

# Of Mice and Meaning: Multidisciplinary Perspectives on the Interconnectedness of Pain, Stress, and Suffering

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**Abstract:** We document definitions of and relationships between pain, stress, and suffering while also reflecting on our own diverse training and experiences. Recognizing a range of causes and interpretations, we differentiate between maladaptive and adaptive forms of pain, stress, and suffering. Measures and identifiers of pain often rely on quantifiable measures, while suffering demands a greater attention to perceptions of self-understanding. Engaging with pain, stress, and suffering means considering how the mind and brain work together in processing and articulating moments of physical agony, heightened anxiety, and unbridled grief, as well as the stories we tell ourselves about these experiences.

*Keywords:* pain, stress, suffering, interdisciplinary

## Postulating Pain

“All becoming and growing, all that guarantees the future, postulates pain.”  
Friedrich Nietzsche

Pain and suffering are an inherent part of the human experience. As such, humans have constantly searched for answers to explain suffering and turn pain into growth and meaning. Narratives and art depicting the human emotion of pain can evoke feelings of connection and empathy among individual hearts and minds as well as insights into the sublime as interpreted by Immanuel Kant, though suffering can also decrease quality of life. There are then both adaptive (beneficial) and maladaptive (adverse) behaviors that arise from pain and stress with suffering, which complicates the way we study and attempt to limit their negative effects on human well-being. Our own scholarship is motivated by our desire to limit maladaptive pain, stress, and suffering.

We are siblings and scholars from seemingly disparate disciplines (one in humanities and one in neurobiology), yet we are both engaged in work to understand—and ultimately alleviate—various facets of pain and suffering. We currently work in two different laboratories at the same institution (Indiana University). Taylor works in a lab with mice and Claire works in a lab on storytelling. Our scholarship includes interpreting reactions to pain, stress, and suffering, both felt and observed, behavioral and aesthetic. Such observations provide further insights into understanding how the mind and the brain process pain and suffering.

Scientists and humanities scholars examining pain, stress, and suffering act as both storytellers and data miners through their respective methodologies. In this article, we reflect on our academic training while also connecting varying interpretations of pain, stress, and suffering to explore the relationship between the three. Definitions of each category are important because they affect

artistic representations as well as interventions, which in turn influences the ways in which we try to minimize unnecessary pain, stress, and suffering. On one hand, Batson (2009) has highlighted the paradox that there is a near universal agreement on the importance of empathy, yet on the other hand there are vast disagreements over *why* empathy is important as well as its effects, origins, and basic definitions (see also Decety & Ickes 2011).

In similar fashion, we suggest an assumed congruency in that identifying, measuring, and finding effective interventions for pain and suffering are critical in decreasing harmful suffering, although differences exist across definitions, methodologies, and expected outcomes. Kanov (2020) has offered definitions of suffering as well as arguments as to why suffering matters, and we add to this work by putting pain, stress, and suffering into conversation with each other. Both pain and stress are often experienced as external forces (“my arm hurts me” or “my job is stressful”) whereas suffering is frequently expressed as a part of self-understanding (“I suffer” as the self actively performs the verb “suffer”). By categorizing and differentiating types of pain, stress, and suffering as well as sharing our own experiences, we provide insights as to how the mind and the brain work in tandem and how suffering in particular affects one’s sense of self. This partnership of mind and brain controls both the way that we experience and respond to unpleasant and potentially debilitating stimuli, as well as the way we measure and represent these experiences.

While other scholars have theorized about the differences between pain and suffering, this article offers the inclusion of stress within this relational scheme. Though many scholars from the humanities borrow from the sciences and vice-versa, this is the first type of direct comparison to our knowledge between two scholars of such diverse backgrounds in collaborating on pain, stress, suffering, and their interconnectedness. In doing this, we attempt to open a conversation on the following questions:

- Why is it important to define and recognize the interconnectedness between pain, stress, and suffering from diverse disciplines?
- What are the potential benefits and harms for individuals and societies that stem from pain, stress, and suffering?
- How will considering both the potential adaptive and maladaptive components of pain, stress, and suffering serve to guide future interventions to decrease needless suffering?

### *Claire’s Background*

My academic journey began as an undergraduate studying history and German. I found myself drawn to the social, political, and moral complexities of the past and concerned by the extent of human suffering that shapes history. I entered a PhD program in Germanic Studies and was immediately overwhelmed by the task of making meaning from terms like “mimesis,” “Hegelian,” “polemic,” and “ontological,” even after looking up their respective definitions. Yet somehow, I was still surprised when I needed to spend thirty minutes explaining what “aesthetics” meant to Taylor as we worked on this manuscript. Much of my current research stems from projects in Indiana University’s Experimental Humanities Lab, directed by Fritz Breithaupt. These projects rely on collaboration across disciplines regarding interests, including empathy, narrative retellings, interactive fiction, violence, and social polarization. Though our lab produces theoretical scholarship (see for example Hiskes et al. 2022), most of our research is experimental (see for example Lagrange et al 2019), with data coming from survey responses to narratives we strategically manipulate.

