Mass Disasters and Children's Mental Health: How General Systems Theory and Behavioral Economics Can Help

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Abstract

The chapters in this book have each focused on particular disasters and have described the unique and often remarkable efforts that arose during these disasters in order to respond to children's mental health needs. In each chapter, we have found invaluable lessons about successes, failures, and the striving of caring professionals to utilize existing resources and expertise to best mitigate negative outcomes for the children of these disasters (we use the term "children" to refer to children and adolescents). These case examples make possible the next phase in disaster research and policy, which we believe will involve abstraction from the individual disaster experiences. This abstraction will allow the creation of theoretical models that identify the key common features of disasters, effective responses to them, and the salient common interactions between these features. In this chapter, we will introduce two promising paradigms, general systems theory (GST) and behavioral economics (BE), which may supply the intellectual architecture for the feature extraction and theoretical abstraction that constitute the next stage of progress in disaster management. By utilizing (GST) and (BE), and applying their toolboxes, we will be better able to understand the common anatomy of disasters and discover common principles for dealing with their consequence in general and their impact on children's mental health in particular.

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20.1 Introduction

Each of the chapters in this book has given us an in-depth look at disasters of a particular type (natural disaster, industrial accident, man-made terrorist disaster, etc.) taking place in a particular social, economic, political, and environmental context. The chapters have described, in eloquent detail, how the unique resources and shortages of each locale played into the efforts to respond to the disaster and to mitigate its effects, especially on children's mental health and development. Because they focus on the unique aspects of each disaster, these chapters aggregate to form a remarkable set of case-based studies, illustrating what is possible when responding to a particular disaster within a pre-existing social, economic, and medical structure.

We have also seen that, because disasters are so frightening, unexpected, and seemingly chaotic, there is a tendency to respond chaotically (Ursano et al. 1994). Many of the chapters confronted this reality squarely and described false starts and missed opportunities, as well as on-the-job learning and examples of overcoming limited resources or poor starting positions to reclaim remarkable recovery narratives. Therefore, everyone tasked with the children's mental health aspect of disaster preparedness, management, and recovery (we will sometimes refer to this triad as DPMR) has a tremendous amount to learn from each of these cases, and we are grateful to the many authors for these contributions.

We believe with Simonovic (2015) that the best way to take these individual contributions to the next phase of research in DPMR involves not what we can learn from each of these cases, but what can we learn from *all* the disasters we have experienced. The next phase involves extracting key characteristics and their interactions from individual disaster experiences and assembling them into abstract but useful models that capture the essential common structures of these phenomena. This may involve the use of abstract representations, mathematical modeling, big data, and computational simulations to help us better understand the common aspects of disasters and common principles for dealing with their consequences–especially in regard to children's mental health. In this chapter, we will introduce two promising paradigms, general systems theory (GST) and behavioral economics (BE), which may supply the intellectual architecture for creating and working with these abstracted models. Indeed, they have already begun to make significant contributions.

Although general systems theory (GST) and behavioral economics (BE) have very different intellectual histories, over the last decades they have shared the distinction that their theories and empirical findings have been increasingly applied to public policy issues (Thaler 2016). In this chapter, we introduce them and indicate how they can be helpful in directing research approaches and formulating policies around children's mental health needs in mass disasters. We hope to begin a discussion as to the applicability of these approaches to help researchers to better advise policymakers on how to optimize efficacious prevention strategies and mitigation approaches. Applicable principles and theories within GST and BE can perhaps serve as a lens to help us better see the responses to past disasters, in order to understand what has been effective, to acknowledge the shortcomings of fragmented nonsystematic responses, and, moving forward, to plan for a more comprehensive approach.

From the framework of GST, we seek to explore disasters as complex holistic phenomena with many interrelated components, whose relationships to each other is the key focus of interests, rather than applying the traditional approach of multiple parallel, discipline-specific analytic tools. As modeled by GST, the economic behaviors of individuals and groups, also referred to as human factors, have often been one of the key components of a complex system. However, recent decades have seen a cogent criticism of classical economics by behavioral empiricists, giving rise to BE as an alternative system for understanding human decision-making in complex circumstances. Therefore, a contemporary understanding of GST involving social phenomena requires an understanding of the component role of BE, as an updated model of the human factor component of a complex system. We propose that research and policy based on GST and BE will help us organize the efforts of the scientists, clinicians, policymakers, first responders, community leaders, medical personnel, and families whose behaviors constitute the disaster response, into a more coherent system to better overcome the immense burden of disasters and their effects on children.

The generalizability and adaptability of policy recommendations based on GST and BE are their greatest advantages. Thus, using GST and BE together is especially helpful for understanding highly complex events such as disasters.

GST and BE are highly complex, and an in-depth exploration of each is beyond the reach of any single chapter. We hope, however, to introduce their general approaches and demonstrate how themes, concepts, and tools from each of these fields show great promise in promoting a deeper understanding of disaster preparedness and response in general and with respect to children's mental health in particular. We hope that we, thereby, inspire the reader to explore these fields more deeply and apply them to their own disaster work.

20.2 A General Systems Theory (GST) View of Children in Disasters

As this book is focused on children, we should begin with an understanding of their unique role in disasters. While disasters may impact all members of an affected community, they also have a tendency to discriminate, and GST can help us to anticipate this. Individuals who are disadvantaged in normal times are especially vulnerable to the effects of disasters, as they are less likely to have the reserves of resources that are needed during times of disaster. Thus, the disruptions of normal systems that accompany disasters place these victims at heightened risk of negative consequences. One such group is children (we use the term "children" to refer to children and adolescents) who are particularly vulnerable during a disaster, regardless of their pre-disaster social or economic status. As they are still physically, cognitively, and emotionally developing, they are at a disadvantage compared to adults.

