

measures.

The number and type of domains of psychopathology can never be clarified on the symptomatic level alone. A continuing back-and-forth validation between internal (i.e., factor structure) and external (i.e., genetic, neurobiological, cognitive, environmental, therapeutic, prognostic, and so forth) construct validity would remain. To illustrate, it has often been said that “our DNA has not read the DSM”, and this obviously holds for any conceptualization of psychopathology at the symptom level.

High-quality multidimensional measurement will not be achieved by subjecting “all existing symptoms of psychopathology” to

factor analysis. Rather, the dimensionality of our measures should be created using a top-down approach, pragmatically choosing clusters of items representing relevant conceptual domains of psychopathology. By subjecting these item clusters to the bifactor model, it will be possible to achieve a dimensional measurement that both lumps (into the general factor) and splits (into specific dimensions). Only then can we fully evaluate the specific associations of psychopathology.

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## Taxonomy of psychopathology: a work in progress and a call for interdisciplinary research

Taxonomy is an essential element in the process of understanding and organizing concepts that form part of any scientific discipline. This exercise of classification has its origins in the mid 1700s with Carl Linnaeus' biological taxonomy, that provided the original rank-based classification of organisms, including plants, minerals and animals. For mental health disciplines, including psychiatry and psychology, this process of classification has been made especially challenging because of issues related to both the conceptualization and the measurement of psychopathology. Some other scientific disciplines work with clearly defined sets of criteria to identify and categorize the phenomena they study. Mental health problems bring complex issues related to symptom presentation and comorbidity that have yet to be agreed on.

The usefulness and applicability of psychiatric nosology stand on at least two pillars. The first is that a taxonomy must reflect clinical reality: patients with mental health problems often present heterogeneous symptoms and comorbid disorders. The second is that a taxonomy must soundly summarize clinical information, based on appropriate statistical models, but without losing fine-grained details that are relevant for research and treatment.

Significant concerns have been raised

as to whether the current categorical classification systems of psychopathology meet either of these requirements. There is indeed extensive recognition that comorbid presentation of psychiatric disorders is the norm rather than the exception<sup>1</sup>, and that symptoms vary across illnesses instead of being limited to individual diagnoses. A dimensional approach may be best suited to reflect this reality.

A productive debate about the appropriateness of a categorical diagnostic system is still ongoing, and concerted scientific efforts have resulted in proposals for sophisticated models as alternative approaches to psychiatric nosology, including the Hierarchical Taxonomy of Psychopathology (HiTOP)<sup>2</sup>, the transdiagnostic approach<sup>3</sup> and the Research Domain Criteria (RDoC)<sup>4</sup>. While a consensus has not been reached yet, there is an undeniable recognition of the pressing need to find more suitable models and methods for classifying psychopathology. Mental health research depends on it but, most importantly, clinical services rely on a suitable nosology to provide appropriate treatments to those who need it.

Lahey et al<sup>5</sup> provide an overview of the hierarchical approach to psychopathology. This approach – which is strongly embedded in psychometric methods – proposes

models in which a higher-order, or general, factor (otherwise known as the p factor) captures correlated symptoms, and lower-order, or secondary, factors encapsulate specific symptoms<sup>6,7</sup>.

There are valuable strengths in this approach, as it provides a concise summary of symptoms across mental health problems and retains a dimensional approach to psychopathology. However, three points deserve further considerations.

First, there is a risk that the bifactor model remains limited to a statistical representation of psychopathology. Findings reviewed by Lahey et al indicate that the p factor is genetically influenced and more stable than the secondary factors. However, this may be an artefact of statistical organization of data with, for example, secondary factors being more prone to include stochastic (i.e., randomly determined) measurement errors that are not influenced by genetic factors and are less inherently stable. These secondary factors may also, in effect, hold key information for treatment and precision medicine.

Second, the development of mental health problems is a dynamic process that changes throughout the life course and depends on social context. While there are findings supporting the validity of the p factor in samples of young children<sup>8</sup>, it is

not clear how the hierarchical approach to psychopathology takes developmental processes and transient problems into account and whether the bifactor model applies to all ages, ethnicities and socio-economic strata.

Third, it is yet not clear to what extent the bifactor model has practical value for clinics and mental health services. A categorical approach has the merit of identifying critical points at which an individual supposedly needs treatment. Without information about impairment, it is hazardous to establish clinical needs based on a continuous representation of psychopathology.

For the growing community of mental health researchers, psychiatric nosology is one of the biggest challenges of our times. It has generated passionate debates about the value, the relevance and the usefulness of current approaches, which are part of a useful process that can lead to a new meaningful and practical classification system. Recent attempts to unify the field into adopting new ways of thinking about psychopathology are unavoidably being developed via a process of trial and error. And, while no proposed models fit the bill just yet, there is great value in this process. This is a work in progress. One recent study,

for example, reported that high scores on the p factor derived from mental health information collected across four decades in a well-characterized birth cohort were correlated with neurocognitive difficulties throughout the life span<sup>1</sup>. Future work from this cohort is expected to further validate this taxonomy.

The bifactor model can be at the intersection where statistical approaches meet clinical knowledge. Interdisciplinary research will be key to addressing remaining concerns with the development of a new nosology of mental health problems. Collaborations across researchers and mental health professionals will hopefully produce a unified dimensional approach and conceptualization of psychopathology that both summarizes information and retains specificity. This needs to be developed with statisticians and psychometricians and to embed philosophical, social and ethical dimensions of psychopathology. Epidemiology, genetics and neuroscience will add value to further tests of validity.

Despite profound changes, the Linnaean taxonomy remains important and relevant to biologists today, two centuries after it was first put forward<sup>9</sup>. We should aim to carry over some worthy aspects from the current classification systems into a new nosol-

ogy of psychopathology. One such aspect is the relevance to treatment and clinical services. Linnaeus did not have the difficult task of considering how to treat animals, vegetables or minerals when he developed his taxonomy. But we do. A nosology that stands the test of time will have to be both relevant and useful for the development of new treatments and prevention programs to reduce the burden of psychopathology on individuals and society.

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