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## RESEARCH ARTICLE

The Concept of Entropy within the Context of Psychosocial Adaptation Following the Onset of Chronic Illness and Disability: Empirical Findings and Rehabilitation Implications

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## ABSTRACT

The second law of thermodynamics, also known as the law of entropy, posits that all physical processes, in a closed system, will evolve over time toward a state of higher disorder and randomness. Isolated and limited efforts to explore and examine the application of this law to human psychosocial processes (psychological entropy) have been undertaken only since the middle of the 20<sup>th</sup> century. In this article, the authors explore direct efforts to illustrate the parallelism between psychological entropy (PE) and the process and structure of psychosocial adaptation to chronic illness and disability (CID). Several CID-associated constructs (e.g., uncertainty, ambiguity, chaotic processes, denial) are explored for their overlapping characteristics with PE. The role of constructs derived from the field of positive psychology, acting to minimize the spread of PE, is also explored. Next, two recent constructs, developed uniquely within the literature on adaptation to CID, namely, illness intrusiveness and disability centrality, are examined in the context of PE. The article concludes with suggestions on how PE can be further explored as to its clinical applications, and research venues within the field of rehabilitation.

**Keywords:** entropy, psychosocial adaptation, adjustment, disability, chronic illness

**Impact**

- In order to elucidate the nature, structure, and processes inherent in psychosocial adaptation to chronic illness and disability (CID), in this article we provide a brief outline of the scope of physical entropy (PE), highlight its historical milestones, and examine its relationships with concepts historically linked with psychosocial adaptation to CID.
- In this article we also discuss recent efforts to link PE to psychological entropy, a construct that has been gaining popularity in psychology and merits attention in the study of adaptation to CID.

In a companion article, we explored potential theoretical, clinical and research applications for rehabilitation professionals relevant to the application of PE, and psychological entropy, in the context of psychosocial adaptation to CID. In the first article in this two-part series, the authors reviewed the historical and epistemological landmarks associated with entropy. Included in the discussion were the nature and forms of entropy, along with its relationships to chaos, time flow, and information theories. Earlier psychodynamic perspectives on entropy, along with two more recent contributions, were briefly outlined. The first article concluded with a discussion of the unique link between physical entropy, psychological entropy (PE), and the psychodynamic processes of anxiety and denial. In the current article, the authors undertake a more speculative course, offering suggestions on the role entropy might play in better understanding psychosocial adaptation to chronic illness and disability (CID). The discussion provided in this mostly unexplored domain is tentative and should be regarded as a possible building block for future theoretical frameworks, research, and clinical implications on the subject.

First, we propose parallel venues that appear to undergird PE and several CID-triggered psychosocial reactions and processes. These include uncertainty, psychological chaos, controllability, and intrusive cognitions vs. denial of condition. Next, proposed relationships between PE and two leading models of adaptation to CID, namely illness intrusiveness and disability centrality, are suggested. Finally, the role that positive psychology may play in minimizing the impact of PE is also examined. Whenever feasible, supportive empirical findings are documented for these assumed parallel processes. The article concludes with recommendations on how to infuse insights garnered from the domain of psychological entropy to rehabilitation practice, research, and theory.

**Psychological Entropy and Adaptation to CID**

The role PE plays in the context of psychosocial adaptation to the onset of CID must be viewed, at the present, with deliberate caution. In fact, these two dynamic constructs (PE and adaptation) should be viewed as parallel processes that may occasionally interact to produce certain functional and psychological outcomes. Since no sufficient theoretical or experimental data presently exist to support any clear causal relationships between the two, the more conservative view would suggest that PE and adaptation to CID should be regarded as partially independent, yet potentially interactive dynamic systems. Indeed, PE may be but a fine-grained fabric of the coarser structure of psychosocial adaptation. In light of these uncertainties, the next two sections provide an overview of the theoretical and empirical findings from the field of adaptation to CID which may suggest a link between the dynamics inherent in PE and findings from the literature on adaptation to CID.

