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The resilience paradox

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ABSTRACT

Decades of research have consistently shown that the most common outcome following potential trauma is a stable trajectory of healthy functioning, or resilience. However, attempts to predict resilience reveal a paradox: the correlates of resilient outcomes are generally so modest that it is not possible accurately identify who will be resilient to potential trauma and who not. Commonly used resilience questionnaires essentially ignore this paradox by including only a few presumably key predictors. However, these questionnaires show virtually no predictive utility. The opposite approach, capturing as many predictors as possible using multivariate modelling or machine learning, also fails to fully address the paradox. A closer examination of small effects reveals two primary reasons for these predictive failures: situational variability and the cost-benefit tradeoffs inherent in all behavioural responses. Together, these considerations indicate that behavioural adjustment to traumatic stress is an ongoing process that necessitates flexible self-regulation. To that end, recent research and theory on flexible self-regulation in the context of resilience are discussed and next steps are considered.

La paradoja de la resiliencia

Décadas de investigación han demostrado sistemáticamente que el resultado más común tras un posible trauma es una trayectoria estable de funcionamiento saludable, o resiliencia. Sin embargo, los intentos de predecir la resiliencia revelan una paradoja: los correlatos de los resultados resilientes son generalmente tan modestos que no es posible identificar con precisión quién será resiliente ante un potencial trauma y quién no. Los cuestionarios de resiliencia más utilizados ignoran esencialmente esta paradoja al incluir sólo unos pocos predictores supuestamente clave. Sin embargo, estos cuestionarios no muestran prácticamente ninguna utilidad predictiva. El enfoque opuesto, que consiste en captar el mayor número posible de predictores mediante modelos multivariantes o aprendizaje artificial, tampoco consigue resolver del todo la paradoja. Un examen más detallado de los efectos pequeños revela dos razones principales de estos fallos de predicción: la variabilidad situacional y las compensaciones de coste-beneficio inherentes a todas las respuestas conductuales. El enfoque opuesto, que consiste en captar el mayor número posible de predictores mediante modelos multivariantes o aprendizaje automático, tampoco consigue resolver del todo la paradoja. Un examen más detallado de los efectos pequeños revela dos razones principales de estos fallos de predicción: la variabilidad situacional y las compensaciones de coste-beneficio inherentes a todas las respuestas conductuales. En conjunto, estas consideraciones indican que la adaptación conductual al estrés traumático es un proceso continuo que requiere una autorregulación flexible. Para ello, se discuten investigaciones y teorías recientes sobre la autorregulación flexible en el contexto de la resiliencia y se consideran los próximos pasos.

心理韧性悖论

数十年的研究一致表明, 潜在创伤后最常见的结果是健康功能的稳定轨迹或心理韧性。然而, 预测心理韧性的尝试揭示了一个悖论:心理韧性结果的相关性普遍非常有限, 以至于无法准确确定谁对潜在创伤有心理韧性, 而谁没有。常用的心理韧性问卷基本上忽略了这个悖论, 因为它只包含一些可能是关键的预测因素。然而, 这些问卷实际上没有表现出预测效用。相反的方法, 使用多变量建模或机器学习捕获尽量多的预测变量, 也无法完全解决这个悖论。对小效应的仔细研究揭示了这些预测失败的两个主要原因:情境多样性和所有行为反应中固有的成本效益权衡。总之, 这些考虑表明对创伤应激的行为调整是一个需要灵活自我调节的持续过程。为此, 讨论了心理韧性背景下灵活自我调节的最新研究和理论, 并考虑了下一步。

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HIGHLIGHTS

- Although correlates of resilience after trauma are known, paradoxically, prediction of resilient outcomes is surprisingly weak.
- Predictors have generally small effects which suggests that the solution to the paradox must involve flexible self-regulation.

