Psycho-neural Reduction Revised: The Case of Suicidality in Bipolar Disorder

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August 24, 2024

Abstract

This paper uses suicidality in bipolar disorder (BD) as a case study demonstrating the preferability of multidimensional over reductionist frameworks in accounting for complex phenomena with cognitive, psychological, socio-environmental, and physiological components. Suicidality, or behaviors and thoughts concerning an intention to end one's life, illustrates the interplay between diverse factors. This multidimensionality is reflected in the heterogeneous strategies for managing suicidality, which range from psychosocial and cognitive to pharmaceutical and technological interventions. Suicidality in BD is a multi-dimensional phenomenon whose study has been productive through the methods of several disciplines. For instance, suicidality in BD is partly genetic and can be aggravated by symptomatic periods, suggesting physiological causal factors. However, some features of suicidality in BD underscore the causal roles of cognitions. Notably, suicidality can persist beyond depressive periods, and is sometimes experienced during mania. This may be due to persistent suicidal ideation, highlighting the need to account for cognitive or psychological causal factors. Models of suicidality in BD typically adopt a pluralistic approach that does not reduce one dimension to another. Rather, they are treated as different facets of a complex phenomenon that interact and influence each other. Moreover, recent studies have shown the promise of physical interventions, e.g., electroconvulsive therapy and deep-brain stimulation, in the treatment of suicidality in BD. Socio-environmental interventions have been successful in suicide prevention more generally. This demonstrates how multidisciplinary, multidimensional explanations are most likely to productively account for how diverse factors contribute to suicidality along with genetic and physiological determinants.

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Keywords

bipolar disorder; suicidality; reductionism and non-reductionism; multi-dimensional frameworks

Introduction

Contemporary psychiatry is facing an identity crisis. Is it a scientific discipline? Is it a social-political movement? Or is it strictly a healthcare practice that relies largely on practitioners' insights and experience? Philosophy of psychiatry is a relatively new field that draws from centuries-long debates in philosophy of mind and philosophy of science. It has the potential to reinvent psychiatry's identity. However, it needs to emancipate from its predecessors and the scholastic debates that dominate them. In particular, debates over reductionism may stall the development of the field if not dealt with in radically novel ways. Our goal in this paper is to show that taking a side in the "reductionist wars" is not feasible for psychiatry. We use*suicidality* in *bipolar disorder (BD)* , also known as manic-depressive disorder, as an example to make the case that traditional debates over reductionism are nothing more than scholastics and that resolving the controversy requires abandoning the assumption of the fundamentality of "levels" in the ontology of neuroscience, psychology, and psychiatry.

Suicidality covers "all the suicidal behavior/acts and suicidal thinking/thoughts referring to an intention to end life" (Nanayakkara et al., 2012, p. 234). It is the outcome of "a complicated sequence of cognitive and behavioural events, beginning with ideation through to planning and an intention to act" (Malhi et al., 2013, p. 559). Suicidality thus highlights the contributions of cognitive, psychosocial, behavioural, and biological dimensions alike. These characteristics are further underscored in suicidality in persons with BD. Suicidality in BD illustrates the interplay between cognitive-affective, neurophysiological, environmental, and social causal factors: it demonstrates the need to account for these components to comprehensively account for a complex phenomenon. This pluralistic framework is reflected in the heterogeneous interventions for managing suicidality, which can be pharmaceutical, technological, psychosocial, cognitive, or a combination of all. It is also reflected in individual responsiveness to such interventions: for instance, suicidality in some persons may be alleviated by medication, while for others a cognitive approach, such as talking or group therapy, is more effective.

The case of suicidality in BD is especially suitable for our purpose because it is a multi-dimensional phenomenon whose study has been productive through the methods of several disciplines. For instance, suicidality in BD is partly due to genetic factors (Kim et al., 2007), and can be aggravated by symptomatic periods. This suggests that its causality has a significant physiological component. However, some features of suicidality in BD underscore the causal roles of cognitions. Notably, suicidality can persist beyond depressive periods, and is sometimes experienced during manic periods (Dilsaver et al., 1994; Miklowitz & Gitlin, 2014). It is believed that this is due to the persistence of suicidal ideation, a cognitive phenomenon, thereby highlighting the need to appeal to cognitive concepts in accounting for suicidality. This is reflected in actual scientific practice: models of suicidality in BD typically adopt a pluralistic approach that does not reduce cognitive or mental factors to neurobiological ones or vice versa.Rather, it treats them as different dimensions of a complex phenomenon that interact and influence each other. Moreover, recent studies have shown the promise of physical interventions on neuromodulation such as electroconvulsive therapy (ECT) in the treatment of suicidality in BD (Kucuker et al., 2021; Liang et al., 2018; Tondo et al., 2021). Additionally, social and environmental interventions have been successful in suicide prevention more generally (Platt & Niederkrotenthaler, 2020). This demonstrates how multi-disciplinary, multi-dimensional explanations are most likely to productively account for how cognitive, affective, psychosocial, and environmental factors contribute to suicidality alongside genetic and physiological determinants.

