QUANTIFICATION IN PSYCHIATRY-BEYOND PSYCHOMETRICS

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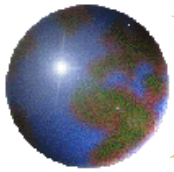
US mental-health chief: psychiatry must get serious about mathematics

Joshua Gordon says that his focus at the National Institute of Mental Health will be on quick wins, brain circuits and mathematical rigour.



Top down (clinical experience) vs bottom up (taxonomic)

- Criteria driven by clinical experience – the clinician perspective bias
  - Multiplicity of ever more subcategories of subcategories
  - Population data fit better with parsimony…
- Classification based on statistical analysis of large dataset item pools… the contribution of numerical taxonomy
  - Example taken from Slade & Watson, 2006, Psychological Medicine.

Inter-Rater Reliability of Selected DSM Diagnoses

- For most DSM diagnostic categories, reliability is good
- Reliability in everyday settings may be lower than in formal research settings
- Validity and reliability are often at odds with each other. DSM-IV accused of sacrificing validity for increased reliability.

Diagnosis	Kappa
Bipolar Disorder	.84
Major Depression	.80
Schizophrenia	.79
Alcohol Abuse	1.0
Any Eating Disorder	.77
Panic Disorder	.65
Avoidant PD	.97
Dependent PD	.86

QUANTIFICATION

• Quantification is the act of giving a numerical value to a measurement of something, that is, to count the quanta of whatever one is measuring. Quantification produces a standardized form of measurement that allows statistical procedures and mathematical calculations. Quantitative research methods are based on a natural science, positivist model of hypothesis testing.

THE RISE OF QUANTIFICATION

- “Growing prominence and success of the natural sciences, especially physics,
- rise of capitalism and the rational spirit in western societies
- Move toward a more rational, bureaucratic, and calculative life,
- an attempt of weak professional groups to pacify social and political pressures for greater accountability. In other words, according to Porter, the surge of quantification in the social sciences was driven mainly by the desire to create an appearance of professionalism and gain legitimacy for social research and public policies
- quantification facilitates the emergence of new categories such as “the nation "or “public opinion.”
- important information is lost for the sake of simplicity and calculability
- Often extended into areas in which it does not make statistical sense--race and ethnicity--CENSUS

- Those seeking a place for measurement within psychology were required to resolve the following inconsistent triad of intellectual currents:
- 1 *The Classical Concept of Measurement*: All measurable attributes are quantitative.
- 2 *The Measurability Thesis*: Some psychological attributes are measurable.
- 3 *The Quantity Objection*: No psychological attributes are quantitative.
- Each of these propositions is contradicted by the other two conjoined. Progress requires rejecting at least one.

The quantity objection psychological attributes are not quantitative

- philosophical roots in the scientific revolution-successes of Galileo's physics, the older, Aristotelian view, according to which the natural world was thought to contain both qualitative and quantitative features, was rejected. It was replaced with a comprehensively quantitative view of the physical world.

Within this new view, the apparently qualitative features of things (such as colours, odours, flavours, etc.) were extracted from the commonsense picture of the natural world and relocated within human 'consciousness'. This banishment of qualitative features to 'consciousness' was closely linked with the distinction between primary and secondary qualities articulated in various versions by thinkers such as Galileo, Hobbes, Boyle, and Locke. The primary qualities were understood to be the quantitative attributes of things and they were taken to be their only real physical properties. The secondary qualities were defined either as combinations of primary

qualities apt to cause qualitative experiences in consciousness, as in Locke (i.e., as physical dispositions)[15] or as the qualitative, conscious experiences themselves, as in Galileo.[16] The content of these qualitative experiences was thought of as having no existence independent of the mind involved.

MEASUREMENT IS UBIQUITOUS

Needed in everyday activities like cooking recipes, medicine dose, measuring body temperature during fever.

Concepts of measurement are often invisible

What can or cannot be measured?

can we measure depression, love , happiness, attitude

“when you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot express it I numbers, your knowledge of it is of a meagre and unsatisfactory kind-Lord Kelvin

MATHEMATICS IS EVERYWHERE

- Physicist Eugene Wigner(1960) –"The unreasonable effectiveness of mathematics in the natural sciences".
- Human mathematics has been developed by human brains, which themselves are evolutionary products of the natural world, thus our mathematics matches the world around us.
- Just as our language influence and constrain what we can think about(Whorf-Sapir's linguistic relativity)- does measurement do the same?

The fundamental problem is that, attitudes or motivation, psychological issues cannot be measured directly, like length or weight; instead, the process of its measurement is indirect and involves several steps.

