways and modalities.

The modalities of mirror neurons are expansive. Work in the auditory limitations of mirror neurons has found that the sounds of an action alone are sufficient in producing a mirror neuron response (Kohler et al. 2002). Also, mirror neurons are shown to be involved in speech processing (Rizzolatti & Craighero, 2004), musical processing, and interpreting the emotional components of music (Molnar-Szakacs & Overy, 2006). Furthermore, somatosensory data suggests that touch involves a visuotactile mirroring system (Ebisch et al., 2008) that may be moderated by personality factors such as openness to experience and conscientiousness (Schaefer, Rotte, Heinze & Denke, 2013). There has also been expansion of somatosensory research into the topic of vicarious pain. Pain has been shown to cross the self-other divide that is bridged through the mirror system, allowing observation of pain in others to activate pain processing mirror neuron systems in the observer (Grégoire, Coll, Tremblay, Prkachin & Jackson, 2016; Budell, Kunz, Jackson & Rainville, 2015; Jackson, Rainville & Decety, 2006; Hoenen, Lubke & Pause, 2015) . The anterior insula, an area involved in the processing of both emotional and sensory information (a combination of which characterizes pain perception), has mirror qualities, as well as the anterior cingulate cortex, a part of the limbic system (Morrison, Lloyd, di Pellegrino & Roberts, 2004; Morrison & Downing, 2007; Botvinick et al., 2005).

Evidence suggests that it is possible for vicarious pain to be experienced and reported while only observing the pain of others (Osborn & Derbyshire, 2010). An observed facial expression of pain activates corresponding cortical areas as if one were to experience that emotion of pain herself/himself (Botvinick et al., 2005; Saarela et al., 2007). These somatosensory cortices are activated in more contexts than the context of witnessing painful facial expressions. In addition, when we have information on the sensory cause of the pain, the mirror neurons in the somatosensory cortex activate (Keysers, Kaas & Gazzola, 2010). Mirror neuron involvement into somatosensation and nociception also aid in practical application, such as through informing theories and therapies concerning phantom limbs— a condition in which an individual still senses (often painfully) a limb that is no longer present on their body (Weeks & Tsao, 2010; Ramachandran & Brang, 2009). This once more demonstrates the complex and varied nature of the mirror neuron system and the functions it serves in connecting us, in a multimodal fashion to the experiences of one another.

Discovery of Goal-Oriented Mirror Neurons

Originally, researchers believed that the self-other mapping functions of neurons were limited to motor mapping. However, a paramount group of goal-oriented mirror neurons have subsequently been discovered. Through a series of experiments that detected the mirror neuron firing of motor neurons when monkeys observed a variety of actions, it was found that often times the same pattern of mirror neurons would fire when an individual observed two separate actions that completed the same goal, even though they did not contain the same individual movement or execution. Neither specific hand placement nor similar movement in general mattered in the pattern of neural firing as long as the intended goal—such as grasping an undefined object (Rizzolatti et al. 1988) or tearing a piece of paper (di Pellegrino, Fadiga, Fogassi, Gallese & Rizzolatti, 1992), came into fruition.

Particularly of interest in the preliminary research on goal oriented mirroring are motor neurons (residing in F5 in the premotor cortex) that are activated by concepts, instead of by physical stimulus, as had been previously detected. These neurons did not have a direct link to a muscle group firing, but to a concept. This demonstrates the association between mirror neurons and higher level thinking (Rizzolatti, Fadiga, Gallese & Fogassi, 1996). Self-other mapping was also assessed in neurons of the medial temporal lobe in monkeys, which are not motor neurons but are higher order in nature. This further supports the theory that an individual's perception of an other is important in this brand of neurons that process sensation beyond simple stimuli mirroring.

As researchers continued to connect possibilities of mirror neurons to higher level functions an increasing variety of mirror neurons with specific functions were discovered. Marco Iacoboni, a neuroscientist and professor at UCLA, urges that the ability of mirror neurons to facilitate mimicry and prediction functions is supported not only by research and data, but also is supported logically when taking into account human theoretical and social theories. Iacoboni (2014) explains that the mirror neuron's powers of prediction are seen through the firing of mirror neurons based not on a specific action, but instead because the neuron recognizes a specific goal. Before the action is completed, the neuron predicts the end result of that action and consequently fires. Not only is imitation occurring mechanically in the parts of the brain associated with the mirroring system, but in addition, imitation at a mirror neuron level is also merging with the emotional regulation system in the brain—the limbic system. This gives further weight to the implications of the mirror neuron system as a social tool (Iacoboni, 2005).

Mirror neuron activation is also sensitive to partial stimulus, furthering the evidence that the mirroring system can account for goals rather than specific action completion. For example, if the mirroring system fires representing an action end goal, when only a partial stimulus is present (Umilta et al., 2001), then it is logical to conclude that the mirroring system must be “filling in” the stimulus gaps and conceptualizing the partial stimulus as its perceived logical whole, therefore predicting an action goal, instead of merely perceiving a disconnected stimulus itself (Iacoboni, 2014). Multimodal goal oriented mirror neurons allow this integration of multiple individual sensory stimuli into a singular goal understanding.

Iacoboni further extended his research into the closely related concept of intention in regards to the mirror neuron system, and ultimately empathy (Iacoboni et al., 2005). The link to empathy was explored through tying a known modality of the mirror neuron system, action intention recognition in the motor and premotor cortex, with emotionally charged actions that were likely to cause empathetic responses, such as recognition of facial expressions. It was established that vicarious activation occurs in monkeys when viewing facial expressions of an other (Ferrari et al., 2012; Ferrari, Gallese, Rizzolatti & Fogassi, 2003). In addition, there may be a right hemisphere mirroring system that informs emotional empathy (Leslie, Johnson-Frey, & Grafton, 2004).

Empathy has been directly implicated in mirror neuron activation through observed facial expressions, partially because we associate facial expressions with emotion and partially because emotional experiences can be activated vicariously.

This link to empathy does not stop here but can be extended, with the function of empathy acting as the common theme or encompassing trait that connects the modalities of the mirroring system. Empathy, in many cases, is achieved through feeling emotions as if you were another. This emotional understanding is difficult to attain when there is no sensory or context information available. By experiencing vicariously through an other, one can better reach a physical understanding, which leads in turn to an emotional understanding and the embodiment of empathy. Even though most single neuron empathy studies have been conducted in monkeys, there is evidence to suggest that the findings regarding mirror neurons and their defining characteristic involvement in empathy translates to the human brain.

