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Flowing Through Pain:
Flow as a Tool to Manage Chronic Pain

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To Ed and Sheryl Beals, my parents, for their consistent support throughout my life

and

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ABSTRACT OF THE DISSERTATION

Flowing Through Pain:
Flow as a Tool to Manage Chronic Pain

by

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Chronic pain perseveres for more than 3 months and affects various aspects of life, including but not limited to work, social relationships, and leisure. Though medication can treat the biological aspects of the chronic pain experience, it comes with side effects and rules set out by health insurance. Due to the various effects on life and limitations of medication, psychosocial treatments for chronic pain deserve more attention. Flow, being in the zone during an actively engaging and challenging experience may provide a respite from pain via decreased pain awareness. We assessed naturally occurring flow activities among the chronic pain population to explore whether being in a flow state is associated with a decrease in pain awareness and intensity (Study 1). Then we conducted an intervention study, where participants spent 15 minutes per day engaging in a flow activity or a mindfulness activity or went about life as usual. We aimed to delve deeper into the relationship between flow and chronic pain in relation to decreasing pain awareness and intensity and compare these effects to those of mindfulness, non-judgmental awareness and acceptance of present moment states,

feelings, and sensations (Study 2). Across the two studies, results revealed that flow and mindfulness have similar effects on pain awareness suggesting that either type of activity can be engaged in with relatively equal decreases in pain awareness and intensity. We also learned that this sample of people with chronic pain chose to engage in flow and mindfulness activities that were active in nature, despite experiencing effects on life that were physical in nature as a result of their chronic pain. These results provide initial evidence in support of flow as a management strategy for chronic pain, such that a flow state can provide temporary respite from unrelenting pain.

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The experience of chronic pain has been described by patients as suffering that is relentless by a force or monster that cannot be tamed (Thomas, 2000), but is formally defined as pain that is ongoing or recurrent, lasting at least 3 months (American Chronic Pain Association [ACPA], 2021). Though the experience of chronic pain is sculpted by a mosaic of biopsychosocial factors that are unique to each person with chronic pain (Fillingim, 2017), the experience of chronic pain has detrimental effects on well-being (Kabat-Zinn, 1982). Therefore, effective management is key, which can also align with the biopsychosocial model, encompassing medications (Seghal et al., 2013); social support (López-Martínez et al., 2008); and psychological modalities such as cognitive behavioral therapy (CBT; Vlaeyen et al., 2007), mindfulness (Kabat-Zinn et al., 1985), and acceptance and commitment therapy (ACT; Buhrman et al., 2013). Psychological flow (Csikszentmihalyi, 1990) is described as being "in the zone" (McCarther, 2018) while actively engaging in an activity and may be another strategy for the management of chronic pain. However, it has only been explored in one study that found null results regarding flow decreasing pain intensity (Robinson et al., 2012). Due to the lack of literature on chronic pain and flow, this dissertation implemented an experiment after conducting a pilot study to examine psychological flow as a management strategy for decreasing the awareness and intensity of chronic pain.

Pain

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage (Furnes & Dysvik, 2012; International Association for the Study of Pain [IASP], 2021; Roditi & Robinson, 2011; Vlaeyen et al., 2007). The experience of

pain has many purposes: It serves as a biological safety alarm (Vlaeyen et al., 2007), warns that we are in danger of hurting ourselves, (Gardner-Nix, 2009), and indicates that we need to change our behavior so that we can stay safe and/or address the cause of the pain (Sturgeon, 2014).

Acute Pain

Acute pain typically has a sudden onset, a specific cause, and is usually experienced as a sharp sensation (Cleveland Clinic, 2020). Examples of acute pain include a cut, bruise, pulled muscle, or broken bone. Acute pain is adaptive and helpful because it reminds us that we are healing and that we need to proceed carefully to avoid continued damage and pain (Gardner-Nix, 2009; Vlaeyen et al., 2007). Typically, acute pain improves with treatment, so it is often temporary and, therefore, is not likely to have an influence on one's identity or well-being (Morley, 2008).

Chronic Pain

On the other hand, chronic pain lasts 3 to 6 months or longer (Gardner-Nix, 2009; Henriksson et al., 2016; Hilton et al., 2017; McCaffrey et al., 2003; Mills et al., 2019; St. Marie & Talebkhah, 2018) or beyond the typical or expected recovery time for the healing of tissue or an injury (Gardner-Nix, 2009; Henriksson et al., 2016; Hilton et al., 2017; McCracken & Marin, 2014; Mills et al., 2019; Robinson et al., 2011; Roditi & Robinson, 2011). Though chronic pain can occur as the result of an injury, it is more likely that chronic pain is due to a medical condition including but not limited to arthritis, fibromyalgia, nerve damage, or lower back pain (Sturgeon, 2014; Hilton et al., 2017; St. Marie & Talebkhah, 2018). According to the 2019 National Health Interview Survey,

20.5% of adults in the United States reported pain on most days or every day, with the most common pain locations including the back, hip, knee, and foot (Yong et al., 2022). Of this group, 10% suffer high-impact chronic pain with associated work limitations (Yong et al., 2022).

Chronic pain is not adaptive, as it no longer signals danger or damage to the body (Kabat-Zinn, 1982; Sturgeon, 2014) due to lasting longer than necessary to provide a protective function for healing of the body (Gatchel et al., 2007). However, chronic pain may be a warning that change is needed in a more global sense (Gardner-Nix, 2009). This change could be physical (e.g., more exercise), social (e.g., connecting with others), cognitive (e.g., more positive thinking), and/or psychological (e.g., living in the moment), dependent upon individual factors. Chronic pain is a detriment to well-being given its length, absence of direct benefit (Kabat-Zinn, 1982; Sturgeon, 2014), lack of a cure for most conditions (Main, 2013), and the negative effects that chronic pain can have on one's life (Roditi & Robinson, 2011). Impairments in various aspects of life due to chronic pain can also negatively influence the well-being and quality of life of the chronic pain sufferer. To elaborate, the effect that chronic pain can have on one's life can appear physically, such as limited ability to move and lack of energy; emotionally, with symptoms such as depression, anxiety, and anger; or vocationally, via decreased job hours or duties and even the possibility of loss of employment (Ball et al., 2017; Cleveland Clinic, 2020).

The association between chronic pain and prolonged physical, functional, and psychological impairment (Gottumukkala et al., 2017) is the primary way in which acute

and chronic pain can be differentiated (Roditi & Robinson, 2011)—such that chronic pain is associated with impairment and acute pain is not. Another way in which chronic pain differs from acute or everyday pain is the fact that pain loses its protective function when it becomes chronic because it is always present despite no immediate danger (Coakley & Schechter, 2013). In sum, chronic pain is pain that continues when it should not (ACPA, 2021; IASP, 2021)—or more specifically, pain that lasts more than 3 months with adverse effects on well-being through negative sensory and emotional experiences, indicating the importance of viewing it through a psychological lens (ACPA, 2021).

Types of Chronic Pain

As previously mentioned, pain can be differentiated based on its chronicity, but classifying pain based only on duration is strictly practical and sometimes even arbitrary (Roditi & Robinson, 2011). The International Classification of Diseases (ICD-11) provides categories of pain that are used as diagnostic codes for medical and insurance purposes, including chronic primary pain, chronic cancer pain, chronic postsurgical and posttraumatic pain, chronic neuropathic pain, chronic headache and orofacial pain, chronic visceral pain, and chronic musculoskeletal pain (Nicholas et al., 2019; Treede et al., 2015). The International Association for the Study of Pain (IASP, 2021) uses a similar breakdown of chronic pain conditions, differentiating between chronic primary pain and chronic secondary pain. However, due to their purpose and use in the medical field, this classification of types of chronic pain and their associated descriptions are rife with jargon that can make it challenging for laypersons to understand, even those with chronic pain.

Another way to define or describe types of pain is to focus on its underlying mechanisms or pathophysiology. Nociceptive pain is caused by actual or threatened tissue damage or injury (e.g., arthritis); neuropathic pain is caused by abnormal nerve function (e.g., neuralgias); nociplastic (non-neuropathic) pain is caused by abnormal nerve signal processing with no known tissue or nerve injury (e.g., tension headaches); and mixed pain is considered an overlap of nociceptive and neuropathic pain (e.g., lower back pain; ACPA, 2021; Behrends, n.d.). However, this classification may also be confusing. For example, fibromyalgia is characterized by widespread musculoskeletal pain in addition to fatigue and other effects on life with a suspected underlying cause of repeated nerve stimulation, though the etiology is not entirely clear (Mayo Clinic, 2021). Fibromyalgia is a type of neuralgia, like trigeminal neuralgia or occipital neuralgia, both of which are classified under neuropathic pain (Behrends, n.d.). However, fibromyalgia is not often associated with known tissue or nerve injury, which means it might be better classified as nociplastic pain. This example demonstrates the challenge of classifying pain based on its underlying mechanisms. More specified breakdowns such as nociceptive pain being categorized as somatic or visceral (Behrends, n.d.) and neuropathic pain as central or peripheral (ACPA, 2021) can further complicate determination of the correct category for a specific pain condition.

In addition to diagnostic codes or underlying pathology, pain can also be classified as a disease versus a symptom (Loftus, 2011) or as primary versus secondary (IASP, 2021; Treede et al., 2019), respectively. Pain is considered a disease in chronic primary pain syndromes such as chronic regional pain syndrome, chronic migraines,

irritable bowel syndrome, and nonspecific low-back pain, examples of long-term medical conditions in their own right. On the other hand, pain is considered a symptom of secondary pain syndromes such as diabetic neuropathy, inflammatory bowel disease, and rheumatoid arthritis (Treede et al., 2019). Determining whether a condition is a primary or secondary condition can be challenging for medical professionals (Treede et al., 2019) and certainly for the general and chronic pain population as well. However, chronic pain is increasingly perceived as a disease entity in itself rather than merely a symptom of another condition, allowing for multidisciplinary conceptualization and treatment of chronic pain (Clauw et al., 2019).

As evidenced by the various ways to categorize pain, chronic pain is not fully understood and is a challenge to understand and treat (Clauw et al., 2019). Because there are hundreds of documented conditions that can cause long-term pain (U.S. Pain Foundation, 2021), along with the complexity of commonly used chronic pain classifications, partly due to the utilization of jargon and other technical language (IASP, 2021; Nicolas et al., 2019), a simpler classification system will be used for the purposes of this dissertation. Chronic pain will be classified by the portion of the body that is most affected by chronic pain conditions. Examples include but are not limited to nerves (e.g., fibromyalgia), muscles (e.g., cerebral palsy), the back (back or spine, unrelated to muscles or nerves), the head (e.g., migraine), joints (e.g., arthritis of various kinds), or connective tissues (e.g., tendonitis). This classification is more user-friendly for the chronic pain population and more easily interpretable for understanding chronic pain conditions.

Understanding the Source of Chronic Pain

Various conceptualizations of chronic pain have been suggested to understand its source and thus potential interventions to reduce pain, including the biomedical model, gate control theory, and biopsychosocial model.

Biomedical Model

The biomedical model views the body and mind as separate and restricts medicine to concerns related to the body at the exclusion of the mind (Longino & Murphy, 1995). This model functions under the assumption that chronic pain is due to underlying tissue damage without addressing the complexity of chronic pain (Thomas, 2000; Vlaeyen et al., 2007). Despite its medical successes, the biomedical model is viewed as reductionistic and incomplete because it fails to consider the psychosocial processes of chronic pain and links between psychosocial and physiological processes (Vlaeyen et al., 2007). Relatedly, the biomedical model led to a primary focus in chronic pain treatment on solely pharmaceutical treatments (Peppin et al., 2015), which often fail to address the full scope of the chronic pain experience and thus result in continued suffering by patients. Furthermore, this model is unable to consider the varying experiences of pain, even among patients with the same underlying physiology (Vlaeyen et al., 2007). Though patients often conceptualize their chronic pain through the biomedical model, it leads them to medicalize their pain without considering psychological effects and coping options related to their pain (Vlaeyen et al., 2007). Consequently, the provision of advice to effectively manage chronic pain beyond its physiology is lacking when chronic pain is conceptualized using the biomedical model (Thomas, 2000).

Gate Control Theory

Until the publication of the gate control theory of pain (Melzack & Wall, 1965), chronic pain was viewed strictly from a biomedical perspective focusing solely on physical and physiological processes of pain. In addition to a basis in physiology, the gate control theory explains psychological and sensory aspects of the perception of pain, along with the emotional, cognitive, and motivational components that influence pain (Campbell et al., 2020). Put another way, the gate control theory of pain emphasizes the importance of cognitive, affective, and sensory influences on pain (Edhe et al., 2014) to explain the physiological process of pain as well as how and why pain fluctuates from one day to another (Katz & Rosenbloom, 2015; Melzack & Wall, 1965) and why it can differ between persons (McCaffrey et al., 2003).

The gate control theory of pain was the first to suggest that pain is not a linear experience, such that sensory stimulation of a pain receptor or multiple receptors in a pathway does not always equate to pain (Campbell et al., 2020). Instead, this theory utilizes the metaphor of a neurological or biological "gate" in the spinal cord and brainstem that modulates the feeling of pain as it travels to the central nervous system. When the gate is open, impulses can flow through the central nervous system leading to the experience of pain, whereas when the gate is closed impulses cannot travel through the central nervous system and pain will not be experienced (Melzack & Wall, 1965). Factors that open the gate and result in an increase of pain intensity can include psychological factors such as stress, anxiety, depression, and frustration, but can also include inactivity along with worry about and focus on pain. Involvement, interest,

concentration, and attention on an activity can be a distraction from pain and help close the "gates" of pain, which results in a reduction of pain experienced. Relaxation and positive emotions such as happiness, joy, and love can also close the pain gates (ACPA, 2021; Center for Integrated Healthcare, 2020; Melzack & Wall, 1965).

In sum, the gate control theory expands on the biomedical model by suggesting that biological, cognitive, emotional, motivational, and sensory factors all play a role in the experience of pain by opening or closing the gate to allow or block pain. This theory introduced a role for psychology in the pain process and described a multidimensional rather than linear process of pain (Campbell et al., 2020). With the advent of this new model or theory of chronic pain came major advances in how practitioners viewed pain, new treatments for pain, and providing patients with hope that pain relief is possible (Campbell et al., 2020; Katz & Rosenbloom, 2015). The gate control theory, often considered the most influential theory of pain, served as the inspiration for the most dominant conceptualization of pain today: the biopsychosocial model (Campbell et al., 2020).

Biopsychosocial Model

Given that pain is influenced by biological, psychological, and social factors (Bruns & Kerns, 2013; IASP, 2021) and that illness including chronic pain involves an interaction between mind and body (Cousins, 1979), applying a multidisciplinary model to conceptualize and treat chronic pain may be most effective. One example of such an approach is the biopsychosocial model, which takes the biological, psychological, and social aspects of pain into consideration throughout conceptualization, assessment, and

treatment (Engel, 1977). Importantly, the biopsychosocial model does not simply consider how biological, psychological, and social factors have a role in illness. Instead, the model considers how these three factors interact to create and influence the experience of pain (Adams et al., 2005; Edhe et al., 2014; Fillingim, 2017; Roditi & Robinson, 2011). Consequently, the biopsychosocial model of chronic pain allows full exploration and treatment for the individualized and personal experience of pain (ACPA, 2021; Fillingim, 2017) and is one of the most widely accepted models for understanding and treating pain (Adams et al., 2005; Roditi & Robinson, 2011).