On a more specific level, I examine cognitive and affective models of suffering in German literature and film. However, my scholarship has also felt very personal. As Cynthia Wallace has noted regarding her own work in literary studies, “We learn about suffering from our reading, and we learn about reading from our suffering” (2016, 231). After an emergency cesarean section in 2021, I had to rate my pain on a scale from 1–10 for a nurse every hour for the two days I spent recovering in the hospital. Each time, I agonized over what the difference between a 4 and 5 might be. When I delayed a narcotic for treating my pain because I had been feeling pretty good—maybe a 3—I

suddenly found myself sobbing in severe abdominal pain. A nurse came in and asked me my pain levels, to which I cried out, “Maybe a 6?” I hated admitting to being over a 5 but also felt like my tears betrayed a pain I did not want to acknowledge. My cognitive brain told me I was fine while my body viscerally rebelled. Admittedly, I was in no condition to narrate any immediate postpartum pain beyond a numbered scale, but I remember feeling the difficulty in quantifying my pain in order for a nurse to understand my level of discomfort and thus provide the best care. The ability to address pain in clinical settings comes largely from the ability to discern it in others, and thus both quantitative data and interpretative skills prove important in relieving pain.

In early 2023, I once again found myself in the hospital, this time with a late miscarriage at around 16 gestational weeks. The medical staff was still concerned with my ratings of pain as I progressed through labor, delivered our tiny baby, and then had to have a D&C to remove a stubborn placenta. In addition to tracking my pain assessments, the hospital staff attempted to address the emotional suffering I was experiencing. A grief counselor visited me and my husband a few hours after the delivery and offered to talk about our loss, though we were beyond words in our raw mourning. The counselor provided us with information on other resources such as therapy and support groups around late pregnancy losses, opportunities to narrativize our experiences as well as sustain others in their own stories. However, during those hours at the hospital, I could only think of my own inability to ever articulate or represent such terrible loss in any form. When asked to do so, I could offer quantitative estimates of physical pain. But suffering this kind of loss was (and is) a process, a developing narrative that would not be neatly resolved in the same way medication eased my bodily pain. This type of suffering will forever be tied with an understanding of myself.

#### *Taylor’s Background*

As an undergraduate, I gravitated toward studying neuroscience because the child in me wanted to bring my fascination with taking things apart to life. I wanted to learn how to ‘take apart’ the brain with the goal of understanding and potentially ameliorating the mental health challenges that I and so many of my friends and family faced. I sought to understand what drove many people to purposefully seek out addictive drugs despite the blatantly negative consequences. I wanted to know the mechanisms of the antidepressants I took for my own battle with anxiety and depression. To pursue these interests, I joined a research lab and spent my time investigating how alcohol (ethanol) affects the electrical activity of mouse neurons in a brain region associated with reward and motivation.

After receiving rejections from all the neuroscience PhD programs to which I applied (my science marks were ‘quite poor’ as one program put it), I was told that working as a technician would increase my chances of acceptance the next time I applied. I then worked for two years as a research assistant in a neuroscience lab at the University of Denver–Anschutz Medical Campus. As I conducted research and interacted with individuals from the campus, I gained more awareness of different scientific philosophies and approaches regarding health and disease within the biomedical sciences. On one hand, there are those engaged in clinical research, characterizing diseases and disorders in human populations and detailing the effects of specific interventions (both drugs and non-pharmaceutical treatments) on their subjects. On the other hand, there are the ‘basic’ scientists, those who often work with rodents, cells, and chemicals, to further our understanding of basic biological processes that govern life. However, one who attempts to approach real-world problems with basic science tools and techniques is often referred to as a ‘preclinical’ or ‘translational’ scientist. I became enamored with the idea that the research I performed in a more ‘basic’ lab setting with rodents could translate to the world as a whole and benefit my friends and family dealing with mood disorders and/or addiction.

With this perspective, I decided to pursue a PhD in neuroscience to gain skills that would help me on my journey to become a translational scientist. In the lab of Andrea Hohmann at Indiana University, I learned how to conduct behavioral experiments in rodents that serve as useful models for

studying the interconnected subjects of neuropathic pain, mood disorders, and opioid addiction. By conducting preclinical behavioral work in each of these areas, I have observed an important theme that links them: dysregulation in the nervous system is associated with the shift from a behavior that is “normal” or “healthy” to a behavior that can be described as “blunted” or “overactive.” Biological systems that are typically useful to an organism’s survival (functional pain, stress, and reward processing) can become problematic for it when the system becomes dysregulated.

### Pain, Stress, and Suffering

We turn now to defining and differentiating pain, stress, and suffering as understood within the humanities and biological sciences. These concepts exist across a spectrum and are the results of different stimuli, thus evoking diverse emotional and physical responses. We created a visualization (see Fig. 1) to provide an overview of similarities and differences between pain, stress, and suffering discussed more in depth in the sections that follow.