They are less able to escape from harm, mobilize help from others, and make critical decisions during the time of a disaster, and the disaster can impede their ability to develop normally (Speier 2000).

While we all have an intuition as to children's vulnerability in a disaster, thinking systematically helps us identify several interacting sources of this vulnerability, some shared with other subgroups, some not. Based on developmental stage, children have physiological vulnerabilities, psychological vulnerabilities, functional and emotional dependence on adults, and decision-making anomalies. Physiologically, children differ from adults in many ways that make them more susceptible to injury. They have a greater body surface area-to-mass ratio than adults, which results in greater absorption of toxins. Their internal organs are less cushioned by subcutaneous fat and thus are more subject to injuries. Moreover, the increased respiratory and heart rates of children cause them to ingest and metabolize toxic substances faster than adults (Gausche-Hill 2009). They also inhale a greater amount of air per pound of body weight compared to adults, which, along with their decreased fluid volume, makes them highly vulnerable to dehydration (Kousky 2016). In addition to these physiological risks, many studies have shown that children have both acute and long-lasting psychological vulnerabilities when exposed to trauma. Children are dependent on adults for both material and psychological resources and have fewer reserves to call upon than their adult counterparts. Children also have a particularly difficult time making good decisions in the stressful circumstances of disasters (Speier 2000). Thus, all children represent enhanced vulnerability and require unique considerations during disaster response and management. The immediate and long-term medical and psychological care of children and adolescents during a disaster requires its own special focus as part of the larger planning that takes place before, during, and after a disaster. This ensures, to the extent possible, the availability and proper application of resources that are specifically tailored to meet their needs. Most of the chapters in this book describe how this was accomplished or how the failure to execute such strategies affected the exposed children in specific scenarios. In this chapter, we hope to start a process of finding common themes from a systematic perspective, using approaches, models, and tools drawn from both GST and BE.

20.3 Characteristics of General Systems Theory

The recent World Disasters Report (International Federation of Red Cross and Red Crescent Societies 2016) by the International Federation of Red Cross and Red Crescent Societies (IFRC) reported 371 disasters triggered by natural hazards—the fourth highest of this decade—and 9,826 deaths from 203 events triggered by technological hazards—the second highest death toll of the decade (International Federation of Red Cross and Red Crescent Societies 2018). It is apparent from these statistics that the rate of disasters, both natural and man-made, is on the rise. Now more than ever, we need an intellectual framework to find common general principles that apply across the multiple contexts of the disasters we face, and which will help us in planning for and dealing with their increasing destructive potential. GST may well be one such framework, as described by Simonovic:

> Systems can be defined as a collection of various structural and nonstructural elements that are connected and organized in such a way as to achieve some specific objective through the control and distribution of material resources, energy, and information across those elements. (Simonovic 2011)

Perhaps the most important characteristic of GST is that it encourages generalization and abstraction and thus the use of modeling approaches (model construction, manipulation, and simulation) as a means of understanding complex phenomena (Strijbos 2010). GST recognizes that many phenomena of interest are complex systems that are made of elements or components that interact in complicated ways. It differs from the traditional scientific approaches which are reductive and analytical and thus focused on decomposing a phenomenon into its parts. GST, by contrast, is focused on how the parts work together to *form* the whole. It is centered on the interactions of the parts, which together make up a whole more complex than the sum of its parts. A simple example is the fact that a lump of coal and a diamond are composed of the same atoms of carbon, and so, from a reductive atomic perspective, they are the same. But it is the complex relationship between the carbon atoms within different crystal structures that makes these two different lumps of carbon serve such distinctive functions. In this sense, GST recognizes that the sum is not only greater than its parts, but the sum is completely different from its parts, because the parts do not just *sum*, rather, they interact in complex ways.

In tackling this complexity, GST tends to work with models that best capture how the relationships between key components create the whole phenomenon that we experience as the disaster. These models can be mathematical and/or computational, but they may also be less formal, as in analogical models. What is important is that these abstract models can be tested against existing or newly collected data and/or simulations, and, once tested and shown to be robust, the parameters in the models can be modified to fit changing or different circumstances.

GST also recognizes that systems can exist in a hierarchy, so that a complex system may be made up of components which are themselves complex systems. Similarly, the former complex system can itself be a component of an overarching system. For example, a cell is a complex system of interacting organelles, but it is also a component of a complex system called a tissue, which is itself both a complex system and a component of a larger complex system, an organ.

In addition, while traditional approaches tended to focus on understanding single causes and simple cause and effect paradigms, GST often deals with multiple factors interacting with each other and sometimes creating complex feedback loops that defy simple cause and effect patterns, as we discuss below. GST also may involve nonlinear dynamics in which small changes may have very large consequences. This high sensitivity to initial conditions is sometimes called "the butterfly effect," a reference to the idea that the mere flapping of a butterfly's wings could set in motion a cascade of meteorological conditions that result in a tornado (Lorenz 2000). Finally, GST also recognizes that systems change and evolve with time.

As reductionism continues to be the prevailing approach in many disciplines, the holism of GST thinking provides a useful contrast (Simonovic 2011). While individual sciences are focused on their own subject matter, GST aims to formulate general principles across different scientific disciplines, often with the goal of more effective problem-solving (Heylighen 1990). Along these lines, another central characteristic of the GST approach has to do with the importance of keeping meaningful goals at the forefront of the process:

> The final and most developed argument in favor of systems approaches must, however, rest upon the diversity, range, effectiveness, and efficacy of the approaches themselves in relation to real-world problem management. On the basis of extensive social science systems literature, it seems that systems ideas and concepts have a resonance with real world practice, which is sadly lacking in much social theory. For this reason, systems methodologies can assist in the task of translating social theory into a practical form and aggregating its findings in practical approaches to intervention. (Simonovic 2011)

20.4 Applying Systems Theory to Policy-Making for Disaster Management

While lauding the potential benefits of GST, Simonovic decried the fact that disaster management has not yet fully adopted a GST approach:

> Disaster management as a process is fully conceived by humanity—ignorant of ecology, and fearful of excessive authority. The current Canadian institutional disaster management context is decentralized, fragmented, and subject to incremental lawmaking. That makes it difficult to address serious disaster management decisions in a comprehensive, holistic fashion. (Simonovic 2011)

In contrast to this piecemeal approach, GST which can take into account the intersecting fields of physical geography, environmental studies, public health, emergency response, health-care systems, and economics, could be very useful as a framework to understand the multidimensional challenges presented by a disaster.