What follows is a brief historical overview of the relationship between the body and the mind, expositions of suicidality in BD followed by how it is modelled, a discussion on how suicidality in BD demonstrates the usefulness of multi-dimensional approaches, and finally, endorsement of levelless, multi-dimensional explanatory frameworks.

The Psychoneural Relation in Psychiatry

Three competing conceptualizations of mental illness dominated 20th century psychiatry: the *medical model, antipsychiatry* , and the*biopsychosocial model* . According to the medical model, mental illness is an organic disease just like any other disease studied and treated in medicine. Even though environmental and social factors may be relevant to the etiology of the disease and its diagnosing, a disease is identified as a biological dysfunction that results from the interaction of genetic and environmental factors. Consequently, neurobiology is the relevant scientific discipline to advance psychiatry (Guze, 1978). The mirror image of the reductive medical model is antipsichiatry which denies any organic cause to mental illness. Psychiatry should instead be considered a practice of helping a struggling individual overcome personal, moral or other problems in living (Szasz, 1960). This conceptualization has been particularly influential in the disabilities rights movement. The biopsychosocial model is an alternative to both of these views as it promotes an integrated multidimensional conceptualization of mental illness, and all disease for that matter. According to this model, diabetes and schizophrenia are both experienced, identified, and diagnosed as complex phenomena which require accounting for biological, psychological, and social factors. Moreover, the success of the treatment of each depends to a large extent on the relationship between the physician and the patient (Engel, 1977). With certain modification, all three of these views have their contemporary proponents. As we indicated earlier, our affinity is with a biopsychosocial approach. However, the main point we are making is that the debates between the proponents of the three models, while overlapping to various degrees with traditional philosophical debates over psychoneural reduction, do not involve any references to levels of any kind.

Traditional discussions of reduction in philosophy of mind are largely motivated by the need to articulate a solution to the mind-body problem, the problem that arises when assuming Descartes' substance dualism which postulates that the ideal (mind) and the material (body) substances which make up reality are so fundamentally different that it is not clear how the two can interact. How do our desires produce actions in our bodies and how do our bodily needs produce ideas in our minds, for example? One way to solve the problem is to show that the distinction is faulty. Either the world is completely ideal or it is completely material. While both options have their proponents, only the latter has gained credence in the analytic philosophy tradition which claims close allegiance with science. Thus, the debates have shifted towards the role of science, or scientific discipline(s), in shedding light on the true nature of the mind-body relation.

20th century psychology was the discipline identified as the science of the mind while physiology was the science of organisms in general. Human minds could now be studied by psychology, while their bodies by physiology. Those who sought to solve the mind-body problem through a scientific study, then aimed at articulating the relationship between psychology and physiology in order to provide a unified account of humans, including their minds and their bodies. Oppenheim and Putnam (Oppenheim & Putnam, 1958) famously introduced their account of*intertheoretic reduction* as a model of unified science. In their view, the relationship between scientific disciplines, or branches, is defined by the theoretical vocabulary, or universe of discourse, corresponding to a level of the multilevel real world where every higher level can be decomposed into the entities of the level below it. Further, a scientific discipline has the potential to reduce the theories of a discipline of a higher level to the vocabulary of its own theories gradually level-by-level, starting with sociology through psychology, biology, and chemistry all the way down to elementary particle physics. Any whole that can be decomposed to the parts of a lower level, in their model, belongs to that level even though its "proper" level is the highest level to which it belongs (Oppenheim & Putnam, 1958, pp. 9–10). Thus the mind can be reduced to a physical entity as psychology can be reduced to neurophysiology, and ultimately physics. Early critics of this reductive view of mind and psychology objected that the reduction of the vocabulary of a higher level theory presupposes a direct correspondence to the vocabulary of a lower level

theory in order for the reduction to be possible. Furthermore, this also presupposes identities between the corresponding properties at the psychological and neurological levels (Fodor, 1974, p. 101). Fodor famously considers this an absurdity and argues for the relative independence of the "special" sciences from physics. Rather than unity, he then advocates disunity of science.