Extension to Neurological Mirroring in Humans

While the findings on specific mirror neuron system functioning is remarkable, it must be noted that the initial breakthrough single cell recording studies were not done with human participants, but with monkeys. Therefore, the systems and the presence of mirror neurons in humans can be deduced but not directly tested due to the ethical concerns of the single mirror neuron recording methods. As a result, skeptics have emerged with significant doubts about the presence of this system in humans. However, in researchers who disagree with the skeptics, some key assumptions are made when extending the argument of mirror neurons past non-human primate to humankind. These assumptions are rooted in a human brain activation that is congruent to the mirror neuron findings verified in the monkey brain in both the anatomical location and in the activity of the relevant neuronal ensembles (Iacoboni, 2014). According to Iacoboni, two examples that meet these assumptions are the posterior part of the inferior frontal cortex and the anterior part of the inferior parietal cortex because the mirroring phenomenon has been verified in the brains of monkeys in parts of the brain that are anatomical and functional correlates. Also, there is group neuron firing in humans that simultaneously represents both the self and other firing conditions that are expressed through a single mirror neuron in a monkey.

This method of discerning correlate mirror neurons systems in humans is widely accepted. Nonetheless, because of extraneous circumstances that allow for single neuron recording in humans to ethically be conducted, there are only a small number of single mirror neuron recording studies involving the human brain. Through recording extracellular activity of neurons, one such study provided evidence of mirror neurons in humans on a single cell basis throughout hand-grasping and facial emotional expression tasks (Mukamel, Ekstrom, Kaplan, Iacoboni & Fried, 2010). The evidence concerning individual neurons that respond both to the execution of a task as well as the observation of a task is most strong in the medial frontal cortex, as well as the medial temporal cortex. This research also observed an interesting excitation and inhibition pattern at the individual cell level that they propose may act as a mechanism for maintaining a self-other distinction during both the observation and implementation of an action (Mukamel, Ekstrom, Kaplan, Iacoboni & Fried, 2010). However, one critique of this otherwise groundbreaking single cell human study is that because of the ethical implications of single cell recording in humans, the sample population of this study was individuals with epilepsy. Basic research on any neurobiologically unhealthy brain must always be examined with some skepticism.

Even so, the above study may still suggest that the leap from what is empirically shown to be present in monkeys, to what is assumed to be present in humans, may be justified. However, a multitude of individual neuron recording studies in humans are needed to confirm the presence of individual mirror neurons without a doubt.

While it still may be too early to definitively claim the widespread presence of individual mirror neurons throughout the human brain, there is strong evidence to suggest that a mirroring system exists and carries out analogous mirroring functions that may in turn serve as a neural basis for empathy. Examining mirror neuron correlate systems in humans, such as the mirroring system involved with emotional facial recognition, can inform the argument that empathy is rooted in mirror neurons.

Humans are amazingly talented at reading minor changes in facial expression to correctly interpret emotion (Schmidt & Cohn, 2001). This trait of facial recognition is theorized to be selected for evolutionarily because early humans, who could understand, work with and recognize others were more likely to survive. It closely follows that facial recognition and expression understanding are closely related to empathy; after all, it is much easier to feel empathy for someone when you can see their face, compared to when you do not have to witness their facial expressions. In addition, it is difficult to feel empathy for things that do not have facial expressions that we can readily identify with. We feel no empathy for a table bearing heavy weight on its back, whereas we are empathetic towards humans who carry incredible weight on their shoulders, literally or metaphorically. We can understand other humans because we inherently understand ourselves, whereas we have little sense or comparison for understanding things without facial expression as a physically represented indicator of emotion.

In 2003, one of the first studies to look at mirror neurons in direct relation to human empathy was conducted. While in a functional MRI machine, the participants were shown pictures of others and either they just looked or the participants tried to imitate the facial expression. They found that many of the same brain areas were activated both for observation and imitation of expression (Carr et al., 2003). The acceptance of a mirror neuron system that is specifically related to empathy through facial processing holds wide support (Enticott, Johnston, Herring, Hoy & Fitzgerald, 2008; Gallese, 2001 ; Morris, Pelphrey & McCarthy, 2006; Uddin, Iacoboni, Lange, & Keenan, 2007), connecting this research even further to social cognition.

Human Brain Regions with Mirroring Capabilities

As we progress the discussion into the capabilities of humans to experience vicariously, it is important to understand the transition from acknowledging the presence of individual mirror neurons in monkeys to the more expansive assumption of a similar mirror neuron system in humans without direct evidence of mirror neurons themselves. In both cases, it is concluded that these systems are functionally analogous in their mirroring abilities. Therefore, in our exploration into neural mirroring and empathy, the confidence in a human mirroring *system* within the brain is as sufficient as the knowledge of *individual* mirror neurons in the human brain in the context of empathy.

In 2012 a meta-analysis of the research on motor mirror neurons was conducted by Molenberghs, Cunnington, and Mattingley. This analysis quantitatively predicts the likelihood that motor mirroring capabilities are present in various human brain structures and pathways based on the cumulative data and fMRI images of previous mirror neuron studies. This analysis demonstrated consistent and strong mirroring activation in the left inferior frontal gyrus (Broca's areas specializing in language processing), right inferior frontal gyrus (associated with impulse control and action initiation), the ventral premotor cortex, dorsal premotor cortex (both areas activated when planning motor activity), the inferior parietal lobule (involved in a mélange of functions including language and mathematical recognition, facial emotion processing and the understanding and organizing of sensory information), superior parietal lobule (involved in spatial orientation), insula (involved in functions surrounding consciousness, homeostasis, and emotion) inferior and middle temporal gyri (sites with the dominant function of visual processing) and lastly the superior temporal gyri (involved in auditory processing).

Taken together, mirroring activity was reliably found in 34 of the human brain's Broadmann areas (BA) as well as within the cerebellum. The most activity was seen in BA 44, BA 7, BA 9, BA 6 and BA 40—which are associated with functions as specialized and varied as language processing (BA 44) to visuo-motor coordination (BA7) to executive functions (BA9) to the planning of movements (BA 6) to understanding phonology and meaning through reading (BA 40). Based off of this analysis, it can be concluded that mirroring activation is widespread in the brain, as Keysers and Gazzola (2009) and Heyes (2010) hypothesized. The results of this careful inspection of the evidence of visuo-motor, emotional and auditory pathways reinforced the hypothesis that mirror neurons may extend beyond simple motor capabilities. In the case of emotional mirroring, significance in activation of related structures was found, such as in the amygdala, insula and cingulate gyrus. All three of which are related to the limbic system—a grouping of structures working together to process and regulate emotion (Molenberghs, Cunnington & Mattingley, 2012).

As described in the meta-analysis above, the potential of mirror neurons as a primary mechanism for empathy was expanded further by the discovery of a variety of modalities of mirror neurons with specific functions that extend beyond motor mirroring. This indicates that the overarching quality of self-other mirroring occurs throughout many different complex systems in the brain, some of which are explicitly tied to emotion and empathetic response, while others are tangentially tied to an empathetic understanding of others.