In the more than four decades since PTSD was formally recognized, the study of traumatic stress has made considerable progress. Yet, like any burgeoning field, there have been controversies (Friedman, Resick, & Keane, 2007; McNally, 2003; McNally et al., 2015). In the early years of traumatic stress studies, the idea

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of resilience to trauma was not so much controversial as not discussed at all. The few times it was mentioned, resilience was assumed to be rare and either a form of 'exceptional emotional strength' (Casella & Motta, 1990) or denial and 'illusory mental health' (Shedler, Mayman, & Manis, 1993). As research on trauma broadened, however, it became increasingly evident that genuine resilience in the form of a trajectory of 'relatively stable, healthy levels of psychological and physical functioning' was far more prevalent in the aftermath of potentially traumatic events (PTEs) than had previously been assumed (Bonanno, 2004, 2005)

Not surprisingly, given the theoretical challenge occasioned by the concept of resilience, there were, and to some extent still are, sceptics (Litz, 2005; Steenkamp, Dickstein, Salters-Pedneault, Hofmann, & Litz, 2012). Scepticism in science is healthy, and in this case scepticism helped spur increasingly more advanced computational methods for identifying the resilience trajectory. Summarizing this work, we recently reviewed 67 unique analyses of outcome trajectories following PTEs (Galatzer-Levy, Huang, & Bonanno, 2018). Although the studies varied in design, computational method, and type of PTE, on average, two thirds of the participants showed the resilience trajectory. Thus, not only is resilience to PTEs common, it is consistently *the majority outcome*.

1. The paradox

As the prevalence of resilience became firmly established, inquiry naturally shifted to the question of mechanism. How do people showing a trajectory of resilience manage to cope so well? Although this question initially seemed relatively straightforward, a closer look at the evidence revealed that resilience was a complex and elusive target. Because the resilience trajectory is so prevalent, encompassing a majority of people, it is also more heterogeneous than other types of outcome (Bonanno, 2005). In other words, there are likely multiple different routes the same end. Practically, this means that the predictors of resilient outcomes are undoubtedly multifaceted (Bonanno, 2005, 2012; Rutter, 1999; Werner, 1985).

A large number of traits and behaviours have been described as 'resilience-promoting'. Although, many of these factors have yet to find empirical support, some have been statistically linked to resilient outcomes (Bonanno, 2021). The quality of evidence varies, but among the most consistently reported predictors are personality variables, supportive resources, financial and educational assets, coping and emotion regulation strategies, minimal searching for meaning, and the experience and expression of positive emotions (see Bonanno, Romero, & Klein, 2015; Bonanno, Westphal, & Mancini, 2011)

Together, these factors would seem to adequately explain resilient outcomes. Surprisingly, they do not. It turns out that the empirical relationships between individual predictors and resilient outcomes are uniformly modest. This creates a paradox: Even though we can identify correlates of resilient outcomes, we still cannot predict who will be resilient and who not with much accuracy (Bonanno, 2021). By extension, any attempt to build or enhance resilience that focuses on one or even a few of the known correlates will likely be inefficacious.

In this article, I consider possible solutions to the paradox. I begin by examining two opposite approaches to resilience: one that ostensibly ignores the paradox by using so-called resilience questionnaires comprised of only a few presumably key predictors, and a second that examines as many predictors as possible using the powerful tools of machine learning. I show that while machine learning is a step in the right direction, neither approach solves the paradox. I then consider the nature of small effects in more detail and, finally, propose a solution to the paradox based on the concept of regulatory flexibility.

2. The myth of the resilient type

Probably the most popular explanation for resilience is the resilient type. This explanation assumes that people become resilient by learning from previous stressful experiences and by gradually acquiring all the necessary ingredients for 'successful stress-coping ability' (Connor & Davidson, 2003). The key assumption here is that not everything associated with resilience is important, just the key traits. And once a person has developed those key traits, and become a resilient type, the next time something truly aversive happens they will have relatively little trouble dealing with it (Connor, 2006).