The first requires agreement on a definition of what is to be measured: what does the concept health include? Should the definition be broad or a narrow

“Measurement, in any true sense, is impossible in psychology, but their opinion
might change if new facts were established”
Final Report BAAS, 1940
“the stars .... we would never by any means
investigate their chemical composition”
Auguste Comte, 1842
???
???

Before we go further, we would like to first clarify that by quantification we do *not* mean statistical analysis. Whereas quantification involves representing observable behaviours and psychological characteristics (abilities, attitudes, dispositions, etc.) with numbers, statistical

analysis involves applying mathematical operations to sets of numerical “objects” and, thus, requires that quantification has already occurred. Moreover, we recognize that in psychology all forms of quantification have traditionally been conceived of as “measurement” (see Stevens,

1946).

Rather, we merely note that by “quantification,” we mean *all* practices of numerical representation, It is also important to note that numerical representation is not the only form of data representation currently used in psychology. There are researchers working in psychology and psychology-related fields who deal only with non-numerical information (e.g., text, images, video, or audio). These non-numeric forms are usually tied to the broader domain of “qualitative

methods,” which is often juxtaposed with so-called “quantitative methods.” The two categories tend to be viewed as two separate classes of methods, giving rise to a quantitate-qualitative dichotomy

There are several ways to classify health measurements.
They may be classified by their
function, or the purpose or application of the method;
descriptive classifications focus on their scope,
whereas *methodological classifications* consider technical aspects,
such as the techniques used to record information.

An example of a functional classification is Bombardier and Tugwell's distinction between three purposes for measuring health: diagnostic, prognostic, and evaluative.
Diagnostic indices include measurements of blood pressure
and are judged for their correspondence with a clinical
diagnosis.
Prognostic measures include screening tests, scales such as the Apgar score)and measures such as those that predict the likelihood
that a patient will be able to live independently following rehabilitation.
Finally, evaluative indexes measure change in a person over time.

OBJECTIVE VERSUS SUBJECTIVE MEASUREMENT

Ratings that involve judgments are generally termed “subjective” measurements. objective measurements involve no human judgment in the collection and processing of information---observing behaviors only constitutes an objective measure if the observations are recorded without subjective interpretation. Climbing stairs may be considered an objective indicator of disability if it is observed and subjective if it is reported by the person. distinction between “subjective” and “objective” measurements does not refer to who makes the rating: objectivity is not bestowed on a measurement merely because it is made by an expert . Nor should we assume that subjective measures are merely “soft” in longitudinal studies, subjective self-ratings of health are consistently found to predict subsequent mortality as well as, or better than, physical measures

ORIGIN OF QUANTIFYING SUBJECTIVE MEASUREMENT

Arguments for considering subjective judgments as a valid approach to measurement derive ultimately from the field of psychophysics.

Psychophysics is concerned with the way in which people perceive and make judgments about physical phenomena such as the length of a line, the loudness of a sound, or the intensity of a pain: psychophysics investigates the characteristics of the human being as a measuring instrument.

Psychophysical principles were later incorporated into psychometrics, from which most of the techniques used to develop subjective measurements of health were derived.