Broadly and Strictly Congruent Mirror Neurons

To understand human empathy in conjunction with our understanding of the vast networks of mirroring systems, it is useful to adopt a reductionist approach, focusing attention on a simple unit level and delving into the defining characteristics of a single mirror neuron. There are two broad categories of mirror neurons that have been described in monkeys—strictly congruent and broadly congruent. Strictly congruent neurons adhere to the mode of the sensory information of the observed. In 1988, Rizzolatti's findings could provide an example of a strictly congruent mirror neuron because the *action* of the experimenter reaching for the peanut was mirrored in an *action*-oriented motor neuron in the macaque.

The second category, broadly congruent, is defined as neurons that are not mode dependent, but instead their mirror-like firing adheres to not only a shared physical action, but also an understood goal (Gallese et al., 1996). For example, if a monkey tore a piece of paper in half, a certain neural pathway would fire. If it then saw a person tearing a piece of paper in half, then the strictly congruent mirror neurons would fire because it saw and vicariously mirrored that action on a neural level. However, if it heard a paper being torn in half by a person that it could not see behind a screen, then the broadly congruent paper tearing mirror neuron pathway would activate because there was an understood intention and an understood result—a piece of paper was torn in half—even if the monkey didn't see the actions used to actually accomplish the goal. The broadly congruent, goal oriented mirror neurons are of particular interest when considering the connections between mirror neuron research and our understanding of empathy.

Human empathy has homologous characteristics of both broadly and strictly congruent mirror neurons. Upon swift reflection, it is apparent that human empathy is not exclusively based in physical stimuli (i.e. strictly congruent), but is also emotionally based and invokes higher levels of thinking. When we are empathetic towards an other, we surely consider the context and frame of reference surrounding a situation (i.e. broadly congruent) and integrate that with our perceptions of an individual, but in no ways could this complex task be reduced to a simple reflex. Emotions as well as our own experiences are integral in creating the complex context that determines our level of empathetic processing.

The rich experience of human empathy is informed and defined by both strictly congruent (i.e. reflexive stimulus input/output) and broadly congruent factors (i.e. higher level processing), oftentimes involving emotion and recognition of intent. Humans can recognize and empathize with emotional pain as well as physical pain, implying that humans use mechanisms like broadly congruent mirror neurons which involve higher order levels of processing in the brain. Strictly congruent, on the other hand, may be a necessary tool for deciphering the sensory information that is coloring and enriching a scene. Strictly congruent mirror neurons are modality sensitive, and therefore, sensory in nature, and aid in the internalization and understanding of the physical world and the context, environment and rich complexity of an empathetic experience.

Origin Theories and their Implications of Function

When evaluating the ties between empathy and the mirror neuron system, it is informative to consider the origins of the mirror neuron system in humans. The biological roots of this system may elucidate some nuances in the function and implications of the mirror neuron system. There are two predominant theories that explain how mirror neurons came to be in humans. One theory stems from an evolutionary perspective. It asserts that as our affinity towards living as social creatures progressed in order to survive as a cohort, we simultaneously developed mirror neurons that advanced human's ability to understand an other, allowing for stronger social interactions and leading to more effective group survival (Gilbert, 2003).

The second theory is based on the plasticity and malleability of the brain. In the associative learning hypothesis, the brain changes throughout a lifetime and learns to relate the experiences of the individual to the experience that we witness in others. This theory suggests that because we have encountered a specific situation and have an intimate knowledge of that situation, we therefore learn to connect this with a similar situation that occurs outside the individual. This gradual learned coupling of the witnessing of experience with the observer's own experience eventually allows neurons to adopt mirroring functions. Cecilia Heyes, a current Professor of Experimental Psychology at Oxford, argues that strong evidence suggests the origin of mirror neurons likely lies with the associative learning hypothesis. She states that mirror neurons stem not from an evolutionary advantage of action understanding, but instead stem from a learned neuronal behavior that results from social self and other interactions throughout one's life (Heyes, 2011).

Significant in the argument for the sensorimotor associative learning hypothesis is that learning happens throughout a lifetime and it is established that neurons and brain systems change throughout a lifespan. Also, infants are exposed to enough sensorimotor stimuli in early years to warrant a hypothesis that mirror functioning is a learned trait (Cook, Bird, Catmur, Press & Heyes, 2014). After observation of infant's learning progressions, the psychologist Andrew Meltzoff hypothesized that the learning of actions occurs through an innate self-other mapping. Meltzoff's "Like Me" theory (2007) lends a psychological perspective based on the observation of action learning and the subsequent assumption of a self-other mapping. While this theory is not based in neuroscience, it helps provide theoretical context and confidence when asserting the possibility of a neural mirroring system.

On one hand, the genetic theory provides a greater reasoning for a link between origin and social function of mirror neuron, while on the other hand, the associative learning account does not necessitate this evolutionary presumption. Natural selection is an integral factor in the evolutionary theory, but it maintains a supplementary role in the associative learning theory in which the individual environment and sensory input throughout a lifespan is central to the understanding of the development of mirror neurons (Cook, Bird, Catmur, Press & Heyes, 2014).

There is evidence from Transcranial Magnetic Stimulation (TMS) studies that suggests a plastic human mirror neuron system (Mehta et al., 2015). However more research in this area must be done to confirm noteworthy and symptomatically correlated plasticity of the mirror neuron system. Nonetheless, if the associative learning theory of mirror neuron origin is correct, then there may be great implications for treatment and therapies for individuals who have disorders or diseases associated with stunted mirror neuron systems, such as autism spectrum disorder (ASD) (Chien et al., 2015; Hu & Huang, 2014; Hamilton, 2013; Dapretto et al., 2005).

Deficits in social-emotional reciprocity, often interpreted as reduced empathy, are hallmark symptoms of Autism Spectrum Disorder (ASD), according to the DSM-5 diagnostic criteria. Individuals with ASD also have blunted activity in motor neuron areas (Martineau, Andersson, Barthélémy, Cottier & Destrieux, 2010), with a clear inverse correlation between the severity of the disorder and the activation level of their mirror neuron systems (Enticott et al., 2012).which may account for some of the social deficits often observed in individuals with ASD. The connection between mirror neurons and ASD provides an example of how an understanding of the mirror neuron system can be used to better understand empathy in individuals who are especially impacted.

