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ORIGINAL ARTICLE

Cognitive Mechanisms Underlying the Link Between Anxiety, Health Behaviors, and Illness Outcomes: Commentary on a Special Issue

Aliza T. Stein[1] · **Slaton Z. Freeman**[1] · **Jasper A. J. Smits**[1]

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Abstract
This commentary synthesizes research examining cognitive mechanisms underlying the links between anxiety, health behaviors, and illness outcomes. We provide a brief summary of contributions to this special issue and review common themes and methodological limitations. Notably, a number of related constructs emerged as amplification factors, increasing vulnerability to psychopathology and maladaptive health behaviors. These include anxiety sensitivity, distress and discomfort intolerance, emotion regulation, health literacy, and repetitive negative thinking. Finally, we discuss clinical implications, and conclude with suggestions for further research in this area.

Keywords Anxiety · Health behaviors · Transdiagnostic

Introduction

Many of the most common and serious medical conditions affecting people in developed countries have strong behavioral determinants (Prather et al. 2017; Schroeder 2007). These include disorders such as heart disease, stroke, cancer, and diabetes, many of which share common behavioral risk factors, such as smoking, alcohol use, poor diet, sedentary lifestyle, and obesity. According to a systematic analysis of the global burden of disease, behavioral risk factors accounted for 30% of attributable disability-adjusted life-years in 2015 (Forouzanfar et al. 2016), with behavioral patterns contributing to an estimated 40% of deaths in the United States (McGinnis et al. 2002).

Despite the fact that these behavioral risk factors are well established and widely known, it is difficult, in practice, to get people to adopt healthier behaviors. For example, from 2010 to 2015, only 22.9% of adults in the United States met the federal guidelines for physical activity (Blackwell and Clarke 2018). Psychologists have been instrumental in developing behavioral interventions that improve health outcomes. For example, lifestyle interventions have been shown to outperform medication in preventing diabetes (Yamaoka and Tango 2005). Despite these advances, there are still large knowledge gaps and extensive unmet needs where effective and targeted behavioral interventions could enhance health outcomes. In order to maximize the impact of behavioral interventions, a better understanding of the underlying, yet malleable, processes that contribute to risk and maintenance of these problems is needed. In particular, a greater understanding of targets that cut across physical and mental health conditions will facilitate the development of transdiagnostic interventions targeting common issues such as stress, depression, and anxiety.

By better understanding these constructs and how they relate, more effective interventions may be developed to help modify behavior and, ultimately, health outcomes. Furthermore, the value of improved health achieved through better health behaviors extends beyond preventing major medical conditions, and contributes to wellness, quality of life, and economic productivity.

The special issue aims to make the case that there are a number of cognitive constructs that are viable targets for interventions that aim to improve health. We briefly review the findings, provide context, and offer some ideas for further study of this important topic.

✉ Aliza T. Stein
atstein@utexas.edu

[1] Department of Psychology, The University of Texas at Austin, Austin, TX, USA

Contributions to the Special Issue

Anxiety Sensitivity

Anxiety sensitivity is defined as the tendency to fear arousal-related physical sensations due to the belief that such sensations may cause physical, social, or cognitive harm (Reiss 1991). Anxiety sensitivity has been conceptualized as a transdiagnostic amplification factor, such that heightened anxiety sensitivity intensifies the drive to avoid or escape negative affective or somatic states (Otto et al. 2016; Smits et al. 2018). In the context of health behaviors, high aversion to negative internal experiences may drive individuals to engage in maladaptive coping behaviors in an effort to quickly reduce distress.

For example, in the current issue, LaRowe et al. synthesize the literature implicating anxiety sensitivity in the relation between chronic pain and cigarette smoking. First, the authors highlight two related constructs: pain-related fear and pain-related anxiety. Pain-related fear is defined as a fear of pain or activities that may cause or exacerbate pain (Zale and Ditre 2015), whereas pain-related anxiety refers to the tendency to experience anxiety in response to pain (McCracken et al. 1992). Further, the authors note important associations between higher anxiety sensitivity and greater (i.e. amplified) pain severity (Ocañez et al. 2010), a higher rate of cigarette use and tobacco dependence (Bakhshaie et al. 2016), as well as higher risk of smoking lapse and relapse (Brown et al. 2001; Mullane et al. 2008; Zvolensky et al. 2009). Consistent with fear-avoidance models, these constructs (i.e., pain-related fear, pain-related anxiety, and anxiety sensitivity) serve to amplify escape and avoidance behavior, contributing to greater chronic pain and functional impairment.