The 20th century philosophy of mind and philosophy of science have proposed numerous versions of reductive and non-reductive accounts of the psycho-neural relation. However, the debates have degenerated into scholastic rhetoric and seem to be of little relevance to real-life experiences such as mental illness. Early 21st century proposals that criticized both the proponents and the opponents of intertheoretic reduction have included *ruthless reduction* (Bickle, 2006),*nonreductive mechanistic explanations* (Craver, 2007), and*mechanistic reduction* (Bechtel, 2007). Variations of these three models of the psycho-neural relation have dominated the reduction wars over the past two decades in philosophy of psychology and neuroscience. However, all three of them have assumed some kind of level-based model. Bickle proposes a direct jump from molecular/cellular interventions to behavioural observations without the need to go up and down the ladder identified by Oppenheim and Putnam. Craver articulates an ontic account of compositional levels of mechanisms which are thus irreducible. Whereas Bechtel assumes an epistemic model of compositional levels and allows for reductive explanations in terms of the lowest compositional level of a given model. However, these level-based accounts of the psycho-neural relation based have, at best, shown to be insufficient to capture the complexity of psychiatric phenomena as it is widely acknowledged that comprehensive approaches to treatment that include psychosocial, pharmacological, and lifestyle interventions are superior to any "single-level" interventions.

In what follows, we will review the literature on modelling of psychiatric phenomena, and suicidality in people with BD more specifically. This kind of modelling draws from methods in genetics, physiology, pharmacology, and psychology. Later, we will reference emerging literature on technological interventions for neuromodulation employed in the treatment of several psychiatric conditions, including suicidality in BD. This will ultimately enable us to make the case for a levelless account of reduction in psychiatry.

Bipolar disorder and suicidality

BD is a common, heritable, and lifelong psychiatric condition. Due to its distinctive symptom profile, BD can provide novel philosophical standpoints on various dimensions of human experience and how they are impacted by the interplay between cognitive, psychological, socio-environmental, and physiological factors.

BD is a spectrum of disorders characterized by alternating elevated and depressed periods, which in turn are accompanied by changes to neural activity, cognition, behaviour, and personality (Angst, 2007). The symptomatic periods of BD are divided into *mania* (or its milder form of *hypomania*), *depression* , and *mixed states* . Among the typical characteristics of manic or hypomanic periods are euphoric mood, increased energy or decreased need for sleep, rapid thinking, associational fluency, impulsivity, and feelings of grandiosity. In some severe cases of mania, psychosis can occur. Common symptoms of depression include low mood, feelings of hopelessness or worthlessness, lack of energy or motivation, restricted thinking, rumination, and cognitive slowness. Mixed states are periods that exhibit a combination of manic or hypomanic and depressed symptoms (for instance being in a low mood yet having increased energy). The fifth edition of the Diagnostic and Statistical Manual (DSM-V) categorizes BD into different types, depending on severity, frequency, and presentation of symptoms, which vary extensively between individuals. The trajectory of BD also varies from person to person: some have more severe and frequent manic or hypomanic periods, while for others depression is more common.

BD is associated with a predisposition towards suicidality. As previously mentioned, suicidality is an umbrella term that encompasses suicidal ideation, i.e., thoughts or preoccupation about suicide, and suicidal behaviour, or actions and attempts related to suicide (Borders, 2020). The population with BD is one of the highest suicide risk groups, in comparison to the general population and all other psychiatric illnesses (Miller & Black, 2020). The suicide rate within the BD population is 10-30 times higher than that of the general population, with up to 20% of persons with BD dying by suicide, and about 20-60% having attempted sui-

cide at least once (Dome et al., 2019). It is estimated that "about one-third to one-half of bipolar patients attempt suicide at least once in their lifetime and approximately 15-20% die due to suicide" (Miller & Black, 2020, p. 2). Individuals with BD who have comorbid personality disorders, a history of suicidal behaviour, or family histories of suicide or suicide attempts are more likely to themselves attempt or die by suicide (Miller & Black, 2020). It is also well established that genetic risk factors are involved in suicidality in BD (Kim et al., 2007). Additional factors contributing to suicidality in persons with BD include poor quality of life, relationships or social support, and childhood abuse or neglect (Miller & Black, 2020).