However, stunted mirror neuron systems are not exclusively associated with ASD. Schizophrenia (Möhring et al., 2015; Mehta et al., 2014; Tseng et al., 2015; Lee, Chun, Yoon, Park & Kin, 2014), and amyotrophic lateral sclerosis (ALS)

(Jelsone-Swain, Persad, Burkard & Welsh, 2015; Eisen, Lemon, Kiernan, Hornberger & Turner,2015) are two other disorders and diseases that include deficits in the mirror neuron system. The mirror neuron system is akin to most other structures and systems in the brain in that an incredible amount of knowledge is gained through study of the lesioned or dysfunctional systems (Iacoboni & Dapretto, 2006). The associative learning theory places great weight on the power of the plastic brain and might suggest that mirror neuron system activation can be taught and corrected for throughout one's life.

Automaticity of the Mirror Response

A key to the understanding of mirror neurons within the relationships we have with others is in appreciating the automaticity of this process. The mirroring behaviors of individual cells in the brain occur automatically and are not cognitively controlled through top down processing. Instead mirror neurons are reflex-like in nature—inevitably firing without conscious awareness or control (Spunt & Lieberman, 2013; Bach, Bayliss & Tipper, 2011; Heyes, 2011). One cannot intentionally regulate the activation or suppression of mirror neurons when they are faced with the task of understanding an other

Given the automatic, reflex-like initiation of the mirror neuron system, C. Fred Alford (2016), a psychoanalytic theorist, argues that it is overreaching to claim that individuals can understand others without higher level mental processes. This rings true if mirror neurons are considered the sole explanation of empathy. However, It seems more likely that the mirroring system is not the sole mechanism of empathy, but instead a key player that may underlie a larger system and work in conjunction with higher level cognition. It is quite possible that perception relies on a framework and a context that includes comparison stimuli and experiences. This mirroring system could act as the stimulus for comparison that makes the experience of others directly relevant to the self. In *Within Each Other: neural mechanisms for empathy in the primate brain*, Iacoboni writes "when the self acts, the self also perceives the other. Self and other become two sides of the same coin. As the two sides of a coin are worthless pieces of metal when separated, self and other also make little sense when separated. Maybe this is why empathy *feels* so powerful" (Iacoboni, 2014, p. 56). Only through the understanding of self can we truly understand others. The inverted statement rings true as well. Only through an understanding of others, and the physiological impact they have on us, can we truly understand ourselves. Because there is a vicarious repercussion of the states and experiences of others within us, the only way we can fully understand ourselves down to the neuron, is if we understand others.

This power and emotional pull ensuing from the self-other connection can make the empathic experience difficult, and at times uncomfortable. The pain of another has the real potential to physically alter the neuronal firing within your brain. While there is some regulation of the extent of the mimicry of this system, in general, this process happens automatically. We can't choose not to empathize when we are in a context that requires it. However, if we do not want to empathize, we alternatively choose to remove ourselves from situations where we inevitably empathize in an uncomfortable way. Unlike spinal cord reflexes, which automatically protect from external stimuli (i.e. the reflexive retraction of a hand when it touches something hot) and pulling the individual away from the world, the mirror neuron system reflexively forces engagement with the world and with others. It functions as a mode of connection, rather than a protective predisposition to disconnect. Reflexive connection allows for vulnerability, which may require that one is subject to a connection to the suffering of an other. This behavioral consequence of the power of empathy will be discussed more in depth throughout the following chapter.

Contention in the Field

A large portion of the scientific community is animated by the recent mirror neuron findings and continues to research these neurons extensively, however, some dispute the proposed implications of these neurons, or even their existence all together. Luca Turella, a cognitive scientist, contends the PET and fMRI studies that claim analogous mirror neuron system in humans, such as the studies discussed previously. He argues that there is weak evidence to suggest that the dual functions demonstrated in a neuronal ensemble (previously discussed as one of the criteria for the justified translation of a mirror neuron in monkeys to a parallel mirror neuron system in humans) is due to a mirror function. He contends that one cannot reasonably have confidence that the overlapping ensembles represent the exact same neurons in humans firing with execution and observation of an event.

Through comparing the qualitative aspects of the data gathered from monkeys with the qualitative data gathered from human studies, Turella, along with others, argue that the mirroring quality is disputable. They argue that the plethora of studies suggesting evidence for a mirroring system in humans might instead be the recording of not one mirroring system, but instead may be the recording of multiple overlapping systems that combined, however not individually, account for the triad of action observation, imitation, and execution function (Turella et al., 2009).

Another chief opponent to the proposed implications of the discovery of mirror neurons is Gregory Hickok, a University of California Irvine professor of cognitive sciences and author of *The Myth of Mirror Neurons: The Real Neuroscience of Communication and Cognition* (2014). A portion of his contentions are centered on the action understanding function of mirror neurons. He contends that the evidence does not suggest that motor mirror neuron activation leads to the understanding of an other's action, but on the contrary, he argues that it is the understanding of an action that results in the neuronal activity. This flips the script on self-other action understanding. Hickok contends that if mirror neurons were the basis of action understanding, then it would be inconsistent that we can understand the actions of others that we cannot complete ourselves, for example, we can understand the flying actions of a bird even though humans cannot fly.

The credibility of the empathetic action understanding argument was challenged through an in-depth look at how we come to understand and how we neutrally react to observing the behaviors of a dog. In an fMRI study, the human neural responses to observations of biting and barking were analyzed. In the biting condition, there were fMRI ensemble activations, however, during the barking conditions there were not (Buccino et al., 2004). Rizzolatti interpreted this finding in a critical review of Hickok's *The Myth of Mirror Neurons: The Real Neuroscience of Communication and Cognition* as a result of the inability of humans to neuronally map actions that we cannot ourselves do and therefore we cannot understand. In this case, biting activates motor neurons because we as humans can bite. However, barking does not cross species and therefore cannot be mapped within the human observer. However, Rizzolatti claims that there are higher inferential processes that initiate to allow for the understanding of things outside of our motor repertoire (Rizzolatti & Sinigaglia, 2016).

While it may be legitimate that we might not be able to truly understand experiences that we cannot experience ourselves, our higher level cognitive processing helps us to fill in the gaps between our limited direct understandings and our conscious perception of full understanding. The mirror system may act as a reflex that provides a basic point of reference based on the stimulus input provided by the experience of the other. Then, layered onto that automatic mirror response is a cognitive processing component that allows for extra interpretation and personal contextualization. If action understanding is based in mirror systems, it also surely works in conjunction with other processing. Very few functions or operations in the brain occur in an isolated or independent circuit, but rather they process as an interconnected, multipath interweaving of individual parts. Mirror neurons are not the lone mechanism of empathy, but it seems clear that they help to achieve and inform a bigger picture.