	<b>Pain</b> 	<b>Stress</b> 	<b>Suffering</b> 
<b>Definition</b>	<ul style="list-style-type: none"> <li>emotional/physical unpleasantness associated with actual or potential tissue damage (temperatures, chemicals, injury, diseases, inflammation, etc)</li> </ul>	<ul style="list-style-type: none"> <li>disturbance to organism's homeostasis</li> <li>environmental/physical pressure that evokes a response from an organism</li> </ul>	<ul style="list-style-type: none"> <li>prolonged distress that leads to existential threat of an individual's sense of self/personhood</li> </ul>
<b>Adaptive Response</b>	<ul style="list-style-type: none"> <li>motivation for an organism to change its state to avoid biological threats to homeostasis and survival</li> </ul>	<ul style="list-style-type: none"> <li>motivation for an organism to change its state to avoid biological threats to homeostasis and survival</li> </ul>	<ul style="list-style-type: none"> <li>motivation to fix source of suffering (biological, interpersonal, political, etc)</li> <li>source of increased personal meaning, growth, purpose, etc.</li> </ul>
<b>Maladaptive Response</b>	<ul style="list-style-type: none"> <li>Pathological/neuropathic pain causing distress in the absence of a threat</li> </ul>	<ul style="list-style-type: none"> <li>chronic/uncontrollable stress negatively affects many body systems and an individual's well being</li> </ul>	<ul style="list-style-type: none"> <li>Needlessly decreases quality of life</li> </ul>
<b>Measures</b>	<ul style="list-style-type: none"> <li>questionnaire (self)</li> <li>inference through behavior (others)</li> <li>physiological markers (nerve conduction, etc)</li> </ul>	<ul style="list-style-type: none"> <li>questionnaire (self)</li> <li>inference through behavior (others)</li> <li>physiological markers (hormones, parasympathetic response, etc)</li> </ul>	<ul style="list-style-type: none"> <li>Reliance on (unquantified) narratives, aesthetics</li> </ul>

Fig. 1. Differences Among Pain, Stress, and Suffering

#### Pain Defined

Pain is defined by the International Association for the Study of Pain (IASP) as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage” (Raja et al. 2020, 1977). Recently updated through small changes of language, the previous definition had received critiques for excluding social and cognitive components of pain as well as trivializing the extent of peoples’ pain (Williams & Craig, 2016, Wright 2011). However, the word “unpleasant” remains the umbrella term for the base characterization of everything from stubbing one’s toe to breaking a femur. Generally, pain comes from external stimuli that inflicts degrees of discomfort on the body or mind but remains separate from self-understanding.

Elaine Scarry (1985) is well known for pushing beyond strictly medical interpretations of pain by applying political and historical lenses in *The Body in Pain*, where she argues that pain defines reality as well as certainty in one’s own experiences. For Scarry, “Physical pain does not simply resist language, but actively destroys it” (4). As we are then reliant on metaphorical expressions to articulate our experiences in the face of linguistic destruction, the ambiguity inherent in metaphor also requires interpretation from the listener (Lakoff and Johnson 1980). This space of uncertainty and

doubt when observing another's pain (also expressed by Scarry) means that the study of pain can often be an imprecise and subjective one. Though an exact method to study pain would prove extremely useful, the reliance on the production and interpretation of metaphors to represent one's internal state creates the potential for imprecision.

David Morris (1991) expands on Scarry's philosophical framework by discussing cultural aspects of pain, particularly in the limited way America medicalizes pain (see also Kleinman 1988). Morris also articulates the "Myth of Two Pains," which commonly divides pain into physical or mental types, though this assumption ignores the "interdependence of mind and body" as well as the multiple ways in which pain can manifest itself (10). Thinking about pain in the sciences and humanities might further this myth of two pains, with science often being drawn to physical pain and the humanities using aesthetics to either provoke or alleviate mental pain. Left unresolved, temporary pains of the mind and body can lead to suffering, though scholarship on suffering gives particular weight to the mind. We see many of the ways that Scarry and Morris describe the significance of intense pain more in line with the existential threat tied together with suffering.

To categorize pain more succinctly, Loeser and Melzack (1999) differentiate pain stemming from nociception (the ability to perceive a noxious stimulus), perception of pain, suffering, and pain behaviors. Within these types, pain also can have anatomical, physiological, and psychological effects (see also Loeser 1980). From a biological perspective, nociception is vital for a species' survival, helping individual organisms to learn about and avoid temperatures, chemicals, and mechanical damage that would threaten their ability to survive and reproduce. Such cases suggest pain can be beneficial in that it acts as a warning sign that something is wrong.

#### *Adaptive/Maladaptive pain processing*

From an evolutionary perspective, a biological process or behavior can be considered 'adaptive' if it helps an organism adjust to its environment, and 'maladaptive' if it hampers an organism's ability to change to better fit its environment. Normal nociception is thus adaptive, as normal pain processing helps an organism learn to avoid potentially damaging temperatures, chemicals, and mechanical pressures. Various factors (genetics, diabetes, chemical exposure, injury, etc.) can cause dramatic shifts in pain processing that result either in a hypersensitivity to non-noxious stimuli (pain response from the touch of a feather) or pain signals sent in the absence of any obvious tissue damage. This type of maladaptive pain processing is often referred to as pathological pain; notoriously difficult to treat, it represents a large health burden globally. Pathological pain is highly correlated with depression and other mood disorders (Von Korff & Simon 1996, Blackburn-Munro & Blackburn-Munro 2001). Interestingly, a genetic inability to experience pain can also cause problems, as affected individuals are unaware of tissue damage and fail to adjust their behavior, sometimes biting off parts of their tongues, suffering burns or bedsores, and often living shorter lives (Cox 2006).