**Entropy, Uncertainty, Lack of Control, Chaos, Denial and Psychosocial Adaptation to CID**

A traumatic experience, such as the diagnosis or sudden onset of CID, encroaches upon existing modes of physical and psychosocial functioning. If chronic in nature, it further impacts earlier levels of psychic organization and structure, necessitates increased amounts of energy use for restructuring psychological homeostasis, and often results in confusion, loss of information, indecisiveness, and uncertainty.<sup>1-3</sup> The ensuing chaotic psychic processes and disorganized behavioral repertoire may flood the psyche and indicate a period of decompensation. They, accordingly, interfere with daily activities. With the passage of time and regained openness to adaptive environmental and social influences, new patterns of self-organization and reclaimed order may emerge to restore psychic equilibrium.<sup>3,4</sup> In his seminal work on the stress syndrome, Horowitz,<sup>5,1</sup> argued that cognitive processing of traumatic experiences constitutes a sequential progression of matching new information about the altered, post-CID, world with earlier schematic representations of the world. Thus, the newly acquired information is progressively modified to fit earlier life schemas. The next few paragraphs provide an overview, from the perspective of PE, of those components often encountered when stress, trauma and psychic disequilibrium prevail.

**Uncertainty**

In one of the earlier attempts to grasp the meaning of uncertainty, the American sociologist Talcott Parsons argued that “exposure to uncertainty is perhaps the most negative aspect of human life and action as distinguished from lower forms of living systems”.<sup>6</sup> (p.145) Research on the role of uncertainty in fueling worry, anxiety, and depression has led to the proposal of the construct of “Intolerance of Uncertainty” (IU),<sup>7</sup> a term reflecting a predisposition (specifically, a high level of aversion to uncertainty) associated with myriad non-adaptive coping responses.<sup>8-11</sup> IU has been consistently found to be intrinsic to a wide range of anxiety and depressive states and generalized negative affectivity.<sup>1, 12-14</sup>

In the context of psychosocial adaptation to CID, PE-linked uncertainty typically becomes evident when health-related cognitive schemas fail to coalesce and are, therefore, manifested in the form of: (a) perceptions of CID-associated ambiguity, inconsistency in comprehending medical information, vagueness about one’s health status, loss of control, doubts about the future, and unpredictability of experienced symptoms; (b) lack of sufficient information-processing capabilities to formulate a clear understanding of the diagnostic, clinical, functional, therapeutic, and prognostic implications of the medical condition; (c) inability to determine the meaningfulness of CID-linked experiences in the context of one’s existence, including efforts to chart future goals, plans, and course of action; and (d) a far-from-equilibrium, nonlinear sequence of reactions, where localized uncertainty (affecting a single CID-linked life domain) expands and externalizes to additional, initially unaffected life domains.<sup>15-17</sup>

Empirical findings on the relationships between uncertainty and psychosocial adaptation to CID consistently support the premise that higher levels of reported uncertainty are linked to increased levels of psychological distress including anxiety and depression, and inversely associated with lower levels of self-esteem, purpose in life, well-being, and perceived quality of life.<sup>18</sup> These relationships have been observed among individuals with heart disease,<sup>19,20</sup> cancer,<sup>21-23</sup> multiple sclerosis,<sup>24-27</sup> chronic pulmonary diseases,<sup>28</sup> end-stage renal conditions,<sup>29</sup> diabetes,<sup>30</sup> HIV,<sup>31</sup> orthopedic conditions such as rheumatoid arthritis,<sup>32,33</sup> and fibromyalgia.<sup>34</sup>

**Lack of Controllability**

Inability to exert control over one’s life (i.e., perceiving rewards to be random and

unpredictable in nature) is one of the defining features of PE. Janoff-Bulman<sup>35,2</sup> argued that, following traumatic experiences, basic life schemas and their assumptive worlds tend to change. In order to make the incoming new data more congruent with life schemas there is a need for controllability of these intrusive data. The individual seeks to reduce randomness (i.e., increased entropy) and regain control and order over old schemas, rather than change them, through more efficient informational processes.<sup>35</sup> Therefore, by adhering to these earlier beliefs about personal control, the individual seeks to reestablish the earlier assumptive world where outcomes could be controlled and events made meaningful.<sup>2</sup>