Rizzolatti contends Hickok's dissension that centers on the practical implications of the motor mirror system. Rizzolatti argues that motor mirror neurons are only one of many types of neurons that possess the mirroring property. If we expand our understanding of the mirror mechanisms to include systems that have been associated with mirroring in humans, then the self-other merging implications are more reasonable. Mirror neurons are clearly not the only mechanism, and may not even be the predominant mechanism, but the fact that mirror neuron systems cannot account for all understanding and empathy is not a basis for the dismissal of the idea.

Embedded in the mirror neuron theory for action understanding is the notion that actions have a 1:1 ratio matching on the motor repertoire because there are specific and unique mirror responses with the observation of specific actions. An example might be that each specific action has a specific and unique mirror response (Rizzolatti & Sinigaglia, 2015). One argument asserts that it is outlandish to accept the direct matching model that mirror neurons offer. If one can understand the actions of beings that we cannot also mimic, then these claims fall apart (Steinhorst & Funke, 2014).

A rebuttal to this position is found through the acknowledgment that understanding is a part of a much bigger system, and therefore the mirror neuron system theory does not inevitably require 1:1 mapping of actions to function. When broadly congruent neurons are factored in to action understanding, it allows for the recognition of intent without a physical stimulus providing the input that leads to a 1:1 cortical mapping. Also, these systems include a higher level of processing that inevitably follows observation. As discussed previously, others suggest that the mirror neuron response is reflex-like in nature and activates without our conscious directing. Therefore, the conscious awareness of our own empathy suggests that there must be a higher level processing step to empathy.

In addition, it is proposed that the direct-matching model does not account for goal and action mirroring. The argument is that either the mechanism can replicate observed action, or the mechanism is involved with higher level processing towards understanding a goal (Steinhorst & Funke, 2014). On one hand, it is argued that humans cannot map directly congruent actions unless there is absolute understanding of every goal. However, one can, in actuality, understand a dog's bark even though we do not have a 1:1 set of neurons for the intention of a dog bark, adding to the contention over the claims of goal-understanding mirror mapping.

On the other hand, humans can interpret what we believe or perceive the dog's bark to mean, even if it is only conjecture. Humans perceive canine vocalizations as warnings, expressions of fear, excitement, etc. Humans tend to anthropomorphize the behavior of dogs. This shows that we put the behavior into words and goals we can inherently understand, therefore allowing it to have a place in our goal mapping mirror system. Steinhorst's argument only holds if we claim to know the true intention of the dogs bark, however that is a fundamental error in her logic. We do not understand the goal of barking, yet we interpret it in human ways we can understand, allowing for the argument of the goal mapping system to prevail.

Looking ahead to future research it would be most useful to find a method that could ethically detect single neuron activation in human, neurobiologically healthy brains. While this may not resolve some of the social theory debates or the contention over the implication of the proposed mirroring systems, it could empirically and confidently confirm the existence of not only mirroring systems as a whole, but of single units with activation that merges the experience of others with the experience and neuronal firing of the self. While this revolution will likely come someday through major advancements in technology, it is not yet on the horizon. Another area that illuminates and further informs this controversy is discovering an indisputable method for distinguishing higher level processing components in action understanding from mirror neuron system contributions. While mirror neurons may be a founding and an integral first step towards understanding an other, there must be additional, unknown factors at play. To account for the richness and complexities of the human empathetic experience, there are likely further mechanisms and components not yet vetted and understood. These other components are currently being investigated and can add valuable insight into the study of empathy in the brain.

The Integration of Neurophysiological and Social Psychological Understanding

Currently, we are faced with positions ranging from great fervor over the discovery of the neural key to human empathy with prospects of endless implications and applications, to positions urging that these findings are limited to the realm of action reciprocity in non-human primates exclusively. We must evaluate the differences within the range of these conclusions in the field. In actuality, the crucial difference of scope lies in the translation of an individual mirroring unit to a systematic mirroring complex in humans. All things considered, functionally, we know that empathy exists in the brain—whether through a conglomeration of systems working in conjunction to allow for empathy, or through a vicarious mirroring system. We know that empathy is an integral part of our being human as well as an inherent function within us. In neuroscience the brain is the end-all-be-all of truth and relevance, but in our everyday life, mechanical estimations that all point to a similar application are sufficient to lead us to a crucial conclusion. Despite the mechanical differences in theories as well as the difference in mirror neuron and empathy origin theories, this literature as a whole can be utilized in an impactful way.

Even though the range of data interpretations on mirror neurons is varied, we must evaluate how all of the data, taken together, can contribute to our understanding of empathy. With this data, our understanding of empathy transitions from an abstract to a concrete understanding of an other. What we previously conceptualized as an intangible response to the experiences and emotions of others, may, in truth, be a concrete, physical alteration of the self as a consequence of exposure to an other, resulting in human empathy.

Neuroscience is on the cusp of describing something that previously has never been comprehensibly explained before. It is an exciting time to be a student of research that will one day mount to create the true narrative explaining the neural basis for the empathy present in humankind. Next, we can merge our greater understanding of empathy in the brain with an understanding of functional applications of empathy through social psychology.

Part II: Understanding Empathy through Bearing Witness

I now know about empathy in the brain, and interpret that the experience of others fundamentally impacts and alters not only our perception of the world, but also the physical functioning of our brains. Others fundamentally alter our being.

Empathy, by definition, must be preceded by some level of perceived understanding or familiarity. To soften the edges of our divisive world, and open our societies narrative to the viewpoints of others to gain a more valid, inclusive and just understanding of our world it is important to start from the ground up. The first step is to understand the function of empathy in our lives and strive for increasing the empathy and compassion that we carry throughout each day.

"Empathy is the faculty to resonate with the feelings of others. When we meet someone who is joyful, we smile. When we witness someone in pain, we suffer in resonance with his or her suffering."

~ Matthieu Ricard

As a society, our propensity to interact face to face with others has seemed to decrease as time and technology advances. It is natural to shy away from discomfort and remain complacent when in a place of comfort, and empathy at times, can be incredibly uncomfortable. It pains us to be involved in the pain of others, even if we are playing a passive observer role. The pain of others is automatically processed within us as we understand the pain relative to our own neuronal firing. This automatic empathetic processing is unwavering and unyielding, so instead we choose, both consciously and secondarily, to avoid situations that would especially trigger this automatic processing in uncomfortable and poignant ways.

One common misconception is that positive change always comes naturally and easily. Change is difficult. Currently underlying our society is the convention of living only within oneself, rather than habitually allowing ourselves the opportunity to feel vicariously the experience of others. An effective and meaningful challenging of this social norm cannot be accomplished passively. In a society that facilitates disconnections with others and the world when things become uncomfortable or trying, this change is difficult and therefore must be intentional and diligently fought for.