Maladaptive pain highlights instances where pain is not constructive. In pain disorders, pain can be traced to a concrete anatomical region (Kumar & Elavarasi 2016). Explorations of emotional, cognitive, and social pain (which occupy the mind rather than the body) often demand different interventions than anatomical pain might, which Loeser and Melzack (1999) also note. An individual would provide different descriptions of chest pain—physical discomfort located near one's heart—and heartache—emotional pain resulting from loss, betrayal, or other negative social factors. We suggest that ongoing pain in this latter category might fit more neatly in a separate definition of psychological suffering rather than biological pain, while emphasizing the interconnectedness of the two domains.

#### *Measuring Pain*

Although challenges exist in identifying and quantifying pain, there are standard methods of doing so. Such data allows scholars to examine if and to what extent an intervention has a significant effect on a person's pain. Clinically, this is often quickly done by asking patients to rate their pain

level on a scale of 1 to 10 as with Claire's hospital experiences, but several more detailed questionnaires can offer clinicians and researchers a more complete picture of the exact nature of one's pain and emotional state (Attal et al. 2018).

As rodents are notorious for their inability to fill out questionnaires, neuroscientists can only *infer* their internal/affective states through quantification of behaviors that could relate to pain response and affect. In this sense, a scientist operates under a narrative: "Because Group A exhibited less preference for sucrose than Group B, A exhibited anhedonia-like behavior." Preclinical scientists rely on various behavioral metrics to assess the level of a rodent's physical pain and affective state (Deuis, Dvorakova, & Vetter 2017). To examine pain, one might use a Von Frey filament, which allows a scientist to quantify the amount of force required for a rodent to move its paw out of the way in response to a mechanical stimulus; this test is useful for quantifying nociceptive hypersensitivities (pathological pain) and evaluate potential treatments for it. Evolutionarily, rodents generally prefer to avoid open, brightly lit spaces where they might be vulnerable to predation. In the Light-Dark Box test, rodents are allowed to freely explore a brightly lit portion of an arena and a darker, 'safer' portion of an arena. If a treatment or condition increases the amount of time a rodent spends in the dark side of the arena, it is typically referred to in literature as producing an 'anxiety-like' behavior. For a more exhaustive review of how pain and negative affect are studied in preclinical settings, see Kremer et al. 2021.

When attempting to characterize and quantify pain among historical and literary figures, scholars face a similar difficulty faced by the rodent behavioral scientist: they, too, are unable to converse with their subject of study (the dead and the imaginary). Currently, there are no standard, interpretive measures for past or imagined pain. In addition to relying on aesthetic descriptions within narratives, we might use our own experiences to imagine the described sensation and make judgments of perceived pain. To our knowledge, no scholarship has investigated potential quantitative measures of aesthetic pain that might only be accessible through word descriptions, images, and imagination. It might be possible to adapt methods used by Brockington et al. (2021) regarding positive (biological) responses to storytelling.

In order for a painful stimulus to enter our awareness, processing and modulation of nociceptive input occurs at various junctions in the body. To illustrate this, we can follow the journey of a pain signal after someone stubs their toe when walking across the room. Receptors that detect mechanical pressure in the toe will be strongly activated, sending an electrical pulse down the neurons in which they reside. These neurons, housed near the spinal cord, transmit signals to other neurons housed in the brainstem and the thalamus, a brain region that acts as a relay station and integration center. From the brainstem and thalamus, signals are quickly sent to other brain regions that allow the toe-stubber to alter their behavior and respond immediately to the injury. As highlighted in Legrain et al (2009), Functional Magnetic Resonance Imaging (fMRI) studies indicate that the anterior cingulate cortex (ACC) is a brain region that plays a role in orienting one's attention to a nociceptive signal, potentially due to its strong connections with premotor areas (involved in motor planning) and the prefrontal cortex (involved in executive function/decision making). The thalamus also sends nociceptive information to the somatosensory cortex, which encodes the origin and timing of the stimulus, and the insula, which plays a role in encoding the emotional aspects of pain. As reviewed in Bushnell et al (2012), nociceptive signals from the periphery are also relayed through the amygdala and the periaqueductal grey, which are also highly involved in emotional processing, fear, and fight-or-flight responses. Studies of chronic pain patients document functional and/or neurochemical dysregulation in most of the above-mentioned brain regions and targeting aberrant activity in the brain regions serves as an attractive strategy to alleviate pain (Narita et al. 2006, Maarrawi et al. 2007, Wood et al. 2007).

While our own research interests center on limiting maladaptive pain, we acknowledge not every scholar and artist views their work as having an activist or even moral bent. Indeed, some artists are

actively aggressive in their work and seek to cause cognitive pain and discomfort, such as in Italian futurism and avant-garde performances around metaphorical and physical ruptures (Perloff 2003). For these artists, transforming art or literature into a type of violence might be comparable with adaptive pain: just as physical discomfort can result in evolutionary benefits, emotional or cognitive discomfort can provide individual or societal benefits. Faced with an art exhibit or collage that performs or provokes pain (for example, witnessing past traumas through music, see Cizmic 2012), a viewer might be provoked into reflecting on and working through the causes and effects of psychological pain. Creators might also promote cognitive rupture for an audience to experience pain simply for pain's sake, considering the act of experiencing pain itself a worthy aesthetic experience. In "The Futurist Manifesto of Lust," Valentine de Saint-Point writes, "It is the painful joy of wounded flesh, the joyous pain of a flowering" (1917). Such paradoxical images of pain do not necessarily imply masochism, but rather emphasize an ongoing, polemic dialectic between the aesthetics of joy and pain.

