Effects of Resilience and Psychological Defenses on the Relationship Between Emotional Distress & Gastrointestinal Health

by

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Abstract

Mental health concerns are commonly associated with chronic disease. Additionally, mental health concerns can have major influence on physical health outcomes. Functional gastrointestinal (GI) disorders are common chronic medical conditions characterized by physiological symptoms that oftentimes accompany mental health conditions. This is due to the bidirectional communication between the central and enteric nervous system that links emotional cognitions and emotions with intestinal functions called the gut-brain axis (GBA). While it is known that psychological distress likely contributes to onset and chronicity of physical complaints, etiology of gut health problems remains unclear. Resilience is the ability to adapt and respond positively to stress. Higher levels of resilience have been associated with reduced GI complaints. Additionally, defensive coping styles have also been associated with predicting levels of resilience. Using a mediation model, this study set out to examine the effects of resilience and defensive coping styles on the relationship between psychological distress and GI complaints. It was hypothesized psychological distress would be positively associated with GI complaints. It was also hypothesized that psychological distress would be negatively associated with less resilience and positively associated with maladaptive defense mechanisms. Lastly, we hypothesized that psychological distress and gut health problems would be partially mediated by resilience and defense mechanisms. Data were collected online using self-report measures from 313 participants. Results found that gut health and psychological distress were positively associated. Psychological distress was negatively associated with resilience and positively associated with maladaptive coping mechanisms. Resilience and defense mechanisms were not

found to explain the relationship between psychological distress and GI complaints. The results support the biopsychosocial model of physical health and psychological well-being. Stress significantly predicted GI complaints. Future research should continue exploring the specific variables that contribute to changes in the bidirectional link between cognition and gastrointestinal health.

Chapter 1

Introduction

Psychological disorders are substantial contributors to the global burden of chronic disease (Vigo et al., 2016). Anxiety and depression are stress-related disorders with high prevalence rates and negative impacts on personal, societal, and health conditions. Anxiety and depression oftentimes cooccur with chronic diseases, such as gastrointestinal (GI) disorders. GI disorders are commonly associated with psychological disorders, such as depression and anxiety. Psychological distress and GI symptoms operate on the similar stress pathways known as the Gut-Brain Axis (GBA), a bidirectional link between the central nervous system (CNS) and enteric nervous system (ENS; Carabotti et al., 2016). The theory that emotional distress and gut-related mechanisms may present comorbidly has been long-established in the literature (Banerjee et al., 2017; Mikocka-Walus et al., 2016; Mussell et al., 2008; Ross et al., 2020; Zhang et al., 2016). Various theories have been posited to explain the etiological links between psychological distress and GI symptoms, including the hypothalamic-pituitary-adrenal (HPA)axis, neurotransmitters, psychosocial factors, and behavioral pathways. Although research continues to confirm links between psychological distress and SI symptoms, there are remaining gaps in the literature regarding the potential variables that explain this relationship continue to exist. The present study seeks to add to the literature in this area by examining if links between psychological distress and gut health are partially mediated by psychological defenses and/or resilience. Prior to reviewing the methods employed for the study, we provide a review of the related literature. We begin by describing the prevalence and impacts of anxiety and depression

generally. We transition to describing how anxiety and depression exist in the context of stress and gut health, and then turn our attention to research linking anxiety and depression to the gut microbiome. Finally, we review our proposed study for further exploring how these associations may be explained through resilience and defensive coping styles.

Psychological Distress & Gut-Health

Mental health disorders have high comorbidity rates with various chronic diseases (Sporinova et al., 2019; Wan et al., 2017). They are linked to increased resource utilization and higher healthcare costs. GI disorders are among various chronic health conditions characterized by structural and physiological abnormalities. This oftentimes involve motility issues, visceral sensitivities, alterations in immunity, modifications in the gut microbiota, and changes in CNS function (Drossman, 2016). GI symptoms are the result of a combination of psychosocial factors and alterations in the gut-microbiome through the GBA axis. Physiological mechanisms of the gut are sensitive to emotional and environmental stressors and can be altered through this brain-gut connection resulting in physical pain, chronic illness, and/or emotional distress. Anxiety and depression are two stress-related psychological disorders are involved in factors of gut health that contribute to and are exacerbated by GI symptoms.

Anxiety

Anxiety disorders are common psychiatric conditions characterized by excessive worry, nervousness, stress, and hyperarousal. They cause distress, interfere with productivity, and can be debilitating (Remes et al., 2016, Simpson et al., 2020). Annual cost for anxiety disorders is estimated to be $42.3 billion (Greenberg et al., 1999). Anxiety disorders also increase risk for other mental health disorders, such as mood disorders and substance use (Nutt & Ballenger 2002; Simpson et al., 2020). The prevalence rate of anxiety disorders in the United States is estimated

to be at 18% (Kessler et al., 2005) which amounts to roughly 60 million people. Prevalence rates are higher among women (5.2-8.7%) who are twice as likely to have anxiety than men. Anxiety is particularly high in young adults (2.5-9.1%) and has shown a substantial increase in this population over time. Various cultures from around the world are also affected and may express symptoms of anxiety differently (Fazel et al., 2005; Baxter et al., 2013; Hawton et al., 2013; Steel et al., 2014).

Anxiety impacts physical health and health care utilization (Simpson et al., 2010). It is associated with increased use of primary and acute care. It is prevalent in many chronic illnesses (1.4-70%), including cardiovascular disease, cancer, respiratory illnesses, and diabetes (Remes et al., 2016). In fact, around 10% of patients with cardiovascular disease in Western countries also experience an anxiety disorder, such as GAD or panic disorder. Anxiety is also notable in other conditions, such as stroke and cancer (Campbell-Burton et al., 2013; Clarke & Currie 2009; Grigsby et al., 2002).

Anxiety appears to play a role in GI symptoms. Mussel and colleagues (2008) examined prevalence of GI symptoms with anxiety in primary care patients; 18% of 380 patients with anxiety complained of at least one GI symptom. Severe anxiety increased fourfold in patients who reported GI symptoms when comparing them to patients without (19.4% vs. 5.6%). In addition, the greater the number of gut health symptoms experienced, the greater the likelihood for meeting the criteria for an anxiety disorder (Mussell et al., 2008). Subsequent investigators have also found self-reported anxiety and GI symptoms to be associated (Banerjee et al., 2017; Tosic-Golubovic et al., 2010).

Depression

Depression is a detrimental psychiatric illness that impacts about 300 million people worldwide (Gotlib, 2019). The prevalence of depression has increased globally in the previous decades (Wang et al., 2017). Lifespan prevalence is about 20-25% for women and 7-12% for men. Depression can affect quality of life and survival, explains 50% of psychiatric visits, and 12% of hospital admissions. Depression is associated with high indirect costs that result from loss of productivity and unemployment (Ho et al., 2013).

Like anxiety, depression is highly comorbid with physical illnesses, such as: asthma 27% (Lu et al., 2012), chronic obstructive pulmonary disease 24.6% (Zhang et al., 2011), arthritis (20%), and stroke 30% (Mak et al., 2013). Additionally, depression has been linked to GI problems. Mussel and colleagues (2008) found that severity of depression increased about fivefold in patients who reported GI symptoms when comparing them to patients without (19.1% vs. 3.9%) in a sample of primary care patients. Other studies have found depressive symptoms and GI complaints to be correlated (Koloski et al., 2002; Locke III et al., 2004; Makharia et al., 2011).

Stress-Related Implications

Anxiety and depression frequently follow stressful experiences (Bear et al., 2021). Additionally, stress levels tend to increase in those experiencing depression and anxiety (Nesse, 1999). It is possible that links between depression, anxiety, and GI issues involve the stress response. Research with humans and animals links composition of the gut microbiome to stress and the onset of mental health disorders (Drossman et al., 2016; Huang et al., 2019; Kaplan et al., 2015; Lima-Ojeda et al., 2017; Peirce & Alvina, 2019). Several studies link inflammation to a variety of mental health conditions (Kaplan et al., 2015; Peirce and Alviña, 2019). Though the

directionality of these paths is not known, there is increasing evidence that inflammation is impacted by the gut microbiome. Therefore, gut microbes likely influence brain function and, in turn, affect mental health at least, in part, as a function of their role in the inflammation process (Rogers et al., 2016).

Psychological Distress and Gut Health

Early studies in this area were specifically focused on exploring the mechanisms behind irritable bowel syndrome (IBS), finding that IBS patients are generally more psychologically impaired when compared to the general population (Sammons, 1987). Hislop (1971) used structured patient interviews and establish that IBS is associated with higher rates of depressive symptoms (when compared to controls without IBS). Liss et al., (1973) found that 92% of IBS patients within a gastroenterology clinic at a university had a specified psychiatric illness.

Subsequent researchers generalized the association between psychological distress and gut function beyond IBS populations. For example, Mussell et al., (2008) investigated the GI symptom prevalence in patients across 15 primary care clinics using self-report measures. Patients with GI symptoms scored significantly higher on depression and anxiety measures (in comparison to patients without GI symptoms). Effect sizes for these differences were considerable. A number of studies in medical settings have further affirmed links between gut health and the severity of depression and anxiety (Simpson et al., 2020; Turna et al., 2019). Using self-report measures, later researchers generalized these findings from primary care patients to community samples, indicating an association between GI and psychological distress in populations not experiencing medical issues (Beshai et al., 2017; Ross et al., 2020).