From a GST perspective, a disaster is a sequence of interrelated events that evolve over time rather than a singular cause and effect event (Simonovic 2015). An effective management plan typically integrates the response of several different government agencies/departments at every level and follows a cycle that involves four intertwined components (Simonovic 2011). *Mitigation* involves actions focused on preventing future emergencies or minimizing their effects. *Preparedness* involves steps taken to make ready for an imminent disaster. *Response* involves measures that are enacted during an ongoing disaster. *Recovery* involves restorative processes after the disaster has ended. While each stage of disaster management presents a unique set of environmental, economic, and humanitarian problems, the response systems and intervention strategies required during each of these stages should ideally work together to form a cohesive and ongoing plan that promotes positive community outcomes despite the impact of the disaster. The multitude of disaster types and clusters (natural, human-caused but unintentional, intentional, etc.) make this a daunting task. Yet, from a GST approach all disasters share common characteristics:

> A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins. (International Federation of Red Cross and Red Crescent Societies 2018)

Thus, an appropriate preparedness and resilience plan for a community is one that ensures that the resources needed to enable a return to self-sufficient equilibrium are prepared and available to be mobilized. In other words, these resources have been identified, procured, and poised for rapid mobilization, with the goal of avoiding any community being overwhelmed by any reasonably anticipated event. GST thinking leads us to define a more abstract goal for disaster management-that is the goal of community sustainability despite the occurrence of disasters. For example, the role of an organization like the Red Cross is to be flexible, pre-supplied, and thus poised to bring different materials and services to communities in need. It is impractical, indeed impossible, for every community to have its own complete supply of such reserves, and so the Red Cross acts, as in an insurance model, to spread the burden of disaster risk across vulnerable communities that each contribute some resources for the common good. Thus, the first lesson of a GST approach to disasters is that the disaster preparedness system must be an aggregation of communities, none of which could afford preparedness by itself. At this level of abstraction, it becomes clear that disaster management shares features with environmental stewardship or shared responsibility for globally managed sustainability, there too as no single community's actions would be effective on its own.

In addition, from a GST perspective, disaster preparedness exists at the dynamic intersection of three major subsystems: the *physical environment* (including the biosphere), the *constructed environment* (buildings, roads, bridges, etc.) which is composed of various manufactured entities, and the *human systems* (sociocultural institutions that effect individuals and communities) (Simonovic 2015). Each of these factors interacts with the other two to contribute to the overall goal of sustainability, but each also has its own sub-goal. The constructed environment, which is tied up with the economic structures, has a goal of efficiency, the social realm has a goal of social cohesion, and the environmental realm has the goal of preservation of the environment.

Disasters involve negative impacts on all three factors; there are ecological, economic, and sociocultural consequences. Typically, social and health service agencies are impacted and disrupted at the same time as individuals are undergoing events such as the loss of a family member or friend, housing displacement, job loss, or separation from caregivers. Thus, disasters create a greater need for social support from community institutions just when these institutions are most disrupted themselves. A simple example is the compound effect of impassible roads during a disaster. Ambulances cannot reach the wounded because the health-care workers cannot reach the ambulances. Effective disaster management must take these linked subsystems into account, and GST models are built to support that kind of planning.

As it pertains to preparedness and to mental health relief services for children and their families, a GST approach recognizes the three phases of disasters—pre-impact,

impact, and postimpact—as existing on a continuum from prevention to treatment. GST would thus recommend a mental health approach that is woven across multiple institutional structures and that would be involved in a broad array of services. These include programs to increase the general resilience of all children through school programs or parent education; programs to identify those children at greater risk for stress-related problems and which offer appropriate support; programs that educate citizens about mental health aspects of disaster preparedness; programs that implement appropriate disaster drills that are sensitive to the mental health implications; as well as the traditional programs that deliver after the fact treatments for disaster-related psychopathology. Such structures would also need to recognize the family unit, in addition to the individual, as a system in need of targeted interventions (Winek 2009).

20.5 GST Tools for Disaster Management

In addition to supplying an overall theoretical approach to disasters, GST provides tools for better formulating, analyzing, and solving management issues and critical decision-making. In particular, various methods and tools have been put forward to assist in predicting and mitigating outcomes of traumatic events on the mental and physical health of those who are involved. We will next give examples of two categories of tools that have been used: computer simulations and optimization techniques.

Computer simulations have been designed for all phases of disaster management. While early simulations required high degree of technical and coding expertise, recent advances in software have made modeling more accessible to researchers and planners. These software tools can be used to create models that can be easily modified for different conditions (Rosenfeld et al. 2009).

One example is a so-called "agent-based" computer simulation model developed by Cohen and colleagues that examines the likelihood of victims accessing the care that they need in the aftermath of trauma (Cohen et al. 2017). They used a simulation that models the behavior of individual decision-makers (agents) who were traumatized in the wake of Hurricane Sandy and could undergo different levels of available mental health treatments. This model allowed for the computation of the incremental cost-effectiveness of different types and levels of services for New York City. They found that using a stepped care system to separate agents who met DSM-IV case criteria for PTSD from agents who did not, was effective in channeling the former into CBT therapy and the latter into less intensive treatment, appropriate to their needs. This stepped care system led to a projected improvement of the reach of the therapy, a 2-year projected reduction in PTSD symptomatology in the full population, a 2-year reduction in the proportion of PTSD cases, and a 10-year improvement in incremental cost-effectiveness when compared to the "usual care" model (Cohen et al. 2017).