An underlying theme inherent in the concepts of uncertainty, unpredictability and uncontrollability can be found in the temporal domain, that is, the anticipated duration of the condition, the pace with which it unfolds, the frequency of the experienced symptoms, and the treatability of the condition.<sup>36</sup> When entropy-linked uncertainty persists, it invariably follows a nonlinear trajectory and results in a spectrum of psychosocial reactions that include, among others: (a) increased levels of perceived threat, anxiety, and depression; (b) increased vigilance and attempts to avoid the perceived stress-inducing event or situation; (c) decreased efforts to engage in cognitive activities (e.g., planning, goal-setting), problem-solving, and direct behaviors employed to diffuse stress; and (d) a threatened pre-CID organization and operation, such that when the mounting uncertainty and uncontrollability exceed one’s capacity for stress tolerance, the person’s biopsychosocial functional system is rendered progressively unstable, ineffective, and turbulent, leading to cognitive, affective and behavioral disorganization that indicates the emergence of a chaotic system.<sup>37-39</sup>

**Chaos**

The notion of disorganized, turbulent, and chaotic psychic states (e.g., shock, acute anxiety, severe depression) following increase in PE-linked uncertainty, must, however, be viewed within the wider spectrum of processes associated with psychosocial adaptation to CID. For example, in their models of ego functions and processes<sup>40</sup> and stress-triggered responses,<sup>5</sup> these authors maintained that following stressful or traumatic life experiences, individuals could employ adaptive responses, and these were termed coping (i.e., coping strategies) and defending (i.e., defense mechanisms). However, when these psychological modalities of combating trauma fail, the person

experiences maladaptive reactions, termed “fragmentation” (decompensation, distraction, non-responsiveness, affective flooding)<sup>40</sup> and “succumbing to stress” (emotional flooding, intrusive thoughts, collapse into chaos, psychotic ideation),<sup>1</sup> both signaling dramatically increased PE (i.e., disorder, disorganization, chaos). Adopting chaos theory’s terminology, it has been argued (e.g.,<sup>3,41,39</sup>) that following CID-triggered increased uncertainty and disorder, a point of bifurcation may be reached where a transition into newer, better organized, and more adaptive levels of order and functioning prevail. That is, the person with CID now attains a positively restructured and more salutary perspective on life with CID (the often termed “adjustment” or “adaptation” phase or status).<sup>42,43</sup> At this level of successful adaptation, the individual’s cognitive, affective, and behavioral functioning is exemplified by such activities as reorganization of life values and beliefs; a search for new meanings; a pursuit of personal, social and vocational goals; overcoming obstacles encountered during this pursuit; and reestablishment of positive self-concept.<sup>44</sup> In chaos theory terminology these activities are tantamount to a mutual exchange between the individual and the external environment, such that “disorder” is gradually expunged, or dissipated, from one’s progressively adapting self into the external environment, while “order” is mobilized, or imported, from the external environment (by either naturally practiced means or through therapeutic interventions) into the self to counter those remaining nonadaptive life domains.<sup>41,39</sup>

### **Denial**

In the context of psychosocial adaptation to CID, denial has been perceived as an inability to process (threatening) information, thus paralleling the same dynamics observed in PE. For example, Lipowski<sup>45</sup> argued that denial of illness reflects denial of facts, meaning, and information about one’s condition. Levine et al.,<sup>46</sup> in the context of adaptation to cardiac disease, posited that one of the primary indicators of illness-associated denial is ignoring both internally-driven and externally-triggered threatening information. A similar view was suggested by Wool and Goldberg<sup>47</sup> among cancer survivors. In their analysis of the role of denial following the onset of medical conditions, Kortte and Wegener<sup>48</sup> maintained that when resorting to partial denial (in contrast to complete denial), the individual avoids acknowledging CID-linked information and its impact on one’s life. Finally, Livneh<sup>49</sup> argued that following the

disruption of one’s life after the onset of CID, psychological equilibrium (low PE) is disrupted, leading to the emergence of disorderly (i.e., chaotic) processes (high PE). The disruption of such adaptive equilibrium necessitates periodic deployment of selective attention and, at times, blocking of one’s perceptual field and cognitive awareness (i.e., denial) of implicated percepts that indicate the presence of pain, distress, and death anxiety.

The relationships among PE and denial present a rather complex theoretical and clinical picture. It can be speculated that, in a closed functional system such as the human body (and psyche), entropy often increases following the sudden onset of CID. This has been documented in the reactions termed shock and anxiety. However, upon the initial work of denial, seeking to stabilize the traumatized psyche and restore equilibrium, entropy tends to decrease. The process later reverses course as the continuous deployment of denial acts to increase PE when external (and reality-based) information is denied access and the person sinks into disorganized cognitive processes and limited awareness.