Experience of Chronic Pain

Though pain is usually adaptive, when it is chronic it often has adverse effects on daily life, level of function, physical and emotional well-being, and quality of life (ACPA, 2021; Gardner-Nix, 2009; IASP, 2021; McCracken & Marin, 2014). To illustrate, compared to those without chronic pain, people with chronic pain report increased difficulty in activities of daily living (22% versus 5%), social engagements (25% versus 6%), and limitations related to work (49% versus 15%), underscoring the deleterious effects of chronic pain on various aspects of life and overall quality of life (Yong et al., 2022). Chronic pain patients may be unable to participate in life to a full extent due to the physical, psychological, and functional effects of chronic pain (IASP, 2021). These effects are multidirectional, such that the physical and functional effects can exacerbate the psychological effects and vice versa. Therefore, all effects should be considered in combination. Physical effects of chronic pain (e.g., limitations in activities of daily life, deformities due to some chronic pain conditions) are explored in depth via

the biomedical and biological view as well as medicine, so the focus here will be on psychosocial effects of chronic pain.

Psychological

Most people with chronic pain experience emotional distress or mood disturbance to some degree in the form of depression, anxiety, irritability, anger, frustration, and/or resentment (ACPA, 2021; Adams et al., 2005; Dansie & Turk, 2013; Kabat-Zinn et al., 1985; Morley, 2008; Vlaeyen et al., 2007). Comorbidity of chronic pain and psychiatric symptoms occur in 20-60% of patients with chronic pain (Brooks et al., 2018, Hansen & Streltzer, 2005; Mills et al., 2019). Moreover, depression and anxiety disorders are nearly three times more prevalent among chronic pain patients than among the general population (Roditi & Robinson, 2011), but anxiety and depression may not always reach the severity of a clinical diagnosis (Sturgeon, 2014).

The experience of chronic pain can produce feelings of hopelessness and helplessness, both symptoms of depression, which can exacerbate pain perception (Adams et al., 2005; McCaffrey et al., 2003). Furthermore, according to a phenomenological study consisting of in-depth interviews of 13 people with chronic nonmalignant pain, the experience of chronic pain can be described in the following ways: devastating, debilitating, tiring, frustrating, exhausting, and leading to feelings of profound depression and helplessness (Thomas, 2000). Depression or depressive symptoms may occur because of the physical suffering that people with chronic pain experience, in addition to sleep disturbances, fatigue, relationship difficulties, high levels of stress, and low quality of life (Hilton et al., 2017; Pei et al., 2021; Sagula & Rice,

2004; Sturgeon, 2014). Moreover, anxiety, fear, and a sense of loss of control associated with chronic pain can contribute to patient suffering (Hansen & Streltzer, 2005). Findings from a study of 19 people with fibromyalgia, a chronic pain condition without visible symptoms, revealed that living with pain leads to a sense of unhappiness and negative feelings about the self in the form of decreased self-esteem and self-confidence (Kelley & Clifford, 1997).

Despite high comorbidity, the relationship between chronic pain and depression is not entirely clear, though it is believed that the association is bidirectional such that chronic pain leads to depression and depression exacerbates pain (Mills et al., 2019; Sturgeon, 2014). Unfortunately, both chronic pain and depression separately lead to a lower quality of life as well as functional impairment, high medical costs, and even work-related disability (Brooks et al., 2018). Given these individual effects, it is possible that the combination of the two leads to even more detrimental outcomes related to these facets of life. Depression is also associated with lower levels of physical and psychosocial functioning, higher levels of self-reported pain, and poorer response to treatment (Adams et al., 2005), highlighting the importance of understanding the two conditions when conceptualizing and treating chronic pain.

Vocational

Chronic pain can affect work via decreased productivity when present or having to stay home due to pain, both of which could lead to termination of the position (Ball et al., 2017) and subsequent economic loss (St. Marie & Talebkhah, 2018). If people do not get discharged from their work position, they may need a change in their duties or

expectations due to their chronic pain condition (Mills et al., 2019). Though not directly psychological in nature, the adjustment of work duties to meet one's limitation or the loss of a job may lead to a decrease in quality of life (Ball et al., 2017). More indirectly, chronic pain is associated with difficulty sleeping, which can lead to fatigue and, consequently, influence work performance (Richardson et al., 1994; Sagula & Rice, 2004). Interestingly, chronic pain is higher among people who are unemployed, perhaps because people with chronic pain are less likely to work because of their pain (Mills et al., 2019). Moreover, both chronic pain and depression are leading causes of functional impairment and work-related disability (Brooks et al., 2018). As demonstrated by the effects that chronic pain has on work, even experiences that do not seem psychological in nature can certainly have a psychological effect on those with chronic pain and must be considered for effective management.

Loss

Negative psychological outcomes can also occur due to grief. Upon hearing this word, most people think of the death of a loved one. However, in chronic pain, grief can occur for several other reasons. Chronic pain sufferers may no longer be able to engage in their career, leisurely activities, or physical activities, or be as involved in certain relationships as they would ideally like to because of the pain they are facing (Sagula & Rice, 2004). Therefore, people afflicted by chronic pain may grieve the loss of these previous activities, experiences, and relationships—which is problematic because unresolved grief can lead to depression and anxiety, which both exacerbate pain (Sagula & Rice, 2004).

Chronic pain can also lead to fragmentation of the self and a loss of the sense of self by highlighting changes in capabilities and opportunities from one's pre-pain self to the current state of chronic pain (Bullington et al., 2003). Another experience of loss is related to the physical body, such that the body was once familiar, predictable, active, and productive but is now a baffling, damaged, or useless barrier to various activities or behaviors due to chronic pain (Thomas, 2000). For this reason, people with chronic pain may need to depend on others for various tasks including monetary support or assistance completing daily tasks (Dansie & Turk, 2013), further undermining their sense of self-efficacy and autonomy.

Relationships

Difficulty in relationships, loss of social relationships, or lack of social support is another common outcome for people with chronic pain (Hilton et al., 2017; Sagula & Rice, 2004). Isolation was thematic in all 13 interviews with chronic pain patients, who described the experience of chronic pain similar to feeling imprisoned, locked, roped, or caged off, and reported that they had few, if any, relationships in which they could be honest and authentic (Thomas, 2000). Many participants reported that they did not receive support from close others including their partners and even felt as though they needed to hide or conceal their pain from their social network (Thomas, 2000). This reluctance to disclose may be due to not wanting to burden spouses with their struggles, given that spouses of patients with chronic pain report higher levels of distress than spouses of pain-free people or spouses of patients with other chronic medical conditions (Jensen & Turk, 2014). Chronic pain can also disrupt family functioning and social

interactions with close others, which can lead to withdrawal from activities (Kelley & Clifford, 1997). Overall, struggles in various types of relationships can lead to inadequate or maladaptive support systems and coping resources (Gatchel et al., 2007), thereby decreasing the likelihood of effectively managing chronic pain.

Summary of Experiences of Chronic Pain

Overall, chronic pain can lead to various psychosocial effects such as psychological turmoil, difficulty working, loss of previous abilities, and relationship complications, which may combine to decrease quality of life and propel those with chronic pain into a downward spiral (Jensen & Turk, 2014; Pei et al., 2021; Robinson et al., 2012; Sagula & Rice, 2004). The psychosocial effects of chronic pain and the various losses it causes can be taxing (Sagula & Rice, 2004), emphasizing the need for multidimensional treatment addressing the psychosocial effects of chronic pain in addition to the more commonly focused biological and physical effects of pain.

Management and Treatment of Chronic Pain

Chronic pain is prevalent in the U.S. (Yong et al., 2022), can present in a variety of ways (U.S. Pain Foundation, 2021), and can have detrimental effects on the way sufferers lives their life (IASP, 2021). Therefore, it is vital to understand the most efficient way to treat this condition as effectively as possible. However, a cure for chronic pain has been frustratingly elusive (Roditi & Robinson, 2011), and complete elimination of pain is rare (Kabat-Zinn et al., 1985). Thus, the focus for treatment of chronic pain is typically management, aimed at mitigating the detrimental effects of the pain experience on well-being, quality of life, disability, and distress (Dansie & Turk, 2013; Roditi &

Robinson, 2011).

Drawing connections to the biopsychosocial view of pain, the experience and effects of pain are highly individualized and personal (Fillingim, 2017), which underscores the need for individualized treatment and management strategies. Moreover, because of the variety of factors that contribute to the experience of chronic pain, patients often do not respond to a single therapeutic modality (Clauw et al., 2019), emphasizing the benefit of a multidisciplinary and multimodal approach to chronic pain treatment (Yong et al., 2022). Multimodal approaches to chronic pain management can more adequately and comprehensively address pain at the biological, affective, behavioral, and functional level (Roditi & Robinson, 2011), in comparison to a single treatment alone. The biopsychosocial model (Engel, 1977) provides a solid framework from which multidisciplinary treatment can be provided, applying biological, social, and psychological management strategies in addition to lifestyle changes and self-management, including exercise (ACPA, 2021; Daenen et al., 2015), activity pacing (Adams et al., 2005), and nutrition (Mills et al., 2021).

Biological Interventions

Medications, especially opioids, are a common form of treatment for chronic pain (Seghal et al., 2013) to decrease the damage to the body while simultaneously controlling pain. However, many factors must be taken into consideration when prescribing medications, including pain diagnosis, pain intensity and duration, comorbid health conditions, medication interactions, side effects, cost, and likelihood of adherence. When opioids are prescribed, addiction to medication is also of concern (Gottumukkala et al.,

2017). The 2019 National Health Interview Survey, a nationally representative household survey, revealed that 22% of United States adults with chronic pain used prescription opioids within 3 months of the survey (Dahlhamer et al., 2021). However, medications – a biomedical approach to chronic pain treatment – fail to address the overall suffering of patients, which is often psychological in nature (Henriksson et al., 2016; St. Marie & Talebkhah, 2018; Thomas, 2000). Consequently, non-pharmacological interventions, such as those that are psychosocial in nature, may be a viable option to supplement medications with the goal of improving the quality of life and well-being of people with chronic pain conditions (St. Marie & Talebkhah, 2018). Though they cannot address the biological aspects of chronic pain, non-pharmacological treatments often have fewer side effects than medication and are more likely to restore satisfaction in daily life (ACPA, 2021).

Social Interventions

Social processes influence lifestyle choices, health decisions, and even the way healthcare is conceived and delivered (Coiera, 2013). In addition, social support can provide a buffer when coping with certain health conditions such as chronic pain (Holtzman et al., 2004). In fact, people with chronic pain who reported higher levels of satisfaction with social support experienced a decrease in pain intensity and depressed mood (López-Martínez et al., 2008). This finding highlights the potential benefits of receiving an adequate level of support in addressing both the physical and emotional aspects of the chronic pain experience. As another example of the importance of social support, illness narratives from 15 people with fibromyalgia were utilized to examine the

importance of support from peers, partners, and family in coping with the condition. Results indicated that support from these networks increased the likelihood of the patient seeking help from healthcare providers, accepting the diagnosis of fibromyalgia, and adapting to the demands of the condition (Cooper & Gilbert, 2017). Though this study was conducted on patients with fibromyalgia, the findings may generalize to other chronic pain conditions.

However, chronic pain patients may not receive adequate social support for a variety of reasons. For instance, relationships may become distant, especially if the individual is no longer able to work (Sagula & Rice, 2004). Furthermore, people with chronic pain may stop making plans with friends or family out of fear that they will have to cancel the plans at the last minute due to pain (ACPA, 2021). Finally, because friends and family may lack knowledge about or understanding of the experience of chronic pain, it can be difficult for social support systems to convey empathy and effectively support someone with a chronic pain condition (Poh et al., 2017).

But these challenges do not mean that people with chronic pain cannot receive social support. If an individual feels as though they are not able to obtain sufficient social support in their immediate environment from medical staff, family, friends, acquaintances, or partners, they can turn to online social networks (OSNs) to receive such support (Coiera, 2013). OSNs allow new relationships to develop by facilitating previously unavailable interactions (Coiera, 2013), especially given that OSNs can be accessed from any location at any time due to the lack of restraints on temporal and geographic boundaries (Chung, 2014). Reaching out to other people who also experience

pain can be helpful to share and understand the highs and lows of the experience (American Psychological Association [APA], 2011). For example, results of a deductive thematic analysis of 572 messages by 132 unique senders on an OSN for irritable bowel syndrome revealed that the primary function of the group was to communicate informational support related to interpretation of symptoms and management of the illness (Coulson, 2005).

Adequate social relationships and associated social support is important for the chronic pain population, given that social isolation often occurs due to the decreasing ability to engage in activities such as work and social activities (Tsai, 2018). Social isolation is one of the most significant negative effects of chronic pain (ACPA, 2021), so emphasizing interventions for chronic pain that can address social isolation may improve emotional and physical functioning for this population (Bannon et al., 2021). Furthermore, building social support and networks is an important mechanism to reduce the influence of pain and improve overall quality of life (ACPA, 2021). However, learning ways to self-manage one's pain is equally important, especially because some people with chronic pain experience skepticism and disinterest rather than support and sympathy when sharing their chronic pain experiences with others in an attempt to receive support (Thomas, 2000).

Psychological

Given that pain is a complex, psychological phenomenon (Morley, 2008), it is important to consider psychological management strategies. Although the comorbidity between chronic pain and emotional distress such as depression makes treatment

challenging (Roditi & Robinson, 2011), both conditions can be addressed using psychological management and treatment strategies (Hansen & Streltzer, 2005). Interestingly, no medication is as potent as the state of mind that a person brings to their illness because the human mind has powers of restoration and can be trained to overcome and manage illness (Cousins, 1979).

The need for psychological treatment, possibly in conjunction with pharmaceuticals, emphasizes the biopsychosocial phenomenon of chronic pain. Biopsychosocial treatment approaches advocate for personalized treatment and management strategies through psychological and psychosocial modalities (Fillingim, 2017), in addition to biomedical treatment through medications. Psychological techniques can benefit those with chronic pain as they learn skills to reduce their pain and suffering and address their mental and emotional wellness via self-management (ACPA, 2021; APA, 2011). Moreover, because pain is a sensory and emotional experience (Raja et al., 2020), developing a healthy mind is important for successful treatment (ACPA, 2021). Various psychological treatments for chronic pain exist, including but not limited to cognitive behavioral therapy, mindfulness, and acceptance and commitment therapy.

Cognitive Behavioral Therapy. Psychological factors that mediate pain and disability include cognitive, behavioral, and emotional components (Adams et al., 2005), alluding to the possibility that cognitive behavioral therapy (CBT) may be a beneficial treatment modality for chronic pain. In fact, CBT is among the most common treatments for chronic pain (Edhe et al., 2014) and has been the treatment of choice for chronic pain for decades (de Boer et al., 2014).

CBT takes a biopsychosocial approach to management of chronic pain by targeting behavioral and cognitive responses to pain as well as social factors that influence reactions to pain (Sturgeon, 2014). Consequently, CBT allows for exploration of how the mind can influence the experience and treatment of pain by highlighting the relationship between emotions, actions, and patterns of pain experience (ACPA, 2021). As part of CBT, maladaptive thoughts or irrational beliefs are challenged and replaced with more adaptive thoughts (Adams et al., 2005; Edhe et al., 2014; Sturgeon, 2014). Cognitive restructuring typically includes recognizing current maladaptive thoughts, challenging the identified cognitions, and reformulating those thoughts in a productive way (Roditi & Robinson, 2011). Additionally, ineffective behaviors can be addressed, and efficacious coping strategies can be taught (Adams et al., 2005; Edhe et al., 2014; Sturgeon, 2014). Behavioral components include relaxation skills, activity pacing, and participation in physical activity to the patient's ability (Roditi & Robinson, 2011).