Cohen's projection of the efficacy and overall cost-effectiveness of the stepped care program illustrates how GST can identify resource allocation plans that are actually efficient, despite the seemingly high up-front costs of implementation

($50.94 to $101.87 million in the case of Hurricane Sandy). This research also raises questions about the potential efficacy of a stepped care approach for persons affected by various other mental health issues besides PTSD. It may be that mental health first responders with minimal training could implement standardized screening instruments for various mental disorders and channel syndromal and subsyndromal persons to the most efficacious treatment programs. But, we need not make assumptions, as a suitable agent-based simulation could help simulate and test such an approach as well.

Another GST approach for integrated disaster management is that of optimization. GST employs a holistic perspective on the concept of optimization with the goal of finding the best possible allocation of resources (human, material, financial, etc.) within a given time period, and in a complex disaster management scenario (Simonovic 2011). Using a dynamic programming model, which assesses individual and community outcomes under a variety of different resource allocation schemes, can be organized to improve overall outcomes to focus resources on the most vulnerable populations, such as the elderly or children.

These tools allow policymakers and governmental agencies to create models that represent disaster scenarios and to manipulate those models to provide key players with an accurate sense of the potential consequences of different management approaches, without having to actually go through each variation experientially. However, the modeling approach must go hand in hand with another important facet of GST: appropriate data collection. Good data is needed for researchers and policymakers to build realistic models in the first place and to iteratively update the models to be more representative (Farmer and Foley 2009). Such models and simulations can also be configured to look back at failed management approaches and identify what went wrong and what could be done better when the next disaster occurs. As a corollary, although there is strong tendency to focus on a rapid return to normalcy in the aftermath of a disaster, it is equally important to use resources to create a reliable mode of collecting relevant data from affected regions and individuals, to improve our modeling and simulations for the future.

20.5.1 GST, Feedback Loops, and Disaster Management

As mentioned above, while traditional approaches tended to focus on simple cause and effect thinking, GST models often involve two-way causal structures, or feedback loops, as the relational structure between the components of a complex system (see Fig. 20.1). Consider feedback loops in the case of a natural disaster. Assume that *A* is the warning/evacuation signal issued by the county/state when a storm or hurricane threat is imminent and *B* is the process of evacuation, of stocking up on supplies, or of ensuring preparedness. The signals of communication to evacuate are vital for any society that is susceptible to experiencing a natural disaster, but historically, even under the best of circumstances, the warning zones are much larger than the impact zones, and most people get a false alarm (Kunreuther et al. 2006). At other times, there are warning signals and the disaster simply does not happen when predicted.

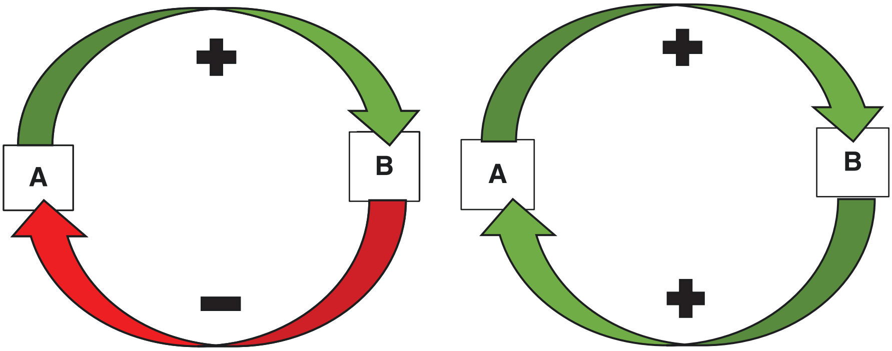

Fig. 20.1 Negative feedback loop (left) and positive feedback loop (right)

In the case of imminent extreme weather events, "false alarm" warnings are often unavoidable (significant increase in *A*). However, if these warnings do not result in an actual disaster, the motivation to prepare for and protect oneself against the event decreases with each "false alarm". Therefore, this negative feedback loop ultimately could cause a "real" warning to go unheeded. Conversely, positive feedback loops amplify change (Simonovic and Ahmad 2005). For example, in a simulated model of flood evacuation, when more people reach safety, it will increase the number of people who attempt evacuation. In the latter example, progress begets more progress. Thinking in terms of feedback loops can assist in the design of communication systems that will increase evacuation in times of imminent disaster. Compared with traditional models of disaster warning, a feedback loop is concerned with both the successful delivery of the message and the human response to the message.

The GST concept of feedback loops is especially salient during the impact phase of a disaster. Simonovic claims that "feedback is the most important property of integrated disaster management systems" (Simonovic 2011), and positive and negative feedback loops for human behavior can significantly change the outcome of a disaster. An increase in warnings (*A*) can at first increase the evacuation response (*B*). In technical terms, *A* increases the marginal propensities of the population to comply with evacuation. But if there is no hurricane, then the unnecessary evacuation feeds back a negative signal and tends to cause a weakening of the effectiveness of signal *A* to cause an evacuation. In actual GST models of disaster warnings, there are multiple feedback loops, and complex mathematics is used to predict optimal timing, frequency, coverage, and other parameters of warning signals that can be adjusted to maximize the effectiveness of the warning signals to result in actual evacuation or other preparedness behaviors (Meyer and Kunreuther 2017).