Indirect empirical support for these speculations can be garnered from research findings indicating that the use of denial in the early stages following the onset of CID, when lasting for a short time period, is adaptive in nature and often associated with restoration of psychological equilibrium or, more specifically, reported higher levels of perceived well-being and lower psychological distress (lower PE). However, extended use of denial, at the expense of resorting to more adaptive modes of coping, is linked to maladaptive functioning and distortion of reality, increased psychological distress and poorer life satisfaction (higher PE).

### **Psychological Homeostasis, Personal Growth and PE**

Adopting a more positive (rather than pathogenic) view of human functioning, during stressful conditions, Antonovsky’s salutogenic theory, termed by him Sense of Coherence (SOC), focused instead on a global orientation or “generalized resistance resources” (e.g., ego strength, adaptive coping, wealth, social support) and those factors that promote health and homeostatic-restoring mechanisms.<sup>50</sup> More specifically, Antonovsky regarded SOC as being comprised of three broad homeostatic-maintaining components, namely, comprehensibility (perceiving the world as predictable, ordered and explicable), manageability (believing that one possesses the

personal and social resources to cope with life demands), and meaningfulness (believing that these life demands are worthy of engagement and commitment).<sup>50,51</sup> These three concepts, which bear a striking resemblance to the main characteristics of negative PE, reflect the essence of SOC which states that perceiving the world to be coherent is a primary indicator of psychological well-being and positive quality of life (lower PE). The construct of SOC, through its three components, also shares a common ground with an equilibrium-disequilibrium conception of human functioning, in which both chaotic and entropic processes, as well as order and (re)organization (negative entropy) may materialize following a traumatic experience.<sup>50,52</sup> Research findings have consistently supported the link between SOC, including each of its components, and successful adaptation to a host of traumatic experiences, including the onset of CID,<sup>53-55,52,56</sup> thus yielding empirical support to the hypothesized relationships between negative entropy, as exemplified by high scores on each of the three SOC scales, and measures of successful adaptation to trauma and CID.

A conceptual extension of the merits of homeostasis-restoring processes can be found in the recent proliferation of constructs derived from the field of positive psychology.<sup>57</sup> Viewed by proponents of this field, achieving a person-environment equilibrium is but a mediatory step towards further growth. Constructs indicating salutary personal traits and strengths, such as resilience, flourishing and thriving, personal (posttraumatic) growth, hope, optimism and transcendence, all indicate that undergirding human happiness and success, negative PE (e.g., increased order and certainty) processes operate and these act to minimize the deleterious effects of unmitigated PE. More specifically, rather than merely restoring earlier successful conditions, these future-oriented virtuous states and traits serve to bolster adaptation and functionality. Indeed, in an anesthetic view of PE, thus seeking to promote human capacity to transcend adversity and loss, Seligman and Csikszentmihalyi adopted the viewpoint that humans are “self-organizing, self-directed adaptive entities”.<sup>58 (p.8)</sup> As argued earlier, it is the openness of the “human system” to positive environmental influences and the ability to import useful energy (i.e., via bolstering personal coping resources, practicing and maintaining healthy life style, and engaging in rehabilitative, therapeutic and social interaction activities) that plays a major role in reversing the course of chaotic processes, combating disorder, and thus concomitantly

decreasing uncertainty, uncontrollability, and anxiety. Similar earlier notions were posited by mainstream rehabilitation psychology scholars such as Wright<sup>59</sup> and Vash.<sup>60</sup> In their models, successful adaptation following trauma and adversity can be understood as a reflection of human capacity to positively cope with (rather than succumb to) CID. Furthermore, in their strength-based frameworks, the supremacy of these successful efforts can be found in the individual’s ability to draw upon counter-PE inherent and acquired traits, including transcending (adversity, loss and trauma), gaining independence, focusing on the positive and doable, and finding meaning and purpose in life.