Suicidality typically—but not exclusively—occurs during depression, wherein feeling low, a sense of hopelessness, rumination, mental pain, and increased susceptibility to stress are common. Suicidality usually arises due to the interaction of these psychological and cognitive factors with stressful social and environmental circumstances, physiological states, and other cognitions pertaining to taking one's own life (Jamison, 1995; Malhi et al., 2018). (NB: "cognitions" refer to thoughts, beliefs, and motivational states, which are sometimes referred to in philosophical literature as *mental states* .) Emphasizing the cognitive dimension, Kay Redfield Jamison (1999, p. 91) writes that "much of the decision to die is in the construing of events, and most minds, when healthy, do not construe any event as devastating enough to warrant suicide." In addition to the aforementioned symptoms, depressed periods are also accompanied by negative construal of social or environmental circumstances, such that one is more likely to regard one's situation as hopeless or inescapable, while at the same time having a diminished ability to see other solutions to perceived problems (Jamison, 1999). Thus, during depression, a person may view death as the only escape from or solution to circumstances experienced as stressful and problematic, and may consequently contemplate suicide. Moreover, persons with BD are believed to be prone to suicidal ideation (Miklowitz & Gitlin, 2014), thereby increasing exposure to cognitive or psychological states that may be translated into suicidal actions. This tendency is further compounded when death is viewed as an end to one's problems and pain (Jamison, 1999).

Nevertheless, in persons with BD, suicidality is not limited to depressed periods. Mixed states, particularly those with a significant depressive component (sometimes referred to as *mixed depression*) are likewise high-risk periods for suicidality. Periods wherein a person with BD appears to be recovering from depression also pose a high risk (Jamison, 1999). Suicidality during mania is sparsely documented, but nevertheless occurs (Dilsaver et al., 1994; Malhi et al., 2018; Miklowitz & Gitlin, 2014). It has been proposed that "persons experiencing mania may have components of the suicidal process in mind but are incapable of putting them into action. It is only when they shift from the manic phase or a depressive or mixed state that they may regain the capacity to do so" (Malhi et al., 2018, p. 341). This thus indicates that being in a depressed state is not a necessary condition for suicidality. Furthermore, in BD, the use of antidepressants (in contrast to mood stabilizers) can also lead to increased suicidality (Miklowitz & Gitlin, 2014). It is believed that the "emergence of suicidal ideation during antidepressant treatment might be genetically driven" (McGuffin et al., 2010, p. 276). When depressed, a person may experience suicidal ideation, but may not have sufficient energy or motivation to carry out suicidal actions to a lethal degree. However, when their energy and motivation increase (e.g., due to the effects of anti-depressants, during mixed depressions with manic/hypomanic components such as agitation or impulsivity, or when the depressed state is beginning to lift) they may become psychologically "strong" enough to complete suicide.

Rapid-cycling BD, defined as "presenting four or more manic or depressive episodes during at least 2 weeks" (Garcia-Amador et al., 2009, p. 74), compounds suicide risk and predisposition towards suicidality (MacKinnon et al., 2005). It has been found that rapid-cycling BD is associated with a higher rate of suicide attempts and a "marked increase of lifetime history of suicidal ideation" (Garcia-Amador et al., 2009, p. 76), in comparison to its non-rapid-cycling counterparts. A person with rapid-cycling BD is potentially faced with briefer asymptomatic periods and more frequent mood episodes throughout their life than their counterparts with non-rapid-cycling BD (Garcia-Amador et al., 2009). It can be inferred from the existing literature that rapid cycling results in exposure to the stressors associated with symptomatic periods, which in turn can aggravate any suicidal tendencies that may be present.

In BD, suicidality has a genetic component (Kim et al., 2007; McGuffin et al., 2010), although what aspects

of suicidality are genetically transmitted is yet unclear. Nevertheless, "[a]ll the genetic epidemiology evidence suggests that suicide and suicidal behaviours are complex traits where there are probably multiple genes with each individual gene having a small effect" (McGuffin et al., 2010, p. 276). Among the candidate genes that stand out are those related to serotonin (McGuffin et al., 2010). There may be an overlap between genes that predispose towards suicidality and those that predispose towards affective disorders, although the extent of this overlap is yet unclear. It has been theorized that expressions of certain BD-related genes are associated with neural, physiological, cognitive, behavioural, and personality processes, traits, or patterns implicated in suicidality. For instance, some genes relevant to stress regulation increase the sensitivity of certain neural systems to stress, making them more reactive to stress-inducing factors in a manner that increases the predisposition to suicidality (Malhi et al., 2018; Mathews et al., 2013). The periodic dysregulation brought about by BD's symptomatic periods, physiological features, and adverse life experiences—including those directly related to the experience of BD—can also bring about "abnormalities in the hypothalamic pituitary adrenal (HPA) axis as well as the serotonergic, dopaminergic, and noradrenergic systems" (Mathews et al., 2013, p. 204) implicated in suicidality. It is also hypothesized that candidate genes may affect the development of brain areas or neural activity in ways correlated with suicidality (Kim et al., 2007). Another possibility is that certain genes are related to the development of the personality traits impulsivity and aggressiveness—which are not uncommon in persons with BD, particularly during manic periods—and which have been identified as suicide risk factors. There are also findings that in BD, suicidal ideation that emerges upon treatment with antidepressants have a genetic basis (Laje et al., 2007), although it is yet unclear how the cognitive component, i.e., suicidal thinking, arises from these neurobiological interactions.