In summary, depression and anxiety have both been shown to be linked to GI problems in a number of studies. Additionally, depression and anxiety are both linked to stress, which can

also be an antecedent of and an outcome of GI problems. While these associations are well established across a number of studies, there is no current consensus of the specific mechanisms that underlie these associations. A number of theoretical explanations, however, have been given and we review these in the next section.

Gut-Brain Axis: Theoretical Perspectives

Several theoretical frameworks have emerged in the past 20 years seeking to explain the mechanisms that underlie the associations between mental states/psychological distress and gut health. A full review of these theories is beyond the scope of this paper; nonetheless, we briefly review the literature on four of these frameworks: the HPA axis, neurotransmitters, behavioral pathways, and psychological characteristics.

Hypothalamus-Pituitary-Adrenal Axis (HPA)

Depression and anxiety are consistently linked to stress. The HPA axis refers to the pathway between the hypothalamus, pituitary gland, and adrenal glands, that helps organize the body's response to stress. When the HPA is activated, the hypothalamus responds by secreting corticotropin releasing hormone (CRH) into the bloodstream, which stimulates adrenocorticotropic hormone (ACTH) secretion through the pituitary gland. Once ACTH reaches the adrenal cortex, the stress hormone cortisol is released into the bloodstream. This chemical cascade affects many organs and results in physiological changes such as such as increased heart rate, and suppressed immune response.

While HPA activity in response to discrete stressors can be adaptive, chronic activity in the HPA can be problematic. Both depression and anxiety have been associated with dysregulation in the HPA pathway. Disruption in HPA axis can also contribute to alterations to the gut-microbiome and effect the composition of gut microbiota (Carabottia et al., 2015; Foster

& Neufeld, 2013; Luo et al., 2018; Sudo et al., 2004; Simpson et al., 2020). The gut microbiome is made up of microorganisms, primarily bacteria, that live in the GI tract (Backhed, et al., 2005). Given that dysregulation in the HPA is associated with both risk for mental distress and risk for GI problems, it has been suggested that HPA dysregulation may explain links between psychopathology and gut health

Animal studies have support this model. Germ-free mice exposed to stressful stimuli, demonstrate overactive HPA axes, and increasing levels of corticosterone (main stress hormone of the adrenal cortex in rodents) and adrenocorticotropic hormone (ACTH) concentrations which disrpute their gut microbiomes (Sudo et al., 2004). These results have been replicated multiple times (Clarke et al., 2013; Luo et al., 2018; Neufeld et al., 2011a; Neufeld et al., 2011b). In humans, there is evidence that abnormalities in the HPA in functional GI disorders and stress sensitive mental health disorders, such as depression and anxiety (Russo et al., 2012).

While experimental methods with humans would be unethical, quasi-experimental and correlational research with humans demonstrates links between HPA activity and mood and anxiety disorders. Carpenter et al., (2004), Lee at al., (2005), and Lee et al., (2006) have found that human beings that have experienced adversity in early-life have increased concentrations of cerebrospinal fluid CRF and associated with heightened stress responses to psychosocial stress. These findings are parallel to studies using laboratory animals. Increased concentrations of cerebrospinal fluid CRF have been continually observed in major depressive disorder (Banki et al., 1987; Hartline et al., 1996; Nemeroff et al., 1984) and certain anxiety disorders, such as posttraumatic stress disorder (Baker et al., 1999; Bremner et al., 1997; Reul & Holsboer, 2002; Sautter et al., 2003).

Overall, research with both animals and humans supports links between HPA function and anxiety and depression. Further, HPA functioning has been shown to impact and be impacted by the composition of the gut microbiome (Luo et al., 2018; Sudo et al., 2004). Thus, it is possible that how people react to and manage their stress may play an important role in linking gut function with anxiety and mood issues. Thus, in searching for variables that explain the association between psychological distress and gut health, researchers should consider focusing on variables, such as psychological defenses and psychological resilience, that are known to modulate the stress response.

Neurotransmitters

Neurotransmitter function has a cyclical relationship with the gut microbiome (Heijtz et al., 2011). Brain chemicals such as norepinephrine, dopamine, and serotonin are involved in different aspects in emotion regulation. For instance, dopamine is related to pleasure and reward, serotonin is involved with mood modulation, and norepinephrine is involved with physiological mobilization. It has been proposed that links between gut health and psychological states may be partially explained by disruptions in shared neurotransmitter systems.

Research with animals has provided some support for this position. The brains of germ-free male rats show increased turnover of norepinephrine, dopamine, and serotonin within the striatum; additionally, the frontal cortex, hippocampus, and striatum had decreased dopaminergic turnover (Crumeyrolle-Arias et al., 2014). Pierce and colleagues (2019) add that, although only male rats were used in the aforementioned studies, there is growing evidence that these changes can be harmful for mental health.

Beyond animal studies, preemptive human studies also implicate neurotransmitters in the psychological distress-gut health relationship. One way this has been studied is by examining

how gut-based interventions impact neurotransmitters (Strandwitz, 2018). For example, human studies show that manipulation of the microbiota impacts levels of gamma-aminobutyric acid (GABA; Dahlin et al., 2005). Ketogenic diet increases GABA levels and improves symptoms of refractory epilepsy in children. More recently, GABA was discovered to be the most altered metabolite in obese patients receiving fecal transplantation from lean donors, improving insulin sensitivity (Kootte et al., 2017). While human studies are in the early stages, these preliminary findings do support the theory that neurotransmitter functioning helps explain the relationship between psychological distress and gut health.

Behavioral Implications

Some have sought to explain links between psychological distress and gut health through behavioral trends. These models assert that psychological distress and/or poor gut health lead to behaviors that increase risk for psychopathology and GI issues. For example, when microbiota from high anxiety mice was transplanted into low anxiety mice, it increased the frequency of observed anxious behavior within the low anxiety mice (Bercik et al., 2011).

The role of psychological distress and gut health as also been evidenced by human studies. For instance, diet has shown to influence changes in the gut microbiota (Alcock et al., 2014). Diet is arguably one of the most important factors in regulating gut microbiome composition and has been noted to act as risk or protective factor from depression (De Filippo et al., 2017; Jacka et al., 2017). Jacka and colleagues (2017) conducted a clinical study and found that adherence to version of the Mediterranean diet resulted in improvement in depressive symptoms in comparison to a control social support control group. Contrastingly, gut microbiome has also been shown to influence eating behaviors. Gut microbes share limited resources and, to ensure the survival of microorganisms, must compete for space and nutrients (Hibbing et al., 2010).

Therefore, it is proposed that microbes manipulate host behavior by creating food cravings that leverage their survival or influencing mood that perpetuates consumption of food that boosts selection of certain species. (Alcock et al., 2014; Leitao-Goncalves et al., 2017).

Psychological States

Most theories seeking to explain links between psychological distress and gut health focus on how psychological states impact complex biological systems. Note that these theories tend to integrate research and postulates of the more specific theories described above. It is clear that microbial composition can be affected by stress hormones and neurotransmitters released as a result of stress (Montiel-Castro et al., 2013). For instance, stressful conditions, such as maternal separation, heat, and auditory stress, have shown to alter the gut microbiota composition in animals (Bailey et al., 2011; De Palma et al., 2014; Moloney et al., 2014). Stress also increases intestinal permeability through the CRF and its receptors (CRFR1 and CRFR2; Overman et al., 2012; Rodiño-Janeiro et al., 2015; Tache´ & Million, 2015). When intestinal permeability is increased, bacteria translocates across the intestinal barrier and directly access the cells of the enteric nervous system (Gareau et al., 2008; Teitelbaum et al., 2008), thereby impacting GI function. The autonomic system is activated by stress, which impacts stomach acid, bile, and mucus production, as well as GI motility (Beckh & Arnold, 1991; Shigeshiro et al., 2012; Soderholm & Perdue, 2001). GI motility is important because it has a strong relationship with the composition of the gut microbiome (Falony et al., 2016; Vandeputte et al., 2016). In short, stress, a psychological state, can affect the functioning of several biological systems that, in turn, altering gut function.

If this theory is accurate, then individual differences in psychological characteristics known to modulate the human stress response should at least partially explain the association

between psychological distress and GI problems. There is some evidence to support this assertion. Park et al. (2017) examined resiliency, using the Brief Resiliency Scale (Smith et al., 2008), in samples of patients with IBS symptoms and healthy controls. Resilience is a coping style characterized by the ability to adapt and recover well in response to stressful situations and has been associated with lower levels of gastrointestinal complaints (Park et al., 2017). Self-reported resilience was significantly lower in IBS patients in comparison to healthy controls (even after controlling for neuroticism). Within both samples, lower resilience scores were associated with increased IBS symptom presentation (i.e., resilience was negatively associated with IBS symptoms), presumably because low resilience limits individuals' ability to mitigate stress responses. Indeed, a subgroup of participants in this study underwent hormonal test challenge to measure HPA activity. Results demonstrated a significant interaction between symptoms of IBS, resilience, and stress response. Specifically, those who were less resilient showed a strong HPA response (longer recovery from stress) and higher IBS symptoms, suggesting that the ability to recover from stress may be impacted by resilience influence gut health (Park et al., 2017).