The simplicity of this explanation has an obvious appeal, as does the fact that it allows for relatively easy measurement using a using a brief, self-report questionnaire (e.g. Gartland, Bond, Olsson, Buzwell, & Sawyer, 2011; Jew, Green, & Kroger, 1999; Wagnild & Young, 1993). Having spent most of my career trying to understand and measure the complexities of resilience, I can see why a simple questionnaire approach would be popular. And, of course, simple does not necessarily mean wrong. Simple explanations can be elegant and powerful. The idea that some of us might be resilient by disposition is also undeniably reassuring; that is, as long as we are on the resilient side of the equation. For people who suffer more extreme trauma reactions, however, it is not likely to be very comforting to hear that some people are just simply resilient and, sorry, but you're not.

But there are serious problems with the type concept. First, there are multiple resilience questionnaires

and they are far from uniform. In other words, different measures include different behaviours and traits. If people are resilient types because they possess the essential ingredients, then some, or perhaps all, of these measures are necessarily missing something. Second, these measures fail to explain why the predictors of resilient outcomes that are not included, e.g. financial resources or additional stressors (Bonanno, Galea, Bucciarelli, & Vlahov, 2006) nonetheless promote resilience. Third, these measures tend to include factors that have not been empirically linked to resilience following PTEs. The most widely used resilience questionnaire (Connor & Davidson, 2003), for example, includes a spirituality factor. Although spirituality *seems* like it should be part of resilience, there is no consistent evidence that it is, even in studies that have explicitly tested for it (Bonanno, 2021).

Conceptual and methodological limitations aside, resilience questionnaires have been exceedingly popular. But do they actually do what they claim to? Simply put, resilience questionnaires should predict the future likelihood that a person will show a resilience trajectory. Surprisingly, to my knowledge no such empirical evidence has ever been reported.

What if we set the bar lower? Put aside the question of a trajectory of resilience *per se*, and ask only whether resilience questionnaires predict mental health generally following a PTE? Unsurprisingly, resilience scales do typically correlate cross-sectionally with mental health. But do they predict future mental health after a PTE? Although here there is some evidence, strikingly, it suggests that resilience scales have little or no predictive utility.

One study, for example, administered a 'dispositional resilience' questionnaire to military peacekeepers before they deployed to a war zone and then assessed their mental health at several points after they deployed (Thomassen et al., 2015). When pre-deployment mental health was accounted for, the resilience scale was unrelated to post-deployment mental health. In another study, active-duty police officers were administered a resilience questionnaire, assessed for a recent PTE, and then repeatedly assessed for symptoms of PTSD and depression during the following year (Marchand, Nadeau, Beaulieu-Prévost, Boyer, & Martin, 2015). The resilience scale failed to predict symptom levels across time. Finally, in another police study, researchers administered two different resilience scales to trainees and assessed their mental health in the nine months after they began their careers as active-duty police officers (van der Meulen et al., 2018). When controlling for baseline mental health, both resilience questionnaires failed to predict future mental health 9 months later.

Resilience questionnaires even failed to predict responses to stress in a controlled experimental setting (Roth & Herzberg, 2017). This study used a student sample and the Trier Stress Test. The students were asked to give oral presentations with only a few minutes of preparation time to what they were told was a 'panel of experts' who would judge their suitability for 'successful studies at a university.' Prior to the test, students' scores on a personality index were used to identify a previously normed resilience profile (Herzberg & Roth, 2006). The resilient types reported about the same level of distress before and after the Trier test, whereas the other students, the non-resilient types, reported greater distress after the task. Yet, on objective measures, such as signs of stress coded from the videotapes and markers of physiological arousal, all students, including the resilient types, had increased stress reactions. In other words, the so-called resilient students were only healthier in their self-report, and not in their actual behaviour under stress, prompting the study's authors to conclude that the resilience personality may be nothing more than a 'self-deception artifact' (Roth & Herzberg, 2017).