These cognitive and behavioral changes are beneficial given that maladaptive feelings, attitudes, and beliefs can influence the perception of pain (Rashbaum & Sarno, 2003). Though CBT is facilitated by a therapist as the teacher or coach (Roditi & Robinson, 2011), the goal of CBT is for patients to develop coping skills to manage their pain and improve their psychological functioning without guidance from or dependence on a therapist (Furnes & Dysvik, 2012). As patients learn new coping skills through CBT, they consequently experience improvements in quality of life and physical functioning (Furnes & Dysvick, 2012).

The evidence points to CBT as an optimal approach to treating chronic pain regarding improvement in daily functioning (McCracken, 2008). Various domains show improvement with the treatment of CBT, such as greater control over pain and greater management of thoughts and behaviors related to pain (Roditi & Robinson, 2011). When CBT was compared with a waitlist condition, CBT was found to have large effects on the pain experience, affect, cognitive coping and appraisal, behavior, activity level, and fulfilling social roles. More importantly, compared to other treatments, CBT was superior for improving the pain experience, coping, and fulfillment of a social role (Morley et al., 1999).

However, CBT for pain lacks a single standard treatment protocol, leading to variation in the number of sessions and specific techniques applied (Edhe et al., 2014). Furthermore, though many systematic reviews conclude that CBT approaches are effective for treatment of chronic pain, the evidence is inconsistent (McCracken & Marin, 2014), suggesting the need for more research using large samples that are diverse in age, chronic pain condition, racial/ethnic minority status, and low literacy (Edhe et al., 2014). Though CBT is the first line (Edhe et al., 2014), dominant (Jensen & Turk, 2014), and gold standard (Sturgeon, 2014) psychological treatment for people with chronic pain, other psychological modalities are also available.

Mindfulness. Originated from Buddhism (Bishop et al., 2004; Grossman et al., 2004; Kabat-Zinn, 1982), mindfulness is now widely utilized in Western psychology (Siegel et al., 2009). Simply put, mindfulness entails presence in the current moment and life in general (Siegel et al., 2009). A common and more detailed definition of

mindfulness includes (1) self-regulation of attention on the present moment and (2) adopting an orientation of curiosity, openness, and acceptance toward the present moment (Bishop et al., 2004; Henriksson et al., 2016; Moore, 2013; Siegel et al., 2009). That is, mindfulness can be described as paying attention in a particular way, on purpose, to the present moment in a non-judgmental way (Brooks et al., 2018; Siegel et al., 2009; St. Marie & Talebkhah, 2018).

The practice of mindfulness generally begins by focusing on something concrete such as one's breath as thoughts and feelings come in and out of consciousness. If the mind strays from the breath, the attention is kindly redirected back toward the breath (Bishop et al., 2004; Sagula & Rice, 2004). Once the individual feels comfortable with this task, they can then focus on their thoughts, feelings, physical sensations, and emotions as they enter and leave conscious awareness, simply observing them in a non-judgmental manner and paying close attention to avoid dwelling on them or attempting to change them in any way (Kabat-Zinn, 1982). Mindfulness meditation, a common form of mindfulness practice, can consist of various practices such as engaging in mindfulness in daily life via eating or walking, focusing on other the breath and other bodily sensations, and even some yoga poses (Kabat-Zinn, 1982). These practices can lead to physiological relaxation and can have benefits on both cognitive and behavioral aspects of one's life and experience with pain (Kabat-Zinn, 1982; Kabat Zinn et al., 1985).

Unlike Cognitive Behavioral Therapy (CBT), which aims to examine and transform negative or maladaptive cognitions into more positive and adaptive thoughts (Edhe et al., 2014; Sturgeon, 2014), mindfulness in all forms allows people to

naturalistically observe their cognitions as they enter and leave immediate awareness (Grossman et al., 2004). The aim of mindfulness interventions related to pain is not necessarily to reduce pain intensity or remove pain completely, but to increase the acceptance of pain in the present moment rather than rejecting the pain, avoiding the pain, or desiring pre-pain status (Gardner-Nix, 2009; Pei et al., 2021; St. Marie & Talebkhah, 2018). When people are mindful of their pain and no longer fight or resist it, they can non-judgmentally embrace it as part of the present moment experience (Sagula & Rice, 2004). Consequently, more stamina is available to cope with the discomfort of pain (Sagula & Rice, 2004). Again, the goal of mindfulness as it relates to pain is not to remove the experience of pain, but rather to increase the acceptance of pain and the ability to cope with it and the psychological effects (e.g., depression, quality of life) of pain more effectively (Ball et al., 2017; Pei et al., 2021).

Through mindfulness, people with chronic pain may learn to observe their physical experiences and sensations of pain as separate from their thoughts and feelings about pain (Kabat-Zinn et al., 1985). This practice is beneficial because this uncoupling via mindfulness can prevent the automatic, habitual panic or stress response that occurs when one experiences aversive states (Sagula & Rice, 2004), such as sudden intense pain or a longer-term flare. This uncoupling allows people to respond to their pain in a more thoughtful manner. This detached observation (Hilton et al., 2017) also leads to the possibility that people may not dwell on their pain or catastrophize about it. The uncoupling and observation of thoughts or feelings as separate from physical sensations

are some of the primary ways in which mindfulness assists people in coping with chronic pain (Kabat-Zinn, 1982).

Numerous studies have examined the effects of mindfulness on chronic pain management (Kabat-Zinn, 1982; Kabat-Zinn et al., 1985; Lee et al., 2017; Sagula & Rice, 2004; Zaghi et al., 2012). Given the volume of studies, we list below a summary of key studies and findings:

- A 10-week stress reduction relaxation program (N = 50) led to a reduction in both pain and mood disturbance (Kabat-Zinn, 1982)—although the study was limited by the lack of a control group and reliance on self-report data.
- A 10-week stress reduction relaxation program (SRRP) included a control group that received traditional treatment. The SRRP group showed significant improvements in present moment pain, depression, anxiety, and utilization of medication while increasing positive affect and self-esteem (Kabat-Zinn et al., 1985).
- An 8-week mindfulness program with 20 minutes of mindfulness practice per day resulted in not only lower levels of depression and state anxiety, but also indicated that mindfulness meditation may accelerate the initial stages of grieving with loss by becoming more aware of what has been lost (Sagula & Rice, 2004).
- A randomized controlled trial that involved a 10-week mindfulness-based group intervention for adults with inflammatory rheumatic joint disease (N = 34) significantly improved self-efficacy, psychological distress, and the processing of

emotions and fatigue; these improvements were still present at the one year follow up (Zangi et al., 2012).

- In a study of people with knee osteoarthritis (N = 80), mindfulness led to higher health-related quality of life and self-efficacy as well as lower perceived stress and depressive symptoms (Lee et al., 2017).
- A meta-analysis (k = 13 randomized controlled trials) found that mindfulness meditation had the most prominent effect on depression and quality of life, but not on the perception of pain itself (Ball et al., 2017).
- A recent meta-analysis (k = 8 randomized controlled trials) examined the effectiveness of mindfulness-based cognitive therapy for people with chronic pain and revealed that this treatment modality had short-term effects on depression but no significant effects on pain intensity, interference, or acceptance (Pei et al., 2021).
- Another recent meta-analysis (k = 18) that focused on chronic pain conditions (fibromyalgia, low back pain, headache/migraine, non-specific chronic pain) concluded that mindfulness interventions are more effective than usual care for all diagnoses examined (Pardos-Gascón et al., 2021). However, this review was unable to compare mindfulness interventions to that of CBT due to lack of research studies comparing these two modalities.

Taken together, these findings provide strong support for the benefits of general mindfulness practices and have clear implications for altering the way in which people cope with pain. Turning to a mindfulness program designed specifically for pain

management, Mindfulness-Based Stress Reduction (MBSR) is a structured program with standardized guidelines for the incorporation of mindfulness meditation, body awareness, and even yoga (St. Marie & Talebkhah, 2018), under the assumption that greater awareness of the body and current internal and external experiences will decrease negative affect and increase coping (Grossman et al., 2004). An 8-week MBSR program incorporating daily home practice revealed that MBSR improves quality of life, provides strategies to cope with pain among chronic headache patients, and can be combined with conventional pharmacological treatment (Bakhshani et al., 2016). MBSR was also found to reduce pain severity, depression, and anxiety along with quality of life among 25 chronic pain patients randomly assigned to MBSR in comparison to no intervention/control (Sheybani et al., 2022). A meta-analysis of health-related studies (k = 20) of MBSR revealed that MBSR is a useful intervention for various chronic health conditions, including chronic pain, regarding improvements in quality of life, depression, anxiety, medical symptoms, and physical impairment (Grossman et al., 2004).

Despite this encouraging evidence in support of mindfulness and specifically MBSR, a six-year longitudinal study (1997-2003; N = 133) revealed that the effects that MBSR has on pain, psychological well-being, and health-related quality of life differ as function of condition and compliance with meditation practice at home. For example, the largest effects related to psychological distress and health-related quality of life were present in those with arthritis, whereas these effects were smallest in those with chronic headache and migraines (Rosenzweig et al., 2010). Therefore, chronic pain conditions and the likelihood of home practice should be taken into consideration when MBSR is

prescribed. In sum, MBSR, which includes mindfulness as its main premise, can be beneficial to manage chronic pain.

Acceptance and Commitment Therapy. Acceptance and Commitment Therapy (ACT) is a variant of CBT (Main, 2013) that incorporates mindfulness. As the name suggests, this form of treatment focuses on acceptance of chronic pain—but not simply putting up with pain (Morley, 2008). Instead, in the context of ACT, acceptance refers to disengaging from ineffective ways of solving pain and starting to create a life with the continued presence of pain (Morley, 2008) or carrying on with an activity despite the presence of pain (McCracken & Vowles, 2006). To reach acceptance, ACT encourages viewing pain as inevitable and viewing it in a non-judgmental manner to continue to derive meaning from life despite the presence of pain (Roditi & Robinson, 2011); the latter component differentiates ACT from mindfulness and MBSR. ACT utilizes previously described psychological management strategies of acceptance, mindfulness, and cognitive-behavioral approaches to manage chronic pain and associated experiences (Roditi & Robinson et al., 2011). The awareness and acceptance of pain fostered through ACT allows for minimization of focus on reduction of pain and focusing efforts on fulfilling behavioral functioning (Sturgeon, 2014). Among chronic pain patients ($N = 76$) who were randomly assigned to an internet-delivered 7-week ACT treatment or control, those in the treatment group showed significant increases in activity engagement and decreases in pain-related distress, anxiety, and depressive symptoms, suggesting that an ACT-based treatment delivered online may benefit people with chronic pain (Buhrman et al., 2013).

Summary of Management and Treatment of Chronic Pain

Multidisciplinary pain management through various health providers (e.g., physician prescribing medications and psychologist training in cognitive-behavioral therapy) and self-management (e.g., exercise, nutrition) can be an effective way to treat chronic pain in a biopsychosocial manner. In fact, multidisciplinary pain management is one of the most effective and efficient ways to assist chronic pain patients in decreasing the severity of pain and its effect on their lives including daily function and improved mood (IASP, 2021). Therefore, a combination of biological, psychological, and social pain treatments is encouraged for the best results in pain management and associated effects of chronic pain (ACPA, 2021; Dansie & Turk, 2013).

To summarize psychological management strategies, all involve focusing on pain in different ways with different outcomes. Cognitive-behavioral therapy (CBT) focuses on the adjustment of cognitions and behaviors to become more adaptive (Adams et al., 2005; Edhe et al., 2014), mindfulness encourages paying attention to the particular moment in a non-judgmental way (Brooks et al., 2018; Siegel et al., 2009), and acceptance and commitment therapy (ACT) encourages a view of pain as inevitable and a focus on deriving meaning from pain through effective functioning (Roditi & Robinson, 2011; Sturgeon, 2014). However, according to the gate control theory of pain, focusing on pain can make the pain worse (ACPA, 2021; Melzack & Wall, 1965). Therefore, a management strategy that does not focus on pain may be beneficial in some circumstances and for some people.

Flow

Psychological approaches to managing pain are vital for its successful treatment, given its biopsychosocial components (Engel, 1977), but more research on psychological strategies to manage chronic pain is needed (Yong et al., 2022). Perhaps flow, first identified by Csikszentmihalyi (1990), is one psychological approach to managing pain that deserves more attention. Flow and its components were identified from qualitative research in a variety of populations, including dancers, musicians, readers, and athletes (Csikszentmihalyi, 1990; Csikszentmihalyi, 2014; Rich, 2013), which revealed that when people become completely focused on an activity, they seem to lose awareness of thoughts and worries about themselves and the world (Csikszentmihalyi, 1990). Some researchers note a lack of agreement about the conceptualization of flow (Romero & Calvillo-Gámez, 2013), whereas others say that most researchers agree upon the definition or description of flow (Moneta, 2021).

Nonetheless, a plethora of sources, including the "father of flow," Mihaly Csikszentmihalyi, report that flow can be described using nine characteristics: the (1) merging of action and awareness via (2) challenge-skill balance, (3) clear goals, and (4) immediate, unambiguous feedback, due to intense (5) concentration and attention on an (6) intrinsically rewarding activity or task, where one (7) loses self-consciousness and a (8) sense of time but has a (9) sense of control (Csikszentmihalyi, 1990; Csikszentmihalyi, 2014; Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014; Rich, 2013; Romero & Calvillo-Gámez, 2013). Importantly, opportunity for action via active engagement in a task is required to achieve a flow state, such that lack of action or

engagement likely does not allow for challenge-skill balance, clear goals, or immediate feedback, which are part of the flow experience.

Merging of Action and Awareness

The merging of action and awareness is considered a hallmark of the flow experience (Csikszentmihalyi, 2014; Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014; Rich, 2013) and can be described as not seeing oneself as separate from the task or activity (Engeser et al., 2021; Sweeny et al., in prep). One way in which this merging can be conceptualized is as being "in the zone," which is a common descriptor of the flow experience (McCarther, 2018, p.1). Therefore, perhaps action awareness merging is the hallmark descriptor or component of flow (Sweeny et al., in prep).

Challenge-Skill Balance

According to many experts in the flow field, the balance of challenge and skill is a necessity for someone to have a flow experience (Romero & Calvillo-Gámez, 2013). Specifically, challenges and skills must be relatively equal, or challenges may be slightly greater than skills (Rich, 2013). This characteristic comes from the quadrant model of flow (Csikszentmihalyi & Larson, 2014; Moneta, 2021), suggesting that challenges and skills can lead to experiences in one of four quadrants: flow (both challenge and skill are high); apathy (both challenge and skill are low), anxiety (challenge is greater than skill), or boredom (skill is greater than challenge). Both challenges and skills are subjective or perceived by the individual depending upon their appraisal of the task and their abilities (Engeser et al., 2021; Rich, 2013).

Clear Goals

As part of the flow experience, people have clear goals as they engage in the activity (Csikszentmihalyi, 2014; Engeser et al., 2021; Rich, 2013). In addition to having a large, overarching goal, one also develops smaller goals, especially as the perceived challenges and skills increase. Rather than using the common term "goal" in this context, others have proposed the phrase "clear action" (Sweeny et al., in prep), as some flow activities, such as those that are creative in nature, may not have clear goals but do contain clear actions.