Other studies using non-clinical samples have shown that certain coping styles have been associated with the hypothalamic-pituitary-adrenal (HPA) axis activity and inflammation, which may alter risks for symptoms of chronic diseases (Oudenhove, 2016). Resilience and defensive coping style have been examined in the context of GI disorders and have been shown to be associated with physiological response of stress (Babl et al., 2019; Bear et al., 2021; Dantzer et al., 2018; Lenzo et al., 2020). Maladaptive defense functions can be characterized as unhealthy cognitive or behavioral reactions that function to suppress negative emotions and have been associated with more pathological stress responses (Cramer, 2008; Prout et al., 2018). While

these relationships exist, further research is needed to better understand how the role of adaptive and maladaptive coping mechanisms impact the relationship between GI and psychological distress.

Summary and Study Aims

Prior research establishes an association between psychological distress and GI symptoms. A leading theory explaining this association asserts that psychological distress can be both a cause and/or outcome of a poorly regulated stress reaction. This stress reaction can dysregulate the HPA, which can contribute to GI problems. It is well known that intense and/or chronic stress contributes to risk for both GI symptoms and psychopathological symptoms (e.g., symptoms of depression). It is also known that there are individual differences in how people regulate and respond to stress and distress. Those who are more resilient to stress and those employing healthy defenses to modulate stress may be less at risk for GI problems. One prior study has examined if resilience helps explain links between psychological distress and gut health (Park et al., 2017). This study focused largely on an IBS sample, and it would be good to replicate it in a non-clinical sample to determine if results generalize. Additionally, no prior study in this area has examined if individual differences in psychological defenses explain links between psychological distress and gut health. Psychological defenses have been shown to have a large impact on how individuals experience stress (Cramer, 2007; Prout et al., 2018). Thus, we propose that they may mediate links between psychological distress and gut health by impacting how the individual experiences and responds to stressors.

Hypotheses

We make the following hypotheses:

Hypothesis 1. Psychological distress will be positively associated with gut health problems such that scores on scales tapping depression, anxiety, and stress will be positively associated with scores on self-report measures assessing gut health problems.

Hypothesis 2. Psychological distress will be associated with less resilience, such that scores on scales tapping depression, anxiety, and stress will be inversely associated with scores of resilience.

Hypothesis 3. Psychological distress will be associated with the use of maladaptive defense mechanisms such that scores on scales tapping depression, anxiety, and stress will be inversely correlated with scales tapping overall defensive functioning (ODF; i.e., degree of adaptability of defenses).

Hypothesis 4. Associative Paths between psychological distress and gut health problems will be partially mediated by resilience and defense mechanisms. To test this hypothesis, we will run a path model in which scores on a depression scale, anxiety scale, and stress scale will be treated as observable indicators of a latent factor (psychological distress). This latent factor will be set to be predictive of a second latent factor composed of scores from PROMIS-GI scales tapping gut health problems. This latent factor will be called gut health. We will test a model in which there is a direct path between the two latent factors (i.e., psychological distress and gut health problems) as well as two indirect paths. The first indirect path will move from the latent factor, psychological distress, to a scale tapping resilience, and ultimately to the latent factor for gut health problems. The second indirect path will run from psychological distress to a scale tapping ODF, and ultimately to the latent factor for gut health problems. This hypothesis will be said to be supported if 1) the model shows an acceptable level of fit for the data, 2) all indirect

paths are statistically significant, and 3) the direct path from psychological distress to gut health problems also remains statistically significant.

Chapter 2

Methods

Participants

313 participants were recruited through Amazon's Mechanical Turk (MTurk). MTurk is an online crowdsourcing service that is relatively representative of the U.S. population of internet users. Those who participate in the in MTurk studies are called Workers. Workers participate based on various study qualifications, such as compensation and study length. The submission must be approved or rejected after a Worker has completed a study, and followed by compensation. (Poalacci et al., 2010). Each worker was reimbursed a payment of $1.50 for participating.

Participants ranged from 18-77 years old (M = 37.82, SD = 10.8). 212 participants identified as male (67.7%) and 101 (32.3%) identified as female (Table 1). Majority of the sample identified as white (N = 234, 74.8%). Additionally, 13.4% identified as black (N = 42), 7.3% identified as Asian (N = 23), 2% identified as Hispanic (N = 9), and 1.6% identified as other N = 5) (Table 1).

Eligible participants were required to be 18 or older, able to complete an online questionnaire in English language, and live in the U.S. As part of the study, the following information was collected from participants: 1) age, 2) gender identity; 3) ethnic identity; 4) marital status; and 5) educational status.

Measures

The measures used in this study are entirely self-report based. While participants signed up for the study through Mturk, study measures were completed through Qualtrics. In addition to logistical benefits, this ensured that Mturk (which has access to identifying data for the participant) did not have any access to participant responses. Similarly, though Qualtrics has access to participant responses, Qualtrics does not have access to any identifying information regarding the participant. Below, we provide a brief description of each measure the study will employ.

Patient-Reported Outcomes Measurement Information System GI Symptom Scale

The Patient-Reported Outcomes Measurement Information System (PROMIS) is a multi-item self-report measure that assesses health outcomes in the domains such as physical, psychological, and social health. The PROMIS- Gastrointestinal Symptom Scales (GI) was developed to assess symptoms specific to GI health (Spiegel et al., 2014). It contains eight scales including: heartburn/reflux (13 items), swallowing issues (7 items), diarrhea (5 items), bowel incontinence (4 items), nausea and vomiting (4 items), constipation (9 items), abdominal pain (6 items), and gas and bloating (12 items). Spiegel and colleagues (2014) found the PROMIS-GI scales to demonstrate good construct validity across symptom scales within the general population and diverse patients with GI issues. The symptom scales can be used across clinical and research application. Extensive reference data and scale information was collected in order to establish validity and reliability. Internal reliability for the various scales is as follows: heartburn/reflux (α =.88), swallowing (α =.91), diarrhea (α =.88), bowel incontinence (α =.90), nausea and vomiting (α =.76), constipation (α =.89), abdominal pain (α =.87), and gas and bloating (α =.94).

The Brief Resilience Scale

The Brief Resilience Scale (BRS; Smith et al., 2008) is a six-item, self-report questionnaire that assess the capacity to tolerate and recover from stress. It contains three positively- and three negatively worded items. Each item is rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Negatively worded items are reverse coded during scoring. Higher scores are indicative of greater resilience. Internal consistency for the scale has been shown to be good (with coefficient alpha as .71; Smith et al., 2008).

The Depression Anxiety Stress Scales

The Depression Anxiety Stress Scale -21 (DASS-21; Henry & Crawford, 2005) is a 21-item, self-report measure containing three scales that assess depression, anxiety, and stress, respectively. Each subscale contains seven items and measures symptoms occurring over the last week. Scales assess the severity of depression (e.g., “I felt that I had nothing to look forward to”), anxiety (e.g., I was aware of dryness in my mouth), and stress (e.g. “I found myself getting agitated.”) Each item made up of a four-point scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). The DASS-21 has demonstrated excellent reliability and validity among clinical and community samples (Antony et al., 1998; Beshai et al., 2017; Crawford et al., 2011; Osman et al., 2012). Internal consistencies estimate for the depression, anxiety, and stress scales have been shown to be strong (with coefficient alphas ranging from .82 to .99). Crawford and Henry (2003) found the DASS-21 showed good convergent and discriminant validity when comparing to other well-validated measures for depression and anxiety.

The Defense Mechanism Rating Scale

The Defense Mechanism Rating Scale-Self Report-30 (DMRS-SR-30; Di Giuseppe et al., 2020) is a novel 30-item, self-report questionnaire that identifies 30 specific defenses that are broken down into three categories: mature, neurotic, and immature; and seven levels: highly adaptive, obsessional, neurotic, minor image-distorting, disavowal, major image-distorting, and action. DMRS describes the psychological phenomenon for each defense mechanism and (e.g. defense mechanism for humor can be described by the question "Did you make humorous comments about challenging personal issues or stressful situations?"). Each item is made up of a five-point scale from 0 (not at all) to 4 (very often/much). Preliminary findings demonstrate that DMRS-SR-30 has excellent internal consistency for Overall Defense Functioning (ODF) score, inclusive of all 30 items. Previous study using a larger sample (N = 5,683) demonstrated that DMRS- SR-30 found alpha coefficients were above .613 on all defense levels (Di Giuseppe et al., 2020). DMRS-SR-30 found good criterion validity and concurrent validity with other well-validated measures for defense measures.

Attention Check Validity Questions

As part of this study, 8 attention check questions were included as a means of gauging engagement and attention. Questions were used to index the validity of each participant's responses. Attention check questions were spread throughout the survey and embedded in the measures described above. Attention check questions adopted a similar form. For example, "Which of the following options is an animal? A) Table, B) Oxygen, C) Dog, D) Vehicle, or E) Thirst." To have data included in the study and qualify for payment, participants must have correctly answered all six out of eight attention check items.