Interestingly, given the focus of this book, Mitchell and colleagues researched the role of youth as the communicators of pending risk to their families and communities, putting them directly in the middle of the feedback loop. He concluded that:

> The findings suggest that the roles of children and youth as potential informants within informal and formal risk communication networks have been significantly underestimated, but their positive role in disaster risk reduction must also be seen in light of its possible burdens. (Mitchell et al. 2008)

This suggests that future feedback models may need to include a parameter regarding the age of those sending and receiving the warning. Applying these GST approaches to disaster management, and in particular to the mental health of children in disasters, can be expected to improve the outcomes for the many children that will be facing disasters in the future.

20.6 Behavioral Economics: A New Approach to Human Decision-Making

As mentioned above, human factors play a key role in GST models, and economics has traditionally been one of the intellectual disciplines dealing with human factors. However, with the emergence of behavioral economics as a subdiscipline of economics, human factors have a new intellectual home and one with many new insights.

Behavioral economics (BE) focuses on the aspects of human decision-making and behaving that were poorly predicted by standard economic theory, which assumed that humans are fully rational decision-makers. BE had roots in research by Amos Tversky and Daniel Kahneman that showed that humans did not make decisions or behave in the utility-maximizing, rational fashion that was demanded by traditional economics (Tversky and Kahneman 1974). BE has, therefore, attempted to discover the underlying cognitive processes that explain and predict the seemingly irrational decisions that humans actually make, especially under conditions of uncertainty and/or stress.

BE has uncovered a number of cognitive biases and heuristics ("quick and dirty" cognitive shortcuts that are used almost automatically in complex decision situations) that humans rely on in place of the utility-maximizing calculations that a perfect economic agent would use (Thaler 2016). BE has also pioneered the concept of correcting for these cognitive biases by altering the so-called decision architecture (also referred to as "choice architecture"). This involves changing the structure or framework in which choices are presented, as a means of helping people overcome these biases and make better choices despite their cognitive limitations (Milkman et al. 2009). A classic example is restructuring the decision architecture of organ donation by making organ donation the default for all adults, while requiring a proactive route to opt out of being an organ donor. This simple difference in decision architecture was responsible for huge differences in rates of organ donation (Johnson and Goldstein 2004). A similar strategy, of having retirement savings automatically deducted from paychecks of new employees, has helped increase retirement savings. Most employees will not opt out of this plan, even if they would not have originally opted-in to it (Choi et al. 2004).

Similarly, BE can be helpful in exploring the cognitive and behavioral barriers that tend to diminish optimal decision-making around disaster prevention and management. Thus, BE perspectives can help us understand the human factor component that contributes to a GST approach to managing disasters.

Decision-making, which is a crucial aspect of disaster management on a community and individual level, is greatly influenced by the fact that some disasters are "low-probability, high-consequence (LP-HC) events." While cognitive biases are ubiquitous, they are especially present, and have particularly bad consequences, in LP-HC events, which have been closely studied by BE. For example, BE has tried to understand why homeowners in regions with high flood risk choose not to purchase insurance until after they have experienced a disaster, and why those that do have insurance choose to cancel it if they do not experience a disaster for a few years (Kunreuther 2016). From the perspective of standard economic theory, which emphasizes rationally calculated risks versus cost, these are irrational decisions. From the BE perspective, however, they fit the models of heuristics and biases, and so these decisions are *predictably irrational*, as Dan Ariely (2010) has called them.

20.6.1 Behavioral Economics and the Management of Disasters

In the pre-disaster stage, mitigation planning must take into account the expected risk of different levels of disasters, which can be expressed as a combination of an estimate of losses for a given disaster and the probability of that level of disaster actually occurring:

$$Expected\ risk = losses \times probability$$

In this model, a disaster which is more likely (higher probability) but has low consequential losses presents the same amount of expected risk as a low-probability, high-consequence (LP-HC) (Simonovic 2011). In fact, classical insurance theory is based on this notion of expected risk, yet people do not think or behave as if they understand the multiplicative logic of insurance theory. As first explicated by prospect theory, and now a cornerstone of BE, people are more likely to prepare for and prevent HP-LC events and tend to treat LP-HC events as if their probability was zero, and therefore the expected loss was ignorable (Kahneman and Tversky 2013). This point was further explicated by Nassim Taleb in his book *Black Swan*, which demonstrated that the impact of rare events can be so devastating because we tend to dismiss them as impossible (Taleb 2007). Taleb draws an analogy with the fact that Europeans had dismissed the possibility of the existence of black swans for many years, until they were seen for the first time in 1697. Taleb, thus, makes the point that not buying insurance for LP-HC events is like betting a lot of money that a black swan will never appear.

Another finding of BE is that people attribute much more value to a given amount of loss than to the same amount of gain, a bias known as loss aversion. Although from a rational perspective it pays to spend resources to prevent LP-HC events, actually spending such resources on protection against a LP-HC event (or buying insurance) is experienced by many as an unnecessary immediate loss and is avoided. Thus, despite the age-old adage of an ounce of prevention being better than a pound of cure, in the face of uncertain losses, many humans prefer not to spend the ounce.

At the community level, it is rational to invest in a prevention strategy or purchase an insurance policy that will provide a reduction in uncertainty and ultimately reduce the loss incurred by a potential disaster. Note that in this analysis the terminology of "insurance" can refer to any measures taken that would either reduce the probability of a disaster (building adequately high levees), reduce its magnitude (build homes on stilts or introduce universal resilience training to youth), or reduce the losses it imposes on the community by purchasing actual insurance. However, many communities choose not to spend money to protect themselves, even where the cost calculations make this a rational decision.

While this has been well described in the realm of property loss, it is even more stark in terms of the psychological impact of disasters on children. While communities might spend money on active-shooter drills in the schools, which are worthwhile and may well save lives, they do not give similar attention to the future mental health of their children, failing to introduce resilience trainings even though they have been shown to be effective (Frydenberg et al. 2004; Wasserman et al. 2010).