Fortunately, it is not necessary for the individual to discover and resolve the social psychological components of empathy all on one’s own. This is a topic that has been well studied because the expansive implications of empathy in our society and in our individual interactions are potentially far reaching and incredibly impactful. Through applying the knowledge gained from research we can embrace the natural yearning as social creatures to connect with others in a way that betters ourselves and betters the world. Empathy and specifically increasing empathy to decrease bias have been studied in depth. The literature suggests that one of the most important indicators of increased empathy is increased contact with others that are unfamiliar in some way.

Building a Connection with One Another

A meta-analysis parsing the mediating factors of reduced prejudice concludes that three factors, including reducing anxiety, increasing empathy, and increasing understanding of an out-group can all be altered through contact. The former mitigating factors of prejudice—decreasing anxiety of interaction with an out-group through contact and increasing empathy and perspective taking through contact— are shown to be the most influential mechanisms through which contact leads to decreased prejudice (Pettigrew & Tropp, 2008).

Research also shows that contact with individuals of an out-group increases the empathy shown to that group. This effect is seen widely across many in-groups and out-groups, revealing that increased contact with others can effectively bring about more empathy for those others within the individual. An explanation of this is that an individual's mirror neuron system is activated when they encounter an other and they therefore partially have the remnants of the experience of another neurally represented within themselves as they interact with an other. This could add to the cognitive changes that result from better understanding the nuances of individuals (as opposed to relying on stereotypes and generalizations) and therefore increasing baseline levels of empathy towards them.

For example, this effect can be seen in children’s empathy for individuals with disabilities. Increased contact between child participants and individuals with disabilities decreased anxiety over meeting someone with a disability and increased positive attitudes towards individuals with disability. Both of these outcomes allowed for greater empathy to be shown towards individuals with disability (Armstrong, Morris, Abraham, Ukoumunne & Tarrant, 2016). Contact with others exercises the mirror neuron system, as well as exercises the cognitive skills of perspective shifting and the cognitive habit of more frequently attempting to understand others. Contact with a member of an out-group works on many different biological fronts to help reduce bias and increase empathy.

Neural markers of empathy were also used in studies to assess the effect contact has on empathy for others. It is known that in-groups and out-groups created through racial barriers largely affect the empathy between particular groups. One study specifically analyzed empathetic responses to observing the pain of others through fMRI brain scans of participants. The participants were shown individuals of other races and individuals of their own race in pain. Consistent with previous race-empathy and bias research, the fMRI results showed increased signs of neural empathy (an increase in activity in the anterior cingulate cortex) when the participants were looking at individuals of their own race, rather than individuals of a different race. Perhaps even more significant and relevant to this investigation of empathy in the brain is that in this study there was a strong correlation between the amount of empathy felt for an individual and the reported day to day contact they had with that race.

Importantly, this correlation existed for simple contact with others only, not accounting for the personal role of that person in an individual's life. The quality or associated meaningfulness of the interactions with individuals of other races did not matter, but instead, the sheer quantity of interactions throughout an average day was a principle factor in amount of empathy shown (Cao, Contreras-Huerta, McFadyen & Cunnington, 2015). For example, based on the findings of this study, it is likely that an individual who interacted with many races other than their own in their daily life, (i.e. at the grocery store, in their workplace, casually interacting on the street, etc.) would feel more empathy towards the pain of people of a different race than a person who is in a largely race homogenous community who has a couple meaningful relationships with individuals of another race (i.e. a close friend or family member). This piece of information becomes increasingly striking when assessed in the context that has been found to be true; simple contact has a profound impact on the automatically initiated mirror system.

Studies have shown that contact with an individual who is a member of the perceived out-group increases the empathy that is shown towards other members of the out-group. In one study, participants were confronted with a virtual individual from an out-group; in this case they were Jewish Israeli participants who interacted with a virtual human Palestinian, discussing a traditionally sensitive issue. All who had contact with the virtual human from the out-group had increased empathy by the end of the experiment.

However, more telling was the evidence that followed analysis of the two conditions that were controlled for as the participants made contact with the virtual human—a mimicry condition and a non-mimicry condition. In the mimicry condition, the participants showed much more empathy towards the out-group than the participants in the non-mimicry condition (Hasler, Hirschberger, Shani-Sherman & Friedman, 2014). This suggests, not only, that understanding of a group brings increased empathy, but also that physical mimicry, through the use of what we can assume is both the motor neuron system and the mirror neuron system working in conjunction, can drastically increase empathy. Contact, as well as a condition that utilizes what we know about physical and psychological mimicry and mirroring, may be a realistic tool in increasing empathy and breaking down biases and barriers.

Research on imagined or virtual contact, such as the study discussed above, has seen an influx as our society and our science try to orient themselves in our rapidly advancing technological culture. Also, we are seeing the pop culture influences of mindfulness and meditation guide research interests, such as the social and personal effects of imagined contact with others (Vezzali, Crisp, Stathi & Giovannini, 2013). Further research could elucidate how we might most effectively use technology and mindfulness for the purpose of increasing empathy between individuals and between groups in our sometimes divisive and polarizing culture.

Studies find that reading and watching T.V. can lead to increased empathy. The more stories an individual encounters, the more opportunities they have to exercise these empathy neurons. Therefore, the stronger and faster these connections become, on a conceptual level, the better and more effectively we are to empathize and understand one another. It is common knowledge that the more we use a neuronal pathway, the stronger and more efficient that pathway becomes. So while we may not have the mechanical and physical understanding completely expounded, we do know that this neuronal plasticity and natural pathway strengthening exists. To increase the compassion we show towards all people we must actively seek out experiences that are different from our own so we can attempt understanding.

It is imperative that we let this knowledge pull us to a better end. Once we know the importance of empathy in our society, and in our brains, we cannot ignore it. This knowledge makes me think. It pulls on my heart and my mind. It is important to confront the reality that it is necessary to seek out contact with individuals who have lived different experiences than us.

Let it be clear that there is no suggestion that observation someone's hardship alone can result in a complete understanding of them. Through seeing the life others live and witnessing the specific struggles they encounter, one cannot claim familiarity. What is being proposed is that if our acquired knowledge of the brain has illuminated something about empathy, then it would be reckless as citizens and as scientists to not use this information to try more earnestly. We might never be able to truly understand anyone besides ourselves, yet despite this constraint; our brains are already on their own accord, relentlessly working to understand. Without any effort on the part of the individual, within them is a physiological trace of the experiences of others. This is a sobering realization of the power that we possess to connect with others. Now only imagine what the impact could be if we combined this natural automatic empathetic processing with intentional and specific conscious efforts towards furthering compassion. The results could be truly remarkable.