Procedure

This is a cross-sectional study. Participants had Worker account access via MTurk's online portal system. Those eligible for the study were able to review study requirements and sign up for the study accordingly. Participants who decided to enter the study clicked a link taking them to the Qualtrics survey. Once arriving at Qualtrics, participants first reviewed a consent form corresponding to the study. This went through the purpose of the study, participant expectations, potential benefits and risks associated with study, anticipated duration of study, and compensatory requirements. It also included information on steps taken to protect confidentiality and provide the contact information for the principal investigator.

Participants who met eligibility requirements and consented to participate were able to begin the survey. First, participants completed a demographics questionnaire to provide additional background information relative to the study. Next, they completed the DASS-21 measure and answered questions about depressive, anxiety, and stress symptoms. Then, participants were asked to complete PROMIS – GI and answer questions regarding GI symptoms. After, they were asked to complete the BRS and answer questions related to levels of resilience. After completing all measures, participants received a randomly generated code which was used to be entered into their Worker account on Mturk in order to receive compensation.

The full survey took approximately 15 minutes to complete. Participants who failed to complete 75% of the attention check measures accurately were not compensated. If the participant completed the measure in six minutes or less, did not complete 90% of the total measure, or demonstrated inconsistent responses, the respondent was not compensated and removed from the data.

Data Analysis

All data was analyzed in SPSS 22 and AMOS. We first examined all item responses to ensure that none are out of range. We then calculated scale totals for each scale. We then estimated internal consistency for each scale using coefficient alpha. We examined scale distributions to ascertain the quality of the data for linear statistics. If distributions showed a reasonable fit to normal curves, linear statistics will be used. If they did not, we considered non-parametric statistical techniques. Prior to testing our hypotheses, we ran a correlation matrix on all scales (*Figure 1*).

We tested our hypothesis that depression, anxiety, and stress are related to GI issues by examining correlations between the DASS-21 scales and the PROMISE-GI total score. We tested our hypothesis that resiliency is inversely associated with GI problems by examining correlations between the BRS and the PROMISE-GI total score. We then used AMOS to test a mediation model. This model is constructed as follows: the three DASS-21 scales will have direct paths to the PROMISE-GI total scores; additionally, each of the three scales will have an indirect path which travels through resiliency. We anticipated that the final model would show acceptable fit and explain significant variance in PROMISE-GI total scores. We anticipated partial mediation. Thus, we expected direct paths to remain statistically significant, even as the indirect path also proved to be significant

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Chapter 3

Results

Descriptive Statistics

DASS Total Score for Psychological Distress

Descriptive statistics for the DASS-21 anxiety, depression, and stress scales are reported in *Table 2. Table 3* shows the intercorrelations between these three scales. These scales were highly intercorrelated, with *r* values ranging from .86 to .89. An Exploratory Factor Analysis, using Principal Axis Factoring, on the DASS-21 items suggested a single overarching factor that explained 61% of the variance. Factor loadings for individual items ranged from .73 to .82, indicating that all 21 items had a strong loading on this factor.

PROMIS-GI Composite Score for Overall Gut Health

Prior to examining our hypotheses, we examined if it was reasonable to form a singular gut health composite using the *t*-scores from individual PROMISE-GI scales. As can be seen in *Table 4*, all Promise GI scales were highly intercorrelated (with *r* values ranging from .70 to .89). Such high intercorrelations suggest that all scales are likely subscales of a larger factor. Thus, we averaged t-score for each of the six scales to produce an overall composite score representing overall gut health problems (OGHP; *Table 5*). Coefficient alpha for the composite scale (using the six subscales as items) was .96, indicating very high internal consistency.

An exploratory factor analysis (EFA) was used to further assess the fidelity of the composite score. This EFA was conducted using Principle Axis Factor (PAF). We specified that one factor be extracted. This factor (i.e,. Overall Gut Health Problems) explained 81.27% of the

variance. Loadings from the factor matrix were uniformly high ranging from .80 (PROMISE-GI Belly Pain scale) to .96 (PROMISE-GI Reflux Scale). In short, higher inter-correlations across PROMIS-GI Scales, the internal consistency estimate for the OGHP composite score, and EFA results for the OGHP composite score all suggest that this overall score is psychometrically sound for capturing the construct assessed by the PROMISE-GI within our sample.

Psychological Distress, Gut Health Problems, and Resilience

The first hypothesis posited that psychological distress would be inversely associated with gut health. Thus, we anticipated that scores for Stress, Depression, and Anxiety would all be correlated with poor gut health (i.e., higher OGHP). As can be seen in *Table 6*, we found support for this hypothesis at the scale level. The DASS Total Score was significantly positively associated with OGHP ($r = .77$, $p < .01$). The effect size for this association was in a high range, indicating a large sized positive relationship between levels of stress, depression, and anxiety and overall gut health; when mood symptoms increase, GI symptoms tend to increase.

Given that those with higher resilience are more robust to stress which reduces their risk for depression and anxiety, our second hypothesis was that resilience would be inversely associated with psychological distress. As can be seen in *Table 3*, BRS resilience scores were significantly negatively associated with the DASS Total Score ($r = -.33$, $p < .01$). The effect size for this association was in the moderate range, indicating a moderate sized inverse relationship between resilience and psychological distress; as resilience increases, psychological distress tends to decrease.

Psychological Distress and Defenses

Several prior studies using a range of methods have established that stress, depression, and anxiety are associated with both increased frequency of defense use and with less adaptive

defenses (Cramer, 2007). Thus, we hypothesized that psychological distress would be associated with less mature defensive function. As such, we expected to find three things: 1) an inverse relationship between ODF and the DASS total score, 2) inverse correlations between use of mature defenses and the DASS total score, and 3) positive associations between the DASS total score neurotic defenses (i.e., Mental Inhibition and Avoidance Defenses) and immature defenses (I.e., Immature, Depressive Defenses). Our hypotheses were confirmed. The DASS total score was significantly inversely related to ODF (r = -.53, p < .01) and mature defenses (r = -.56, p = .0.01). The effect size for this association indicates a large relationship between overall defense function and psychological distress; as psychological distress decreases use of mature and adaptive defenses tends to increase. The DASS total score was significantly positively associated with both neurotic defenses (r = .36, p < .01) and immature defenses (r = .46, p < .01). The effect size for this association indicates a moderate sized, inverse relationship between neurotic/immature defenses and psychological distress; as psychological distress increases use of neurotic/immature defenses tends to increase as well. *(Table 3)*

Mediation Model

In Hypothesis 4, we stated that we anticipated that the relationship between psychological distress and OGHP would be partially mediated by two variables: defensive functioning (i.e., ODF) and resilience. Psychological defenses and resilience have both been shown to help individuals mitigate challenges associated with stress and psychological distress. Thus, we anticipated use of adaptive defenses and higher levels of resilience would partially explain links between psychological distress and OGHP. While not required, most mediation involves associations between the predictor variable (in this case DASS Total), the mediator variables (in this case, ODF and the BRS score), and the dependent variable (in this case, OGHP). As noted

above, we found expected associations between all of these variables. Thus, we proceed to test the mediation model depicted in Figure 1 using AMOS. We used standard procedures for examining direct and indirect effects. Specifically, we set AMOS to use a Maximum Likelihood estimation procedure. To maximize statistical testing and generate standard error estimates, we also instructed AMOS to use 1,000 Bootstrapped samples and examined bias-corrected confidence intervals (Set to 95%).

Statistics assessing model fit indicated that the data fit the model to a significant extent. The model Chi-Square was significant ($X^2 = 5.41$, p = .02), but this is common in social science research when large samples are used. More importantly, the Comparative Fit Index (CFI) was .99 and the Tucker-Lewis Index (TLI) was .92 (CFI and TLI scores greater than .90 are indicative of adequate model fit; Brown, 2015). The Root Mean Square Error of Approximation (RMSEA) was, however, 0.12. Typically, RMSEA of < .06 is indicative of good fit (Brown, 2015). Overall, these statistics provided mixed support for model fit (i.e,. the predictor variables are significantly predicting the dependent variable).

Poor fit for RMSEA likely reflected the fact that we found no evidence for mediation. The numbers within the parentheses in Figure 1 indicate effects when all variables in the model are used to predict OGHP. The coefficients for the indirect path from psychological distress through ODF was quite small (0.03), as was the indirect path from psychological distress through resiliency (0.02). Bias corrected confidence intervals for both indirect paths contained a zero, indicating that they were *not* statistically significant. The direct path from psychological distress to OGHP was large (0.79) and statistically significant (95% confidence interval ranged from .71 to .87).

Overall, data from the model indicate three things. First, as noted above, all three variables had unique direct effects on risk for OGHP. Psychological distress was positively correlated with OGHP, whereas ODF and resilience were both negatively correlated. Second, when used in combination, only psychological distress proved to be a unique predictor of OGHP. In other words, the contributions (i.e., usefulness) of ODF and resilience for predicting OGHP was greatly diminished after psychological distress was accounted for. Finally, we found no evidence of mediation. Neither ODF nor resilience mediated the association between psychological distress and OGHP. Thus, while psychological distress is clearly associated with OGHP, this association in our study was not explained by ODF or resilience.