Immediate Feedback

In addition to having clear goals or actions, people receive unambiguous and immediate feedback during flow (Csikszentmihalyi, 2014; Engeser et al., 2021; Rich, 2013), which allows them to track their progress toward their goals. Feedback might be clear in the case of sports or games, where one is either winning or losing, but may not be as clear in creative activities such as painting. Therefore, immediate feedback during an activity may be viewed as a facilitator of flow rather than as a component of flow itself (Sweeny et al., in prep).

Concentration on the Task

When a person is engaged in a challenging activity, puts their skills to the test, and attempts to meet goals with progress guided by immediate feedback, it follows that the person is concentrating on the activity. In the case of flow, the person's attention and concentration are focused only on the activity or task at hand (Nakamura & Csikszentmihalyi, 2014). This concentration seems to arise due to action and awareness

merging, such that if the activity one is doing and the activity one is thinking about are the same, then complete concentration and attention is focused on that activity.

Autotelic Experience

Engagement with the chosen activity should be autotelic in experiences of flow. An autotelic experience is one that is pleasurable and intrinsically rewarding, or an activity in which an individual engages simply because they want to (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014; Wright et al., 2006). Activities with an autotelic nature, those that are intrinsically rewarding without external rewards, are believed to lead to flow more readily than non-autotelic activities (Csikszentmihalyi, 2014; Rich, 2013). Flow theorists generally agree that people in flow are only aware of the autotelic nature of an activity after the fact, once they have emerged from their flow state (Sweeny et al., in prep).

Loss of Self-Consciousness

Focused concentration while actively participating in an intrinsically rewarding activity can in turn lead to a loss of self-consciousness, such that concerns about the self, including biological needs like hunger, become irrelevant during a flow state (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014). Loss of self-consciousness can also include not worrying about how others view you or your progress during an activity (Sweeny et al., in prep).

Transformation of Time

The intense concentration the flow state entails can distort one's perception of the passage of time due to a lack of attention on time and its passage (see Droit-Volet, 2018).

Distortion of time, typically such that time is passing faster than usual (Engeser et al., 2021; Wright et al., 2006), can be considered a consequence of flow. When an individual is in flow, completely attentive to and concentrated on an activity that is merged with their thoughts, they have no opportunity to consider how time is passing. Therefore, it is unlikely that the transformation of time is a component of flow; rather, it is likely a consequence (Sweeny et al., in prep).

Sense of Control

Despite not having a sense of self-consciousness or an awareness of the passing of time, people in flow typically do have a sense of control, often conceptualized as subjective control or effortlessness of one's actions and the demands of the activity (Csikszentmihalyi, 1975; Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014). In a different view, the control component of flow has been described as a sense of efficacy and autonomy, or the ability to complete actions that match the challenge of the activity and the knowledge to respond in ways that lead to success (Sweeny et al., in prep). The autonomy aspect of control captures the idea that flow is facilitated when people have made the choice to engage in the activity, which aligns with the experience being autotelic (Sweeny et al., in prep).

Flow Activities

When considering whether an activity can produce a flow state, the components of flow described above (Csikszentmihalyi, 1990; Csikszentmihalyi, 2014; Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014) must be considered. Common flow activities include but are not limited to dancing, sports, rock climbing, playing chess, music

performance, music composition, visual arts, pursuing education, and work (McCarther, 2018; Moore, 2013; Nakamura & Csikszentmihalyi, 2014; Rich, 2013), but it is believed that the most common type of flow activity is play and the most common form of play is games (Csikszentmihalyi, 2014). Some activities including sports, games, and music are more conducive to flow given the presence of clear goals and feedback (Rich, 2013). Similarly, activities with unreachable pinnacles like athletics, arts, and creativity allow for infinite increases in development of skills (Csikszentmihalyi, 2014), which is conducive to flow given the challenge-skill balance component.

While some assume that flow can emerge in almost any activity, even passively watching television (Rich, 2013), others conclude that watching television is not conducive to flow due to the lack of effortful attention (Nakamura & Csikszentmihalyi, 2014; Romero & Calvillo-Gámez, 2013). However, if a television program creates challenge, requires some skill, and involves active engagement (e.g., a game show or true crime "whodunit" shows), then television can facilitate a flow state (Sweeny et al., in prep). Moreover, some activities that are boring to most people can induce flow for others, such as a child folding laundry or a teenager driving (Rich, 2013). The activities in which people find flow depend on opportunities available and existing skills, which are dependent on cultural contexts (Engeser et al., 2021). Regardless of the flow activity of choice, flow can have various benefits for chronic pain patients.

Benefits of Flow

The benefits of flow have been studied via experience sampling methods (Csikszentmihalyi & Larson, 2014; Moneta, 2021), participation in a flow activity of

choice (Rogatko, 2009), manipulation of a flow state in a lab setting through a Tetris-like game (Rankin et al., 2019), and various other methods. Using qualitative analysis, one study examined the flow experience among 7 people, including a sailor, musicians, and gardeners. These participants described the process of flow as enjoyment and positive distraction (Wright et al., 2007). Distraction has been cited as a strategy that is effective in reducing the experience of chronic pain (McCaffrey et al., 2003), and flow can be seen as a form of distraction given that one's attention is fully focused on the task or activity (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014; Romero & Calvillo-Gámez, 2013). Furthermore, if the interpretation of pain is regulated by a distracting, pleasant experience, awareness of pain can be decreased. The gate control theory reports that this reduction in pain perception is possible by receiving attention from a loved one or even listening to soothing music (McCaffrey et al., 2003), but it may be particularly facilitated through more actively engaging activities that induce a flow state.

People also experience a sense of control as part of the flow state (Csikszentmihalyi, 1975; Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014), in turn benefitting those with chronic pain, given that a lack of control can contribute to patient suffering (Hansen & Streltzer, 2005). Furthermore, improving a sense of control and allowing patients to participate in their care is beneficial for chronic pain patients (Hansen & Streltzer, 2005), both of which can be attained through a flow state.

Additionally, flow might be especially beneficial for people who experience both chronic pain and depression, such that both conditions may lead to an increase in feelings of hopelessness and helplessness (McCaffrey et al., 2003). Flow provides a sense of

meaning in life (Engeser et al., 2021), a benefit for the chronic pain population given that meaning is often called into question when living with chronic pain (Thomas, 2000). Relatedly, flow is associated with higher self-esteem (Wright et al., 2006), likely due to reaching goals and making progress related to the chosen flow activity. Higher self-esteem is a beneficial outcome generally but especially important for the chronic pain population, given that chronic pain has been associated with decreased self-esteem (Kelley & Clifford, 1997).

Moreover, flow may be directly beneficial for depression, given that flow is not typically accompanied by unpleasant emotions (Moore, 2013). Though having a conscious experience of happiness while in a flow state would eliminate complete absorption in an activity and, therefore, end a flow state, flow is a rewarding experience that can ultimately lead to happiness and satisfaction, possibly through the provision of fulfillment and adding meaning to life (Engeser et al., 2021). While flow may not directly address the physical experience of chronic pain, a flow state may provide a temporary respite from experiences and feelings associated with chronic pain.

Given the variety of psychological modalities to treat and manage chronic pain, it is surprising to note that an in-depth literature review revealed only one study that explicitly examined flow experiences for people with chronic pain. The study required 30 chronic pain patients to complete ecological momentary assessments seven times per day for seven days to examine pain intensity while in a flow state. Results indicated that mean pain scores were not significantly lower in a flow state when compared to apathy, relaxation, or anxiety states, the other three quadrants of the quadrant model of flow

(Csikszentmihalyi & Larson, 2014; Moneta, 2021). However, results revealed that flow was indirectly a beneficial experience, such that flow led to increased concentration, self-esteem, and motivation (Robinson et al., 2012). Overall, these results have interesting implications for the non-pain-related effects that flow can have on people with chronic pain, but more research is needed on the topics of flow and chronic pain to confirm and extend these results.

The Current Studies

The studies in this dissertation have two primary goals to learn more about flow as a possible management strategy for chronic pain. First, we aim to explore the associations between naturally occurring flow activities and pain awareness and intensity (Study 1). Then, with those results in mind, we facilitated an intervention study to explore the effects of a chosen and purposefully initiated flow activity on pain awareness and intensity (Study 2). In addition to these primary aims, these studies will provide a list of flow activities that are naturally occurring (Study 1) or purposefully chosen (Study 2) by the chronic pain population.

Study 1

To explore the associations between flow and chronic pain, we first conducted a pilot study given the dearth of evidence on the topic. Broadly, the pilot study examined associations between naturally occurring flow and pain in a sample of chronic pain sufferers and tested the role of flow above and beyond experiences of mindfulness.

First, (RQ1) we aim to answer the following between-person question: Do people who experience flow states experience less pain in comparison to people who do not

experience flow states? Despite previous research concluding a null finding regarding pain intensity ratings being significantly lower in a flow state (Robinson et al., 2012), we believe that individuals who experience flow states will encounter less pain in comparison to individuals who do not experience a flow state or experience them less frequently.

Next, (RQ2) we aim to answer the following within-person question: When people experience flow, do they encounter less pain in the moment? Flow may be beneficial for individuals who experience chronic pain such that when in an optimal state of flow, there may be a loss of awareness of one's physical state including the awareness of pain (Billington et al., 2016). Therefore, we hypothesize that when in flow, participants will experience less pain in that moment.

Finally, (RQ3) we want to answer the following question: What are the activities that induce flow among individuals with chronic pain? Results gleaned from this inquiry will allow us to categorize activities that lead to the experience a flow state, which will create a list of flow-inducing activities that could be beneficial for individuals managing chronic pain. Given that this specific topic has not yet been examined, this aim is exploratory and has no a priori hypotheses.

Method

Participants

Two-hundred adults (age 18+) from all over the world with chronic pain were recruited from Prolific to participate in an 8-day longitudinal study to assess naturally occurring flow activities and pain intensity. Table 1 presents sample characteristics.

Procedure

Users of Prolific signed up to participate in this study entitled "Flow and Chronic Pain." Participants of this study completed a consent form and a baseline survey (Monday) followed by 7 days of consecutive surveys (Tuesday-Monday) via Qualtrics. Surveys were completed each evening just before bed or as late as possible. Participants were compensated $3.45 for completion of the baseline survey and $1.65 for each of the 7 consecutive daily surveys, a total of $15 if the study was completed in full. Compensation was awarded through Prolific and PayPal after data was reviewed for completion each day. To decrease attrition throughout this longitudinal study, reminder messages were sent to participants who had not responded to each daily survey by 10:00pm PST. All participants were de-identified through an arbitrary participant identification number that was used for record keeping and data analyses.

Measures

Baseline. The baseline survey contained measures of demographics, pain, optimism, autotelic personality, mindfulness, and flow.

Demographics. Demographic information, including age, gender, sexual orientation, race/ethnicity, marital status, children, living situation, education level, employment, income, and country/U.S. state of residence, was gathered.

Pain. Questions about pain, such as current experience of chronic pain, duration of chronic pain experience, how chronic pain affects daily life, chronic pain diagnosis, time since chronic pain condition diagnosis, and treatments for chronic pain, were asked to learn more about participants chronic pain experiences.

Optimism. Dispositional optimism was assessed with the Life Orientation Test-Revised (LOT-R; 10 items; Scheier et al., 1994; e.g., "In uncertain times, I expect the best," "I rarely count on good things to happen to me"; 1 = *strongly disagree*; 5 = *strongly agree*, $M = 2.82$, $SD = .80$, $\alpha = .85$).

Mindfulness. Dispositional mindfulness over the past four weeks was examined through the Cognitive and Affective Mindfulness Scale Revised (CAMS-R; 12 items; Feldman et al., 2007; e.g., "I tried to notice my thoughts without judging them," "I was able to focus on the present moment"; 1 = *rarely or not at all*; 4 = *almost always, M* = 2.61, $SD = .46$, $\alpha = .78$).

Autotelic Personality. Participants' propensity for autotelic experiences was investigated through the Autotelic Personality Scale (26 items; Tse et al., 2020; e.g., "I think the process of completing a task is its own reward," "I care more about enjoyment of a task than rewards associated with it"; 1 = *strongly disagree*; 7 = *strongly agree*, $M = 4.56$, $SD = .74$, $\alpha = .87$).

Flow. Dispositional flow over the past four weeks was explored via the Dispositional Flow Scale-2 (DFS-2; 36 items; Jackson & Eklund, 2002; e.g., "I was challenged, but I believed my skills would allow me to meet the challenge," "It felt liked time went by quickly"; 1 = *never*; 5 = *always*, $M = 3.12$, $SD = .56$, $\alpha = .95$).

Daily. After baseline, participants completed the following questionnaires in the evening for seven consecutive days. All daily surveys began by gathering participants' Prolific ID.

Daily Activities. An adapted version of the Day Reconstruction Method (Kahneman et al., 2004) was utilized to assess how participants spend their time each day. Participants reported all activities engaged in during specific time periods (e.g., 6am-9am, 9am-11am, 11am-2pm) in an open-ended format.

Daily Pain. Daily pain was assessed by participants rating their pain intensity during each time frame of the Day Reconstruction Method throughout the day (1 = *less intense than average*, 3 = *more intense than average*, $M = 1.73$, $SD = .50$, $\alpha = .93$) with options for *did not notice* (recoded as 0 = *did not notice*, 1 = *did notice*; $M = 0.90$, $SD = .16$, $\alpha = .92$) and *do not remember*.

Overall Flow. Flow throughout the day was assessed via an abbreviated version of the Short Flow Scale (5 items; Csikszentmihalyi, 1990; e.g., "I felt very absorbed in what I was doing," "I felt very stimulated and challenged"; 1 = *not at all*; 7 = *very much*, $M = 4.26$, $SD = .84$, $\alpha = .92$).

Flow Activity. A description of flow was provided followed by an open-ended request for participants to report and briefly describe the activity they engaged in that day that most closely resembled flow.

Pain During Flow Activity. Participants were then asked to rate their pain awareness and pain intensity as they engaged in that activity (1 = *less intense than average*, 3 = *more intense than average*; $M = 1.62$, $SD = .64$, $\alpha = .93$) with options for *did not notice* ($M = .88$, $SD = .20$, $\alpha = .92$), and *do not remember*.

Flow During Flow Activity. Participants completed a shortened version of the Dispositional Flow Scale-2 (DFS-2; 9 items; Jackson & Eklund, 2002; e.g., "I was

challenged, but I believed my skills would allow me to meet the challenge," "I was completely focused on the task at hand"; 1 = *strongly disagree*; 5 = *strongly agree, M* = 3.75, *SD* = .45, α = .94) with the activity that most closely resembled flow that day in mind. Rather than including 36 items, four for each of the nine characteristics, only nine items were included, one per characteristic of flow, in an attempt to decrease survey fatigue.

Mindfulness During Flow Activity. The Mindfulness Attention Awareness Scale (MAAS; 5 items; Brown & Ryan, 2003; e.g., "I was doing something without paying attention," "I was doing something automatically, without being aware of what I was doing"; 0 = *not at all*; 6 = *very much*, *M* = 5.21, *SD* = 1.11, α = .80) was also completed with the activity that most closely resembled flow that day.

Completion. All participants received the completion statement with a reminder to complete the next survey by 11:59pm PST the following day.