20.7 Behavioral Economics and Cognitive Fallacies in Disaster Management

While the cognitive biases that are a focus of BE have been known for decades (Tversky and Kahneman 1974), more recently Kahneman hypothesized that the presence of two competing cognitive systems within each of us may explain the source of these biases (Kahneman and Egan 2011). It is, therefore, useful to think of human cognition as containing two cognitive systems working simultaneously and often in competition. System 1 involves fast thinking—automatic and instinctual—and it is the system responsible for safety and basic needs. System 2 involves slow thinking, a more deliberative and purposeful decision-making process. It is concerned with long-term planning, complex relationships, and strategic thinking. It is the "decision-making" we are more consciously aware of, and it requires our attention and effort. Cognitive biases are a result of the conflict between these systems, a conflict that often derails the process of rational decision-making and accounts for decisional biases (myopia, amnesia, optimism, inertia, simplification, and herding) (Meyer and Kunreuther 2017). As a result of these competing systems, we often fail to learn from the past, do not always make the most rational choice, do not fully understand risky situations, and, in many cases, do not even notice these deficits.

While this contributes to many suboptimal decisions in everyday life (we eat too much, save too little, and take risks carelessly), in the context of disaster preparedness and response, these biases are far more destructive and have contributed to unnecessary casualties, property damage, and to worsened mental health outcomes (Meyer and Kunreuther 2017). Meyer points out, however, that an awareness of these biases and an adjustment of classical disaster management strategies in ways that take these human factor fallibilities into account could help improve future disaster management in ways not yet realized.

We have already mentioned two cognitive biases that incline individuals to engage in suboptimal prevention, be it through preventing loss or covering the loss with an insurance policy. Those were loss aversion, which gives too much weight to the immediately experienced costs of prevention, and the low probability bias which treats a low probability event as an impossibility. Meyer introduces two others which are most relevant in the mitigation phase: the myopia bias and the amnesia bias. The myopia bias is the tendency to focus on the present and the near future rather than the long run. This bias disincentivizes investment in precautionary measures like insurance, infrastructure fortification, etc., since they are costly in the short term with benefits most likely realized only over the long term. Notice that this reinforces the behaviors due to loss aversion but constitutes a distinct cognitive bias. Loss aversion is about loss/gain trade-offs, and myopia is pertinent to now/later trade-offs.

The amnesia bias inappropriately minimizes the impact that previous pain and hardship have on current decision-making. Having past painful experiences direct our current behavior is actually very useful, if done with proportionality. It is when we give the past experiences too little or too much influence that we run into trouble. Thus, the amnesia bias is probably very important for our capacity to be resilient and for women to continue to go through labor in order to have children. However, in the disaster context, the passage of time can weaken the emotions and memories associated with past losses, and, as a result, we may fail to create meaningful preparations for the next (probabilistic) occurrence. In that case, too much amnesia bias works against readiness. On the other hand, too little amnesia is an inability to let time soften the emotional pain of a disaster. This can manifest as post-traumatic stress disorder (PTSD). In this condition individuals give too much weight to the prevention of future harm and may avoid even safe situations or over-prepare for unlikely harm. Thus, the amnesia bias can be seen as working in both directions, either underweighting or overweighting the importance of past experience when making judgement about the how to face the future.

During the response phase, other biases can come to the forefront. One example is the optimism bias, which involves an unrealistic assumption that a disaster will somehow leave them and their property unscathed (Meyer and Kunreuther 2017). This optimism bias is probably advantageous for us humans during the normal stress of everyday life, but in the context of a disaster it further contributes to the large numbers of citizens who fail to evacuate even as the disaster is encroaching on the porch. Another related bias is the inertia bias, a tendency to stick with the status quo, or a default option, when faced with a risky and ambiguous decision. An example is when one is facing the decision whether to evacuate a home that has not yet been affected by a storm.

Notice that more than one cognitive bias can operate in a situation, and when they pull in the same direction, it is even harder to overcome these biases. Thus, the decision to evacuate a currently unaffected home during a storm will draw on both the optimism bias to lower the perceived risk, despite what the authorities might say, and on the status quo bias, which emphasizes the "stay put it's working so far" argument in the decision-maker's mind. These bring System 1 to the forefront at the exact moment when the deliberative and purposeful thinking of System 2, including probabilistic thinking, is so badly needed for the right decision.

The last example can help us understand a more general principle of cognitive biases. In stressful moments that require a fast decision, the simplification bias is activated and leads people to focus only on the most salient information while ignoring other available information. The trade-off here is between a fast and efficient cognitive process that may be lifesaving when running from a lion, and a more thoroughgoing, slower process that incorporates more sources of information and may be lifesaving in more complex circumstances, such as choosing the best cancer treatment. Thus, it is not the application of System 1 or System 2 that is problematic but rather the matching of the appropriate cognitive strategy to the situation.

In sum, there are multiple cognitive biases which taken together preclude many people from making the rationally appropriate and cost-effective protective investments for their future or lead to suboptimal responses during a disaster. The nature of disasters and the difficult and unfamiliar decisions they demand will sometimes lead to poor decision processes which are driven by cognitive biases. Indeed, this failure has been one of the great challenges for disaster managers in their attempts to get their population to be better prepared, to have appropriate insurance, to have a family plan, to evacuate when told, and to seek psychological help for themselves and their children after a disaster has passed.