Elevated anxiety sensitivity has been associated with negative perceptions of physical health (e.g., McLeish et al. 2007), which may contribute to health-risk behaviors, such as cannabis use (Farris et al. 2016; Zvolensky et al. 2009), to cope with negative affect and distress. This pathway may be especially problematic in veteran populations with posttraumatic stress disorder, which have higher rates of cannabis use (Bonn-Miller et al. 2012; Bujarski et al. 2016; Goldman et al. 2010; Metrik et al. 2016), and are more likely to report coping-related motives for use (Metrik et al. 2016). In the current issue, Farris et al. examined the role of anxiety sensitivity and cannabis use frequency in predicting perceived physical health and functioning in cannabis using veterans. The authors found that higher frequency of cannabis use was associated with decreased role functioning due to health problems and poorer overall health in individuals with elevated levels of anxiety sensitivity. These data provide initial support for anxiety sensitivity as a cognitive mechanism that may interact with cannabis use to promote negative health outcomes.

Similarly, anxiety sensitivity has also been shown to predict health behaviors such as exercise, which has important clinical implications for behavioral health interventions. Enjoyment of, and affective response to, physical activity is another important predictor of exercise behavior (e.g., Ekkekakis et al. 2008). Therefore, processes such as anxiety sensitivity, which interfere with enjoying physical activity, are important to study. Prior work has indicated the anxiety sensitivity is negatively associated with physical activity levels (e.g., Farris et al. 2016; McWilliams and Asmundson 2001; Sabourin et al. 2011; Smits and; Zvolensky 2016) and prospectively predicts lower physical activity engagement (e.g., Hearon et al. 2014; Moshier et al. 2016). In the current issue, Farris et al. report on a secondary analysis of baseline data from a clinical trial of mildly depressed, low active, treatment seeking smokers, examining whether baseline anxiety sensitivity is associated with state affect pre/post exercise as well as enjoyment during a 1-mile walk test 2 weeks later. They found that higher baseline anxiety sensitivity is associated with higher concurrent negative affect, lower enjoyment of physical sensations of physical activity, as well as blunted positive affective response and higher state anxiety following exercise. Thus, interventions targeting factors that interfere with positive affective responses to exercise (e.g., anxiety sensitivity) may be beneficial for improving exercise and health outcomes (Otto and Smits 2018; Smits et al. 2010).

Anxiety Sensitivity may also predict and amplify health anxiety and related behaviors. In the current issue, Horenstein et al. examined the relation between anxiety sensitivity, intolerance of uncertainty (dispositional fear of unknown; Carleton 2016), and health anxiety in predicting health care utilization. The authors used a series of hierarchical logistic regression to cross-sectionally examine the singular and combined influence of anxiety sensitivity, intolerance of uncertainty, and health anxiety on utilization of general, specialist, and emergency care in a nonclinical sample. Results indicated the relationship between health anxiety and health care utilization is moderated by anxiety sensitivity and intolerance of uncertainty, such that general care utilization was strongest among those with elevated levels of both anxiety sensitivity and intolerance of uncertainty. The models predicting specialist care and emergency care did not yield significant results. These findings extend earlier reports of the interactive effects of anxiety sensitivity and intolerance of uncertainty (Norr et al. 2015; O'Bryan and McLeish 2017). Whether intervening on anxiety sensitivity or intolerance of uncertainty or both yield the hypothesized downstream effects requires follow-up experimental research.

Epilepsy is associated with lower quality of life, especially among those with comorbid anxiety disorders, and

individuals with epilepsy have a higher prevalence of anxiety disorders than the general population (20–40%; Beyenburg et al. 2005; Pham et al. 2017; Wiglusz et al. 2018). In this issue, McLeish et al. examined the relation between anxiety sensitivity and seizures in the past year (based on chart review) in adult non-smokers with epilepsy. Participants (n = 49) were recruited from a larger study looking at the effects of cigarette smoking on epilepsy severity and quality of life. Results indicated that, while controlling for negative affect and seizure presence, higher anxiety sensitivity was associated with poorer overall quality of life as well as poorer quality of life scores on domains of seizure worry, medication effects, work-driving-social limitation, and cognitive functioning, but not emotional well-being and energy difficulties. Neither anxiety sensitivity nor negative affectivity was associated with a presence of seizures over the prior year. Although some studies have shown that heightened anxiety sensitivity is associated with worse epilepsy outcomes, the current study did not find a relation between anxiety sensitivity and incidence of seizures.