### *Stress and resilience*

Much like pain, people often view stress in a negative light given its contribution to many adverse mental and physical health outcomes. The concept of stress as we understand it today was first introduced into biomedical contexts by endocrinologist Hans Selye, who suggested that stress was a "nonspecific response of the body to any demand" (Tan & Yip 2018). Selye's work documented how various "stressors" in an organism's environment (food deprivation, exposure to extreme cold, sleep deprivation, harmful chemicals) caused similar deleterious effects on several organs in rats. Biologically, there are several well-defined biological pathways that experience increased activity in response to an environmental stressor. The hypothalamic-pituitary-adrenal (HPA) axis consists of the adrenal glands and two brain regions called the hypothalamus and pituitary gland, which release "messenger" hormones into the bloodstream in response to a stressor. The adrenal glands subsequently release cortisol into the bloodstream, which arouses the body and initiates a 'fight or flight' response. We may not consciously think about these biological processes when we watch a horror film or realize we forgot about a work assignment, but we are all familiar with the heightened mental awareness and anxiety that accompany stress.

Although most people might not describe their stress as painful, stress can be an unpleasant sensation reaching back to the core medical definition of pain. Koolhaas et al. (2011) suggests that stress "should be restricted to conditions where an environmental demand exceeds the natural regulatory capacity of an organism, in particular situations that include unpredictability and uncontrollability" (1291). Without safety nets for regulating stress, it can become overwhelming. Ongoing stress has a direct link with suffering (Quick & Henderson 2016). Similar then to unaddressed pain, continual high stress levels can lead to suffering. However, not all interpretations of stress directly lead to suffering or even negative outcomes. Healthy levels of stress can also motivate us to complete important tasks or remove ourselves from a dangerous situation (McGonigal 2016). From an evolutionary perspective, an organism that does not experience any stress in the presence of a predator would be much less likely to survive and reproduce. When we are engrossed in a novel, TV series, or even artwork, we might feel stress (or relief) from the intensity of the story or image presented. This reaction, rooted in an evolutionarily advantageous biological response and regulated by various systems in the body and brain, emphasizes the interconnectedness between the brain, body, and mind in aesthetic experience.

Although stress is not necessarily a cause of disease *per se*, chronic or uncontrollable stress can exacerbate or increase the risk for the development of a wide variety of physical illnesses and mental disorders such as depression, anxiety, or post-traumatic stress disorder (Salleh 2008). When examining stress's role in the development of mental disorders, it is helpful to consider the concepts of resilience and vulnerability to stressors. For example, while many war veterans are exposed to trau-

matic events during their service, only subpopulations will develop mental disorders (Fogle 2020). Currently, scholars from many disciplines are engaged in understanding the biological, psychological, and social factors that play into stress resilience. Such resilience and stress management skills can prevent momentary pains of stress from turning into sources of ongoing suffering.

Though in this article we articulate pain, stress, and suffering as separate concepts, we also recognize the convergence of their physical manifestations in the body. For example, by measuring electrodermal activity, a Galvanic Skin Response (i.e. increase in sweating) can indicate pain level (Aqajari 2021) or emotional/mental state in a patient (Markiewicz 2021).

The hypothalamus acts as a crucial link between the brain and the body, as it receives neural information from many brain regions that process pain/stress and regulates the release of hormones (cortisol, oxytocin, among others) into the bloodstream. Interestingly, studies have shown dysregulation of cortisol (too much or too little) among chronic pain patients, highlighting the need for interventions that are helpful in both domains (Hannibal 2014). Recently, researchers found that storytelling decreased cortisol levels and pain scores in hospitalized children, while simultaneously increasing oxytocin levels and positive emotions (Brockington 2021). Interestingly, storytelling as an intervention was superior to a control social intervention (solving riddles), illustrating the unique and potentially useful therapeutic potential of storytelling in clinical settings. The high degree of neuroanatomical and functional connection between the brain regions that process stress and pain highlights the (literally) interwoven relationship between how we think and feel, how we process pain and stress, and how dysregulation in their functionality might combine to produce what we call suffering.

Acutely, stress can suppress pain, while chronic stress can amplify ongoing pain. Additionally, chronic pain can introduce stress into an individual's life, creating a vicious cycle that can culminate in an individual's extended suffering. Alternatively, artistic expression and storytelling, incorporated in some models of therapy, can reduce pain as well as stress through increased cognitive and affective processing, limiting the more negative effects of suffering. The physiological, neuroanatomical, and experiential interplay between pain, stress and suffering highlights the potential for holistic interventions based in aesthetic experience (i.e. art, music, narrative therapy) to compliment strictly biological approaches in medicine. Understanding the biological mechanisms of storytelling could potentially guide its incorporation into clinical settings and bolster its legitimacy as a therapeutic strategy for treating pain and stress.