3. The promise and perils of machine learning

If resilience cannot be captured by a single questionnaire, then the problem is undoubtedly multivariate. Yet, multivariate approaches to prediction often struggle with analytic problems, e.g. multicollinearity, higher-order interactions, and non-linear relationships, which are not easily managed by traditional analytic tools. These problems can be readily accommodated, however, using machine learning (Galatzer-Levy, Ruggles, & Chen, 2018; Karstoft, Galatzer-Levy, Statnikov, Li, & Shalev, 2015; Schultebraucks & Galatzer-Levy, 2019). Machine learning has, in fact, already been used for some time to identify outcome trajectories following PTEs (e.g. Bonanno et al., 2008). In this case, the analysis is *unsupervised* because the target trajectories are not specified in advance. However, once the outcomes are known, attempts to identify predictors of those outcomes becomes a *supervised* analysis. Combining these two approaches, supervised and unsupervised machine learning, creates an especially powerful method (Galatzer-Levy et al., 2018).

We recently used this combined method to identify trajectories of resilience and PTSD symptoms and their predictors following admission to an emergency department for a PTE (Schultebraucks et al., 2020). Owing to the versatility of this approach, we were able to consider over 70 baseline psychological and biological predictors. The resulting algorithm discriminated trajectories of PTSD symptoms with a high level of accuracy, both in the original sample and in an independent validation sample. We then repeated this combination of supervised and unsupervised machine learning in another recent study to discriminate the trajectories based on genetic predictors (Schultebraucks, Choi, Galatzer-Levy, & Bonanno, 2021). Specifically, combinations of 21 unique polygenic scores related to various psychiatric disorders

and health conditions. Overall discriminatory accuracy was again quite good.

Nonetheless, as effective as these methods were, there are at least three reasons why machine learning falls short of fully addressing the resilience paradox. First, although classification accuracy was robust when based on a wide range of predictors, in practical application biological and genetic markers may not always be available. In this case, prognostic classification is greatly reduced. In our ED study, for example, when we considered only biological variables, discriminatory accuracy was reduced to a 'fair' level and when we considered only psychological variables, discriminatory accuracy fell to a near chance level. Second, and more critically, even when overall classification is robust, discriminatory accuracy still tends to be less accurate for the resilience trajectory. In our study of polygenic predictors, for example, discriminatory accuracy was in the 'excellent' range for the chronic depression trajectory and still meaningful but only in the 'fair' range for the resilience trajectory. Based on these results, we concluded that 'resilience is a more complex construct that is influenced by many risk and protective factors and it seems that the genetic component can explain only part of it.' Third, and most important, even when a diverse set of biological and psychological measures might be available, machine learning algorithms are still largely limited to prediction. Although predictive algorithms can inform advances in theory by illustrating different and even unexpected predictor variables (Galatzer-Levy et al., 2018), their use to date has not yet illuminated the mechanism by which these predictors come together to foster resilient outcomes.

4. Making peace with small effects

Small effects are remarkably common. It has been more than half a century since Mischel (Mischel, 1969) famously highlighted the modest effects of personality traits. More recently, reviews of the predictors of PTSD have similarly noted their generally small effect sizes (e.g. Brewin, Andrews, & Valentine, 2000).

Yet, small effects by themselves are not necessarily problematic (Funder & Ozer, 2019; Prentice & Miller, 1992). The problem arises only when we fail to consider the nature of these effects or simply assume that they are more influential than they might actually be. This is a particularly pernicious problem when correlates of resilient outcomes are championed for the building of resilience. Even when it might be possible that these factors could be enhanced, that would likely increase the odds of actual resilient outcomes only slightly.

One of the primary contributors to small effect sizes is the simple fact that situations constantly change. It was Mischel's (1969) thoughtful critique of the personality research that helped bring situational variation to the foreground. In subsequent research, Mischel and colleagues (Mischel & Shoda, 1995; Mischel, Shoda, & Mendoza-Denton, 2002) discovered that the overall effects of presumably stable personality traits were modest because people are not actually consistent in their behaviour across situations. However, this research also showed that people behaved much more consistent in the same *types* of situations. A similar person-situation dynamic is undoubtedly relevant to potential trauma. Although PTEs tend to induce at least some transient traumatic stress in most people, these events nonetheless vary greatly in both the nature of the challenges they produce and in the way they unfold over time. And, not surprisingly, behavioural responses to PTEs also tend to vary, both across situations and within individuals.