Finally, Dixon et al. offer another example of how anxiety sensitivity mediates the relation between illness and health outcomes. In the current issue, Dixon et al. examined the role of anxiety sensitivity as it relates to various skin diseases and symptoms of several anxiety disorders (generalized anxiety disorder, social anxiety disorder, and health anxiety). The authors conducted correlational and mediation analyses on cross-sectional survey data comprised from 237 adults reporting at least one active skin disease. Consistent with previous research demonstrating high levels of anxiety and related disorders among individuals with skin disease (Picardi et al. 2004; Woodruff et al. 1997), 62.9% of responders in this study reported social anxiety levels above the clinical cutoff (i.e. Social Phobia Inventory > 19; Connor et al. 2000) and almost half of the sample (47.7%) demonstrated high levels of anxiety sensitivity (i.e. Anxiety Sensitivity Index-3 > 22; Taylor et al. 2007). The authors found a significant indirect relationship between each domain of anxiety (i.e. social, health, and general) and skin-related impairment with anxiety sensitivity mediating this relationship. These findings highlight the need for additional research on the effects of anxiety sensitivity on the trajectory of illness-related impairment and quality of life.

Tolerating Distress and Discomfort

Distress Tolerance, the perceived ability to tolerates distress, has been hypothesized to heighten the aversiveness of emotional distress and motivate maladaptive avoidance and coping behaviors (Leyro et al. 2010). Similar to anxiety sensitivity, distress tolerance is thought to contribute to the development and maintenance of psychopathology and maladaptive health behaviors.

Distress tolerance has also been associated with alcohol use and sleep disturbance (Reitzel et al. 2017; Short et al. 2016) and may amplify the bidirectional relationship between alcohol use and sleep disturbance. Sleep problems are related to a variety of negative physical and mental health outcomes. In the present issue, Smith et al. conducted a secondary analysis of an online survey examining stress and health outcomes in firefighters, a population highly prone to sleep disturbance. This was the first study to examine sleep, alcohol, distress tolerance together. The authors found significant main effects of distress tolerance and alcohol use on sleep, such that higher alcohol use and lower distress tolerance are associated with greater global sleep disturbance. Importantly, there also was a significant interaction between distress tolerance and alcohol use on sleep, such that the effect of higher alcohol use on disturbed sleep was greatest among individuals with lower distress tolerance. Clinically, these findings suggest that targeting distress tolerance may improve sleep and reduce alcohol use.

In contrast to distress tolerance, which can refer to either emotional or physical distress, discomfort intolerance refers specifically to perceived ability to withstand physical discomfort in addition to cognitive and affective responses to such discomfort (Schmidt et al. 2006). In this issue, McLeish et al. examined the associations between discomfort intolerance and indices of asthma management, while controlling for anxiety sensitivity. The authors have previously demonstrated that the Anxiety Sensitivity Index physical concerns subscale is associated with worse asthma symptoms (McLeish et al. 2011, 2016) and sought to examine additional anxiety-related cognitive-affective vulnerabilities. They found that higher discomfort intolerance was associated with worse asthma management and asthma-related quality of life, even when controlling for anxiety sensitivity physical concerns. This highlights the unique explanatory value of withstanding physical (discomfort intolerance) versus affective distress (anxiety sensitivity). Despite the fact that they are distinct constructs, the authors suggest that interoceptive exposure may be a useful intervention to target both, highlighting a similar underlying mechanism.

Difficulties with Emotion Regulation

Emotion regulation has been conceptualized as consisting of several related processes. These include awareness, understanding, and acceptance of emotions as well as the ability to control behavior in response to emotion and employ environmentally appropriate strategies to modulate emotional responses to meet situational demands and individual goals (Gratz and Roemer 2004). Deficits in emotion regulation have been related to anxiety (e.g., Baker et al. 2004; McLaughlin et al. 2007; Mennin et al. 2009; Tull and Roemer 2007) and

negative health behaviors such as smoking (Adams et al. 2012; Farris et al. 2016; Szasz et al. 2012).