Chapter 4

Discussion

This study set out to explore the relationship between psychological distress and GI complaints, in addition to whether resilience and defensive coping styles can explain any part of this relationship, to better understand the variables that can be targeted during treatment for individuals who present with this comorbidity. Online data collection involving 313 participants indicated a positive association between GI complaints and psychological distress. Moreover, psychological distress was negatively associated with resilience and positively associated with maladaptive coping mechanisms. Resilience and defense mechanisms were not found to explain the relationship between psychological distress and GI complaints. The overarching pattern of our findings links with prior research in this area, has some implications for clinicians, and raises both practical and theoretical issues that future researchers in this area may wish to consider. We discuss each of these below, prior to considering the limitations of this study and possible future directions for this line of research.

Several prior studies have reported similar results using different measures of psychological distress and different indexes of gut health (Banerjee et al., 2017; Mikocka-Walus et al., 2016; Mussell et al., 2008; Ross et al., 2020; Zhang et al., 2016). There are biological reasons to expect strong links through the GBA. Various studies have also shown that people with GI complaints are likely to report mood symptoms. For example, Mussell et al., (2008) studied anxiety and depressive symptom prevalence in patients with GI complaints using clinical interviews and concluded that patients with GI symptoms scored significantly higher on

depression and anxiety measures. A similar pattern of results have been associated between gut health, depression, and anxiety (Banerjee et al., 2017; Mikocka-Walus et al., 2016; Mussell et al., 2008; Ross et al., 2020; Zhang et al., 2016), again suggesting that mental states characterized by emotional distress increase risk for gut problems. Our findings were in line with this research. Individuals with self-reported symptoms of stress, anxiety, and depression were more likely to report increased gut-health complaints.

Early research into the mental health-gut health association was focused on clinical populations that were experiencing gut health problems. More recently, however, the association between mental distress and gut health has been observed in non-clinical samples. For example, Ross and colleagues found correlations between GI complaints and mood symptoms in a sample of college student samples (Ross et al., 2020). This study extended on these findings by sampling a non-clinical, community population. When our findings are considered in light of the prior work with non-clinical populations, they join with them in suggesting that psychological distress is likely to impact gut function in a wide range of populations. In other words, the impact of psychological distress on gut function does not appear limited to those who are already at risk for gut health problems. Instead, psychological distress appears to increase risk for gut issues across several populations.

Psychological distress and mental states can impact gut function implications for clinicians. Medical professionals should be attentive to potential mental health problems within patients who complain of GI symptoms in addition to the medical explanations for these symptoms (Mussel et al., 2008). Inversely, mental health professionals should be aware that those presenting with anxiety, depression, and heightened stress may need interventions designed to reduce risk for gut issues (e.g., altering diet; increasing activity). Such interventions may be

provided in conjunction with traditional treatment techniques seeking to reduce depression, improve management of anxiety, and/or boost resilience to stress. While psychotherapists have historically shown limited interest in focusing on issues related to gut function, there are signs that this pattern is changing. For example, the self-help guru and famed clinical psychologist Nicole LePera describes herself as a "holistic psychologist" and has proposed an approach to treating mental health issues that emphasizes the need to attend to gut health (LePera, 2021). Together with prior research in this area, the present study suggests that such efforts are worthwhile and important for the field to pursue.

While the primary contribution of this study is to replicate prior work establishing the association between psychological distress and gut health in a community sample, the present study also sought to extend prior research. Specifically, we examined if factors previously linked to risk for stress and psychological distress would also be related to gut function (Babl et al., 2019; Bear et al., 2021; Dantzer et al., 2018; Lenzo et al., 2020). One theory for these links has to do with stress modulation. Both resilience and adaptive defenses are expected to modulate the stress reaction. Modulation of the stress response may mitigate the intensity of the response and reduce risk for physical challenges and mental health difficulties. For instance, adaptive coping styles are associated with the reduced HPA axis activity and inflammation, which may lower risk for symptoms of other chronic diseases (Keefer, 2018). Consistent with these expectations, our results found resilience and more adaptive defensive styles to be inversely associated with gut health problems. In short, those who are more reliant and utilize more mature defenses report fewer gut health issues.

A number of theorists have proposed theories that would explain why resilience is associated with reduced risk for gut health problems. Resilience has been associated with

structural changes in the brain that involve neurochemical markers such as noradrenaline, corticotropin-releasing hormone, and cortisol, as well as chemicals like dopamine and serotonin that are associated with the brain-gut axis and stress modulation (Keefer, 2018; Park et al., 2017). According to previous research, individuals who report GI symptoms also tend to report lower levels of resilience (Park et al., 2018).

Not all of our hypotheses regarding resilience and defenses were confirmed. We expected resilience and defense function to affect (i.e., mediate or moderate) the relationship between psychological distress and gut-health; however, our findings did not support this assertion. Correlations were in the expected directions: as psychological stress and GI complaints increased, self-reported resilience decreased while maladaptive defenses increased. The relationship between psychological distress and gut health, however, was not mediated or moderated by resilience and/or psychological defenses. This suggests that as psychological distress increases, risk for gut issues may increase (regardless of one's level of resilience or use of adaptive defenses). One explanation for our failure to find is that resilience and defense styles share variance with psychological distress. Studies have shown that negative emotionality, such as neuroticism, is a predictor of resilience and that emotion-oriented coping is linked with low resilience (Campbell-Sills et al., 2006). Higher levels of neuroticism create vulnerability to psychological distress (Kling et al., 2003; Ormel et al., 2004). In other words, when people are distressed they are less resilient and are more likely to use less adaptive defenses (Cramer, 2008; Mayordomo et al., , 2016; Seghal et al., 2017). Given that this was a cross-sectional study, measuring defenses and resilience at the same time as distress may have confounded these associations. Since the relationships in this study were observed cross-sectionally, self-reporting is based on current state of stress, resilience, and coping styles. Since these constructs are not

expected to be independent (i.e., people in greater distress may be experiencing lower levels of state resilience and defensive function), our method may have limited our ability to properly test the hypothesis suggested by our model. In the future, longitudinal research that assesses resilience, defensive function, psychological distress, and gut function over time may prove more fruitful for assessing the possibility that links between psychological distress and gut health are explained or impacted by resilience level and defensive function. There are two alternative explanations to consider. The first involves the timing of the study and the second involves a completely alternative hypothesis. We discuss each below.

Our study was conducted during the COVID-19 pandemic, which may have impacted individual's resilience and defensive functioning. Recent findings within a community sample have shown that defense mechanisms have impacted resilience in response to the stressors surrounding the COVID-19 pandemic (Di Giuseppe et al., 2020; Marazziti et al., 2020). According to recent studies, depression has increased from about 11% to 34% and anxiety has increased from about 7% about to 25% worldwide since the Covid-19 pandemic (Salari et al., 2020; Santabarbara et al., 2021). Additionally, social support, self-efficacy, internal locus of control and sense of coherence are elements of resilience according to previous research (Conversano et al., 2020). These protective factors may have been compromised due to the varying external stressors that have been introduced in the previous year. A few examples involve changes in employment status, ambiguity in work-life boundaries, increased personal demands, social isolation, physical illness, and loss of loved ones. Longitudinal research, outside of a pandemic, would likely address confounding variables that may be affecting the relationship between psychological distress in the context of fixed psychological traits in relation to gut-health.

A final alternative explanation is that our theory is incorrect. We had proposed that links between psychological distress and gut health would be explained and/or impacted by defenses and resilience. An alternative model would flip the order of elements. Specifically, it is possible that links between defensive functioning, resilience, and gut health are explained by psychological distress. A limited number of prior studies have examined links between psychological defenses and somatic symptoms, such as gut problems (Babl et al., 2019; Lenzo et al., 2020). Other studies have looked at resilience and gut health (Bear et al., 2021; Dantzer et al., 2018). Consistent with our study, research in this domain suggests that less adaptive defensive styles and lower levels of resilience are both linked to risk for gut challenges. In our sample, associations between these risk factors and gut health fell to near zero levels after accounting for psychological distress. As noted above, both maladaptive defensive styles and lower levels of resilience increase risk for psychological distress and appear to intensify negative reactions to stress. Thus, it is possible that observed links between defenses, resilience, and gut health are explained through risk for psychological distress. In other words, maladaptive defenses and lower resilience increase risk for psychological distress which then increases risk for gut health problems. While data from our present study supported model, this is not the model we asserted apriori of our study. Given we discovered this pattern post hoc and given potential problems with confounds created by a cross-sectional approach, future researchers need to test this revised model before it could be viably considered. At this time, we can simply state that this approach to the model effectively explained associations between psychological defenses, resilience, and gut health in our sample.

Limitations

There were limitations in the present study that can provide direction for future research. 1) The study used cross-sectional data from on online sample and was not based on measures being administered repeatedly over time. We do not know whether stress is the cause or result of gut-health symptoms. Additionally, other lifestyle factors that influence the onset of stress and GI symptoms were not examined in this study. 2) The information was not collected from individuals who were presenting for clinical services. Contribution of physical disease was not assessed. 3) Samples from crowdsourcing platforms such as Mturk may not be fully representative of the general population; individuals who use crowdsourcing platforms tend to have a specific profile such as younger age, higher education, and a more specific clinical presentation (Chandler & Shapiro, 2016).