20.7.1 Cognitive Biases Encountered in Government Decision-Makers

While we have been discussing cognitive biases in the realm of individual decision-making, these biases can be just as prevalent and even more harmful when the decision-makers are public officials making decisions for the whole community. For example, the myopia bias, which primarily affects decision-making in the mitigation phase of disaster management, is commonly encountered in governmental organizations and public policymakers (Kunreuther and Michel-Kerjan 2010). The incentive systems for these individuals (constituent approval and reelection) necessarily take place over a short horizon that cannot take into account the long-run value of costly preventive investment, especially in LP-HC situations. Thus, either the long-term value of the preventive investment is underestimated, or the decision to invest is hindered by procrastination on the part of the policymakers.

Procrastination is a particularly challenging foible to overcome for public officials, as it combines the shortsightedness of the myopia bias with its companion, the historical amnesia bias. For example, natural disasters such as floods, hurricanes, and tsunamis (as described in many of the chapters of this book) have a tendency to strike the same regions repeatedly due to their geographical susceptibility. Yet, despite knowing this, many regions fail to implement effective precautionary measures in a timely fashion after a disaster has occurred, and especially after a close miss. Procrastination takes advantage of the fact that a LP-HC disaster is not likely to occur in the short run, so public officials who take this bet by cutting preparedness budgets tend to win in the short run. Moreover, according to Meyer and Kunreuther (2017), the importance of the amnesia bias is not that the facts of a disaster are forgotten; rather it is that the emotional impact fades over time. This can be even more pronounced when government decision-makers, who did not themselves experience the disaster, are making decisions for others who did.

A telling example of how these BE theories of government action play out in reality is given in the chapter in this volume by Finelli and Zeanah (2019). They discuss the consequences of under-preparedness in the state of Louisiana during Hurricane Katrina that led to widespread loss and displacement of communities, as well as long-term psychopathology in exposed children and their caregivers. During the disaster 85% of New Orleans was flooded, largely due to the failure of the protective levee system, which could not withstand the force of a Category 3 hurricane. It turns out that New Orleans, which is below sea level and surrounded by water on three sides, was a victim of both the myopia bias and the historical amnesia bias on the part of government officials. In 1965, Hurricane Betsy (Category 4) flooded the city in a manner similar to Katrina, prompting the need for a levee system that would prevent such a disaster from reoccurring. The initial shock of Betsy did spur the government, policymakers, and environmentalists to take action. But with time, the sense of urgency caused by the devastating loss was replaced by an attitude of complacency, allowing procrastination to take over. When Hurricane Katrina ultimately struck, 40 years later, the levee improvements were still under construction. It is no wonder, then, that many areas of New Orleans flooded due to massive breaches in the still inadequate levee system.

The optimism bias is also relevant to our team's research related to attacks on the World Trade Center (WTC) on September 11, 2001. The WTC was the target of a deadly terror attack 8 years prior to 9/11. The detonation of 1500 lb of explosives beneath the North Tower killed 6 people and injured a thousand. Yet, the towers were subsequently acquired by real estate mogul Larry Silverstein and had record-high occupancy just before the 9/11 attacks. Meyer and colleagues postulate that this involved the optimism bias, which also factored into the insurance coverage of Silverstein's newly acquired property. Despite the obvious and traumatic history of a deadly terrorist attack and a subsequent security report that suggested that an airline collision was a potential risk, insurers bundled losses of any similar future attack under an "all other perils clause," which meant that the possibility of a serious future terrorist attack was deemed so unlikely that it was not independently priced when the plan's premium was calculated (Meyer and Kunreuther 2017).

In addition to a failure to properly anticipate the property damage that might occur from a second attack on the WTC, there was a complete lack of anticipation of the psychological effect of such an attack, especially on children. Our research group conducted a study of the New York City schoolchildren in the aftermath of 9/11 (Hoven et al. 2005). In the first 6 months after 9/11, a projected 205,000 students in grades 4 through 12 were likely experiencing anxiety/depressive symptoms, and they remain more vulnerable to mental health disorders as a result of this exposure. But these high psychological risks were not considered in any systematic way in disaster preparedness planning prior to 9/11. To date (2018), there has been a plethora of research on the mental health consequences of 9/11 on adults and children (Farfel et al. 2008). One might expect that we have learned our lesson and are adequately prepared for the mental health consequences of the next major disaster. Remarkably, we are no better prepared with treatment clinics have no improved preventative programs and no better access to resiliency training. It is as if we learned little from 9/11 in the children's mental health preparedness arena. The cognitive biases are clearly at play at the planning and governmental level.

Interestingly, there is an example of a preventative mental health program for children involved in disasters coming out of one of the most devastated regions of the world. In their chapter in this volume, El-Khani and Calam (2019) explore the effects of the Syrian conflict on affected children. Their research found that caregiver mental health was prospectively associated with child mental health. They illustrate that investing in and promoting good parental mental health, as well as positive parent-child relationships, serves as a protective factor for children against the stressors of an armed conflict. Generalizing from this work would involve a restructuring of mental health systems to broadly deliver appropriate preventative mental health services to all families at risk for disaster exposure. Such programs are the psychological equivalents of adequate levees or vaccination programs. If we treated "resilience vaccination" as seriously as we treat viral vaccination, we would be on our way to an appropriate level of public mental health disaster preparedness.

20.7.2 Overcoming Cognitive Biases: The Behavioral Risk Audit

The goal of BE is not limited to identifying cognitive biases. On the contrary, BE sees its role as improving human decision-making by diagnosing cognitive biases and developing approaches to overcome them. One such approach, as mentioned above, involves designing the decision architecture, that is, restructuring the way that choices are represented in order to overcome cognitive bias (Thaler and Sunstein 2009). An example, already mentioned, would be to make organ donation the default position when driving licenses are issued while allowing for a proactive opt-out. This would actually use the status quo bias to increase organ donation. Thaler and Sunstein refer to this approach as *Nudge*, to distinguish it from strict governmental regulations that change behaviors through the law, but do not allow for free choice.