Another important but underappreciated contributor to small effect sizes, again particularly relevant to PTEs, comes from the natural cost-benefit tradeoffs inherent in virtually all traits and behaviours. To cite a prime example, coping and emotion regulation strategies are commonly understood in simple binary terms, as either uniformly adaptive or maladaptive. For instance, cognitive reappraisal is widely considered to be highly adaptive, while avoidance and suppression are assumed to be consistently maladaptive (e.g. Aldao, Nolen-Hoeksema, & Schweizer, 2010). This assumption exemplifies the *fallacy of uniform efficacy* (Bonanno & Burton, 2013). A closer look at the evidence reveals that strategy effectiveness is highly dependent on fit with situational demands (Cheng, 2001; Cole, Michel, & Teti, 1994; Gross, 1998; Lazarus & Folkman, 1984; Mattlin, Wethington, & Kessler, 1990). More specifically, research has shown that a given self-regulation strategy may be useful in some situations, but less useful or even maladaptive in other situations or other points in time (e.g. Kalokerinos, Greenaway, & Casey, 2017; Kalokerinos, Greenaway, Pedder, & Margetts, 2014; Troy, Shallcross, & Mauss, 2013). The same cost-benefit tradeoffs also apply to other presumed resilience-promotion factors, including those widely viewed as exclusively adaptive, such as positive emotions (see Gruber, Mauss, & Tamir, 2011) and supportive social behaviours (e.g. Dakof & Taylor, 1990), and exclusively maladaptive, such as threat perception (Galatzer-Levy et al., 2014; Messman-Moore & Brown, 2006). Indeed, from a broader, comparative lens, it becomes clear that cost-benefit tradeoffs characterize literally all traits and behaviours across animal species (Brown & Vincent, 2008; Georgiev, Klimczuk, Traficonte, & Maestripieri, 2013; Kalisky, Dekel, & Alon, 2007; Orr, 2005).

5. Flexible self-regulation

The considerations above all point to the same basic conclusion: The predictors of resilient outcomes show only modest overall effects because they are not beneficial in every situation or at every point in time. And, by extension, the mechanism that underlies resilience must involve some sort of adjudication process; some

way of working out, moment by moment, what the best response might be and then engaging in that response. But how would a person do this? How would a person determine, for example, when to seek support from others, when to use distraction, when to talk about the event, or try to make sense of it, or keep their spirits up, and so on? That process, and the mechanism that underlies resilience, I have proposed is flexible self-regulation (Bonanno, 2005, 2021).

There is a growing theoretical and empirical literature on flexible self-regulation (see Bonanno et al., 2004; Bonanno & Burton, 2013; Cheng, Lau, & Chan, 2014; Kashdan & Rottenberg, 2010). Although there is not yet theoretical consensus, one point of agreement across this literature is that flexible self-regulation, like resilience, is not a simple, one-dimensional construct but, rather, involves multiple interacting components.

5.1. The flexibility sequence

Charles Burton and I (Bonanno & Burton, 2013) proposed that one primary component of flexible self-regulation involves three sequential steps, later dubbed *the flexibility sequence* (Bonanno, 2021). Briefly, the initial step in the sequence, *context sensitivity*, gets right down to the task of working out the demands of a particular situation. Here was ask ourselves, explicitly or implicitly, "What is happening? and 'What do I need to do?' This step is arguably the most critical in the sequence because it provides the context-specific information required to guide all subsequent responses (Aldao, 2013). In the next step, *repertoire*, we chose a regulatory response that will best meet the specific challenges we are facing at that moment from the set of regulatory strategies we are able to use effectively. In other words, here the question shifts from "What do I need to do? to 'What am I able to do?' This leads to the third and final step, *feedback monitoring*. Until recently, almost all research on self-regulation stopped at strategy selection. However, flexible responding requires ongoing monitoring. We do this essentially by asking ourselves, 'Is it working?' and then either continuing, ceasing, adjusting or replacing strategies as necessary.