### **Entropy, Illness Intrusiveness, Disability Centrality, and Psychosocial Adaptation to CID**

The psychosocial impact of the onset of CID, especially when sudden and traumatic in nature, is influenced by the intervening impact of two related constructs, namely, illness intrusiveness<sup>61,62</sup> and Disability Centrality.<sup>63,64</sup> The origins of these two constructs can be traced back to the seminal work of Kurt Lewin,<sup>65</sup> whose theory of “life space” (LS) incorporated the notions of central and peripheral regions of the self.<sup>66,67</sup> Whereas central regions of the LS are located near the self’s core, and accordingly exert greater influence on other regions, peripheral regions are less inherently influential and are dependent on these central regions for direction and meaning. It follows, then, that the onset of CID activates one’s perceptions of the meaning, importance, and centrality of illness (and disability) to one’s self-concept (Illness self-concept).<sup>65,67</sup> When illness self-concept is perceived as central, it exerts a powerful force on the individual’s belief system, future plans and present needs, as well as interpersonal relationships, thereby contaminating neighboring (more peripheral) regions of LS importance. The pervasive influence that illness self-concept exerts on one’s LS, along with mounting illness preoccupation, combine to render the individual more susceptible to experience reduced life satisfaction and self-esteem.<sup>67</sup> From the PE perspective, this scenario suggests that the influence of these nonadaptive, intrusive forces further bolsters disorganization, disorder, uncertainty, and perceptions of personal uncontrollability, all combining to increase the spread of local and temporal entropy.

According to Horowitz, a failure to control the flow of these incoming CID-triggered cycles of intrusive thoughts results in excessive levels of emotional flooding and re-traumatization. When the ability to control the emotional flooding reaches

an optimal level the flooding subsides, disorganized thinking diminishes, and tolerable doses of new, post-CID, information can be successfully managed, as PE is gradually reduced. At the opposite end, denial (as the opposing pole to intrusion), acts to ward off anxiety-provoking emotional flooding and intrusive thoughts. It also, when diminished with time, tends to exert a less pervasive influence with an end result of increased control over one's thoughts and emotions, indicating that the traumatic life event has been successfully reconciled.<sup>1,2</sup> This regained control suggests adaptive completion and the creation of reality-oriented life schemas, that is, a return to a phase of lower level of PE.

As was argued earlier, high entropy is typically associated with loss of information, disorganization, lack of control, and unpredictability, all psychological patterns consistent with the onset of traumatic CIDs. Such patterns are further associated with the degree to which one's CID disrupts one's life (Illness Intrusiveness) and the level of psychological importance the individual with CID associates with each affected life domain (Disability Centrality). More specifically, following the onset of CID, the disruption of functioning experienced in many life domains, weighed by the importance (i.e., perceived centrality) of these domains, decreases one's subjective quality of life (QOL), as well as one's capacity to restore or regain pre-onset QOL. The previously available information required to solve problems, make informed decisions, and make present- and future-oriented plans is compromised as PE increases disproportionately. Also reduced is the capacity for perceived control over valued life outcomes<sup>63,68</sup> and participation in meaningful life activities,<sup>62</sup> additional hallmarks of PE.

The onset of traumatic CID, therefore, sets in motion a chain of emotional, cognitive and behavioral events that suggests an increased rate of the typically experienced PE. More specifically, following CID, disorder and disorganization take over and replace one's previously experienced, ordered, and functional life style. Indeed, as illness intrusiveness, gaining momentum from such experiences as aversive symptoms, pain, physical discomfort, oppressive medical regimen, functional losses, medication side effects, and threat of death become more influential, PE increases, and earlier adhered-to goals, plans, and belief systems disintegrate and appear irrelevant.<sup>61,69</sup> As the impact of the CID increases, that is, as illness impact (intrusiveness) become more prominent, one is confronted with issues of loss and restriction of future plans and goals, and threat to one's

accustomed life style. Commensurate with these aspects of Illness Intrusiveness, threats of uncertainty and perceived lack of control also mount.<sup>70,69,62</sup>

At the opposite pole of the psychosocial adaptation to CID, one may find successful efforts to curb the progress of increased CID-triggered entropy, typically bolstered by the person's successful negotiation with the internal and external environments. By definition, effective self-appraisals, coping, and environmental navigation reduce illness intrusiveness, decentralize disability in the person's self-schema, and bring order that minimizes PE. For example, as the initial deleterious impact of the CID on one's life is gradually absorbed and processed, the individual comes to terms ("acceptance") with the lost functional abilities and certain previously held beliefs. The earlier intrusiveness of the condition, and its influence on daily living, slowly loses its initial impact. Likewise, the earlier impact of CID on more central domains is diminished and more peripheral domains of importance assume greater influence due to newly instituted life roles.<sup>63,64</sup> This temporary scrambling of the importance of central and peripheral life domains is a signature of reduction, that is, loss, in available information (i.e., disorganization) and rise of uncertainty levels, both indicating increased PE. The ensuing increase in PE (i.e., uncertainty, disorganization, disorder, anxiety) has been reported in the literature to be associated with decreases in experienced QOL and diminished perceived well-being.<sup>15,71,72,26,73</sup>