### *Suffering*

As mentioned in our previous sections, both stress and pain can lead to suffering, which we consider a longer and more intense negative experience, as well as one more concerned with the perception and preservation of the self. The transition from pain and stress to suffering fundamentally involves medical perspectives with holistic conceptions of who we are. It is especially here that the collaboration of neuroscience, medicine, and the humanities is needed.

Instead of concentrating on defining suffering itself, much of the existing literature on suffering examines the effects and possible meaning of suffering and its effects of self-understanding or self-actualization. Philosophy has long pondered the transformative potential of suffering and its contrastingly nihilistic nature (see for example Nietzsche 1886, Bataille 1989, Schopenhauer 2010), as well as ways to transcend everyday suffering, exemplified in Buddhist psychology and practices (Burton 2016). Frank (2001) reflects on whether research on suffering is possible in that "suffering resists definition because it is the reality of what is not" (355), or rather, it is less observable and measurable than pain in most instances.

Nevertheless, scholars in the humanities and sciences have negotiated several characteristics of suffering. Reich (1989) contrasts pain with suffering, defining pain as "acute or chronic physical, mental, or emotional distress associated with...[an] unpleasant stimulus characterized by discomfort, which the mind perceives as an injury or threat of injury" to the body (85). Suffering, he goes



on to suggest, “is of a different order” than pain—it is existential anguish over such an injury or threat of injury. Again, the adjective “unpleasant” covers a wide variety and intensity of suffering, but its existential nature signifies a greater connection to the self. Suffering can, of course, extend beyond the typical anatomical nature of pain. Medically speaking, it is the “perception of serious threat or damage to the self” (Chapman & Gavrin 1999, 2233).

Similarly, Kanov (2020) proposes that suffering is “the severe or protracted distress people experience when an instance of pain or injury (emotional, physical, or otherwise) disrupts one’s basic personhood” (86). There is then a focus on preservation of the self. In this sense, suffering can be viewed as more of an issue of sustained and uncontrollable harm to an individual, a mind, or a soul rather than the immediate consequences of tissue damage. We see an element of chaos included in these definitions of suffering where instability negatively impacts the self, though such chaos may also lead to reflection on and transformation of the self.

For Wallace (2014), suffering includes “undergoing—or actively, allowing oneself to be affected by—some outside force, most often pain or distress” (19). In her work on the literary ethics of suffering, Wallace focuses on “women borne” and the distinct ways the literary female suffers. She interprets suffering as “both the action [cause] and the pain or distress itself” and thus part of the passivity that “typically take the female gender association in the Western binary that associates activity with maleness” (20). In this way, suffering may be gendered and interpreted as something one must endure rather than actively seek alleviation. Though we do not go into detail here, we recognize that medicine historically and at present does not value all articulations of pain equally, often discounting or ignoring women’s pain, especially Black women, which leads to unnecessary ongoing suffering and preventable deaths (Hoffman & Tarzian 2001, Chemaly 2018, Cooper Owens 2017, Cleghorn 2021). Even in preclinical research, historically the majority of studies only examine male subjects (Zakiniaiz et al 2016), leading to a 2016 mandate by the National Institutes of Health for researchers to address sex as a biological variable in preclinical studies. Seemingly “objective” measurements of pain still require interpretation by healthcare providers (as well as researchers) which thus contribute to structural inequities in healthcare and unresolved suffering (Bailey et al 2021). The misjudgment and disbelief of the pain and suffering experienced by marginalized groups, including Black and Indigenous populations, people of color, trans individuals, those with disabilities, and women, should be rectified. Narrativizing pain is a way to share one’s lived experiences. Though there is a spectrum of precision in measuring pain and suffering, the stories we tell ourselves and others affect the way we experience pain, stress, and suffering as well as how others respond.

### *Measures and Meaning of Suffering*

Suffering often requires lengthy descriptions regarding negative effects on the self (Charmaz 1999). Thus, suffering often comes in the form of lengthier narratives instead of brief descriptions or quantitative measures. If pain can be traced to the receptors and cell activity in the brain, suffering might be metaphorically tied to the soul. Limited attempts have been made to measure descriptions of pain through words rather than numbers, such as the McGill Pain Questionnaire (Melzack 1975), though such questionnaires are not standard. Narratives offer a way to both explain and attempt to understand one’s suffering, and usually the more complex or poignant the suffering, the more description it requires. A 10 on a scale from 1–10 simply cannot cover all the distress one is experiencing, though attempts have been made to create a self-reported suffering scale (VanderWeele 2019). Suffering may be more accurately depicted through phases that reflect a transformative arc. Reich (1989) offers three stages of suffering: 1) mute suffering, 2) expressive suffering (narrativizing and interpreting one’s experiences), and 3) finding a new identity in one’s suffering (see also Sölle 1984). For us, the suffering narrative can be termed as a tale of strong, negative emotions, often interwoven with attempts of meaning making.