A family history of suicidality is one of the more consistent risk factors for suicide, in the BD population and in general. There is extensive evidence that suicidality aggregates within families (Brent & Mann, 2005; Voracek & Loibl, 2007), partly due to genetically transmitted biological or psychiatric features, but also as a result of other heritable factors such as behavioural patterns. Nevertheless, not all families with a history of suicide have a history of psychiatric illness; likewise, a history of psychiatric illness is insufficient to account for aggregation of suicidality within families. It has been proposed that familial transmission of suicidality can be attributed to a combination of genetically inherited responses to stress, the presence of psychiatric disorders, imitation of behaviour and cognitive patterns, and exposure to similar environments and the stressors therein (Brent & Mann, 2005).

Of all the risk factors for suicide, the most consistent and precarious is a history of prior suicide attempts (Gonda et al., 2012). At least half of completed suicides in the BD population were carried out by individuals with a history of attempted suicide (Miller & Black, 2020). In the same vein, having previously attempted suicide "increases the risk of suicide by 37-fold in bipolar patients" (Miller & Black, 2020, p. 4). Moreover, "the lifetime rate of prior suicide attempts was found to be significantly higher in bipolar patients compared to unipolar [depression] patients" (Gonda et al., 2012, p. 18). Prior suicide attempts can raise the threshold and habituation to pain, which in effect serve as "cognitive rehearsal" (O'Connor & Kirtley, 2018, p. 4) or preparation for subsequent suicide attempts that may have a greater likelihood of pain and lethality (Malhi et al., 2018). From a cognitive perspective, it is also believed that "[e]ach time a suicidal mode becomes activated, it becomes increasingly accessible in memory and requires less triggering stimuli to become activated the next time" (van Heeringen, 2012, p. 118).

Modelling suicidality in BD

Although there is a substantial corpus of literature documenting the quantitative aspects of suicidality in persons with BD, far less is known about *why* people take their own lives (Jamison, 1999). There is still much to be learned about the mechanisms and processes over which implicated factors interact to generate suicidality. Issues that have been addressed yet remain incompletely answered include how suicidal ideation leads to suicidal action, why suicidality and suicide are not uniform outcomes of being faced with the same risk and predisposing factors, and how internal (e.g., neurobiological, physiological, and genetic features) and external factors (e.g., environmental stressors, quality of life and relationships) mediate or aggravate suicidality across individuals. Furthermore, to comprehensively understand the causality of

suicidality, the*reasons* for suicide must be explored. This involves examining the cognitive dimensions of suicidality, which are extensively intertwined with psychological, social, and environmental factors. A number of models (Malhi et al., 2013, reviewed in 2018) exist that aim to explain why suicidality in persons with BD (as well as in those without BD) occurs. Significantly, these models account for suicidality in terms of the interplay between cognitive, psychological, social, and physiological factors, thereby highlighting the effectiveness of multi-dimensional explanatory frameworks. Some of these models are briefly reviewed in what follows.

The *stress-diathesis* model (Brent & Mann, 2005) proposes that suicidality depends on interactions between the individual's threshold for stress and the presence of internal and external predisposing factors. This threshold is influenced by the interactions between pre-existing risk factors (such as psychiatric history, genetic predisposition to suicidality or psychiatric illness, previous trauma, and other factors that affect neural and physiological systems responsible for regulating stress and emotional responses) and presently or recently experienced stressors in the environment (such as difficult life circumstances or poor quality of relationships). Importantly, this model holds that "the development of suicidal behavior involves a vulnerability or diathesis as a distal risk factor, which predisposes individuals to such behavior when stress is encountered" (van Heeringen, 2012, p. 114). In BD, symptomatic periods, substrates of the disorder, and their effects on physiology and lived experience act as a diathesis, as they can increase vulnerability to suicidality, in particular through difficulty regulating affect, restricting thought patterns, causing psychic pain, increasing impulsivity and/or aggression, decreased resilience to stress, frequent or prolonged exposure to depressive periods or that may be accompanied by suicidality.