Negative PE, however, is gradually "borrowed" from the external environment in the form of new interests, goals and plans, relationships, and renewed adaptive coping strategies, as well as direct exposure to medical and psychological therapeutic interventions. These external sources coalesce to stabilize functioning, improve QOL and act to harness the earlier increase in PE. They, therefore, endow the person with CID with those coping resources (e.g., resilience, self-determination, hope, optimism, sense of coherence) needed to offset psychic disorganization, uncertainty, and emotional turmoil. The earlier runaway increase in PE begins to subside as the person manages to chart out a more predictable and ordered life course. Confidence in one's ability to reach life goals and, with it, renewed certainty of their successful implementation increases. Renewed coping efforts continue their course of achieving more efficient and adaptive outcomes of negotiating the present situation and instilling venues for future directions. As a result, increases in one's perceived QOL and self-concept, as typical

indicators of decreased PE, gradually return to their earlier levels and signal “reorganization” and “positive adjustment”.<sup>44,74</sup>

Empirical findings derived from the literature on the role played by Illness Intrusiveness and Disability Centrality have consistently documented the link between higher experienced levels of these two constructs and negative affectivity (e.g., emotional distress, depression, anxiety), as well as between lower experienced levels of these two constructs and positive affectivity (e.g., QOL, perceived well-being, resilience). More specifically, Illness Intrusiveness has been found to be associated with poorer psychological well-being and reduced personal control,<sup>61</sup> with pain catastrophizing and increased levels of depression, anxiety and emotional distress among people with MS.<sup>69,75</sup> Illness Intrusiveness has also been reported to correlate with negative psychosocial outcomes among people with rheumatoid arthritis, end stage renal disease, cardiac disease, and cancer.<sup>69,76</sup> In addition, as suggested earlier, Illness Intrusiveness was significantly and positively associated with a central indicator of PE, that of illness-generated uncertainty.<sup>26</sup> This finding has been found to be particularly robust when severity of the condition and its symptoms are greater.<sup>61,69</sup> This finding supports the validity of the assumption that more severe medical conditions result in greater uncertainty about the future, trigger increased levels of anxiety, thus reflecting the essence of PE.

### **Implications for Rehabilitation Practice and Research**

Any implications, based on current understanding of PE, must be maintained with caution. The following implications, more specifically tailored, for the fields of rehabilitation, medicine, and medical psychology must, therefore, be viewed with this caveat.

### **Rehabilitation and Psychology Practice Implications**

First, PE can be reduced by exporting ordered and organized energy from external sources. This is tantamount to providing accurate and focused medical, psychological, social (e.g., practicing interpersonal skills, overcoming attitudinal barriers), and vocational information on the status and implications of one’s CID. Second, PE can be minimized by employing therapeutic and self-management interventions to counteract the debilitating impact of CID-associated uncertainty and anxiety. Indeed, the full spectrum of self-management interventions encompasses such

diverse components as (a) medical/health management; (b) behavioral management (cultivating, maintaining and promoting those life plans and roles that seek to address the impact of CID); and (c) psychosocial/emotional management (processing and handling cognitive and affective reactions to the onset of CID, as well as adaptive coping modes necessary to assuage them).<sup>77,78</sup> According to Hirsh et al. (2012), anxiety is associated with higher PE when perceptual, cognitive, and behavioral options are forced into a state of stagnation, such that the person is confronted with a scenario where no clear options are present, and no choices can be readily pursued. Furthermore, under the frozen-like state that typically follows a traumatic experience, such as sudden onset CID, one’s fundamental beliefs and assumptions about the self and the world are shattered, and previously held goals and plans are abruptly disrupted.<sup>2</sup> To mitigate such eventualities, the client is assisted in the development of a cognitive framework, or map, of his or her personal life space, including the surrounding physical and interpersonal environments, to combat ambiguity, uncertainty and the ensued anxiety. The client is directed to acquire, practice, and manage an organized and adaptive body of knowledge, a set of coping skills, and other specific behaviors necessary to efficiently plan, pursue, and execute those personal life goals most relevant to his or her current needs and wishes. Ultimately, a successful implementation of these life goals should constitute a necessary link to the performance of meaningful work, an essential hallmark of reduced PE.<sup>16,79,80</sup>