Depending on the nature of situational challenges, a person might cycle through the flexibility sequence any number of times. For example, an especially difficult or demanding circumstance may necessitate repeatedly correcting and revising strategy use. Additionally, since situational challenges are not static but constantly changing, the regulatory strategy likely to be most effective will tend to change over the course of the same stressor episode (Folkman & Moskowitz, 2004). Simply put, what works at one moment may no longer be effective a short while later. It is often be necessary to cycle through the flexibility sequence multiple times within the same stressor episode. Finally, for more enduring traumatic stress reactions, it may be necessary to cycle through the sequence repeatedly over a period ranging anywhere from a few hours to a few weeks or longer.

5.2. A flexibility mindset

A related component of flexible self-regulation has to do more specifically with personality traits. When we originally developed the idea of the flexibility sequence, we focused primarily on coping and emotion regulation strategies. However, it quickly became apparent that the sequence is applicable to virtually all regulatory behaviour or resources, with one prominent exception: Personality. Several personality dimensions have been empirically associated with resilient outcomes, again with generally modest effects. But, in this case the effects are small, not because personality traits are not always effective, but rather because their influence on resilient outcomes is indirect (Carver & Connor-Smith, 2009).

Traumatic stress is highly unpleasant, as are the disturbingly intrusive memories and images that typically accompany it. Normally, we want nothing more than to push those memories and images out of consciousness. Unfortunately, responding flexibly to traumatic stress necessitates at least some engagement with its content. Personality traits associated with resilience promote that engagement by forming a motivational foundation for flexible responding. Optimism, for example, fosters a willingness to work for the expected positive future (Carver & Scheier, 2014). Optimism also interacts with other traits, like coping self-efficacy (Benight & Harper, 2002), and challenge orientation (Tomaka, Blascovich, Kibler, & Ernst, 1997), to create an overall conviction, a flexibility mindset, that helps people engage with the task at hand (Bonanno, 2021).

6. Where to from here?

If flexibility is the mechanism behind resilient outcomes, as I have argued, then it will be imperative to fully articulate how its components function together. I described two components emerging from my research programme, the flexibility sequence and the flexibility mindset. Each component has its own subcomponents that influence each other and the broader flexibility process. How these components interact is not yet well-understood, nor is their relationship to other possible approaches to flexible regulation (Aldao, Sheppes, & Gross, 2015; Sheppes, Scheibe, Suri, & Gross, 2011).

Thus far, the steps of the sequence have been studied almost exclusively in isolation. Recently, however, we identified latent profiles of these abilities (Chen & Bonanno, 2021). Reassuringly, most people fell into profiles of moderate or high ability for all three steps. This makes sense. If flexibility is the mechanism of resilience, and most people are resilient,

then most people should also be reasonably flexible. We also identified three less frequent profiles, each characterized by a deficit in one ability. These profiles were associated with elevated depression while, of particular interest, the profile characterized by low context sensitivity was uniquely associated with elevated anxiety.

It will also be crucial to examine in greater detail how the flexibility mindset and sequence influence both each other and longitudinal and prospective resilient outcomes. Research to date has shown that the association of these components with adjustment is revealed most clearly in higher-order interactions with situational constraints and exposure severity (Levy-Gigi et al., 2015; Westphal, Seivert, & Bonanno, 2010). However, to truly unpack these relationships in all their complexity, it will be imperative to again enlist sophisticated deep learning data analysis. Although, machine learning has its limitations, some form of algorithm-driven modelling is likely the only realistic way to fully probe the temporal and situational dynamics of flexible self-regulation (Galatzer-Levy et al., 2018) and, thus, ultimately, the only way to fully resolve the resilience paradox.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Access to data and data analysis

No data were analyzed in relation to this manuscript.

Ethical approval

Because no data were involved in this manuscript, ethical approval was not required.

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