In this issue, Versella et al. examined emotion regulation using cross-sectional self-report data from a survey of electronic nicotine delivery system users. They examined whether internalizing symptoms (stress and anxiety) and several vulnerability factors (anxiety sensitivity, distress tolerance, and emotion regulation) differed by the type of nicotine used (electronic nicotine delivery alone, electronic nicotine delivery alone with a past history of combustible cigarette use, or a combination or current electronic and combustible cigarette use). They did not find any significant differences in anxiety sensitivity or distress tolerance between groups but did find that current electronic nicotine delivery users without any history of combustible cigarette use had higher stress and worse emotion regulation than dual users. They also exhibited the highest level of anxiety of the three groups. These findings suggest that it may be harder to transition from combustible to electronic nicotine delivery for those who report greater deficits in emotion regulation, and that individuals who were able to fully transition may represent a subset of people who have a higher tolerance to aversive experiences (e.g., withdrawal).

Health Literacy

Health literacy is defined as the extent to which an individual is capable of obtaining, processing, and understanding health information and services required for making appropriate health decisions (Kutner et al. 2006). Although higher health literacy is typically associated with positive health behaviors and outcomes, initial research has demonstrated that, in the context of anxiety, greater health literacy may be related to maladaptive behaviors, such as reassurance seeking (Ishikawa et al. 2016; Jorm 2000).

In this issue, Zvolensky et al. (2018) presented cross-sectional findings from a large (n = 537) survey examining the relation among health, anxiety sensitivity and dependence and perceived risks and benefits of e-cigarette use. The authors found that greater e-cigarette health literacy was related to greater perceived risks and benefits of e-cigarette use and greater e-cigarette dependence. Interestingly, these findings were only observed for individuals with higher, but not lower, anxiety sensitivity. These results suggest that health literacy may be a double-edged sword in individuals with high anxiety sensitivity, highlighting the potentially maladaptive nature of information/reassurance-seeking behaviors in this population (Ishikawa et al. 2016).

Thinking Styles (Repetitive Negative Thinking & Positive Thinking)

Repetitive negative thinking is an umbrella term that refers to cognitive processes such as worry and rumination (Ehring and Watkins 2008). In this issue, Hughes et al. conducted an interesting study using ecological momentary assessment of negative affect (total, anxious, overwhelmed), repetitive negative thinking (e.g., rumination, worry), and self-injurious thoughts and behaviors. The authors found that repetitive negative thinking, negative affect, anxiety, and feeling overwhelmed predicted both thoughts of, and engagement in, non-suicidal self-injury. Specifically, feeling anxious and overwhelmed predicted non-suicidal self-injury, and this relationship was moderated by repetitive negative thinking. These results underscore the importance of examining the potential for transdiagnostic amplification factors to predict negative health behaviors. Similar to anxiety sensitivity, repetitive negative thinking may serve to amplify the aversiveness of negative affective responses, driving individuals to engage in maladaptive coping behaviors. non-suicidal self-injury may function and be maintained through a similar process of negative reinforcement that is seen in other maladaptive health behaviors associated with heightened anxiety sensitivity (e.g., smoking, reassurance seeking).

Most research in this issue focused on risk and maintaining factors, however Gallagher et al. remind us of the importance of studying protective factors. In the current issue, Gallagher et al. examined positive thinking, including optimism and mastery, as protective factors for fostering resilience in cancer survivors. Mastery is defined as one's perceived control over outcomes (Pearlin and Schooler 1978), whereas optimism is defined as a more global/generalized tendency to except positive outcomes, regardless of perceived agency in promoting those outcomes (Scheier and Carver 1992). Gallagher et al. used structural equation modeling to identify the unique contributions of optimism and mastery to coping and health outcomes using cross-sectional data collected from the 3rd wave of the Midlife in the U.S. National Study of Health and Well-being (MIDUS). Cancer outcomes can be unpredictable and are thus associated with anxiety, maladaptive health behaviors, and overall poorer emotional health (Andrykowski et al. 2008; Lelorain et al. 2010). Improvements in cancer treatment have resulted in higher survivorship, making it increasingly important to identify risk and protective factors associated with mental health outcomes. Cognitive traits such as optimism and mastery may serve as protective factors for these negative outcomes (i.e. anxiety, health behaviors, physical health, emotional well-being). While both mastery and optimism both uniquely predicted these outcomes, optimism appears to be a stronger predictor of mental health and coping, whereas mastery only outperformed optimism in predicting physical health outcomes in men. Although limited by the cross-sectional nature of the study, these findings support further study of interventions targeting positive thinking to promote better mental health outcomes in cancer survivors. Importantly, these findings encourage us to consider the potential

utility of assessing and targeting potentially modifiable protective factors in addition to risk factors.