Future Research

Future studies should examine whether stress can predict the onset of gut-health symptoms. This can be investigated by using repeated-measures approach over time and would provide insight into cause-and-effect relationships. This could provide further explanation for resilience and adaptive coping mechanisms as protective factors of psychological distress and GI complaints. Future studies can also implement clinical interviews to examine differences between data collection involving clinical observations versus online self-report measures. Future studies can also examine other lifestyle factors that have been shown to heavily influence functional health as additional variables for examining the relationship between gut-health and psychological distress. For instance, assessing for lifestyle stressors that were specifically influenced by the pandemic and controlling for these variables in the context of resilience and coping style in relation to gut health. Other health factors can also be addressed in future

research. The role of nutrition, sleep, exercise, dietary changes, and supplements (eg. anti/probiotics) which are shown to influence the same stress pathways that impact cognition and chronic health conditions, including GI disorders, warrant future research. Studies should also monitor changes in patterns of psychological symptoms that are present alongside GI complaints in the context of cognitive intervention.

Chapter 5

Conclusion

The current results support the biopsychosocial model of physical health and psychological well-being. Stress significantly predicted GI complaints. Future health initiatives should focus efforts on developing treatment plans for and educating individuals about the relationship between GI symptoms and stress index. Evidence-based psychotherapy that supplement pharmacological treatments may be promising for reducing stress-related functional complaints. Since self-reported resilience and adaptive coping styles do not appear to explain the relationship between psychological distress and GI symptoms, future studies should continue to focus researching the potential confounds that impact the relationship psychological distress and gut-health. Better understanding of the specific characteristics that impact the relationship between GI symptoms and stress-related disorders will lead to more targeted interventions within a biopsychosocial framework versus purely biological approaches.

Tables

Table 1
Descriptive Characteristics (n=313)

	N	Minimum	Maximum	Mean	Std. Deviation
Age	313	18	77	37.82	10.8

	Frequency	Percent	% Valid	% Cumulative
Gender				
Male	212	67.7	67.7	67.7
Female	101	32.3	32.3	100
Race/Ethnicity				
Asian	23	7.3	7.3	7.3
Black	42	13.4	13.4	20.8
Hispanic	9	2.9	2.9	23.6
White	234	74.8	74.8	98.4
Other	5	1.6	1.6	100
Education Level				
High-School Graduate	18	5.8	5.8	5.8
Some College	36	11.5	11.6	17.4
College Degree	194	62	62.4	79.7
Graduate School/Post-College Degree Education	63	20.1	20.3	100
Marital Status				
Single	39	12.5	12.5	12.5
Dating	19	6.1	6.1	18.5
Married/Long-Term Relationship	242	77.3	77.3	95.8
Divorced	9	2.9	2.9	98.7
Separated	1	0.3	0.3	99
Widowed	2	0.6	0.6	99.7
Other	1	0.3	0.3	100
Employment Status				

Unemployed	13	4.2	4.2	4.2
Employed or Full-Time Student	294	93.9	94.2	98.4
Other	5	1.6	1.6	100
Household Income				
Equal to or less than $20,000	23	7.3	7.3	7.3
$20,001-$50,000	99	31.6	31.6	39
$50,001-$100,000	134	42.8	42.8	81.8
$100,001-200,000	47	15	15	96.8
Equal to or more than $200,001	8	2.6	2.6	99.4
Prefer not to say	2	0.6	0.6	100

Table 2
Descriptives of Scale Scores

Variable	Mean	SD	Maximum	Minimum	Skewness	Kurtosis
DASS Total	2.1338	.76370	1.00	4.00	.016	-1.046
Depression	2.0747	.81879	1.00	4.00	.103	-1.153
Anxiety	2.1635	.80808	1.00	4.00	.010	-1.020
Stress	2.1631	.76705	1.00	4.00	.073	-.891
Maturity	57.205	12.7196	40.6	80.1	-.019	-1.408
Mental Inhibition	31.4434	5.46041	21.82	50.85	1.525	1.967
Avoidance Immature	31.0873	3.34496	19.64	43.60	-.400	1.584
Depressive Interpersonal Ambivalence	33.9071	4.20560	19.25	46.15	-.832	1.097

Note. DASS Total = Depression, Anxiety, Stress Scales Overall Score

Table 3
Descriptives of Independent Correlations Between Psychological Distress and Defenses

	Anxiety	Depression	Stress	DASS Total	BRS	Mature Defenses	Neurotic Defenses	Immature Defenses
Anxiety	-							
Depression	0.87	-						
Stress	0.86	0.89	-					
DASS Total	0.95	0.96	0.96	-				
BRS				-0.33	-			
Mature Defenses				-0.56	0.33	-		
Neurotic Defenses				0.36	- 0.32	-0.64	-	
Immature Defenses				0.46	- 0.26	-0.79	0.10	-
ODF				-0.53	0.28	0.93	-0.40	-0.91

Note. DASS Total = Depression, Anxiety, Stress Scales Overall Score; BRS = Brief Resilience Scale; ODF = Overall Defense Function.

Table 4
Intercorrelations among PROMIS-GI Scales

	Belly Pain	Diarrhea	Constipation	Gas & Bloating	Reflux	Nausea & Vomiting
Belly Pain	-					
Diarrhea	0.77	-				
Constipation	0.75	0.86	-			
Gas & Bloating	0.70	0.77	0.82	-		
Reflux	0.75	0.85	0.89	0.88	-	
Nausea & Vomiting	0.73	0.82	0.84	0.83	0.91	-

Table 5
Descriptives for the PROMIS-GI scales and the PROMIS-GI Composite Score

Variable	Mean	SD	Skewness	SE	Kurtosis	SE
Belly Pain	54.65	14.77	-0.92	0.14	0.41	0.28
Diarrhea	54.76	10.31	-0.32	0.14	-1.27	0.28
Constipation	55.08	12.39	-0.24	0.14	-1.13	0.28
Gas & Bloating	56.24	11.11	-0.46	0.14	-0.79	0.28
Reflux	56.77	14.89	-0.04	0.14	-1.24	0.28
Nausea & Vomiting	57.21	12.72	-0.02	0.14	-1.41	0.28
OGHP	55.77	11.66	-0.09	0.14	-1.32	0.28

Note. PROMIS-GI = Patient-Reported Outcomes Measurement Information System – Gastrointestinal Symptoms; OGHP = Overall Gut Health Problems from the PROMIS – GI composite score.

Table 6
Descriptives of Independent Correlations Between Psychological Distress and Defenses

Variable	PROMISE OGHP
DASS Total	0.77
BRS	-0.23
Mature Defenses	-0.43
Neurotic Defenses	0.34
Immature Defenses	0.30
ODF	-0.39

Note. OGHP = Overall Gut Health Problems from the PROMIS – GI composite score; ODF = Overall Defense Function.

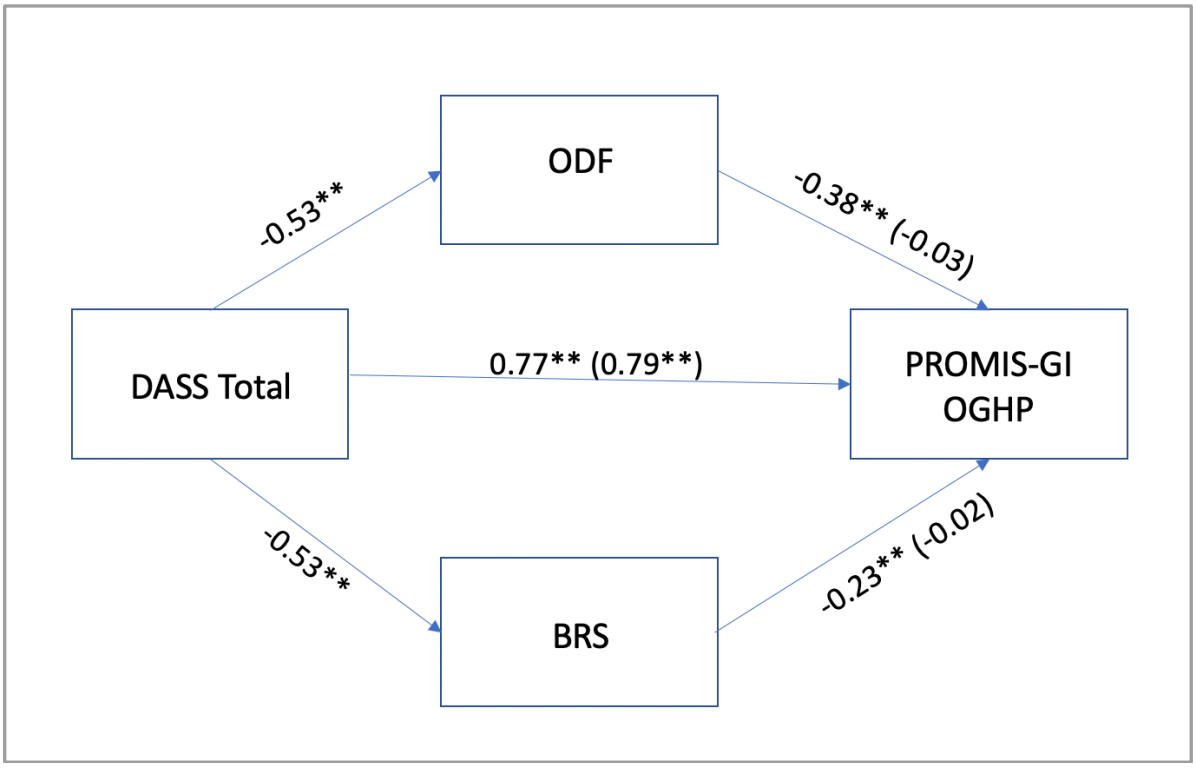
Table 7
Descriptives for Predictor Scales