Suffering should be taken seriously in and outside of medicine despite the difficulty in articulating its complexity and effects on physical, emotional, mental, and social well-being (Chapman & Gavrin

1993, 1999). Healthcare systems have traditionally relied on biological approaches to understand pain; however, suffering can extend between these processes and demands different modes of measurement and invention. Unlike pain/nociception, which has evolutionary benefits, suffering can often stem from issues in biological and social systems. For example, normal pain processing systems gone awry can send ‘pain’ signals to the brain even in the absence of anything harmful to an individual, resulting in excruciating discomfort that can last for decades. Clinically, patients afflicted with chronic pain conditions often experience comorbid depression and anxiety (IsHak 2018, Von Korff 2018). Similarly, dysfunction in family, community, and national relationships can create sustained suffering for members experiencing abuse, oppression, and war. The interpretation of suffering can be much less measurable than the warning signs attached to pain.

There are different schools of thought and religious traditions around suffering, as well as its relationship with individual agency. Ancient schools of thought like Stoicism and modern sciences like Cognitive Behavioral Therapy share the aim of overcoming suffering. In these approaches, pain need not be a negative aspect of life, but the reactive temptation to dwell with pain can lead to suffering. Many modern approaches and motivational speakers may link choice and suffering, focusing on such adages like *pain is mandatory, suffering is optional*.

Though most would agree suffering is disruptive and negative, many people find meaning in their own suffering as well as that of others, especially in religious and philosophical contexts. A simple search on suffering at the public library in Bloomington brings up self-help genre titles such as *Inside the miracle: enduring suffering, approaching wholeness* (Nepo 2015), *Silence and beauty: hidden faith born of suffering* (Fujimura 2016), and *Tears to triumph: the spiritual journey from suffering to enlightenment* (Williamson 2017). Suffering, in these contexts, acts as an impetus for personal growth and also offers connection to others. In this sense, suffering can potentially lead an individual from a state of spiritual poverty (Helminiak 2020) to a state of deep meaning, purpose, and connection with the divine. Stress, too, can be motivating in accomplishing tasks, removing oneself from misfortune when possible, and providing evolutionary benefits (Hoffman & Hercus 2000). Increased empathy for those who suffer can be a prosocial behavior that drives connection and understanding as well as decrease loneliness (Klimecki 2019, Konrath & Grynberg 2016, Batson & Ahmad 2009), with empathetic behavior connected with observing pain even being found in mice (Langford 2006). However, empathy may also lead to increased polarization (Breithaupt 2017) and competitive victimhood (Noor et al 2012). By pointing out some of the perceived benefits to suffering, we do not mean to trivialize the very real physical and mental health issues associated with suffering. Negative outcomes including violence against self or others should be minimized.

Bruneau, Pluta, and Saxe (2012) found that reading stories about either physical pain or emotional suffering reflected similar patterns for both in neuroimaging. However, stories about physical pain indicated higher responses in the Shared Pain Network whereas those about emotional experiences demonstrated higher responses to areas corresponding with the Theory of Mind Network, or the ability to understand how another person is thinking and feeling (229). Even imagining another’s pain demonstrates the important differences in neuroprocessing between types of pain.

Many have documented the adaptive effects of suffering, using more aesthetic methods such as art and literature as measures (Musso & Enz 2016). De Vries (2012) examines the ways musicians and artists allow and even engage with suffering in their works rather than avoiding it altogether. Similar to our comments on aesthetic works that evoke pain, creators may actively work to perform and reflect suffering through poetry, art, music, narratives, and film among other mediums. These works are not always meant as a cathartic process that leads to a harmonious end like Aristotle may have envisioned of drama, and indeed characterizing suffering as an inevitable resolution does a disservice to the parts of suffering that cannot be articulated (Edgar 2007). Indeed, attempts to represent the unrepresentable might further suffering instead of providing a space of healing. Adorno’s oft quoted but seldom contextualized statement on the impossibility of poetry after the Holocaust

(1949) highlights the unrepresentable nature of this particular atrocity and the incompatibility of mimesis (replication) with real, felt suffering. This, of course, has not stopped people from identifying and representing various forms of trauma.

At the risk of overstepping such boundaries ourselves, we suggest a network of dynamic, interacting factors that can begin as stress or pain and develop into suffering, including physical, mental, and emotional anguish in addition to the limited existing quantitative measures. Diagnosing the kind of stressor(s) that lead to suffering can be helpful in then identifying appropriate and effective resolutions. We offer a starting point for categorizing suffering in Table 1. This categorization is not a comprehensive list of stressors and types of suffering, but a beginning for future work to explore.