Challenges and Future Directions

Papers in this issue point to anxiety sensitivity, tolerance of distress and discomfort, emotion regulation, health literacy, and thinking styles as potentially important constructs to target when the aim is to change health behaviors and associated health outcomes. Specifically, these constructs reflect cognitive processes underlying the maintenance of maladaptive health behaviors such as combustible and electronic cigarette use, cannabis use, health care utilization, alcohol use, and non-suicidal self-injury as well as illness and treatment outcomes relating to chronic pain, asthma, epilepsy, skin disease, and cancer.

The studies presented in this special issue represent the first and important step to identifying putative therapeutic targets, namely providing a snapshot of how these variables relate to important health outcomes. The relations documented in these papers were modest in strength, providing evidence for a signal, and tests of interactions showed that the relation between any of these constructs and any health (behavior) outcome likely will vary depending on a host of other protective or risk factors. The effort of understanding the "circumstances" under which putative protective, risk, or maintaining factors exert their effects represents one important next step in the identification of treatment targets and the development of corresponding intervention strategies. Fine tuning models such that they recognize moderators of effects will ultimately help ensure the efficient and cost-effective delivery of interventions. Models that also account for the possibility that relations may change over time or at the different stages of health behaviors (e.g., initiation, maintenance, relapse, etc.) or health outcomes will help with decisions about when to intervene to obtain the most optimal effects.

An additional critical next step is to move this line of work toward experimental research, in which target mechanisms are systematically identified and then "engaged" through intervention. The articles in this issue identify several target mechanisms. Additional studies determining the extent to which each of these targets can be engaged in treatment across different contexts will help inform treatment development and refinement efforts. Some initial successes have been documented by Michael Zvolensky and colleagues. Indeed, following early work confirming that anxiety sensitivity was cross-sectionally related to smoking behavior and several processes related to the maintenance and relapse of smoking (Leventhal and Zvolensky 2015), he and colleagues showed that interventions that reduce anxiety sensitivity aid smoking cessation (Smits et al. 2016; Zvolensky et al. 2014, 2018). Next stage research in this area can focus on personalizing interventions, considering for example, patient preferences (e.g., type of intervention to reduce anxiety sensitivity) as well as issues around timing of the intervention relative to the quit attempt (e.g., before, during after).

We also believe that the research that is the focus of this special issue would benefit from expanding assessment strategies. Self-report measures are limited and importantly including measures at multiple levels (e.g., behavioral, cognitive biological) using different modalities allows for better testing of model-driven hypotheses. For example, existing psychophysiological measures of sleep efficiency (e.g., wrist actigraphy or polysomnography), physiological arousal (e.g., heart rate or skin conductance), and discomfort intolerance (e.g.., cold pressor task) could be incorporated into existing study designs, providing opportunity for replication and extension of these findings. Taking advantage of technology (e.g., smartwatches) that allows for frequent, ecologically valid, multimodal assessments may further aid the quality of this research and the confidence we can have in the inferences that are drawn. Finally, further research into developing behavioral measures to assess constructs such as anxiety sensitivity, intolerance of uncertainty, and emotion regulation will be critical for advancing research in this field.

Conclusion

The set of papers in this issue highlight the potential importance of cognitive mechanisms in the relation between anxiety, health behaviors, and medical illness outcomes. Because many of these cognitive risk and protective factors are modifiable with treatment, this work has the potential to have significant clinical impact. As such, we hope that the work presented promotes research focused on replication and extension.

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Compliance with Ethical Standards

Conflict of Interest Slaton Freeman and Aliza Stein declare that they have no conflict of interest.

Informed Consent Not applicable. This article does not contain any studies with human participants performed by any of the authors.

Animal Rights This article does not contain any studies with human participants or animals performed by any of the authors.

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