	X	*SD*	Alpha	Skewness	*SE*	Kurtosis	*SE*
Anxiety	2.07	0.82	0.93	0.10	0.14	-1.15	0.28
Depression	2.16	0.81	0.93	0.01	0.14	-1.02	0.28
Stress	2.16	0.77	0.92	0.07	0.14	-0.89	0.28
DASS Total	2.13	0.76	0.97	0.02	0.14	-1.05	0.28
BRS Resilience	3.10	0.68	0.68	-0.05	0.14	1.04	0.28
Mature Defenses Factor	31.44	5.46	0.92	1.53	0.14	1.97	0.28
Neurotic Defenses Factor	31.09	3.34	0.96	-0.40	0.14	1.58	0.28
Immature Defenses Factor	33.91	4.21	0.96	-0.83	0.14	1.10	0.28
ODF	4.65	0.23	0.98	1.14	0.14	1.23	0.28

Note. ODF = Overall Defense Function

Figures

Figure 1
Mediation Model



Note. Numbers outside the parentheses indicate main effects. Numbers within the parentheses indicate effects in the final path model (where all variables are entered as predictors). DASS = Depression, Anxiety, and Stress Scale; ODF = Overall Defensive Functioning; BRS = total score from the Brief Resilience Scale; PROMIS-GI OGHP = the Overall Gut Health Composite Score calculated from the PROMIS-GI.

Appendices

Appendix A: Demographics Questionnaire

Please enter your age below.

_____

Select the option that best describes your gender identity.

- Male
- Female
- Non-Binary
- Transgender
- Intersex
- Prefer not to say
- Other _____

Select the option that best describes your race/ethnicity.

- Asian
- Black
- Hispanic
- White
- Prefer not to say
- Other _____

Select the option that best describes your education level.

- Grade school
- Some high school/secondary education
- High-school graduate
- Some college
- College Degree
- Graduate school/Post-College Degree Education
- Other _____

Select the option that best describes your marital status.

- Single
- Dating

- Married/Long-Term Relationship
- Divorced
- Separated
- Widowed
- Other _____

Select the option that best describes your employment status.

- Unemployed
- Employed or Full-Time Student
- Other _____

Select the option that best describes your household income.

- Equal to or less than $20,000
- $20,001-$50,000
- $50,001-$100,000
- $100,001-200,000
- Equal to or more than $200,001
- Prefer not to say
- Other _____

Appendix B: Depression Anxiety Stress Scale - 21 (DASS-21)

Instructions: Please read each statement and indicate how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

Response Options:

- Did not apply to me at all
- Applied to me to some degree, or some of the time
- Applied to me to a considerable degree or a good part of the time
- Applied to me very much or most of the time

1. I found it hard to wind down.
2. I was aware of dryness of my mouth.
3. I couldn't seem to experience any positive feeling at all.
4. I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion).
5. I found it difficult to work up the initiative to do things.
6. I tended to over-react to situations.
7. I experienced trembling (e.g. in the hands).
8. I felt that I was using a lot of nervous energy.
9. I was worried about situations in which I might panic and make a fool of myself.
10. I felt that I had nothing to look forward to.
11. I found myself getting agitated.
12. I found it difficult to relax.
13. I felt down-hearted and blue.
14. I was intolerant of anything that kept me from getting on with what I was doing.
15. I felt I was close to panic.
16. I was unable to become enthusiastic about anything.
17. I felt I wasn't worth much as a person.
18. I felt that I was rather touchy.
19. I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat).
20. I felt scared without any good reason.
21. I felt that life was meaningless.

Appendix C: Brief Resilience Scale

Instructions: Please respond to each item by marking one box per row.

Response Options:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly agree

1. I tend to bounce back quickly after hard times.
2. I have a hard time making it through stressful events.
3. It does not take me long to recover from a stressful event.
4. It is hard for me to snap back when something bad happens.
5. I usually come through difficult times with little trouble.
6. I tend to take a long time to get over setbacks in my life.

Appendix D: Patient-Reported Outcomes Measurement Information System – Gastrointestinal Symptoms (PROMIS-GI)

PROMIS-GI: Belly Pain
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, how often did you have belly pain?
   - Never -> *if never, go to #7*
   - One Day
   - 2-6 days
   - Once a day
   - More than once a day

2. In the past 7 days, at its worst, how would you rate your belly pain?
   - Not bad at all
   - A little bad
   - Somewhat bad
   - Quite bad
   - Very bad

3. In the past 7 days, how much did belly pain interfere with your day-to-day activities?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

4. In the past 7 days, how much did belly pain bother you?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

5. In the past 7 days, how often did you have discomfort in your belly?

- Never
- Rarely
- Sometimes
- Often
- Always

PROMIS-GI: Diarrhea
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, how many days did you have loose or watery stools?
   - No days -> *If no days, go to #4*
   - 1 day
   - 2 days
   - 3-5 days
   - 6-7 days

2. In the past 7 days, how much did having loose or watery stools interfere with your day-to-day activities?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

3. In the past 7 days, how much did having loose or watery stools bother you?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

4. In the past 7 days, how often did you feel like you needed to empty your bowels right away or else you would have an accident?
   - Never -> *If never, you are finished.*
   - One time during the past 7 days
   - 2-6 times during the past 7 days
   - Often once a day
   - More than once a day

5. In the past 7 days, how much did feeling you needed to empty your bowels right away interfere with your day-to-day activities?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

6. In the past 7 days, how much did feeling you needed to empty your bowels right away bother you?
- Not at all
- A little bit
- Somewhat
- Quite a bit
- Very much

PROMIS-GI: Constipation
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, how often did you pass very hard or lumpy stools?
- Never -> *If never, go to #3*
- One Day
- 2-6 days
- Once a day
- More than once a day

2. In the past 7 days, how much did hard or lumpy stools bother you?
- Not at all
- A little bit
- Somewhat
- Quite a bit
- Very much

3. In the past 7 days, how often did you strain while trying to have bowel movements?
- Never -> *If never, go to #6*
- Rarely
- Sometimes
- Often
- Always

4. In the past 7 days, how much did you usually strain while trying to have a bowel movement?
- Not at all
- A little bit
- Somewhat
- Quite a bit
- Very much

5. In the past 7 days, how much did straining during bowel movements bother you?
- Not at all
- A little bit
- Somewhat
- Quite a bit

- Very much

6. In the past 7 days, how often did you feel pain in your rectum or anus while trying to have bowel movements?
- Never -> *If never, go to #8*
- Rarely
- Sometimes
- Often
- Always

7. In the past 7 days, at its worst, how would you rate the pain in your rectum or anus during bowel movements?
- Not bad at all
- A little bad
- Somewhat bad
- Quite bad
- Very bad

8. In the past 7 days, how often after a bowel movement did you feel unfinished - that is, that you had not passed all your stool?
- Never
- Rarely
- Sometimes
- Often
- Always

9. In the past 7 days, how often did you use your finger or toilet paper to get out a stool?
- Never
- Rarely
- Sometimes
- Often
- Always

PROMIS-GI: Gas & Bloating
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, did you have swelling in your belly?
- No -> *If no, skip to #5*
- Yes

2. In the past 7 days, how bad did the swelling in your belly get?
- Not bad at all
- A little bad
- Somewhat bad
- Quite bad

- Very bad

3. In the past 7 days, how much did you usually strain while trying to have a bowel movement?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

4. In the past 7 days, how much did having swelling in your belly bother you?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

5. In the past 7 days, how often did you feel bloated?
   - Never -> *If never, skip to #12*
   - Rarely
   - Sometimes
   - Often
   - Always

6. In the past 7 days, in general, how severe was your bloating?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

7. In the past 7 days, at its worst, how severe was your bloating?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

8. In the past 7 days, in general, how severe did your bloating feel?
   - Not at all
   - A little bit
   - Somewhat
   - Quite a bit
   - Very much

9. In the past 7 days, how often did you know that you would feel bloated before it happened?

- Never
- Rarely
- Sometimes
- Often
- Always

10. In the past 7 days, how much did feeling bloated interfere with your day-to-day activities?
    - Not at all
    - A little bit
    - Somewhat
    - Quite a bit
    - Very much

11. In the past 7 days, how much did feeling bloated bother you?
    - Not at all
    - A little bit
    - Somewhat
    - Quite a bit
    - Very much

12. In the past 7 days, how often did you pass gas?
    - Never
    - Only once or twice a day
    - About every 3-4 hours
    - About every 2 hours
    - About every hour

13. In the past 7 days, how often did you have gurgling or rumbling in your belly when you were not hungry?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Always

PROMIS-GI: Gastroesophageal Reflux
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, how often did you have regurgitation—that is, food or liquid coming back up into your throat or mouth without vomiting?
    - Never -> If never, skip to #5
    - One day
    - 2-6 days
    - Once a day
    - More than once a day

2. In the past 7 days, what was the most food or liquid you had come back up into your mouth at one time?

- None
- Enough to fill a little of my mouth
- Enough to fill some of my mouth
- Enough to fill most of my mouth
- So much that it filled my entire mouth

3. In the past 7 days, after eating a meal how often did food or liquid come back into your throat without vomiting?

- Never
- Rarely
- Sometimes
- Often
- Always

4. In the past 7 days, how often did you re-swallow food that came back into your throat?

- Never
- Rarely
- Sometimes
- Often
- Always

5. In the past 7 days, how often did you feel like you were going to burp, but food or liquid came up instead?

- Never
- One day
- 2-6 days
- Once a day
- More than once a day

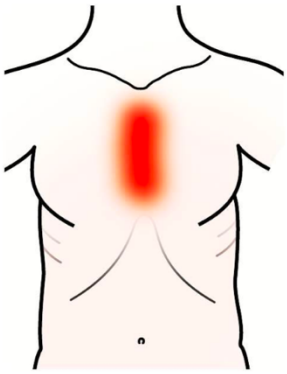
6. In the past 7 days, how often did you feel like there was too much saliva in your mouth?