Type of Stressor/Suffering	Description
Loneliness	social isolation and rejection, grief and emotional devastation after losing a loved one
Oppression	lacking basic freedoms, such as those living under dictatorships
Physical torture	intentional infliction of severe pain
Helpless Observation	watching someone in pain or dying (varying degrees of intimacy/affectedness), empathy acts as impetus
Unfulfilled expectations	desperately desire for something without obtaining it (house, job, partner, baby, etc)
Poverty	hunger, lack of housing and important physical resources, dehumanization
Trauma and abuse	physical, sexual, religious, familial, systemic, racial physical or physiological injury
Guilt	regret for a past wrong
Addiction	failure to control a repeated behavior despite ongoing negative consequences (Goodman 1990)
Disease	illness adversely affecting the body or mind
Unaddressed pain	chronic or ongoing pain that is not properly managed
Natural Disasters	adverse effects from extreme weather that limits resources, destruction of homes and community
War	armed conflict between two or more groups that results in death, wounds, and loss
Spiritual Poverty	Lack of meaning or belonging, experiences of existential angst (often paired with “an abundance of material goods,” see Helminiak 2020)

**Table 1.** Types of stressors and suffering along with their descriptions.

In addition to systematizing types of suffering as a tool for identifying effective interventions in medical settings, a potential formal questionnaire might help individuals, medical providers, therapists, advocates, and scholars differentiate between individuals experiencing stress and those undergoing suffering. Questions might measure frequency and intensity of the stressors mentioned above. We also suggest open-ended questions where individuals can narrativize their experiences in order to provide important effects that might be missed through quantitative measures, a common practice in standard therapy. When attempting to characterize suffering in historical, literary, or artistic contexts, a quantitative framework might also be helpful and innovative for narrative theory. Using a list of official stressors as a guide, scholars could determine frequency and interpret intensity of each stressor within a narrative or work. Frequency and intensity measures might be aided by AI technology such as sentiment analysis and textual analysis, common tools already used in digital humanities.

### Implications and Conclusion

In exploring the relationships among pain, stress, and suffering, this article was also an exercise in bridging disciplines to discuss concepts that have universal importance. We were surprised by how difficult it was to not only find a common vocabulary but also agree on a direction for this article and find commonalities within the larger study of pain. While one of our goals was to document methods of studying pain, stress, and suffering, we also have come away from the cowriting experience with increased commitment to collaborative work on the matter. Examining how mind and brain work together in processing and articulating moments of physical agony, heightened anxiety, and unbridled grief influences the narratives we create about these experiences as well. Traditionally, the sciences attempt to explain and describe natural laws that govern our world, while the humanities can offer interpretations and deeper meaning of these laws and the lived experiences of those in the world. However, conversations between these disciplines, common in narrative medicine and bioethics, create innovative solutions for problems related to negative health outcomes and offer more complete narratives.

Positive interventions in pain, stress, and suffering often rely on interdisciplinary research and play a critical role in understanding pain and suffering and reducing unnecessary kinds of both. *Interdisciplinary* is usually talked about between two very similar fields, such as projects incorporating molecular biology and biochemistry or history and literature. However, we advocate for projects that utilize knowledge from diverse fields that further creative insights in our understanding of how the arts and sciences come together in unique ways.

Creating spaces where scholars from vastly different fields can come together to discuss individual projects as well as collaborate with others is an important step in combining and thus furthering scientific and humanistic knowledge. Epstein (2014) reviews some of the challenges and advantages in making interdisciplinary work a collaborative process such as funding, attitude, communication, time, institutional climate, and proximity to other scholars (see also Nancarrow 2013, Bronstein 2003, Brewer & Lövgren 1999). However, such work is worthwhile in the ways collaborative efforts expand and deepen knowledge on a subject, even helping scholars overcome common biases within their own disciplines (Repko & Szostak 2020).

The way that we perceive and connect pain, stress, and suffering is important because it affects medical treatments and other interventions on both small and large scales. While accepting the presence of pain and suffering in our world and even embracing adaptive aspects of both, we care about definitions and relationships because we care about trying to minimize harmful suffering. Investigating some of the biological mechanisms that mediate aesthetic experiences has profound potential to guide aesthetics for therapeutic benefit in contexts of both physical and emotional pain. More effective collaboration and improved common language between basic scientists who study pain in the brain and humanities scholars who study depictions of suffering in relation to the mind and conceptions of self would facilitate more effective and creative solutions to alleviate problems

relating to pain and suffering. Understanding the extent of pain and suffering can encourage prosocial, empathetic, and effective interventions that range from medicinal treatments to art, music, or storytelling therapy.

Individual differences in the ability to cope with pain, stress, and suffering also reveal the need for a variety of solutions in decreasing unwanted pain, stress, and suffering. One person's rating of a 4 on a 1–10 pain scale might physiologically be the same as another person's 7, and each of these individuals may desire different interventions when it comes to possible medication or therapies. An array of factors can affect the way one experiences pain, including demographic variables, genetic factors, and psychosocial processes (Fillingham 2017). External and internal influences on the way one experiences pain, stress, or suffering provide another example of the challenges in creating objective measures of these concepts. We emphasize the importance of ongoing research to effectively pair aesthetics-based interventions with the appropriate clinical indication. Understanding individual differences both in pain/stress processing as well as responsiveness to different aesthetic experiences will be important for determining which therapies are applicable to which individuals for which difficulties they are facing.

Pain and stress have the potential to negatively impact our lives, while suffering can affect the perception of one's very sense of self. The aesthetics of pain, stress, and suffering influence how we interpret each of them in addition to the quantitative or narrative descriptors those in pain may provide. Further research may look to fill in gaps between cognitive neuroscience and aesthetics regarding pain and suffering, such as examining efficacy of new questionnaires, expanding and analyzing categories of stress and suffering, and continued experimental approaches to interpretations of pain.

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