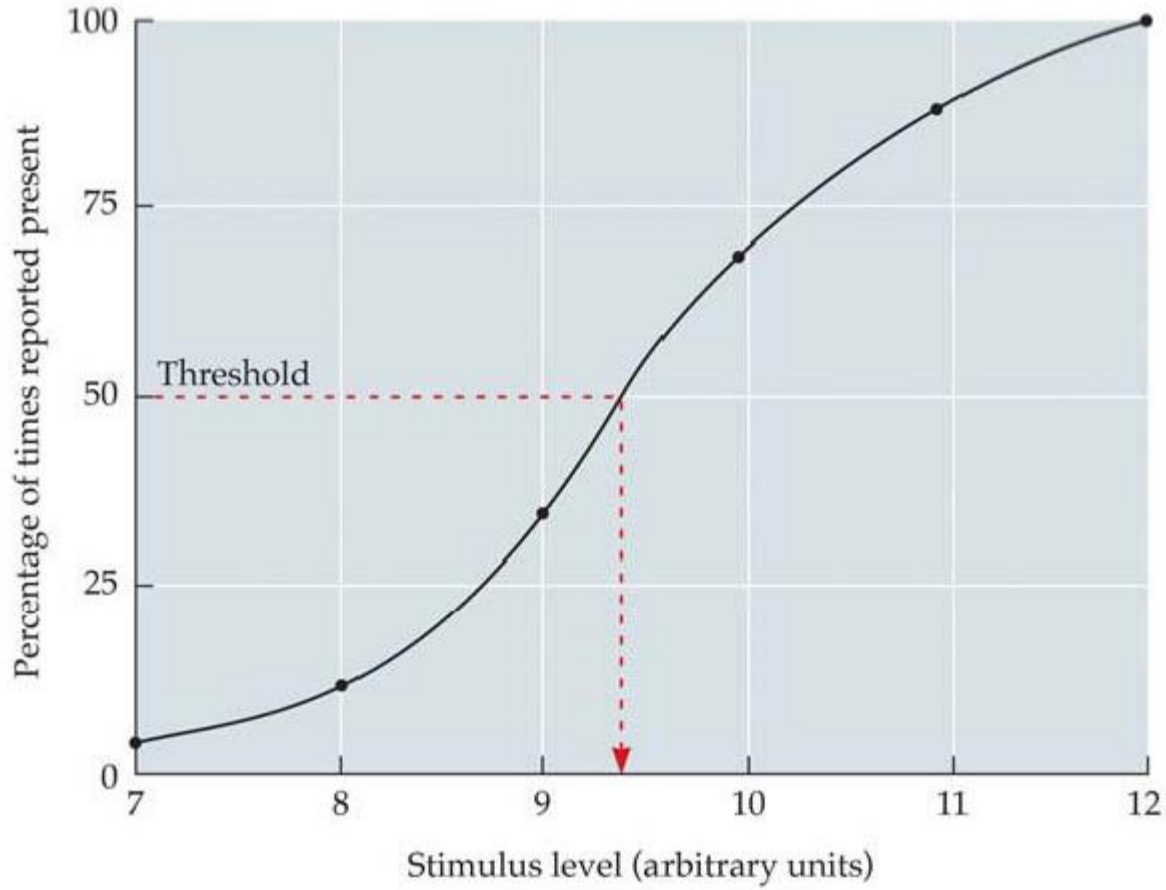
Psychophysics

- Physics
- Psycho
- Thresholds: how sensitive are our senses?
- Scaling: How does our perception change as a stimulus is changed in intensity or in magnitude?

Levels of Processing: Terms

- Detection: Is there any stimulus out there?
- Discrimination: Are the stimuli out there different?
- Recognition: Does this stimulus belong to a known category (e.g. dog)?
- Identification: Is this a specific stimulus (e.g., my dog Spot)?

Absolute thresholds



SENSATION AND PERCEPTION, Figure 1.12 © 2006 Sinauer Associates, Inc.

power law recognized that humans can make consistent, numerically accurate estimates of sensory stimuli. It agreed, also, that the relationship between stimulus and subjective response was not linear, but it differed from Fechner's law in stating that the exact form of the relationship varied from one sensation to another. This was described by an equation with a different exponent for each type of stimulus, of the general form:

$$R = k \times S^{b,}$$

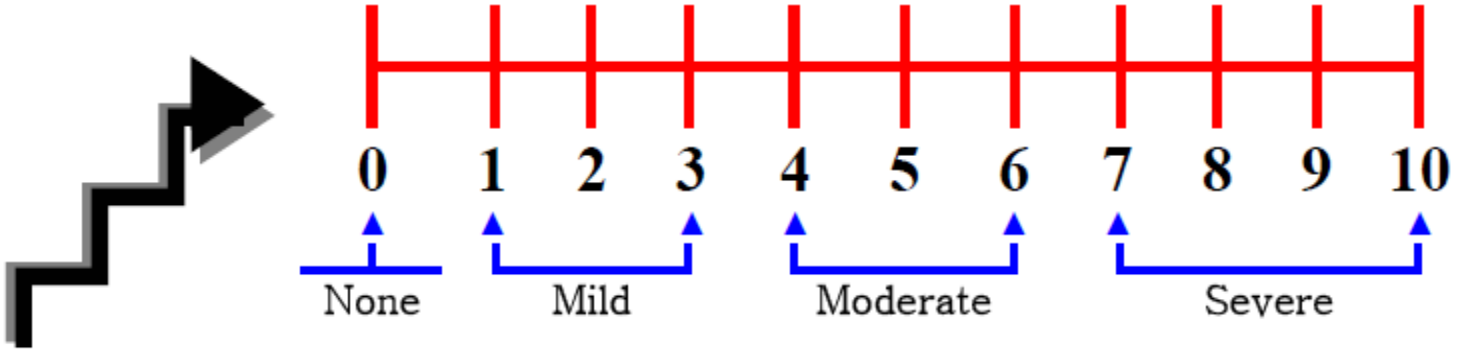
where *R is the response, k is a constant, S the* level of the stimulus, and *b an exponent that typically* falls in the range 0.3 to 1.7 When the exponent *b is unity, the relationship* between stimulus and response is linear, as proposed by Weber's law.