- Never
- Rarely
- Sometimes
- Often
- Always

7. In the past 7 days, how often did you feel burning in the red area shown in the picture below - that is, behind the breastbone?

- Never

- Rarely
- Sometimes
- Often
- Always



8. In the past 7 days, how often did you feel burning in your throat?
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

9. In the past 7 days, how often did you burp?
   - Never -> *If never, go to #11*
   - One day
   - 2-6 days
   - Once a day
   - More than once a day

10. In the past 7 days, how much did burping bother you?
    - Not at all
    - A little bit
    - Somewhat
    - Quite a bit
    - Very much

11. In the past 7 days, how often did you have hiccups?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Very often

12. In the past 7 days, how often did you feel like there was a lump in your throat?
    - Never -> *If never, you are finished.*
    - Rarely
    - Sometimes
    - Often
    - Very often

13. In the past 7 days, how much did having a lump in your throat bother you?
    - Not at all
    - A little bit

- Somewhat
- Quite a bit
- Very much

PROMIS-GI: Nausea & Vomiting
Instructions: Please respond to each question or statement by marking one box.

1. In the past 7 days, how often did you have nausea—that is, a feeling like you could vomit?
   - Never -> *If never, skip to #3*
   - Rarely
   - Sometimes
   - Often
   - Always

2. In the past 7 days, how often did you know that you would have nausea before it happened?
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

3. In the past 7 days, how often did you have a poor appetite?
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

4. In the past 7 days, how often did you throw up or vomit?
   - Never
   - One day
   - 2-6 days
   - Once a day
   - More than once a day

Appendix E: Defense Mechanism Rating Scale - Self-Report - 30 (DSMR-SR-30)

Instructions In the past week, how much did you deal with difficult emotions or situations in the following ways?

Response Options:

- Not at all
- Rarely/slightly
- Sometimes/somewhat
- Often/a lot
- Very often/much

1. Did you perceive others as “all good” or “all bad”?
2. Did you react as if you were detached from personally relevant issues?
3. Did you develop somatic symptoms, such as headache, stomach pain, or the loss of ability to do something, in response to emotional situations?
4. Did you offer physical or psychological help to others in need?
5. Did you have repetitive or serial daydreams to which you retreated in lieu of real life?
6. Did you think about how you would handle difficulties that you might expect in the future?
7. Did you feel as if there was nothing positive or redeeming about yourself?
8. Did you have an attitude of giving much more than you received without perceiving the imbalance?
9. Did you ask for physical or emotional support while doing your best to handle the problem?
10. Did you try to diffuse the tension by engaging in creative activities?
11. Did you have an attitude of suspiciousness or perceive others as untrustworthy, unfaithful, or manipulative?
12. Did you make humorous comments about challenging personal issues or stressful situations?
13. Did you reflect upon your emotional experiences and personal thoughts?
14. Did you try to take your anger out on yourself or express it with self-harming behaviors?
15. Did you justify or give plausible explanations to cover up the real reasons for personal problems or stressful situations?
16. Did you take an active role in solving problems that arose?
17. Did you idealize yourself or others for your/their personal characteristics?

18. Did you consciously or unconsciously try to irritate someone in indirect or annoying ways?
19. Did you temporarily put aside your personal needs to deal with other things that needed to be done?
20. Did you focus on minor or unrelated matters that distracted you away from a problem that makes you anxious?
21. Did you discuss an emotional topic in general or impersonal way, without considering or experiencing your feelings?
22. Did you complain about how others don't understand you or don't really care?
23. Did you experience strong feelings toward someone, thinking that the other
24. Did you feel confused, "spaced out," or unable to talk about a distressing topic?
25. Did you engage in verbal or physical fights?
26. Did you have trouble remembering simple things?
27. Did avoid thinking about personal problems or feelings?
28. Did you perceive yourself as very strong, powerful, untouchable?
29. Did you have contradictory or conflictual ideas about a topic that makes you anxious?
30. Did you devalue yourself or others for your/their personal characteristics?

Appendix F: Validity Check Questions

1. Select the option that is an animal.
   - Table
   - Dog
   - Car
   - Happiness

2. Which item below is a tool?
   - Hammer
   - Red
   - Animal
   - Passion

3. I am a human being.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

4. Select the option that is a color.
   - Honesty
   - Truck
   - Red
   - Heart

5. Select the option that is a number.
   - Flower
   - Cat
   - Four
   - Bus

6. For this item, please select the "Very Often/much" option below.
   - Not at all
   - Rarely/Slightly
   - Sometimes/Somewhat
   - Often/a Lot

- Very often/much

7. Select the option that is a body part.
   - Journal
   - Nose
   - Elephant
   - House

8. For this item, please select the "Not at all" option below.
   - Not at all
   - Rarely/slightly
   - Sometimes/somewhat
   - Often/a lot
   - Very often/much

Appendix G: Consent Form

UNIVERSITY OF MICHIGAN-DEARBORN

EFFECTS OF MOOD ON GUT-HEALTH AND RESILIENCE CONSENT FORM

Study ID: HUM00198848

Principal Investigator: Sally Thrasher, University of Michigan-Dearborn
Faculty Advisors: Caleb Siefert, Ph.D., University of Michigan-Dearborn; Susana Pecina, Ph.D., University of Michigan-Dearborn

You are invited to participate in a study focusing on how aspects of coping styles (e.g., hardiness, defensiveness) may influence links between gastrointestinal symptoms, stress, and well-being. Taking part in this research project is voluntary. To participate you must be at least 18 years old.

Participation involves answering questionnaires about your emotional states, your stress level and if you have recently experienced gastrointestinal symptoms. You will also be asked to provide demographic information (e.g., age; ethnic identity). This study will take approximately 20-30 minutes. Please be assured that your responses will be kept completely confidential.

Benefits of the Research: Although you may not directly benefit from being in this study, others may benefit due to the increased knowledge researchers may gain from your data. You may also find the experience of participating in this research to be interesting.

Risks and Discomforts: There are very few anticipated risks for this study. However, even though researchers have taken steps to minimize these risks, you may still experience some risks related to your participation. These risks may include possibly feeling frustrated while completing the study. It is also possible that you may experience the self-report measures as boring or intrusive. The questions that they contain are not typically experienced as intrusive, but nonetheless, may be experienced as such. Remember, all of your answers are completely anonymous. If a question is too intrusive, you may elect to not answer the question.

Compensation: As a part of your participation in Amazon Turk, you agree to serve as a research subject for this experiment. You will receive $1.50 for your participation in today's study if you meet the compensation criteria.

To be eligible for compensation you must 1) be over the age of 18 and must be in the United States, 2) answer 90% or more of the questions, 3) correctly answer 90% of the validity items, 4) pass a response consistency check, and 5) fulfill time requirements. Participants who do not fulfill these requirements will not be compensated and your data will not be used in the final data analysis. You may withdraw at any time from today's study without penalty; however, you will not be compensated. The data from those who withdraw will not be used in the final data analysis.

Participating in this study is **completely voluntary**. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer any survey question for any reason. If you decide to withdraw early, any data you provided will be deleted and/or destroyed and will not be used in any way within this study.

We will protect the confidentiality of your research records by storing the data you provide in a private survey, of which only the researcher has access. At the end of this project, we will keep your data and may use it for future analysis. We plan to publish or present the research of this study, but **will not include any identifying information, such as IP addresses**.

There are some reasons why people other than the researchers may need to see the information you provided as part of the study. This includes organizations responsible for making sure the research is done safely and properly.

If you have any questions about this research, or would like to learn the findings of this study, you may contact jirjis@umich.edu or csiefert@umich.edu.

As part of their review, the University of Michigan Institutional Review Board Health Sciences and Behavioral Sciences has determined that this study is no more than minimal risk and exempt from on-going IRB oversight.

Thank you for your participation in this study.

If you **DO NOT** agree to participate in this study, please close the window and exit out of the page.

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