The Importance of Bearing Witness

Personally, I am the product of a Jesuit higher education that has been partially rooted in studies of social justice. I have come to hold the Jesuit mission extremely closely to my heart. Some of the six core Jesuit values take up residence in my thoughts more often than others, but I have come to interpret all of them in a way that resonates most with me, while still keeping the original spirit of each value alive. One value in particular that is important for furthering the work on empathy is the Jesuit urging to be in service *for* and *with* others. To me, this value revolves around embracing the idea that a catalyst for growth and transformation involves being not only *for* but *with* others, To truly effect change, the Jesuit values suggest that one must not only be an advocate *for* but an advocate *with*, even as this requires becoming comfortable with discomfort. Only when we realize how we are interconnected in our service *with* others can we apply our passions in service *for* others. We cannot provide just advocacy and tailored service if we do not bear witness first.

Every person deserves the right to be treated with respect and care. Often, trying to survive on the margins of our society effectively deprives an individual of these basic needs. Our society often makes it convenient to ignore and dehumanize the marginalized, as opposed to engaging with others and sharing in a piece of their pain and struggle. Sharing in the lived experiences of individuals who are at a vulnerable point in their lives may be uncomfortable. Nevertheless, bearing witness to the cruelties of the world is of utmost importance not only for the bystander’s growth and change in perceptions or bias but for the individuals themselves.

To bear witness is to allow oneself to be impacted. By enveloping oneself in the unfamiliar experience possessed by an other there is a change in both the self and the other. The observer can be impacted in a very profound way through bearing witness. As illuminated through the previous review of mirroring systems, the impact is not just on an idealistic level. If one bears witness often, the neural connections to empathy strengthen, creating a real, physically measurable impact. Also, there is immeasurable value in bearing witness to the suffering of an other, even if there is no action that the observer can take to fix the situation. Suffering alone is a horrible fate. By simply bearing witness to the suffering of another, the sufferer no longer has the immense task of carrying the weight of their story all on their own. In some cases, sharing one's experience and story with another person brings great relief, and allows the sufferer to no longer feel powerless, silent and alone in their struggle. The sections that follow attempt to place the concept of empathy through bearing witness in the context of real world applications.

"for there is nothing heavier than compassion. Not even one's own pain weighs so heavy as the pain one feels with someone, for someone, a pain intensified by the imagination and prolonged by a hundred echoes."

~ Milan Kundera

Bearing Witness to War

War is an atrocity that is often thought of as indescribable. Samuel Hynes, a war memoirist, dives into the idea of bearing witness in the context of war in *The Soilders' Tale: Bearing Witness to Modern War*. Hynes describes an account bringing to light this idea, "war cannot be comprehended at second-hand, they say; it is not accessible to analogy or logic. 'How can they judge who have not seen?' a French soilder-writer of the First World War asks; another agrees, in a sentence that seems to echo the *Roland* poet: 'The man who has not understood with his flesh cannot talk to you about it'... 'Those who haven't lived through the experience may sympathize as they read, the way one sympathizes with the hero of a novel or a play, but they certainly will never understand, as one cannot understand the unexplainable'" (Hynes, 1998, p. 1-2). War may simply be an experience that is so otherworldly to those who have not been directly impacted, that it is impossible to imagine and fully appreciate the implications and effects that it has on the world and on an individual.

While this may be true, it should not dissuade from attempting to understand, despite the inability of individuals who have not been face to face with the horrors of war to ever truly reach a complete understanding. If anything, this makes the attempts at understanding even more prudent and valuable. If those who have not been in the trenches of war cannot understand with our flesh, there is still an opportunity to understand not the war itself, but the individual's stories and interpretation of war through our mirror neurons.

A perspective into the power of bearing witness is depicted through the stories of war. Hynes emphasizes bearing witness as an extraordinary tool of the powerless. In the context of World War II and the use of weapons with powers of destruction beyond comprehension, Hynes states, “helplessness is a condition of victim literature, perhaps the definitive condition. So as long as you do something, oppose your enemy somehow, you are not entirely a victim... ‘Nowhere before in the history of the world had people been subjected to the devastating effects of the atomic bomb.’ And so the helpless man opposes, by bearing witness” (Hynes, 1998, p. 274).

Hynes describes bearing witness as an important act of defiance. It gives power to the powerless and the marginalized. Hynes tells, “if there is nevertheless some affirmation in these dark books, it must be this: that in this brutal world of powerless suffering it was possible, just possible, to be an agent—by small assertions of the will in opposing actions and, afterward, by telling. Because remembering is an action; to bear witness is to oppose. If you make the truth survive, however terrible it is, you are retaliating against inhumanity, in the only way the powerless have” (Hynes, 1998, p. 269). Everyone has the ability to bear witness in some form or another. This human potential cannot be diminished by a hierarchy or by status. It is a power that everyone has at their disposal. As the soldier witnesses the atrocities of war, it is important now to bear witness to their story, respecting and furthering the stance that they made in witnessing and in some cases, the helplessness they overcame.

There is something fundamental about our humanity that is irrevocably lost when these individuals perish unheard and these stories fade away unheeded. This tragic alternative disrespects all that is sacrificed when individuals bear witness to war, and it overlooks all that can be gained when we bear witness to their stories.

The Ethical Obligation to Witness

Ideas from the French philosopher Emmanuel Levinas provide an ethical account of human interaction that is instrumental in elucidating the importance of bearing witness. In a text, entitled "Totality and Infinity: An Essay on Exteriority", written by Levinas in 1961, he asserts that individuals have an ethical obligation when interacting with one another. Levinas especially emphasizes the power of the face-to-face interaction stemming from the face as the erudite external representation of the self, and a reminder of the fundamental ethical duty we have to the other.

American philosopher Edward Casey describes his interpretation of Levinas' stamce on interaction, stating "On the one hand, this relation brings out in the subject, the self as witness of the Other, an acute sense of obligation and justice, of desire as transcendence toward the Good, which is revealed only in the face of the Other" (Casey, 2006, p. 81). Levinas asserts that the true catalyst for ethical and moral behavior is the face to face connection between two individuals. Casey comments on the importance of a relationship centered on bearing witness asserting, "Just this sense of seeing is antithetical to the ethical relation, wherein we are enjoined to grasp the

Other in his or her fragility and distress (though also, and as a function of this very need, as an uncompromisable obligation placed on us to witness the Other)" (Casey, 2006, p. 89). Casey reaffirms Levinas' notion of ethical obligation to the other, in the context of understanding in times of vulnerability and hardship.

Levinas' ethics of the face inspires an in depth look at bearing witness as an integral role in nursing. Nurses are often present at the most vulnerable and emotion filled times in a life. Not only are nurses responsible for the physical health of their patients, but they are burdened with an understood obligation to better the emotional health of their patients. This is an incredible and oftentimes overwhelming role that they are asked to play. It is suggested that there is a moral necessity for a creation of space, and education to allow nurses to carry out this moral duty of bearing witness to suffering, disorder, disease, grief, joy, fear and vulnerability *with* others (Naef, 2006).