Attrition

Two hundred participants completed the baseline survey, but compliance decreased as the survey continued, with 86% completion on days 1 and 2, 83% completion on day 3, 80% completion on days 4 and 5, 78% completion on day 6, and 74% completion on day 7.

Analyses

All analyses were conducted using SAS 9.4 statistical software program except for kappa reliability of open-ended responses into coding categories, which were analyzed via R 4.0.3 statistical software. The primary analytical approach was multilevel

modeling to test whether participants experienced less pain in the moment when they were in a flow state (RQ2; H2). Those models also tested whether participants who experienced more flow over the course of the study experienced less pain over the course of the study (RQ1; H1). Exploring the flow activities that participants reported during the study entailed coding of open-ended responses by four independent coders after organizing flow activities into categories, which were summed (RQ3; H3).

Results

Table 2 presents correlations among key study variables.

Flow Activities

The most common flow activities reported by participants included work (e.g., physical or non-physical work-related activities), physical leisure (e.g., walking, exercising, cycling, yoga, dancing, swimming), and non-physical leisure (e.g., games, organizing, reading, being on the computer, watching TV/Netflix, crocheting, knitting). Table 3 displays the frequency of these flow activities as reported by participants.

Daily Flow Predicting Daily Pain

We first ran multilevel models predicting daily pain (intensity and awareness) from person- and grand-mean centered daily flow. When models failed to converge, we removed the person-mean centered variable from the random line (all models converged via this strategy). We present tests of fixed effects of our focal predictors. Table 4 presents the results of these models.

Results revealed that daily flow was significantly and negatively associated with both pain awareness and pain intensity at the within-person level, such that when

participants reported high levels of daily flow relative to their norm, they reported lower levels of daily pain awareness and daily pain intensity relative to their norm. Daily flow was not significantly associated with pain awareness or pain intensity at the between-person level.

Flow and Mindfulness During Activity Predicting Pain During Activity

Multilevel modeling was also used to predict pain awareness and intensity during the activity from flow and mindfulness during the target activity, both centered at the within- and between-person levels (Table 5). Results revealed that flow during the activity was negatively associated with pain awareness and intensity during the activity at the within-person level, such that participants who reported more flow during the activity than their norm also reported less pain awareness and intensity than their norm. Flow during the activity was also negatively associated with pain intensity during the activity at the between-person level, as was mindfulness during the activity. These associations indicate that participants who reported more flow and mindfulness during their flow activities across the study also reported less pain intensity across the study.

Discussion

In sum, results of Study 1 revealed that naturally occurring flow activities fell into categories of work, physical leisure, and non-physical leisure. Results also revealed that participants reported lower levels of daily pain awareness and daily pain intensity on days when they reported high levels of daily flow relative to their baseline. Finally, results revealed that flow during the activity predicted less pain awareness and intensity within persons and less pain intensity between persons; mindfulness during the activity

predicted only less pain intensity between persons. These results support the hypothesis that flow may be a beneficial management strategy for chronic pain via distraction from pain, though more research is needed to determine causality. Moreover, though not significant, participants were more aware of their pain when they experienced mindfulness during their activity compared to flow, which aligns with the goals of mindfulness in increasing awareness of present states, thoughts, and feelings. However, mindfulness can heighten awareness of pain for better (acceptance) or worse (rumination) and being less aware of pain during flow may provide a respite from unrelenting chronic pain.

Although the findings from this pilot study provide initial evidence regarding the potential benefits of flow above and beyond those of mindfulness (a state similar in its focused attention), the study was also limited in a number of ways. Most notably, an experimental intervention is needed to confirm a causal relationship between flow and pain intensity, given the possibility for reverse causality (pain impeded flow). Study 2 aims to address this limitation.

Study 2

The primary goal of this dissertation is to replicate and extend the findings from study 1 by implementing an experimental design to explore the association between flow and chronic pain more deeply, given the possibility that flow can serve as a pain management strategy for people with chronic pain. As part of study 2, we proposed five research questions.

First (RQ1), a conceptual research question facilitated this project: Is flow

beneficial for mitigating pain, above and beyond established effects of mindfulness? Though we hypothesized that both flow and mindfulness will be more effective than a control group for decreasing awareness of chronic pain, we exploratorily examined which activity – flow or mindfulness – is more effective in decreasing awareness of chronic pain.

Second (RQ2), which of the nine components of flow have the strongest association with reductions in pain? We hypothesized that three conditions of flow – challenge-skill balance, clear goals, and immediate feedback – will promote a combination of six experiences representing the subjective experience of flow: action-awareness merging, concentration on task, transformation of time, loss of self-consciousness, sense of control, and autotelic experience (see Figure 1). We hypothesized that these three flow facilitators and six facets of flow will be associated with less pain; the specific pathways between the three conditions, six experiences, and two outcomes are exploratory.

Third (RQ3), what flow activities do people with chronic pain choose to engage in? This study provided an opportunity to learn more about the flow activities that are preferred by the chronic pain population, which depend on person-activity fit including skills; characteristics; preferences; personality; resources; physical, mental, and intellectual abilities; current management of pain (pharmacological and/or psychological); and pain intensity. Therefore, we had no a priori hypotheses regarding activity choice; instead, this study provided a database of flow activities that may benefit those with chronic pain.

Fourth (RQ4), in what ways are beneficial effects of flow and mindfulness (as a comparison condition) moderated by individual differences (e.g., flow proneness, trait mindfulness, daily activities, stress)? We explored whether flow and mindfulness are helpful in different situations or for different people when linked to chronic pain. This question was also exploratory. Trait mindfulness, trait flow, trait optimism, autotelic personality, and more can be explored as moderators regarding helpfulness of flow or mindfulness on a given day.

Fifth (RQ5), and finally, how long do the effects of flow and mindfulness on pain last after the flow activity has concluded? No a priori hypotheses existed for this question given the lack of research addressing flow and chronic pain.

Method

Participants

Adults (age 18+) who currently live in the United States and have experienced chronic pain for a duration of 12 weeks (3 months) at minimum were eligible to participate in this study. The target sample size was 300 participants with 100 participants per group. Participants earned up to $20 as compensation for their participation in all portions of the study (baseline and five consecutive days of daily surveys, aside from questions they opted to skip). All participants were de-identified through an arbitrary participant identification number that was used for record keeping and data analyses. Table 6 presents sample characteristics.

Procedure

This longitudinal study consisted of 1 day of baseline surveys (Friday), a 7-day break period, and 5 consecutive days of data collection (Thursday through Monday). All aspects of this study including recruitment and data collection were conducted online. Participants were recruited through Prolific, answered questionnaires via Qualtrics, and received compensation through Prolific and PayPal.

First, participants completed a consent form, provided demographic information, and completed baseline measures including 1-3 self-reported flow activities. After baseline, participants were randomly assigned to one of three groups: flow, mindfulness, or control. Seven days lapsed between baseline and the start of daily data collection to give the research team an opportunity to ensure that participants reported at least 1 activity in the baseline surveys that is flow-inducing. If self-reported flow activities were not flow-inducing by even the lowest standard (i.e., if participants list activities like "sleep" or "just sitting there," as they did in some cases in the pilot study), participants were contacted by the research team via Prolific messaging and guided to identify an activity that meets the criteria of flow.

During these seven intervening days, participants were also informed of their randomly assigned study condition via Prolific messaging. The *flow* group was instructed to participate in a/the flow activity they indicated in the baseline survey (or identified with the research team via Prolific messaging) for 15 minutes each of the five days of daily data collection. The *mindfulness* group was instructed to complete a mindful activity for 15 minutes each day of the five days of daily data collection. A list of

mindfulness activities (e.g., present moment mindfulness, body scan, breathing, mindful eating, a mindful nature walk) were provided to participants via Prolific messaging along with links to guided mindfulness activities via YouTube. Finally, the *control* group went about life as usual. These manipulations along with the daily questionnaires were completed by 11:59pm PST each day of daily data collection.

To decrease attrition between baseline and the start of daily data collection, a reminder message about the start of the study and the requirement for participation in their randomly assigned manipulation was sent to participants through Prolific the day prior to the start of the daily surveys (Thursday). Post-study questions were added to the fifth and final day of data collection. Each day, participants received compensation after their data was reviewed for completion.

Measures

Baseline. The baseline survey contained measures of demographics, pain, optimism, autotelic personality, mindfulness, and flow along with self-reported flow inducing activities.

Demographics. Demographic information including age, gender, sexual orientation, race/ethnicity, marital status, children, living situation, education level, employment, and income was gathered.

Pain. Questions about pain such as duration of chronic pain experience, how chronic pain affects daily life (categories extracted from the pilot study), chronic pain diagnoses (based on what part of the body is most affected by pain), time since initial chronic pain diagnosis, and treatments for chronic pain (intuitive categories and based on

the pilot study) were asked.

Optimism. As in Study 1, we assessed dispositional optimism with the Life Orientation Test-Revised (LOT-R; 10 items; Scheier et al., 1994, *M* = 2.94, *SD* = 1.03, α = .93).

Mindfulness. Dispositional mindfulness over the past four weeks was examined through the Mindfulness Attention Awareness Scale (MAAS; 15 items; Brown & Ryan, 2003; e.g., "I find it difficult to stay focused on what's happening in the present," "I find myself doing things without paying attention"; 1 = *almost always*; 6 = *almost never, M* = 2.98, *SD* = 1.02, α = .93).

Autotelic Personality. As in Study 1, we assessed participants' propensity for autotelic experiences with the Autotelic Personality Scale (26 items; Tse et al., 2020, *M* = 4.82, *SD* = .77, α = .86).

Flow. As in Study 1, we assessed dispositional flow over the past four weeks with the Dispositional Flow Scale-2 (DFS-2; 36 items; Jackson & Eklund, 2002, *M* = 3.22, *SD* = .54, α = .93).

Flow Activity. One to three flow activities were solicited from each participant for two reasons: (1) to ensure that participants' self-reported flow activity has the potential to foster flow (e.g., requires active engagement, is challenging, and meets the characteristics or components of flow), which was vital for participants randomly assigned to the flow condition, and (2) to compile a list of activities that can induce flow for the chronic pain population. The prompt to solicit these activities emphasized (1) an activity that is above and beyond typical daily activities, (2) an activity that gets participants "in the zone", (3)

time passing quickly when doing the activity, and (4) active engagement in the activity. Participants were also provided with a list of activities that are not flow-inducing given their lack of active engagement (e.g., mindlessly watching television or scrolling social media, laying down/resting, sleeping).

Daily. After the seven-day break for flow activity verification and informing participants of their randomly assigned group, daily data collection occurred for five consecutive days dependent on random assignment to one of three groups: flow, mindfulness, or control. All studies began by gathering the participant's Prolific ID.

***Daily Activities*.** An adapted version of the Day Reconstruction Method (Kahneman et al., 2004) was utilized to assess how participants spend their time each day. Rather than having participants report their activities in an open-ended format, a check-all-that-apply list was provided with the following categories: chores, commute, cook, eat, get ready, interaction with others, kids, leisure, medical, medication, physical activity, school, work, and other (with an open-ended box to add an unlisted activity).

***Daily Pain*.** Along with reporting their activities during specific time frames throughout the day (6am-9am, 9am-11am, 11am-2pm, 2pm-4pm, 4pm-7pm, 7pm-10pm), participants also rated their awareness of their pain (e.g., 0 = *I was not aware of any pain*; 1 = *My pain was hardly noticeable*; 2 = *I was aware of my pain only when I paid attention to it*; 3 = *I was aware of the pain periodically*; 4 = *I was aware of the pain more often than not*; 5 = *I was constantly aware of the pain, M* = 2.23, *SD* = 1.17, α = .97) and the intensity of their pain (e.g., 0 = *I had no pain and could function at my typical level*; 1 = *I had pain, but I could function at my typical level*; 2 = *I had pain and was limited in*

some activities; 3 = *I had pain and was limited in most activities*; 4 = *I had pain and could not do any activities*; 5 = *I had pain, and it was so severe I was in crisis and/or needed medical attention, M* = 1.36, *SD* = .82, α = .98) during each specified time frame. Though validated pain scales for pain intensity are available including the Visual Analogue Scale (Heller et al., 2016; Langley & Sheppeard, 1985), the Numeric Rating Scale (Hartrick et al., 2003), and the McGill Pain Questionnaire (Melzack, 1975), they all have limitations and are appropriate in varying situations (Hawker et al., 2011). We aimed for an objective (rather than subjective) measure to compare ratings within and between persons more effectively. Therefore, we created the scales of daily pain awareness and intensity that included verbal descriptions rather than solely a numeric or visual scale.

Overall Flow and Mindfulness. As in Study 1, flow throughout the day was assessed with an abbreviated version of the Short Flow Scale (5 items; Csikszentmihalyi, 1990, *M* = 3.09, *SD* = .96, α = .90). Mindfulness throughout the day was assessed with the State Mindfulness Attention Awareness Scale (MAAS; 5 items; Brown & Ryan, 2003; e.g., "I was doing something without paying attention," "I was doing something automatically, without being aware of what I was doing"; 0 = *not at all*; 6 = *very much, M* = 6.14, *SD* = 1.24, α = .95).

Exploration of Condition Experiences. The following inquiries were only made of the participants randomly assigned to either the flow condition or the mindfulness condition. The control condition did not receive this portion of the survey given that it explores experiences related to the manipulation of flow or mindfulness.

Pain Related to Condition. Participants reported on their awareness of pain before (M = 2.49, SD = 1.28, α = .91), during (M = 2.08, SD = 1.33, α = .88), and after (M = 2.10, SD = 1.35, α = .92) the manipulation as well as the and the intensity of pain experienced before (M = 1.51, SD = .87, α = .89) , during (M = 1.27, SD = .87, α = .88), and after (M = 1.33, SD = .93, α = .91) the manipulation of either a chosen flow or mindfulness activity, dependent upon their randomly assigned group. Response options and anchors aligned with the day reconstruction method reporting of pain awareness and intensity.

Participants also reported their pain awareness (M = 1.94, SD = .59, α = .70) and pain intensity (M = 1.88, SD = .55, α = .66) as they engaged in the manipulation in comparison to their typical pain intensity (e.g., 1 = *less intense than average*; 2 = *about average*, 3 = *more intense than average*). If participants experienced a reduction in pain awareness and/or intensity as the result of their manipulation (flow or mindfulness), they were asked how long this reduction lasted after the conclusion of their activity (0-5 minutes; 6-10 minutes; 11-15 minutes; 16-30 minutes; 30-60 minutes; 60-90 minutes; 90-120 minutes; more than 120 minutes).

Flow Condition. First, participants in the flow condition reported which flow activity they added to their day in an open-ended format as part of the study manipulation. Then, with the specific flow activity in mind, participants completed the Dispositional Flow Scale 2 (DFS-2; 36 items; Jackson & Eklund, 2002, M = 3.66, SD = .53, α = .98) to assess flow during the flow activity and the State Mindfulness Attention Awareness Scale (5 items; Brown & Ryan, 2003; M = 6.50, SD = 1.07, α = .95) to assess

mindfulness during the flow activity.

Mindfulness Condition. Similar to the flow condition, participants reported the mindfulness activity they completed in an open-ended format as part of the study manipulation. Then, with the mindfulness activity in mind, participants completed the Dispositional Flow Scale 2 (DFS-2; 36 items; Jackson & Eklund, 2002, $M = 3.59$, $SD = 0.55$, $\alpha = .98$) to assess flow during the mindfulness activity and the State Mindfulness Attention Awareness Scale (as in Study 1, 5 items; Brown & Ryan, 2003, , $M = 6.70$, $SD = 0.95$, $\alpha = .93$) to assess mindfulness during the mindfulness activity.