The *cry of pain (CoP)* model identifies three cognitive components of suicidality (van Heeringen, 2012 citing Williams and Pollock 2001; Williams, 2002). The first is *sensitivity to signals of defeat* , wherein "an involuntary hypersensitivity to stimuli signaling 'loser' status increases the risk that the defeat response will be triggered" (van Heeringen, 2012, p. 118). Of the three, feelings of defeat appear to be the most influential in generating suicidal behaviour (Malhi et al., 2013). The second, *perceived "no escape,"* is the outcome of a restricted capacity for problem-solving that leads to perception that one cannot escape from problems or difficult circumstances. Finally, *perceived "no rescue"* refers to the inability or difficulty in imagining that the future can have in store positive events and experiences. A "biologically mediated *mental helplessness script"* (Malhi et al., 2013, p. 560) can arise when these states are experienced. Depending on the individual's internal and external circumstances, this script may be acted on in the form of suicidal behaviour. Importantly, these cognitions tend to accompany depressed periods, and thus may be recurrent or frequent in persons with BD.

According to the *bipolar suicidality model (BSM)* (Malhi et al., 2013), the *appraisal system* , which assigns valence to information about one's circumstances or internal states, is likewise implicated in generating suicidality. When the appraisal system evaluates one's situation negatively, it is possible for feelings of defeat, entrapment, and hopelessness to arise, which can thus give rise to a suicide script wherein suicide appears as a viable option for relief or escape. Importantly, in BD, the appraisal system is affected by the cognitive and emotional dysregulation engendered by symptomatic periods (Kelly et al., 2012; Malhi et al., 2013), so that appraisal of circumstances may be disproportionately negative or positive during depression and mania or hypomania, respectively.

The *interpersonal theory of suicide (IPTS)* (Joiner, 2005) argues that a sense of *thwarted belongingness* and *perceived burdensomeness* , combined with an *acquired capability for suicide* are responsible for suicidality (Malhi et al., 2018). Thwarted belongingness is defined as "feelings of isolation that emerge from actual or perceived rejection by peers/friends and/or family, and exclusion from social interactions and gatherings," while perceived burdensomeness refers to the "perception that one is implicitly or explicitly a burden on others" (Malhi et al., 2018, p. 342). While the degree to which a person experiences these thoughts can change over time, especially during symptomatic periods, it is nevertheless possible for them to become deeply entrenched or relatively permanent in the construal of one's situation, at times to the point that one begins to view suicide as the only viable option. According to the model, this is how suicidal ideation

can arise. However, transformation of ideation into action requires having the actual capacity for suicidal behaviour. This capacity may manifest as a tolerance for the level of pain involved in suicidal actions, or a diminished fear of death. These aspects of the capacity for suicide are dynamic and variable over time, and are susceptible to influence by the symptoms of BD (Malhi et al., 2018). It is when all these factors are present and sufficiently salient that suicidal actions are likely to be carried out.

The *integrated motivational and volitional (IMV) model* (O'Connor & Kirtley, 2018) is a biopsychosocial model that "delineates the final common pathway to suicidal ideation and behaviour" (p. 2). According to the IMV, suicidal ideation is engendered by defeat and entrapment, while the translation of suicidal ideation to suicidal behaviour is driven by*volitional moderators.* The model has three phases:*pre-motivational* , which elucidates the biopsychosocial context of individual predispositions toward suicidality, such as by "identifying vulnerability factors and triggering negative events" (O'Connor & Kirtley, 2018, p. 3); *motivational,* which refers to the emergence of suicidal ideation and formulation of suicidal intentions; and*volitional,* wherein suicidal actions are implemented. Among the constructs central to the model are *defeat/humiliation* and*entrapment.* Individuals who possess *vulnerability factors* are more likely to develop suicidal ideation when faced with adverse experiences (pre-motivational phase). Vulnerability factors can be biological, psychosocial, environmental, or cognitive; BD and its symptoms act as a constellation of vulnerability factors that fall within these different domains. Vulnerability factors increase susceptibility to feelings of defeat or humiliation, which in turn can lead to a sense of entrapment. Depending on which *motivational moderators* , i.e., aggravating or protective factors, are present, suicidal ideation can naturally progress from entrapment (motivational phase). Importantly, these motivational moderators are largely cognitive or psycho-social, and include "reasons for living, attainable positive future thinking, adaptive goal pursuit, belongingness or connectedness", or "feeling a burden, having little or no social support, and depleted resilience" (O'Connor & Kirtley, 2018, p. 4). Finally, *volitional moderators* bring about the last, volitional phase of the model, by mediating the translation of suicidal cognitions into suicidal behaviour. Volitional moderators can be understood as factors that reinforce or facilitate the implementation of suicidal actions. Similar to the IPTS, volitional moderators encompass the "components of the acquired capability for suicide (fearlessness about death and increased physical pain tolerance)," as well as other internal and external factors like prior suicide attempts, availability of instruments for suicide, "exposure to the suicidal behaviour of others. . . , [and] exposure to inappropriate representations of suicide" (O'Connor & Kirtley, 2018, p. 4).