Bearing Witness to Lived Trauma:

Another example of the imperative to bear witness is in the context of trauma. When an individual has lived through a trauma, it is obvious that there is no way to alter the traumatic actions of the past; however, there is a possibility of mitigating the mental burden that the past places on the everyday life of the victim. Listening to the story of another allows listeners to better understand, and therefore better serve the needs of the victims. In addition, speaking their story out loud can allow victims to bring forth an experience that has been haunting them in a way that mitigates the amplification of emotion that can happen when a story is confined to the space of one's own mind. As the story transitions from taking sole residence in the memory of an individual to being shared with others, the survivor is sometimes alleviated from a portion of the anxiety resulting from the trauma, even if only in a small way.

In our society, there is a cultural desire to fit our career success within the narrative of "valid work", which often strives for monetary gain or success in the traditional sense of the word. However, it is urged that the emotionally laborious work of bearing witness to the stories of trauma presented by a victim is the most important work a person can do (Thornton & Novak, 2010). We often find ourselves acting in a way that marginalizes and dehumanizes others to serve as a protectant for our own comfort, even though neurobiologically we are programmed to connect and to feel pain with others on a fundamental level. There is something at the core of our being that we lose when we neglect our responsibility to bear witness.

When meditating on the life work that we are called to do and our personal propensity towards helping others, it is helpful to consider the motivations behind human helping behavior. The Empathetic Joy and Empathy-Altruism Hypothesis proposed by Batson et al. (1991) questions the underlying motivation for empathetic feelings and their result in helping behavior. This perspective speaks to the social implications of a mirroring system in humans that causes a self-other merging. A possible explanation is that we help others because we are connected to them physically, such that their pain causes us some amount of vicarious pain. We help the other to mitigate our own discomfort, as opposed to helping because of pure altruism (Batson et al., 1991).

Another theory states that empathy often leads to a helping response on the behalf of the victim, encouraged by pro-social moral reasoning. However, if one is in distress them self then their inclination to help others decreases. This decrease is thought to be explained by self-centered thinking that can lead to moral disengagement (Paciello, Fida, Cerniglia, Tramontano & Cole, 2013). It is difficult to be engaged with another human when all of one's energy is being allocated towards surviving in their own time of distress. Engagement is the cornerstone of the mirror neuron system, and moral, as well as physical, disengagement leads to inaction. There is a high time and energy cost to helping others. If we remove ourselves from interactions then we can bypass the engagement that is inherent in our relationships with others (as a result of our mirror neuron system) and therefore decrease the personally endured costs of helping.

At the cognitive level, fMRI data have shown that humans have some control over the physical and neuronal responses that result from the witnessing of pain in others, which can regulate our empathetic concern and ultimately our propensity to help one another (Lamm, Batson, & Jean, 2007). Despite their differences in reasoning and motivation, all of the above hypotheses give emphasis to the fundamental impact that others have on the self and the relationship this has to our propensity to help others.

Bearing Witness Conclusions and Implications

Through the above examples of the real application and impact of bearing witness to the defining, and sometimes painful experiences of others I hope to not overwhelm with the tragedies of the modern world, but to help illuminate a few of the many areas where contact and compassion make a difference, and where a lack of them exist. The consequences of bearing witness and the resulting empathy have been discussed. Without contact, there is a decrease in empathy. This results in less empathetic concern, more stigmatizing attitudes, and decreased engagement with the helping of others (Lebowitz & Dovidio, 2015).

The act of bearing witness, (demonstrated through the research concerning empathy and contact) increases understanding and decreases stigmatization of those who are different from us. Psychological and social phenomena, such as empathy, are clearly integral in our experience as human. While there is still a large amount of research to be done, we are beginning to see that at least one portion of our innate nature of empathy lies in these mirror neurons. Scientifically, we are still at the cusp of composing a cohesive and indisputable explanation of the basis of empathy and the full explanation within the brain. However, his knowledge of the mirror neuron system and how it may relate to empathy gives a greater meaning to the Jesuit value of living not only *for* others, but *with* others and can further inform the presiding Jesuit question of *how we ought to live*.

"Compassion allows us to bear witness to suffering, whether it is in ourselves or others, without fear; it allows us to name injustice without hesitation, to act strongly, with all the skill at our disposal"

~Sharon Salzberg

I envision a global community consisting of a vast and profoundly diverse group of individuals that show tolerance, respect, compassion and empathy for one another. However, this does not happen if we do not interact, engage and bear witness to the lives of others that are different from our own in a way that results in positive change and growth .We can transform the world if we increase our empathy and understanding individual by individual. The implications are massive, considering that empathy is a fundamental part of our being— informing our love, our conflict, our hatred, our stereotypes, our dehumanization, and our compassion.

It is important that we strive to think and act intentionally outside of our single system unit, which seems to be promoted above all in our western majority culture. The mirroring system, inherent in our brain shows that isolation from others is not natural, and that attempts at understanding others through interaction are at the core of our being. As we proceed with our lives, our personal stake and our resulting allocation of attention must remain both in the academic community and the empirical knowledge that is discovered, as well as in the global, social community of humankind, in attempts to apply the information to better our world. Neuroscience gleans its greatest meaning and importance through the ways in which the fundamental knowledge that is attained can impact lives—such as through identifying the mechanical inner workings of empathy. Philosophy provides a moral direction to academic research application, and social psychology offers effective strategies that can improve our interactions with others, resulting in a more empathetic world.

The applications of mirror neuron research, that imply self-other merging with empathy as the byproduct, are universal. They act on a multidisciplinary level, crossing academic fields, race, religion, illness, gender and experience. There is a physical change in the witness, which in turn leads to a conceptual change in understanding, stigma, and compassion. We can make profound change in the world if we use our scientific knowledge to increase our empathy and understanding. The product of our love, our conflict, our hatred, our stereotypes, our dehumanization, our compassion, and our communities, relies on this fundamental component of our being.

There is a physical imprint that is left upon us through witnessing the experiences of an other. I have argued that research in the neuroscience of empathy points to a very real and poignant insight—the importance of bearing witness to the experiences and the suffering of others. In some cases bearing witness can be painful, emotional, difficult and uncomfortable. In other cases this connection might be joyful, breathtaking, and awe-inspiring. However, in all cases, when we neglect our responsibility to bear witness to one another we irrevocably lose something that is undeniably beautiful and that unites us in our humanity. Amidst the knowledge that we are invariably connected to one another in a neurobiological, social, and moral way that is rooted in empathy, I ask each individual of the world, how can we best be *for* and *with* one another, and strengthen our humanity through the empathy and the compassion that connection fosters?

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