Completion. As in study 1, all participants received the completion statement with a reminder to complete the next survey by 11:59pm PST the following day.

Post Study. On the final day of the study (day 5), a few additional questions were added to the daily survey. We recognize that autonomy may affect the results of this study given that participants in the flow and mindfulness condition were able to choose an activity to add to their typical daily routine, in comparison to the control group who was instructed to go about life as usual. We recognize this potential confound between the experimental and control groups, a practical and unavoidable difference because assigning a particular flow or mindfulness activity may not induce flow or mindfulness, respectively, for all participants. To control for potential differences between conditions in experienced autonomy, the Balanced Measure of Psychological Needs (Sheldon & Hilpert, 2012) was completed by all participants with the past five days in mind (e.g., "I was really doing what interested me," "I was free to do things my own way"; 1 = *strongly disagree*; 5 = *strongly agree*).

After all surveys were completed, all participants reviewed a debriefing statement that explained the purpose of the study and were thanked for their participation.

Attrition

Thirteen participants in the flow condition and one participant in the control condition withdrew from the study between baseline (Friday) and the start of daily data collection (the following Thursday). Therefore, a second, but identical baseline survey took place during the 7-day break (between initial baseline and start of daily data collection, on Tuesday, 4 days after the initial baseline and 2 days prior to daily data collection) to gather 14 additional participants. Throughout the duration of the 5 days of data collection, 3 participants from the mindfulness group sent a message to the researcher through Prolific requesting to stop the study due to daily payment not being enough and the timing of the survey not working out, for example. Therefore, the final sample size was 297, with 100 participants in the flow group, 97 in the mindfulness group, and 100 in the control group. Due to attrition, 14 participants originally randomly assigned to the flow condition completed no daily surveys, 28 participants originally randomly assigned to the mindfulness condition completed no daily surveys, and 13 participants originally randomly assigned to the control condition completed no daily surveys. Two hundred ninety-seven participants completed the baseline survey, but compliance varied as the survey continued with 68% completion on day 1, 72% completion on day 2, 67% completion on day 3, 72% completion on days 4, and 71% completion on day 5.

Analyses

All analyses were conducted using SAS 9.4 statistical software program except for kappa reliability of open-ended responses into coding categories, which were analyzed via R 4.0.3 statistical software. The primary analysis was multilevel modeling to test the effect of the experimental conditions on daily experiences of flow (RQ1; H1). Additional multilevel models explored the relative predictive power of each of the nine components of flow (self-reported) in predicting daily pain, regardless of experimental condition (RQ2; H2). Such models also tested whether associations between condition assignment and pain were moderated by individual differences such as flow proneness, trait mindfulness, autotelic personality, and baseline pain (RQ4; H4).

Exploring the flow and mindfulness activities that people with chronic pain chose to engage in required coding of open-ended responses and organizing flow activities into categories, which were then summed (RQ3; H3). Forty-three independent coders coded all responses for flow activities throughout the five days of data collection into predetermined categories, and 5 independent coders coded all responses for mindfulness activities throughout the five days of daily data collection into predetermined categories. Descriptive statistics characterized how long the effects of flow and mindfulness on pain lasted, as reported by participants (RQ5; H5), and multilevel models tested the effect of condition on the perceived duration of the activity's effect.

Results

Daily Flow and Daily Mindfulness Predicting Daily Pain

Table 7 presents correlations among key study variables. To test associations between self-reported flow and mindfulness experiences and daily pain reports, we ran multilevel models predicting daily pain awareness and intensity from person- and grand-mean centered flow and mindfulness, controlling for day in the study (Table 8). Results revealed that flow was significantly and negatively associated with both daily pain awareness and daily pain intensity at the between-person level, such that participants who reported more flow on average also reported less pain awareness and less pain intensity. Flow was also significantly and negatively associated with both pain awareness and pain intensity at the within-person level, such that when participants reported high levels of daily flow relative to their norm, they also reported lower levels of daily pain awareness and daily pain intensity.

Mindfulness was significantly and negatively associated with both pain awareness and pain intensity at the within-person level, such that when participants reported high levels of daily mindfulness relative to their norm, they also reported lower levels of daily pain awareness and daily pain intensity. However, between-person associations revealed only a significant and negative association between daily mindfulness and daily pain intensity, such that participants who reported more mindfulness on average also reported less pain intensity.

Flow and Mindfulness During Activity Predicting Pain During Activity

To test associations between self-reported flow and mindfulness experiences during the target activity (flow and mindfulness conditions only) and reports of pain during the activity, we ran multilevel models predicting pain awareness and intensity during the activity from person- and grand-mean centered flow and mindfulness during the activity, controlling for day in the study (Table 9). Results revealed that flow during the activity, but not mindfulness, was negatively associated with pain awareness during the activity at both the within- and between-person level. Flow during the activity and mindfulness during the activity were both negatively associated with pain intensity during the activity at both the within-person and between-person levels. That is, participants who generally experienced more flow during their target activities also reported less pain awareness and intensity during those activities; the same was true for mindfulness, but only regarding pain intensity. Furthermore, on days when participants experienced particularly high levels of flow during the activity, compared to their norm, they also reported particularly little pain awareness and intensity during the activity; the same was true for mindfulness, but only regarding pain intensity.

Flow and Mindfulness Activities

Participants had the opportunity to choose the target activity – flow or mindfulness, dependent upon their randomly assigned condition – they participated in for each of the five days of daily data collection. Frequencies of all categories of flow and mindfulness activities can be viewed in Table 10 and Table 11, respectively. Among participants randomly assigned to the flow condition, the most frequent flow activities

were physical activity (e.g., walking for exercise, stretching, yoga, weightlifting, going to the gym, playing sports), games (e.g., any format including online, phone, computer, in person, single player, or multi player; puzzles, including jigsaw, number, word), reading (e.g., book, magazine, poem, in hard copy or electronically), and chores (e.g., housework, cleaning, grocery shopping, taking care of animals, working on cars, yard work). Among participants randomly assigned to the mindfulness condition, the most frequent mindfulness activities were non-active mindfulness (e.g., focusing on the breath, body scan), moment-focused mindfulness (e.g., guided meditation, present moment), and active mindfulness (e.g., nature walk, yoga).

Time Trends in Daily Pain

Given that our intervention occurred each day over five days, we first examined trends in daily pain across the study with multilevel models predicting daily pain awareness and daily pain intensity from day in the study (centered at the midpoint). We then ran these analyses separately by condition (Table 12). Results revealed a significant decrease in pain awareness but not pain intensity. However, the decrease in pain awareness only occurred in the flow and mindfulness conditions. Daily pain intensity did not significantly change over time for any of the three experimental groups.

Effects of Condition

To test the effects of condition on daily pain, as well as on experiences of flow and mindfulness as manipulation checks, we ran multilevel models predicting daily pain, flow, and mindfulness from condition, day in the study (centered at the midpoint), and the interaction between the two (Table 13). Condition was coded in various ways,

depending on the focal comparison. We coded the first condition of the pair as +0.5 and the second group of the pair as -0.5 (the third condition was coded as 0) for the following comparisons: flow versus control, mindfulness versus control, and flow versus mindfulness. When comparing flow and mindfulness versus control, flow was coded as +.5, mindfulness as +.5, and control as -1.0.[1]

A multilevel model comparing the flow and control conditions on daily flow revealed a main effect of condition, such that participants in the flow group were higher in daily flow than participants in the control group. A multilevel model comparing the mindfulness and control conditions on daily mindfulness revealed a main effect of condition, such that participants in the mindfulness group were higher in daily mindfulness than participants in the control group. However, models comparing the flow and mindfulness conditions did not reveal significant condition differences in daily flow or daily mindfulness, nor in pain during the target activity.

We next compared flow and mindfulness conditions on daily pain. We found no effect of condition, nor an interaction between condition and change over time. Thus, we focus on models that test the flow and mindfulness conditions (together) against the control condition for our primary analyses. Those models showed no overall effect of condition but did reveal an interaction between condition and change over time. The results presented above (Table 12) indicate that daily pain awareness decreased across the study in the flow and mindfulness conditions, but not the control condition. Although the

[1] Controlling for measures of psychological need fulfillment at the end of the study in our analyses did not substantially change our results, so we present results of simpler models.

time trends in daily pain intensity were not statistically significant, the significant interaction effect indicates that the non-significant declines in pain intensity in the flow and mindfulness groups differed from the non-significant increase in pain intensity in the control group.

Moderators of Condition Effects

We explored various moderators to consider whether the intervention affected different people in different ways. For example, people with baseline pain may be more or less responsive to an intervention for their pain. We also considered flow proneness (assessed via trait flow and autotelic personality) and trait mindfulness as measures of person-activity fit. We believed that flow interventions might fit better if someone is higher in flow proneness, and mindfulness interventions might fit better if someone is higher in trait mindfulness.

We tested these moderators in multilevel models predicting daily pain awareness and intensity from condition (flow and mindfulness vs. control), day in the study, the grand-mean centered moderator, and all possible interaction terms. We focus on the three-way interaction, given the above finding that condition effects unfolded over time rather than on average across the study (Table 14). Results revealed that baseline pain and trait mindfulness were not significant moderators of the association between condition and change over time in pain. However, trait flow moderated the relationship for daily pain awareness, and autotelic personality moderated the relationship for both awareness and intensity.

To decompose these interactions, we first examined the two-way interactions between each moderator and change over time, separately by condition. We then estimated change over time in daily pain for those high (+1*SD*) and low (-1*SD*) in trait flow and autotelic personality, separately by condition. For trait flow, the only significant two-way interaction emerged in the control group, such that the daily pain awareness of participants low in trait flow did not change significantly over time (a non-significant increase), whereas the pain awareness of those high in trait flow significantly decreased over time. Participants in the flow and mindfulness conditions decreased in pain awareness over time, regardless of their level of trait flow. The pattern was identical for autotelic personality and daily pain awareness.

No two-way interaction was significant for autotelic personality and daily pain intensity; however, one notable time trend emerged, which likely drove the three-way interaction: Participants in the control group who were low in autotelic personality reported an increase in pain intensity over time.

Duration of Activity's Effect on Pain

Descriptive statistics revealed that reductions in pain awareness and intensity lasted approximately 6-10 minutes for the flow and mindfulness groups combined (awareness: $M = 2.15$, $SD = 1.83$; intensity: $M = 2.14$, $SD = 1.94$). Further analyses revealed that 36-50% of participants on any given day reported that the reduction in pain awareness or intensity did not last beyond the conclusion of the activity or that they did not experience any benefit in pain awareness from their flow or mindfulness activity; in

contrast, between 1-7% participants on any given day reported 120+ minutes of reduction in pain awareness or intensity after their activity.

Multilevel models were used to predict duration of the activity's effect from condition (flow = +0.5, mindfulness = -0.5, control = 0), day in the study, and the interaction between the two variables (Table 16). No predictor was significant for either pain awareness or pain intensity.

We further explored whether experiencing flow or mindfulness, regardless of the activity type, predicted the duration of its benefit. Multilevel models predicted duration of the effect from person- and grand-mean centered flow and mindfulness during the activity. Flow during the activity consistently predicted the duration of its benefit, at both the within- and between-person levels and for pain awareness and intensity. Mindfulness during the activity did not predict the duration of its benefit.

Flow Components Predicting Pain Awareness and Intensity During Activity

Finally, we explored whether particular components of flow experiences during the target activity were particularly predictive of pain awareness and intensity during the activity, using multilevel models predicting pain from each person- and grand-mean centered flow component (i.e., individual items in the flow scale; separate models for each item) and controlling for day in the study (Table 18). All components significantly and negatively predicted pain awareness and intensity during the activity at the between-person level. More relevant to our investigation, all components significantly and negatively predicted pain awareness during the activity at the within-person level except for immediate feedback and loss of self-consciousness, and all components significantly

and negatively predicted pain intensity during the activity at the within-person level except for loss of self-consciousness.

General Discussion

The broadest aim of this dissertation was to explore associations between chronic pain and flow within a sample of people who suffer from chronic pain to determine whether flow has benefits for decreasing chronic pain awareness and/or intensity above and beyond well-established benefits of mindfulness. We also aimed to explore naturally-occurring and independently-chosen flow activities among the chronic pain population. Interpretations and implications will focus on day-over-day experiences rather than person-level experiences (i.e., averaged across the study), given the activity-specific nature of flow (Nakamura & Csikszentmihalyi, 2014).

Flow and Mindfulness Activities

Study 1 revealed that the most common naturally-occurring flow activities among this sample of participants with chronic pain were work, physical leisure, and non-physical leisure. As part of Study 2, participants with chronic pain chose to engage in physical activity, games, reading, and chores most frequently to elicit flow. In Study 2, the most frequently chosen mindfulness activities included those that were non-active, moment-focused, or active.

Interestingly, activities that are active in nature appear in both naturally-occurring flow activities as well as individually-chosen flow activities and mindfulness activities. This level of activity was unexpected given that 45% of participants in Study 1 reported that chronic pain affects their ability to engage in physical activities, and 85% of

participants in Study 2 reported that chronic pain affects physical aspects of their life. Self-reported limitations in physical activities in both studies included walking beyond mobility, lifting, squatting, kneeling, and exercising. Yet, many participants reported that exercise was a flow activity for them (Study 1) or chose to engage in active forms of physical activity like exercise to elicit flow or nature walks to elicit mindfulness (Study 2). Perhaps choosing to engage in physical activities in a flow or mindfulness context indicates that these samples of chronic pain patients do their best to keep moving despite physical limitations. After all, inactivity is an impediment to the improvement of chronic pain (Hansen & Streltzer, 2005), and physical activity can reduce pain severity and increase quality of life (Mills et al., 2019).

Flow and Mindfulness Predicting Pain

Exploring daily flow and mindfulness as predictors of daily pain revealed consistent results across studies, such that participants reported relatively low levels of pain awareness and intensity compared to their norm on days when they reported relatively high levels of flow compared to their norm. This effect was also found for mindfulness in Study 2 (Study 1 did not include a measure of daily mindfulness).

We also saw consistent results when exploring flow and mindfulness during a specific activity predicting pain during that activity. Flow seemed to matter more than mindfulness in predicting pain outcomes when asking participants to indicate the activity that most closely aligned with flow in Study 1. We considered that this finding might be due to that study's focus on a naturally-occurring flow activity rather than purposefully participating in a flow activity above and beyond typical daily activities. However, this

explanation is unlikely, given that when participants engaged in a flow or mindfulness activity of their choice in Study 2, we again saw that flow experiences during the activity were more strongly associated with pain outcomes than mindfulness experiences during the activity, especially with regard to decreases in pain awareness during the target activity. These findings suggest that flow has stronger predictive power in relation to decreasing pain awareness and intensity in comparison to mindfulness.

Effects of a Flow and Mindfulness Intervention

Daily pain awareness decreased in a roughly linear fashion for participants in the flow and mindfulness conditions during the five-day study period in Study 2. Results further revealed that both flow and mindfulness were more beneficial than a no-intervention control in reducing pain awareness and intensity. However, flow and mindfulness did not outperform one another in reducing pain awareness and intensity. Though flow was not beneficial for mitigating pain above and beyond the established effects of mindfulness, these results are nonetheless powerful. If mindfulness is not a desirable activity, perhaps due to its difficulty for some people (Kabat-Zinn, 1982; Siegel et al., 2009), people can get into a flow state and experience similar effects on their pain. Flow states may be viewed as more accessible given that flow activities are often hobbies that are engaged in on a regular basis.