Finally, the *three-step model (3ST)* (Klonsky & May, 2015) is explicitly described as an "ideation-to-action framework" by its proponents. These steps are 1) *the development of suicidal ideation* , 2) *strong versus moderate ideation,* and 3)*progression from ideation to attempts.* The model has four concepts: "pain, hopelessness, connectedness, and suicide capacity" (Klonsky & May, 2015, p. 116). It is proposed that suicidal ideation is the outcome of the conjunction of pain—especially prolonged pain—*and* feelings of hopelessness. Both pain and hopelessness must be experienced, as neither on its own is sufficient to give rise to suicidal ideation. However, a sense of connectedness can act as a protective factor that can moderate or alleviate suicidal ideation. While connectedness is typically interpersonal or social, it can also "refer to one's attachment to a job, project, role, interest, or any sense of perceived purpose or meaning that keeps one interested in living" (Klonsky & May, 2015, p. 117). Finally, the translation of suicidal ideation into suicidal action depends on the capacity for suicide, the lack of which hinders the process from moving to the third step. Expanding Joiner's (Joiner, 2005) conceptualization, the proponents distinguish between *dispositional, acquired,* and*practical* contributors to the capacity for suicide. Dispositional factors refer to "relevant variables that are driven largely by genetics, such as pain sensitivity or blood phobia" (Klonsky & May, 2015, p. 119), and other physiological predispositions such as those associated with suicidality in BD (see §3). Acquired factors refer to "habituation to experiences associated with pain, injury, fear, and death," while practical factors consist of "concrete factors that make a suicide attempt easier" (Klonsky & May, 2015, p. 119).

Taken together, these models demonstrate the effectiveness of multi-dimensional frameworks in elucidating the complex causality of suicidality. While the models are not limited to suicidality in BD, they have provisions for constellations of predisposing factors such as the biological, cognitive, and psychosocial features associated with BD. Although suicidality is not unique to BD, their intricate relationship forms a distinctive

starting point for investigating the structure of suicidality.

Suicidality and the need for multi-dimensional approaches

What suicidality in BD demonstrates is that rather than developing traditional reductionist frameworks, it would be productive to develop a heterogeneous framework that can bring together multiple disciplines. On one hand, it could provide insight into experiential aspects since this is the kind of phenomenon that cannot be alienated from experience. On the other hand, it could direct neuroscience inquiry and provide "validation of a neurobiological proposal" (Varela, 1996, pp. 344–345). A benefit of heterogeneous frameworks that incorporate mental states as constructs is able to accommodate unpredictability (Chang, 2012), such as individual presentations of BD and experience of suicidality. While there are patterns in the risk and predisposing factors, there is extensive variation in suicidality across individuals. Aspects of individual life experience such as culture, mores, norms, social circumstances, personal values, or character traits act as differential factors with significant and not entirely predictable influence on suicidality. These factors affect how suicidal cognitions (e.g., "I want to end my suffering by killing myself") interact with other cognitions (e.g., "If I kill myself nobody will look after my dog"), as well as how the courses of action they give rise to (e.g., "I won't kill myself because I'm worried about what will happen to my dog if I do"). A heterogenous framework can thus present a comprehensive picture of suicidality that accounts for physiological processes and their effects on lived experience and phenomenology, a particularly crucial aspect of understanding why suicidality occurs.

Suicidality is an exemplar of a phenomenon calling for a heterogenous approach, since it is characterized by multiple dimensions—from the biological through to the psychological and cognitive to the sociocultural. It can likewise be addressed through multidisciplinary methodologies, depending on its individual presentation. While suicidality is largely regarded as a phenomenon that must be prevented or alleviated, the type of intervention through which it can be addressed successfully varies across individuals: some may be more responsive to a pharmaceutical approach that intervenes biologically, while for others a psychological approach that addresses its cognitive aspects is more effective. On the other hand, treatment based on one dimension may not always be effective if suicidality is the outcome of factors from another. For instance, medication may not sufficiently address suicidality arising from how one construes one's circumstances, whereas talking therapy may not successfully alleviate suicidality when it is caused largely by biological factors. An important component of treatment strategies is thus to identify which dimension—mental, physical, or environmental—is more salient to suicidality in a particular case, and address it accordingly.