A related approach that has been developed in order to help individuals and policymakers overcome the myriad cognitive biases they face in preparing for and responding to disasters is called the behavioral risk audit (BRA) (Meyer and Kunreuther 2017). This approach places a heavy emphasis on acknowledging and overcoming the cognitive biases that interfere with effective decision-making in the various phases of disasters. While traditional models of DPMR do little, if anything, to take into account the state of mind that people experience in a real disaster, the BRA takes this as a starting point. For example, traditional models advocated for overly ambitious preparedness checklists even though actual individuals at risk are likely to adopt only one or two measures of self-protection (Meyer and Kunreuther 2017).

The BRA begins with an enumeration of core biases (myopia, amnesia, optimism, defaults, simplification, and herding). In a second step, the approach calls for an assessment of how each or several of these biases might lead to an underestimation of risk posed by a specific disaster scenario. In step 3, an analysis is done of how the risks identified in the previous step might adversely impact the efficacy of the existing preparedness measures. The fourth and final step involves the development of motivational tactics to assist individuals and policymakers to overcome the errors identified in the previous steps (Meyer and Kunreuther 2017). In this way, it becomes possible to overcome many cognitive biases that more traditional models of disaster preparedness and response have not unaccounted for.

While the BRA is a general approach for overcoming biases, there are also specific approaches for overcoming individual biases. The historical amnesia bias can be overcome by cognitive retraining through effective media campaigns that include emotionally salient narratives or visual reminders of effects of past disasters. Of course this could be misused or perceived as manipulative, but stark verbal reminders of the effects of cigarettes, and in Europe, gruesome images on cigarette packages, have effectively impacted the decision to smoke (Mannocci et al. 2013).

Despite the rising rate of their occurrence disasters are still considered fairly rare events, and, as we have discussed, rare events are cognitively processed as having zero probability. This underestimation of personal risk can be helped by presenting disaster statistics to individuals in a more understandable and compelling manner. For example, instead of describing the likelihood of a disaster occurring in any given year, the probability over the period of expected home ownership may be more salient and overcome this bias. The longer timeframe not only provides more serious statistics, but it also helps customers make long-term, wise, and effective prevention investments that they might have otherwise avoided. In addition, there has been a great deal of research over the last 20 years on how to better present statistics and risk information to ordinary individuals so that they can better understand and use them in their decision processes (Gigerenzer 2015).

The decision architecture for improving individual home disaster preparedness or buying insurance can be redesigned by providing long-term low-interest loans for these specific expenditures, lowering the initial out of pocket cost and challenging the loss aversion and myopia biases. Additionally, governments can identify disaster-prone areas and impose taxes on them to build sustainable, long-term means of protection against disasters. This alters the decision architecture by forcing individuals to consider the actual additional costs of living in a risky area before they move in.

Understanding cognitive biases can also shape the messaging that is used to communicate disaster preparedness to the population. For example, directing messaging exclusively to the deliberative brain (System 1) at the expense of instinctual brain (System 2) is insufficient. Complicated decisions about what to do when facing an impending disaster involve a lot of competing variables, and the human mind has a tendency to only take into account the most salient information. Creative redesign of messaging that targets both systems and focuses on a handful of executable strategies would improve the efficacy of public communication leading up to a disaster.

Finally, an important bias that can also be advantageous to disaster management in the pre-impact phase is the herding bias. The tendency to follow the herd can lead to both very positive and very negative outcomes. The herd sometimes possesses an aggregate wisdom not available to individuals (Meyer and Kunreuther 2017). If policymakers can encourage these positive herding tendencies, they can be mobilized in a beneficial fashion. This can be promoted by rewarding pioneers, who take the initiative to model protective steps, such as having emergency plan or complying with early evacuation. This has been shown to work in the arena of health behaviors, where wearing seatbelts, refraining from smoking, bicycle helmets, and better diets have become cultural norms and save countless lives (Meyer and Kunreuther 2017).

20.8 Conclusion

While a thorough description of GST or BE is beyond the scope of a single chapter, we hope we have given a taste of how these methods work and how they can be mobilized for the challenges of disaster management. We hope we have also indicated how BE and GST can work together to offer a critique of current practice and point to novel ways of organizing our thinking and planning processes around disaster preparedness and management.

BE is informed by the careful psychological study of human decision-making under risk, pointing out its successes and failures. BE is informed by concepts of decision-making, perceived cost versus benefit, delayed gratification, and other concepts that disproportionately affect populations responding to natural and man-made disasters. In the past, planning for disasters was made without including what is known about how humans behave under these types of stressful situations. Therefore, BE is perfectly poised to help us understand the shortcomings of the human factors involved in traditional approaches to disaster preparedness and management. BE can now help us to acknowledge how cognitively daunting it is to make vital decisions in the lead up to, and the aftermath of, these events. It can help us become aware of the relevant biases and how we can use systematic methods, such as the BRA, to mitigate their influence and significantly improve both individual decision-making and policy-making.

GST can help us to better understand natural and man-made disasters as complex and interrelated systems which require dynamic and comprehensive solutions. The

GST approach to preventing or minimizing the impact of disasters before they strike allows for a more robust, systematic, and empirically-minded approach to disaster preparation and response. This approach could mitigate the physical harm, loss of life, property damage, and financial hardship that contribute to mental health problems in the months and years following a disaster and could also support the mental health of those affected by disasters. In addition, a GST approach to mental health preparedness and prevention programs and to mental health services in the wake of a disaster could maximize the efficacy of limited resources.

Given their innocence and fragility, children are too often the most profoundly affected when a disaster strikes. More needs to be done in the service of their protection so that they can grow and thrive during what should be the most carefree years of their lives. The improvements to DPMR that could be realized by the use of BE and GST are, therefore, promising for the mental health of children in the wake of calamitous events.

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