The finding that flow and mindfulness have similar effects on pain is not surprising given that they are similar in many ways. For instance, both flow and mindfulness can be beneficial in coping with typical life stressors. A phenomenological study that examined the experiences of three people revealed that an artist felt more able

to cope with possible stressors in life after being in a flow state (Wright et al., 2006). Similarly, mindfulness reportedly provides people with the opportunity to cope more effectively with unavoidable stressors of daily life (Greeson, 2009). Compared to people without chronic pain, those who experience chronic pain report greater life stress and more psychological distress (Fillingim, 2017). Therefore, additional modalities to manage stress are beneficial for the chronic pain population; flow and mindfulness may be two such avenues.

As another example of the similarities between flow and mindfulness, they both focus on the present moment, not worrying about the past or considering the future (Moore, 2013). The focus of flow is the present moment activity via concentration on the task at hand (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014), whereas the focus of mindfulness is present moment thoughts, feelings, and sensations (Siegel et al., 2009). Though participants practiced present-moment mindfulness 66 times throughout the five-day study period via activities such as guided meditation, non-active mindful activities occurred twice as often, a total of 125 times throughout the study period. Non-active mindful activities included eating mindfully, focusing on items of a specific color in the immediate surroundings, or focusing on one's breath. Active mindfulness activities, such as nature walks or yoga, were endorsed 65 times throughout the study, just one time fewer than present-moment mindfulness. Mindfulness activities that were not solely focused on the present moment may have mechanisms that are similar to flow, perhaps serving as a distraction from the experience of pain. Therefore, perhaps these

forms of non-active and active mindfulness have different effects on pain awareness and intensity than present-moment mindfulness, a topic that deserves more research.

Moderators of the Benefits of Flow and Mindfulness

Of the individual differences considered, only the two measures of flow proneness, trait flow and autotelic personality, seemed to influence the effect of the intervention. Perhaps surprisingly, being high or low in trait flow or autotelic personality did not alter the effects of the flow or mindfulness intervention, such that participants decreased in pain equally regardless of flow proneness. However, the control condition, in which participants were asked to go about their daily life as usual except for answering surveys in the evening during the five days of data collection, revealed different results. Participants high in flow proneness by either measure (trait flow or autotelic personality) experienced decreases in pain awareness across the week, much like the participants in the flow and mindfulness conditions. In contrast, participants low in flow proneness in the control condition increased in pain across the study, significantly so in the case of autotelic personality and pain intensity.

These results are puzzling, as it is difficult to imagine what occurred in the control condition to decrease pain among those high in flow proneness. Perhaps drawing attention to various psychological and physical experiences via our surveys was beneficial for pain awareness in those for whom flow comes naturally but was harmful for pain among those who struggle to experience flow. Undoubtedly, these results are exploratory and need to be replicated, but the consistency of results across two measures of flow proneness bolsters the findings. In the future, researchers implementing flow and

mindfulness interventions can take these moderators into consideration, such that pre-existing tendencies toward flow or autotelic experiences may determine the activities that benefit people with chronic pain.

Duration of Flow and Mindfulness Activities' Effect on Pain

Though many participants did not report a reduction in pain awareness or pain intensity after the conclusion of their target activity, others reported a reduction in pain awareness for up to 2 hours (the largest amount of time listed on the survey) after the conclusion of their target activity. The average reported benefit was around 10 minutes. Though this respite may not seem significant, people with chronic pain have described the experience as suffering that is unrelentless by a force or monster that cannot be tamed (Thomas, 2000). Consequently, any break from the unwavering experience of chronic pain can be beneficial and is likely welcomed.

Duration of pain awareness or intensity after the conclusion of the activity did not differ by flow or mindfulness condition, suggesting that flow and mindfulness activities have similar effects on duration of pain relief following the conclusion of the target activity. However, flow and mindfulness experienced during the activity, regardless of the activity type, was associated with the duration of the activity's effect. Participants experienced a longer benefit for pain awareness and intensity when they experienced flow during their target activity, but not when they experienced mindfulness during their target activity. Perhaps this result indicates that flow has longer lasting effects than mindfulness after the conclusion of the activity. When no longer actively practicing mindfulness, a non-judgmental accepting view of pain may no longer take place, whereas

after the conclusion of flow, beneficial effects such as self-efficacy due to reaching goals may persist.

Components of Flow

All components of flow except clear goals, immediate feedback, and loss of self-consciousness predicted pain awareness, and all components except loss of self-consciousness predicted pain intensity. Thus, most components of flow seem to predict pain awareness and intensity during the activity rather than one component conferring benefit.

We predicted that well-supported conditions of flow – challenge-skill balance, clear goals, and immediate feedback (Csikszentmihalyi, 1990; Csikszentmihalyi & Nakamura, 2010) – would lead to the remaining six characteristics of flow and that, together, these conditions and characteristics would decrease pain awareness and intensity during a flow state. Challenge-skill balance appears as the third and fourth strongest predictor of pain awareness and intensity, respectively, in our data. Challenge-skill balance is considered an important precursor, characteristic, or key requirement to enter the state of flow (Engeser et al., 2021; McCarther, 2018; Wright et al., 2006). Therefore, perhaps it is unsurprising that it is an important predictor of positive effects on pain awareness and intensity in this sample. However, clear goals and immediate feedback, the other two conditions of flow, did not appear as strong predictors of pain awareness or intensity in these studies.

Four components of flow most strongly predicted pain awareness and intensity in differing order: autotelic experience, sense of control, challenge-skill balance, and

concentration most strongly predicted pain awareness, whereas sense of control, concentration, autotelic experience, and challenge-skill balance most strongly predicted pain intensity. Interestingly, these components are the more proximal or subjective experiences of flow, rather than the primary components of flow.

Autotelic experience, or enjoying in the flow activity for its own sake (Engeser et al., 2021), surfaced as the strongest predictor of pain awareness. When activities are autotelic in nature, they are repeated due to enjoyment and are sought out for their own sake (Robinson et al., 2011; Wright et al., 2006). A strong association between autotelic experience and decreases in pain awareness may be particularly beneficial. If a person is doing a flow activity because it is intrinsically enjoyable, they will likely continue to seek it out and experience reductions in pain awareness along with many other beneficial outcomes as a result.

Sense of control emerged as the strongest predictor of pain intensity and the second strongest predictor of pain awareness. A sense of control can be beneficial, as increased control over one's life has been viewed as a protective factor against severity or exacerbation of chronic pain (Adams et al., 2005). Moreover, when various aspects of life including work, social activities, and leisure are at the mercy of one's chronic pain, experiencing some form of control in one's life could be beneficial for pain awareness and intensity. Desiring a sense of control over experiences in life that are undesirable (e.g., chronic pain) seems natural (McCracken & Vowles, 2006). Perhaps being in a flow state permits this experience of control, which has downstream effects on chronic pain.

Concentration on the task, such that attention is completely focused on the flow

activity (Rich, 2013), was the second strongest predictor of pain intensity. Many participants reported engaging in physical leisure activities such as exercise, weightlifting, and yoga, and physical activities often require intense concentration to do them correctly and without injury. Moreover, exercise is beneficial to reduce pain severity or intensity and improve physical functioning (Mills et al., 2019), which may benefit the chronic pain population given their report of chronic pain affecting physical aspects of their daily life.

Together, these results suggest that people with chronic pain should focus on flow activities that promote autotelic experiences, a sense of control, and concentration on the task to decrease the awareness and intensity of pain. These findings should be replicated but provide a springboard for suggesting flow activities that may benefit the chronic pain population.

Limitations and Future Directions

The results of this dissertation are not without limitations, but these limitations can inform additional future directions worthy of exploration.

Sample Characteristics

The demographic characteristics of participants in our samples are a limitation of the findings of this data. Women are more likely to experience pain and experience greater intensity of pain than men (Mills et al., 2019), so our samples being predominantly female is not necessarily a downfall. However, learning about the pain and flow experiences of men or people of other gender identities is important. Despite being able to generalize results outside of the United States, Study 1 was correlational in nature

and focused on naturally-occurring flow activities. We found some indications that cultural variations in daily activities (e.g., more physical activity by proxy of walking as a form of commuting) as well as access and coverage of healthcare (e.g., treatments for chronic pain) vary between countries. Therefore, Study 2 focused only on participants in the United States to gather a foundation of the associations between flow and pain in an intervention context.

Although we gathered both national and international samples, most of our participants were Caucasian. Given ethnic variations in prevalence and outcomes of pain-related conditions (Mills et al., 2019), exploring benefits of flow on pain among people from a variety of ethnic backgrounds and from various countries and cultures is needed. Similarly, exploring the ways in which flow and mindfulness influence pain awareness and intensity for different chronic pain conditions (e.g., joint, back, nerve conditions) will be beneficial to gain a more nuanced understanding of the effects of flow on pain. Taking access to healthcare and current treatment modalities into consideration might also be valuable, as flow may benefit people who have lower quality health coverage, given that it can be achieved in any setting without the guidance of a professional. Independence and self-facilitation allow for wider access to this management modality, as well as the opportunity to engage in it more frequently in comparison to traditional therapies such as cognitive-behavioral therapy or medication management. In the future, flow could be compared with well-supported modalities of pain management to consider its relative efficacy.

No Activity Control Group

In Study 2, the control group went about life as usual with no added activity prior to completing the daily questionnaires each evening of the five-day study. Therefore, it is possible that the effects of the flow and mindfulness group outperforming the control group on decreasing pain awareness and intensity are due to doing something in the flow and mindfulness group versus doing nothing in the control group. We tested one possible indication of this potential confound by controlling for autonomy, along with competence and relatedness, but these additions to the models did not substantially change our results. Nonetheless, in future studies, implementing an activity for the control group that does not manipulate pain in a way similar to flow will be beneficial to explore whether simply doing something beyond daily activities is beneficial for decreasing pain awareness and intensity or if flow and mindfulness are uniquely beneficial for pain.

Lacking Control Over Manipulation

Because this study was conducted online through Prolific, we did not have the opportunity to monitor participants to ensure that they were engaging in activities as directed. We were diligent in ensuring that all participants chose a true flow activity at the start of the study if assigned to the flow condition, but we had to rely on participants' reports of their activities during data collection. Controlled lab studies to replicate our effects would provide reassurance that flow and mindfulness activities are specifically beneficial for pain.

Timing of Self-Reports

Participants' experiences of pain awareness, pain intensity, flow, and mindfulness were documented at the end of the day through self-report questionnaires. Retrospective recall is subject to bias that affects the accuracy of responses (Junghaenel & Stone, 2021), especially overestimation of negative events (Peters et al., 2000) or remembering events more clearly if they are aligned with the current mood (Junghaenel & Stone, 2021). Therefore, self-reports of experiences after the fact may not be entirely accurate (Follick et al., 1984).

In the future, methodologies that gather data multiple times throughout the day to study people in their daily environment, such as the experience sampling method (ESM; Larson & Csikszentmihalyi, 2014), may be beneficial. The ESM gathers real-time assessments of people in their naturalistic environments using an electronic device (e.g., pager, programmable watch, cell phone), which provides a signal cueing the person to complete a self-report questionnaire. Though gathering data about an experience right after it happened would be beneficial, the ESM is often programmed to occur at random intervals throughout the day. If it were to occur when engaged in a flow activity, the flow state would be interrupted, thereby possibly thwarting the opportunity for benefit to pain awareness or intensity. Moreover, frustration may occur when being signaled during an activity that suffers from interruption (Fahrenberg, 1996), such as flow or when someone is feeling unwell due to pain and related experiences. When designing future interventions, careful consideration should be given to the benefits and drawbacks of

methods of data collection to diminish participant fatigue and daily interruption while gathering accurate data.

Limitations of Flow

Despite the myriad benefits of flow, including for pain management, it has its downsides. The distortion of time (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014), captive attention while in a flow state (Engeser et al., 2021; Nakamura & Csikszentmihalyi, 2014), and being so involved in a flow activity that nothing seems to matter including human needs like hunger or fatigue (Moore, 2013; Robinson et al., 2012) can be dangers of flow. These factors can lead people to neglect other responsibilities such as work, school, home life, family, or relationships due to participating in flow-inducing activities. Similarly, flow activities may be used as a source of procrastination to avoid doing undesirable or unpleasant tasks or tasks that need to be completed but are challenging due to pain. Despite these downfalls of flow, engaging in activities that lead to the experience of flow can provide an increase in self-esteem and life satisfaction (Wright et al., 2006), a benefit for people with chronic pain given the losses that they may face because of their pain (e.g., work, psychosocial; Furnes & Dysvik, 2012; Sagula & Rice, 2004). Flow is a state that is easily accessible after understanding the components of the experience. For this reason, flow is a readily-implemented and scalable means of coping with or managing the experience of chronic pain and is therefore worthy of future exploration within the chronic pain population.

Limitations of Mindfulness

Undoubtedly, moment-to-moment awareness and acknowledgement of one's thoughts, affective states, perceptions, and physical sensations (Grossman et al., 2004) can be exhausting. Present-moment mindfulness can also be challenging, as the mind often wanders to ideas, opinions, anticipations, and desires (Kabat-Zinn, 1982). However, just as muscles get stronger and physical fitness improves through physical exercise, people can develop the ability to become more mindful through regular practice at the "mental gym" (Siegel et al., 2009). In addition to the challenge of practicing mindfulness, simply observing an intense experience without action can be distressing (Kabat-Zinn, 1982), and becoming more aware of one's thoughts can be debilitating, especially if those thoughts are self-defeating (Sagula & Rice, 2004). Despite these limitations, mindfulness is well-supported as a management strategy for pain through the acceptance of and resulting improvements in pain (Hilton et al., 2017; Kabat-Zinn, 1982; St. Marie & Talebkhah, 2018).

Conclusion

No study to date has explored flow, mindfulness, and chronic pain through an experimental intervention. Findings from two studies highlight that flow and mindfulness are similar in their effects on decreasing pain awareness and intensity. Study 1 explored the associations between naturally-occurring flow activities and pain awareness and intensity in a correlational manner. Study 2 extended this work by facilitating an intervention to prompt participants to engage in a flow or mindfulness activity of their choice and thus tested the causal effects of flow and mindfulness on pain awareness and

intensity. Taken together, this dissertation reveals that both flow and mindfulness can serve as tools in a "toolbox" for coping with the experience of chronic pain. Moreover, both flow and mindfulness permit many options of activities that can elicit these states, which provides an opportunity for people to explore what works best for them to gain optimal effects and pain relief, even for a short time. In conclusion, when in pain, consider flowing through it—and if that does not help, give mindfulness a try.