CROSS-MODALITY MATCHING

most convincing evidence from cross-modality matching. *judgments of various* stimuli were made by rating responses on numerical scales Knowing the response exponents, in terms of numerical judgments, for different stimuli (e.g., loudness,

brightness, pressure), arithmetical manipulation of these exponents can postulate how a person would rate one stimulus by analogy to another.

Thus, in theory, a certain degree of loudness should match a predictable brightness or pressure of handgrip—the cross-modality matching. Experimental testing of the predicted match could then be used to test the internal consistency of the power law. As it turned out, the experimental fit between observed and predicted values was remarkably close, often within only a 2% margin of error



Indications: Adults and children (> 9 years old) in all patient care settings who are able to use numbers to rate the intensity of their pain.

Instructions:

1. The patient is asked any one of the following questions:
   - What number would you give your pain right now?
   - What number on a 0 to 10 scale would you give your pain when it is the worst that it gets and when it is the best that it gets?
   - At what number is the pain at an acceptable level for you?

exponent for line length was unity, which justifies the use of visual analogue scales to represent abstract themes such as intensity of pain or level of happiness.

The simplest way to quantify estimates of healthiness is to ask directly for a numerical estimation:

“On a scale of 0 to 100, how severe is your pain?”

However, this may be a difficult task; many people find adjectives (e.g., mild, moderate, or severe) far more natural.

Measurement requires the assignment of numerical scores to such descriptions, and this is achieved by using one of many scaling procedures. These assign a numerical score to each answer category for each topic covered (e.g., pain or difficulty climbing stairs); combining the scores for a given pattern of responses provides a numerical indicator of the degree of disability reported.

Traditionally, psychophysics studied subjective judgments of stimuli that can be objectively measured on physical scales such as decibels or millimeters of mercury. In the social or health sciences, by contrast, we often use subjective judgments because no objective physical ways yet exist to measure the phenomena under consideration. Psychometrics concerns the application of psychophysical methods to measuring qualities for which there is no physical scale and this forms a cornerstone in the development of health measurement methods.

This holds valuable implications for health measurement: people can make numerical estimates of subjective phenomena in a remarkably consistent manner, even when the comparisons are abstract, indeed, more abstract than those involved in subjective health measurements. Finally, studies validating the power law suggested that people can make accurate judgments of stimuli on a ratio, rather than merely on an ordinal scale of measurement; that is, people can accurately judge how many times stronger one stimulus is than another. Judgments of this type are termed “magnitude estimation” and are used in creating ratio-scaled measurements