Third, and more specifically, instituting interventions indicated by models such as illness intrusiveness and disability centrality can be adopted to mitigate and contain the growing PE within one’s life space that follows severe CID onset. Both the illness intrusiveness<sup>61,69</sup> and disability centrality<sup>68,81</sup> models espouse helping clients with the experience of increased control over the CID, and teaching/practicing self-management skills, thus countering the pernicious growth of PE. The following therapeutic components<sup>82,69</sup> have been stressed: (i) identifying which specific CID characteristics, and their related therapeutic concomitants, interfere with one’s life style and performance of valued activities; (ii) helping the client to assume responsibility and control over managing the CID, including reasonable mastery over the external environment; (iii) educating and assisting the client to master relevant (and adaptive) coping skills and behaviors (e.g., time management, goal-setting, problem-solving,

interpersonal communication) to offset the life-disrupting aspects of CID; (iv) facilitating the infusion of self-management skills into daily routines; (v) exploring opportunities for experiencing satisfaction in peripheral, affected and nonaffected, domains followed by implementing domain-specific educational, social, recreational and vocational goals; and (vi) assisting clients to pursue and maintain active and rewarding participation in those activities that are of importance to them.

### Research Implications

First and foremost, any future research concerning the nature of PE within the context of psychosocial adaptation to CID requires the contextual operationalization of and development of a psychometrically sound instrument to measure such processes. Initial stages of such an endeavor could examine, for instance, the work of Dishion et al.,<sup>83,84</sup> DeYoung,<sup>85</sup> and Hirsh et al.,<sup>16</sup> for relatively concrete examples of the various facets of generic PE processes and indicators, such as disordered cognitive processes, difficulties in processing information, experienced anxiety, uncertainty in reaching goals and making plans, reduction in one's ability to perform meaningful activities including job performance, and diminished meaning in life. Also, more specifically, CID-generated indicators of PE could be examined and these include diminished ability to comprehend medical information and one's health status, chaotic cognitive and affective processes, reports of life-impacting psychological distress, signs of maladaptive denial, experiences of CID as intrusive to one's ability to adhere to accustomed life style, and experiences of CID as central to one's self-concept.

Second, following the development of a measure to depict CID-generated PE, research efforts need to address the role of PE as a predictor of, moderator, and/or mediator between CID-linked variables (e.g., condition type, severity, duration), environmental conditions (e.g., medical regimen, social supports, accessibility, attitudinal barriers) and psychosocial adaptation outcomes (e.g., quality of life, psychological distress, level of functioning). With our present still-emerging level of understanding of the role of PE in explaining adaptation to CID, a first step would require the exploration of the essence of PE, that is, its nature, structure, processes, components, antecedents, consequences, mutability, and verifiably testable indicators, and their individual and composite relationships with adaptation. For example, the role of PE, as a mediator or moderator between

antecedents, such as severity of CID (degree of functional limitations) and outcomes (e.g., QOL) could be tested with a longitudinal research design. The variance contributed to such outcomes could be partitioned out to examine the specific contributions of the antecedent variables, other mediators (e.g., coping, meaning making, posttraumatic growth) and PE. The significance of the unique contribution, by PE, to the variance of outcomes could then be tested. In addition, the conceptual structure of PE could also be examined by relating it to such existing related constructs as SOC, where correlations between PE and (a) SOC's comprehensibility, manageability and meaningfulness, as well as (b) self-determination's autonomy, competence and relatedness<sup>86</sup> could be directly tested. It might be hypothesized that such correlations should yield moderately strong associations, since spuriously high correlations (suggesting redundancy of content) or appreciably low correlations (suggesting independence between constructs) would fail to support the uniqueness of PE's contribution to psychosocial adaptation to CID. Also, specifically to the thesis of this article, the potentially mediated relationship among PE, disability centrality, and illness intrusiveness could also be examined. The development of a measure, or measures, of CID-generated PE would enable the testing of both general and specific assumptions and hypotheses suggested by these models. This includes both general assumptions, including, for example, the expectation that PE would be positively associated with measures that indicate increased illness intrusiveness (e.g., greater severity of a CID and its symptoms, impact on more centrally important domains or goals, spread, uncertainly, reduced perceived control) and more specific questions about the interactions of PE and adjustment over time based on these frameworks, and the efficacy of clinical interventions established based on illness intrusiveness and related models (e.g., related to enhancing perceived control).