One step towards developing a stable heterogeneous approach towards addressing suicidality is to establish points of contact regarding the "biological realization of [cognitive] structures" (Murphy, 2008, p. 128). An example of this task would be identifying neural correlates of typical types of suicidal cognitions—such as feelings or beliefs of "hopelessness…, perceived burdensomeness…, thwarted belongingness…, defeat…, and unbearability" (Bryan et al., 2022, p. 270)—or determining the physiological and neurological characteristics accompanying them. Another step is to use explanations from one dimension to formalize or describe cognitive concepts, while not dismissing the relevance of their content (Smith et al., 2022). The importance of cognitive content is underscored by BD, wherein the physiological effects of symptomatic periods can generate suicidal cognitions, which however may not always be responsive to physical interventions such as medication. It would be helpful to recognize which physiological processes contribute to realizing the different types of suicidal cognitions (Bryan et al., 2022, 2022; Rudd & Bryan, 2021). This could then help trace their interactions with physical factors associated with other factors implicated in suicidality, such as the types of brain activity and physiological processes associated with BD's symptoms, thereby helping to understand how certain sets of physiological conditions contribute to certain types of cognitions.

Concluding remarks: Making the case for levelless reduction

So far, we have shown that in psychiatry, both psychological and neurobiological conceptualisations of mental illness are widely utilised with seemingly no tension. In this section, we discuss recently explored treatments of suicidality in BD that demonstrate further the inadequacy of level-based models of reduction of the

psychoneural relation.

Psychosurgery and electro-magnetic neuromodulation interventions for the treatment of psychiatric conditions have seen a resurgence with recent developments in biomedical technology (Staudt et al., 2019). Cutting-edge techniques include vagus nerve stimulation (VNS), transcranial magnetic stimulation (TMS), deep brain stimulation (DBS), electro convulsive therapy (ECT), magnetic seizure therapy (MST), among others (Trapp & Williams, 2021). There is growing literature on the effectiveness of neuromodulation techniques for the treatment of depression (Conroy & Holtzheimer, 2021), bipolar disorder (Mutz, 2023) and suicidality (Kucuker et al., 2021). ECT has shown positive results specifically in the treatment of suicidality in BD (Kucuker et al., 2021; Liang et al., 2018; Tondo et al., 2021). These interventions are typically recommended as add-ons to the better established psychosocial and pharmacological interventions, though they are often last resort interventions for treatment-resistant conditions.

DBS, and human-machine interfaces more generally, clearly challenge the ontological assumptions underlying the traditional level-based views of the psychoneural relation and the corresponding scientific disciplines that study each component at a specific level. In human-machine interfaces, a mechanical part is directly connected with a biological organism as its proper part. However, a mechanical arm is functionally and compositionally at the same "level" as a biological arm. In the case of DBS, the mechanical parts—electrodes, pulse generator, and connecting wire—are not meant to provide a functional analogue of any organic part of an organism. Rather, they help the brain restore some specific function by being novel mechanical parts augmenting the organism's nervous system. Thus, the "levels" of scientific disciplines cannot align with the levels of organisation in the thus blended organism. This goes to show that debating over the proper account of levels so as to reduce them or make sure that they are independent from one another threatens to turn into mere scholastic bickering and philosophy would fail to make a meaningful contribution to psychiatry.

Another set of interventions for suicide prevention also poses a challenge for the level-based view of the psychoneural relation in psychiatry. Environmental programs for suicide prevention may include restricting access to commonly used means for suicide such as firearms or pharmaceuticals, raising public awareness, and providing guidance on news reporting. Restricting access to bridges, tall buildings and railway tracks have proven to be among the most successful interventions for suicide prevention (Platt & Niederkrotenthaler, 2020). Here, the intervention is out of the scope of the composition of the organism, but it restricts behaviour. So, the intervention is indirectly on the whole organism. However, it is based on physics rather than biology or psychology.

All this goes to show that the integration of all factors would be better conceptualised through a levelless model of the psychoneural reduction. We are not alone in this motion for abandoning the notion of levels in the conceptualisation of the psychoneural relation. Recently, Bickle et al. (2022) have proposed a case study that exemplifies the inadequacy of the level-based reduction debates to capture the reality of contemporary scientific practice in the field of cellular and molecular cognition. We suggest focusing on *multi-dimensional* rather than *multi-level* accounts of psychiatric phenomena. In our view, reduction may occur in psychiatry, but it is a reduction of boundaries between the disciplines employed in the study of psychiatric phenomena in which multiple disciplines blend for the purpose of providing multi-dimensional explanations. Consolidation, or reduction in number, occurs. However, it does not entail one discipline subsuming another. Thus, our approach could be considered as*interdisciplinary reduction* as opposed to the outdated view of*intertheoretic reduction* .

Conflict of Interest

The authors declare no conflicts of interest.

Data Accessibility

Not applicable.

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