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Table 1

Study 1 Sample Characteristics

Participant Characteristics	n = 200
% Female	76%
Age	
Mean (*SD*)	34.4 (*11.2*)
Range	18 to 66
Ethnicity	
Caucasian	90%
Diagnosed with chronic pain condition by medical professional	
Yes	57%
Chronic pain condition diagnosed by a medical professional	
Nerve conditions	35%
Arthritis	21%
Connective tissue conditions	20%
Effects of chronic pain on life	
Activities of daily life	56%
General	46%
Physical Activities	45%

Table 2

Study 1 Correlations Among Key Study Variables

	Daily pain intensity	Daily flow	Awareness during activity	Intensity during activity	Flow during activity	Mindfulness during activity	Trait flow	Mindfulness	Autotelic personality	Baseline pain
Daily pain notice	.69**	.03	.43**	.23**	-.08	.06	-.12	-.07	-.07	.07
Daily pain intensity	--	.13	.41**	.49**	-.15*	-.03	-.01	-.03	.03	.15*
Daily flow		--	-.07	-.17*	-.52**	.08	-.06	-.05	-.04	-.05
Pain awareness during flow			--	.63**	-.08	-.08	-.02	-.006	-.01	.08
Pain intensity during flow				--	-.28**	-.27**	-.02	.006	.02	.18*
Flow during flow activity					--	.36**	-.07	-.03	-.03	-.07
Mindfulness during flow activity						--	-.03	.02	-.02	-.17*
Trait flow							--	.64**	.68**	-.06
Mindfulness								--	.66**	-.13
Autotelic personality									--	-.02

Note: $^{**}p < .01$; $^{*}p < .05$. Daily measures are averaged across the study period.

Table 3

Study 1 Naturally Occurring Flow Activities

Flow Activity Category	Frequency (N)	Kappa
Work	241	0.93
Physical leisure	231	0.91
Non-physical leisure	210	0.88
Chores	146	0.89
NA	86	0.90
Cooking	83	0.96
Kids	72	0.92
Shopping	49	0.92
Social	45	0.93
Animals	33	0.94
Driving	21	0.90
Eating	8	0.83

Table 4

Study 1 Daily Flow Predicting Daily Pain

	Within-person associations		Between-person associations	
	b	95% CI	*b*	95% CI
Daily flow				
Pain awareness	-0.01**	[-0.02, -0.004]	0.004	[-0.02, 0.03]
Pain intensity	-0.16**	[-0.20, -0.13]	-0.09	[-0.18, 0.0005]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 5

Study 1 Flow and Mindfulness During Activity Predict Pain During Activity

	Within-person associations		Between-person associations	
	b	95% CI	*b*	95% CI
Flow During Activity				
Pain awareness	-0.06**	[-0.10, -0.03]	-0.02	[-0.10, 0.48]
Pain intensity	-0.44**	[-0.54, -0.33]	-0.31**	[-0.53, -0.09]
Mindfulness During Activity				
Pain awareness	0.01	[-0.006, 0.03]	-0.0008	[-0.03, 0.02]
Pain intensity	-0.03	[-0.08, 0.03]	-0.10*	[-0.18, -0.02]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 6

Study 2 Sample Characteristics

Participant Characteristics	n = 300
% Female	54%
Age	
Mean (*SD*)	42.3 (*13.7*)
Range	19 to 79
Race	
White	81%
Black/African American	7%
Diagnosed with chronic pain condition by medical professional	
Yes	74%
Chronic pain condition	
Joints	42%
Back	41%
Nerves	35%
Effects of chronic pain on life	
Physical	85%
Fatigue	73%
Mental	69%

Table 7

Study 2 Correlations Among Key Study Variables

	Daily pain intensity	Daily flow	Daily mindfulness	Awareness during activity	Intensity during activity	Flow during activity	Mindfulness during activity	Baseline pain	Trait flow	Autotelic personality	Trait mindfulness
Daily pain awareness	0.87**	-.36**	-.21**	.87**	.80**	-.18*	-.17*	.61**	-.23**	-.14*	.02
Daily pain intensity	--	-.35**	-.26**	.82**	.90**	-.23**	-.24**	.62**	-.17**	-.13*	.06
Daily flow		--	.25**	-.39**	-.40**	.54**	.18*	-.25**	.48**	.33**	-.08**
Daily mindfulness			--	-.20*	-.21**	.32**	.78**	-.14*	.38**	.42**	-.63**
Pain awareness during activity				--	-.88**	-.24**	-.21**	.58**	-.13	-.12	-.04
Pain intensity during activity					--	-.29**	-.23**	.55**	-.04	-.15	-.008
Flow during activity						--	.43**	-.12	.47**	.40**	-.06
Mindfulness during activity							--	-.07	.32**	.35**	-.55**
Baseline pain								--	-.12**	-.09	.003
Trait flow									--	.65**	-.32**
Autotelic personality										--	-.44**

Note: $^{**}p < .01$; $^{*}p < .05$. Daily measures are averaged across the study period.

Table 8

Study 2 Daily Flow and Daily Mindfulness Simultaneously Predicting Daily Pain

	Within-person associations		Between-person associations	
	b	*95% CI*	*b*	*95% CI*
Daily flow				
Daily pain awareness	-.15**	[-.22, -.07]	-.39**	[-.54, -.25]
Daily pain intensity	-.12**	[-.18, -.68]	-.26**	[-.36, -.16]
Daily mindfulness				
Daily pain awareness	-.20**	[-.27, -.13]	-.77	[-.17, .01]
Daily pain intensity	-.13**	[-.18, -.08]	-.74*	[-.14, -.01]

Note: $^{**}p < .01$; $^{*}p < .05$.

Table 9

Study 2 Flow and Mindfulness during Target Activity Simultaneously Predicting Pain During Activity

	Within-person associations		Between-person associations	
	b	95% CI	*b*	95% CI
Pain awareness during activity				
Flow during activity	-.53**	[-.80, -.26]	-.44*	[-.87, -.01]
Mindfulness during activity	-.10	[-.24, .04]	-.20	[-.43, .26]
Pain intensity during activity				
Flow during activity	-.39**	[-.59, .19]	-.35**	[-.61, -.09]
Mindfulness during activity	-.13**	[-.21, -.04]	-.15*	[-.28, -.07]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 10

Study 2 Flow Activities

Flow Activity Category	Frequency (*N*)	Kappa
Physical activity	71	0.91
Game	60	0.92
Read	41	0.98
Chores	28	0.76
Mindfulness	28	0.88
Cook	20	0.96
Create (art)	14	0.57
Music (play)	11	0.89
Hand dexterity (art)	11	0.75
Computer	10	0.58
Television	10	0.72
Art (draw, paint)	9	0.85
Digital art	7	0.81
Work	6	0.48
Not applicable (blank)	6	0.88
Write	5	0.80
General art (other art, hobbies)	5	0.31
Social	4	0.58
Photo (art)	4	0.83
Not flow	4	0.49
Unclear	1	0.18

Table 11

Study 2 Mindfulness Activities

Activity Category	Frequency (N)	Kappa
Non-active mindfulness	125	0.88
Moment focused mindfulness	66	0.82
Active mindfulness	65	0.88
Flow	50	0.84
Neither (mindfulness nor flow)	10	0.52
Blank	2	0.75
Unclear mindfulness	1	0.08

Table 12

Study 2 Time Trends

	Linear Effect of Time							
	Overall		Flow Condition		Mindfulness Condition		Control Condition	
	b	*95% CI*	*b*	*95% CI*	*b*	*95% CI*	*b*	*95% CI*
Daily pain awareness	-.08**	[-.12, -.04]	-.12**	[-.19, -.05]	-13**	[-.19, -.06]	-.01	[-.08, .05]
Daily pain intensity	-.009	[-.04, .02]	-.04	[-.08, .008]	-.04	[-.09, .007]	.04	[-.01, .09]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 13

Study 2 Condition Predicting Pain, Flow, and Mindfulness

	Time		Condition		Interaction with time	
Condition Grouping	*b*	*95% CI*	*b*	*95% CI*	*b*	*95% CI*
Flow (.5) vs. control (-.5)						
Daily pain awareness	-.08**	[-.12, -.05]	.19	[-.15, .54]	-.11*	[-.20, -.02]
Daily pain intensity	-.01	[-.04, .02]	.04	[-.20, .28]	-.07*	[-.14, -.01]
Daily flow	-.05**	[-.09, -.02]	.44**	[.17, .71]	.04	[-.05, .12]
Mindfulness (.5) vs. control (-.5)						
Daily pain awareness	-.09**	[-.12, -.05]	.22	[-.14, .59]	-.12*	[-.21, -.03]
Daily pain intensity	-.01	[-.04, .01]	.13	[-.12, .38]	-.08*	[-.15, -.01]
Daily mindfulness	.05*	[.007, .08]	.43*	[.06, .79]	.05	[-.05, .15]
Flow (.5) vs. mindfulness (-.5)						
Daily pain awareness	-.08**	[-.12, -.04]	-.02	[-.38, .35]	-.0003	[-.10, .10]
Daily pain intensity	-.01	[-.04, .02]	-.09	[-.35, .16]	.001	[-.07, .07]
Daily flow	-.05**	[-.09, -.02]	.25	[-.05, .54]	-.07	[-.16, .02]
Daily mindfulness	.05*	[.005, .09]	-.16	[-.54, .21]	-.01	[-.12, .09]
Flow during activity	-.007	[-.03, .02]	.08	[-.09, .24]	-.04	[-.08, .01]
Mindfulness during activity	.008	[-.04, .05]	.17	[-.52, .13]	.05	[-.09, .10]
Flow (.5) and mindfulness (.5) vs. control (-1)						
Daily pain awareness	-.09**	[-.12, -.05]	.14	[-.07, .34]	-.07**	[-.13, -.02]
Daily pain intensity	-.01	[-.04, .01]	.05	[-.09, .19]	-.05**	[-.09, -.01]

Note: $^{**}p < .01$, $^{*}p < .05$. Numbers next to condition labels indicate effects coding for that comparison.

Table 14

Study 2 Moderators of Condition (Flow and Mindfulness vs. Control) by Time Effects

	3-way interaction	
	b	95% CI
Baseline pain x condition x time		
Daily pain awareness	-.07	[-.17, .02]
Daily pain intensity	-.06	[-.13, .01]
Trait flow x condition x time		
Daily pain awareness	.14**	[.05, .22]
Daily pain intensity	.05	[-.02, .11]
Autotelic personality x condition x time		
Daily pain awareness	.09**	[.03, .16]
Daily pain intensity	.05*	[.007, .10]
Trait mindfulness x condition x time		
Daily pain awareness	-.03	[-.08, .02]
Daily pain intensity	-.01	[-.05, .02]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 15

Study 2 Decomposing Moderators by Condition by Time Effects

	Daily pain awareness		Daily pain intensity	
	b	95% CI	*b*	95% CI
Trait flow				
Flow condition: Trait flow x time interaction	.09	[-.04, .23]	--	--
-1 SD trait flow: Time effect	-.17**	[-.28, -.07]	--	--
+1 SD trait flow: Time effect	-.07	[-.17, .02]	--	--
Mindfulness condition: Trait flow x time interaction	.06	[-.05, .17]	--	--
-1 SD trait flow: Time effect	-.16**	[-.24, -.07]	--	--
+1 SD trait flow: Time effect	-.09*	[-.18, -.01]	--	--
Control condition: Trait flow x time interaction	-.13*	[-.23, -.03]	--	--
-1 SD trait flow: Time effect	.05	[-.03, .13]	--	--
+1 SD trait flow: Time effect	-.09*	[-.18, -.001]	--	--
Autotelic personality				
Flow condition: Autotelic x time interaction	.07	[-.01, .16]	.02	[-.03, .08]
-1 SD autotelic personality: Time effect	-.18**	[-.25, -.11]	.03	[-.02, .07]
+1 SD autotelic personality: Time effect	-.06	[-.14, .006]	-.01	[-.06, .03]
Mindfulness condition: Autotelic x time interaction	-.004	[-.07, .06]	.02	[-.03, .08]
-1 SD autotelic personality: Time effect	-.12**	[-.20, -.04]	-.06	[-.12, .0007]
+1 SD autotelic personality: Time effect	-.13**	[-.21, -.05]	-.02	[-.08, .04]
Control condition: Autotelic x time interaction	-.11*	[-.19, -.02]	-.06	[-.12, .009]
-1 SD autotelic personality: Time effect	.07	[-.01, .15]	.08**	[.02, .14]
+1 SD autotelic personality: Time effect	-.10*	[-.19, -.01]	-.007	[-.07, .06]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 16

Study 2 Condition Effects on Duration of Activity's Effect on Pain

	Time		Condition		Interaction with time	
	b	*95% CI*	*b*	*95% CI*	*b*	*95% CI*
Duration of effect on pain awareness	.09	[-.01, .20]	.13	[-.43, .70]	.16	[-.05, .36]
Duration of effect on pain intensity	.07	[-.02, .17]	.22	[-.38, .82]	.10	[-.10, .29]

Note: $^{**}p < .01$, $^{*}p < .05$. Condition coded as flow = +0.5, mindfulness = -0.5, control = 0.

Table 17

Study 2 Flow and Mindfulness During Activity Predicting Duration of Activity's Effect on Pain

	Within-person associations		Between-person associations	
	b	95% CI	*b*	95% CI
Pain awareness				
Flow during activity	.97**	[.52, 1.41]	.90**	[.33, 1.48]
Mindfulness during activity	.008	[-.22, .23]	-.11	[-.41, .20]
Pain intensity				
Flow during activity	.89**	[.46, 1.33]	1.07**	[.47, 1.67]
Mindfulness during activity	.14	[-.08, .36]	-.20	[-.52, .11]

Note: $^{**}p < .01$, $^{*}p < .05$.

Table 18

Study 2 Flow Components Predicting Pain Awareness and Intensity During Activity

	Within-person associations		Between-person associations	
	b	95% CI	*b*	95% CI
Challenge-skill balance				
Pain awareness during activity	-.34**	[-.53, -.14]	-.60**	[-.99, -.21]
Pain intensity during activity	-.25**	[-.38, -.12]	-.45**	[-.70, -.21]
Action-awareness merging				
Pain awareness during activity	-.23*	[-.41, -.05]	-.59**	[-.98, -.20]
Pain intensity during activity	-.21**	[-.34, -.09]	-.43**	[-.67, -.19]
Clear goals				
Pain awareness during activity	-.19	[-.41, .03]	-.62**	[-1.00, -.23]
Pain intensity during activity	-.20**	[-.35, -.05]	-.45**	[-.69, -.21]
Immediate feedback				
Pain awareness during activity	-.17	[-.35, .02]	-.65**	[-1.03, -.27]
Pain intensity during activity	-.17**	[-.29, -.06]	-.49**	[-.73, -.25]
Concentration on the task				
Pain awareness during activity	-.31**	[-.50, -.12]	-.64**	[-1.03, -.25]
Pain intensity during activity	-.30**	[-.43, -.17]	-.48**	[-.72, -.34]
Sense of control				
Pain awareness during activity	-.36**	[-.53, -.18]	-.61**	[-1.00, -.22]
Pain intensity during activity	-.34**	[-.48, -.20]	-.47**	[-.71, -.23]
Loss of self-consciousness				
Pain awareness during activity	-.11	[-.26, .04]	-.60**	[-.99, -.21]
Pain intensity during activity	-.85	[-.19, .02]	-.45**	[-.69, -.20]
Transformation of time				
Pain awareness during activity	-.15*	[-.30, -.01]	-.60**	[-.99, -.20]
Pain intensity during activity	-.11*	[-.22, -.0005]	-.46**	[-.70, -.21]
Autotelic experience				
Pain awareness during activity	-.41**	[-.56, -.27]	-.59**	[-.98, -.20]
Pain intensity during activity	-.27**	[-.38, -.16]	-.45**	[-.69, -.21]

Note. $^{**}p < .01$, $^{*}p < .05$.

Figure 1

Study 2 Exploratory Pathways between Flow Components as Visual Depiction of RQ 2