### Summary and Conclusions

The adoption of a central physics construct, namely entropy, to elucidate psychological processes, and more specifically, human adaptation to adversity and the onset of CID, serves to further legitimize the veracity of and insights gained by the fields of rehabilitation, medicine, and psychology. Psychological entropy, in its various clinical manifestations, appears to play a central role in elucidating the dynamics that underlie psychosocial adaptation to CID. Prior to the onset of CID, lower levels of PE are the rule. This lower entropy status is



a reflection of organized and ordered homeostasis, operational in an open system, between the individual and his or her surroundings. Following the onset of CID, in contrast, PE increases, suggestive of the novel disordered and disorganized life space in which the individual now finds himself or herself. Unless external interventions or available coping and related personal resources are deployed to combat this increase in PE, nonadaptive psychological processes are expected to overtake the psyche, and with them, poorer psychosocial functioning and increased psychological distress are likely to be experienced.

Generally speaking, PE is inversely associated with post-CID degree of adaptation. As PE increases (e.g., increasingly disordered cognitive processes, perceptions of uncertainty, experienced uncontrollability, unpredictable life course), so do experiences of failed psychosocial adaptation (e.g., increased anxiety, reduced self-esteem, diminished capacity to set life goals and pursue future plans). Indeed, entropy-linked disorganized and chaotic psychic processes are likely to usher in uncertainty and ambiguity about the present and future, thus resulting in loss of control over one's life, anxiety and distress. Denial, when applied measurably and judiciously, may play a salutary role in the initial period following the onset of CID by reining in the progress of PE. However, when denial is adopted for a longer duration, thus inhibiting the flow of reality-based information, the temporary decrease in PE reverses its course and nonadaptive psychosocial processes and behaviors ensue.

In a parallel vein, when the process of psychosocial adaptation following CID onset is impaired by the deleterious infiltration of heightened CID impact (that is, experiences of intrusiveness, perceptions that condition occupies a central focus in one's life, and assumed disability identity) into one's life space, the adaptive process is negatively affected, and as a result perceived

well-being, self-esteem, and QOL are compromised. Disorganized and chaotic cognitive processes and perceptions of uncontrollability and uncertainty further flourish, thus contributing to the spread of PE from its originally localized and temporally-contained domain.

This pursuant runaway process of increased PE, however, may be successfully harnessed with the "borrowing" of negative PE from the external environment. Since entropy is a necessary product of a "closed system" it can be contained, even reversed, upon resorting to externally-located resources (e.g., medical treatment, rehabilitation services, psychotherapeutic interventions) and the utilization of effective personal coping skills, successful past experiences, and related personality strengths (e.g., resilience, optimism, sense of coherence, self-determination). The employment of these resources and processes operates to counteract increased PE and acts to stabilize physical and psychological functioning, as well as chart a renewed life course with reenergized future goals, plans, and activities. Finally, as PE gradually subsides, accompanied by experiences of increased positive affectivity and improved QOL, the process of psychosocial adaptation can reemerge and be successfully implemented.

#### **Ethical Compliance Section**

No funding was secured for this paper. The authors, therefore, have no funding to disclose. No human participants were used for this paper. Compliance with Ethical standards is, therefore, not applicable. The authors declare they have no conflict of interest.

No human participants were used for this paper. Informed consent is, therefore, not applicable for this paper

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**Author's notes**

<sup>1</sup>Predating the work of Parsons<sup>6</sup> and Freeston et al<sup>7</sup> on uncertainty intolerance, were the contributions of Frenkel-Brunswik<sup>87</sup> to understanding intolerance of cognitive ambiguity and emotional ambivalence, as reflections of rigidity and narrowness of consciousness.

<sup>2</sup>Although several variations on the link between energy and (physical) entropy exists, they all typically follow the equation of  $\Delta E = T \Delta S$ , that is a

change in heat energy ( $\Delta E$ ) is a function of accelerated molecular activity, or temperature, ( $T$ ) times a change in entropy ( $\Delta S$ ). When applied to the domain of psychological entropy, a speculative argument could be made that psychological energy (energy psychology) is a function of emotional turmoil (upheaval, distress) times psychological entropy (uncertainty, ambiguity).