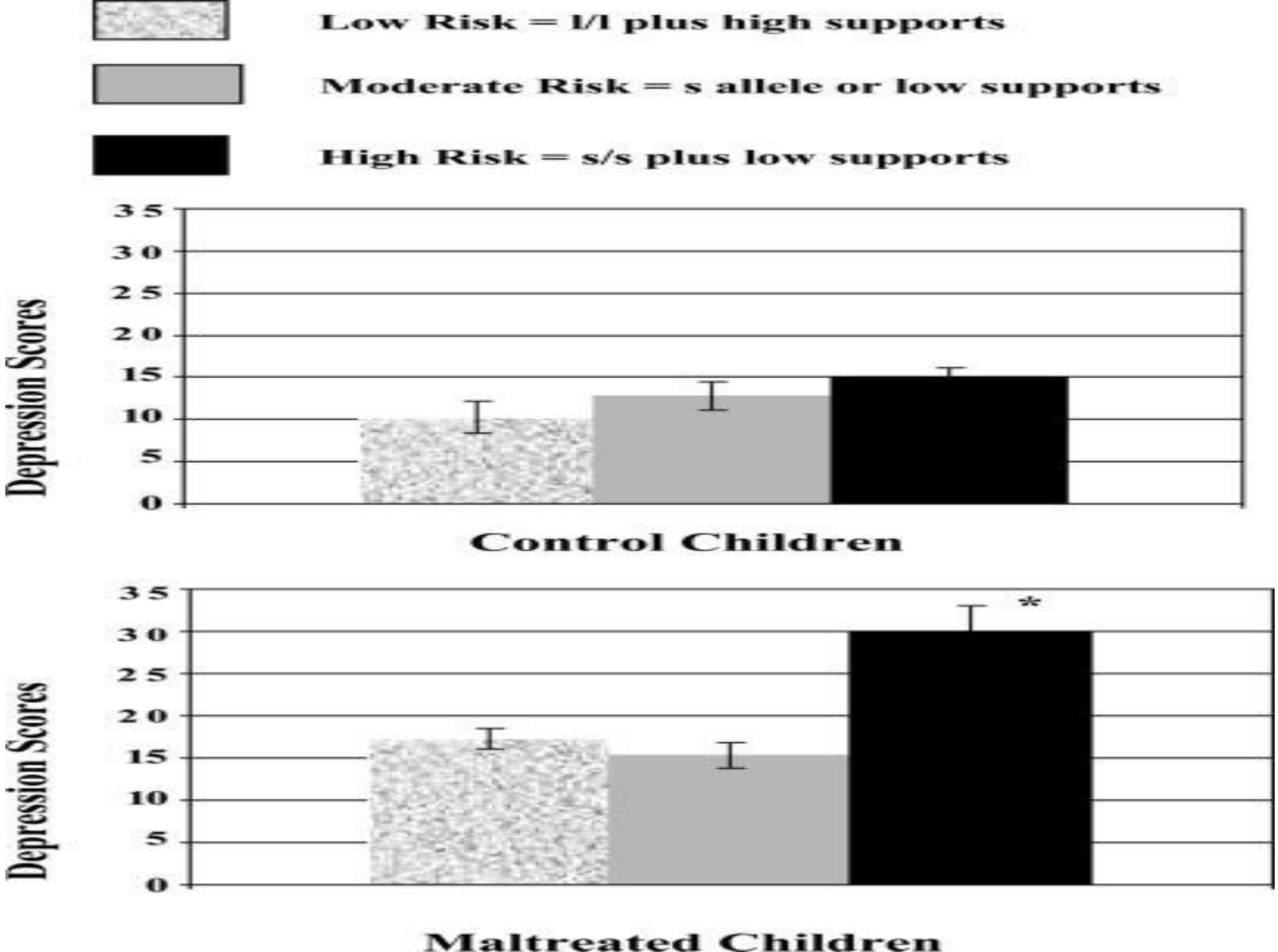
Kline (2000, p. 1) de®nes psychometrics as ªpsychometrics refers to all those aspects of psychology which are concerned with psychological testing, both the methods of testing and the substantive findingsº. Cronbach (1990,p. 34) refers to psychometrics as ªpsychometric testing sums up performance in numbers. Its ideal is expressed in two famous old pronouncements: If a thing exists, it exists in some amount, and, if it exists in some amount, it can be measuredº.

Michell (2000)is concluded that psychometrics is a pathology of science . . .

Measurement, as a scientific method, is a way of finding out (more or less reliably) what level of an attribute is possessed by the object or objects under investigation. However, because measurement is the assessment of the of a level of an attribute via its numerical relation (ratio) to another level of the same attribute (the unit selected), and because only quantitative attributes sustain ratios of this sort, measurement applies only to quantitative attributes. Psychometrics concerns the measurement of psychological attributes using the range of procedures collectively known as psychological tests. As a precondition of psychometric measurement, these attributes must be quantitative.

FACTOR ANALYSIS

Factor analysis can be used to describe the underlying conceptual structure of an instrument; it shows how far the items accord in measuring one or more common themes. Applied to validation, factor analysis can be used in studying content validity: do the items fall into the postulated groupings? Factor analysis can also be used in test construction to guide the selection of items on the basis of their association with the trait of interest. Typically, separate scores would be calculated for these components of the measurement instrument. Factor analysis can also be used in construct validation by indicating the association among subscale components of measurements or even complete measures. Scales measuring the same topic would be expected to be grouped by the analysis onto the same factor (a test of convergent validity), whereas scales measuring different topics would fall on different factors (divergent validity).


Low Risk = l/l plus high supports
Moderate Risk = s allele or low supports
High Risk = s/s plus low supports
Depression Scores
35
30
25
20
15
10
5
0
Control Children
Depression Scores
35
30
25
20
15
10
5
0
*
Maltreated Children

Hamilton Depression Scale - Factors

I. Psychic Depression

- Depressed mood
- Guilt
- Suicide
- Retardation
- Helpless / Hopeless
- worthless

II. Amotivation

- Work & Activities
- Physical Symptoms
- Sexual Symptoms
- Weight Loss

III. Psychosis

- Insight
- Depers / Dereal
- Paranoia
- Obs / Compuls.

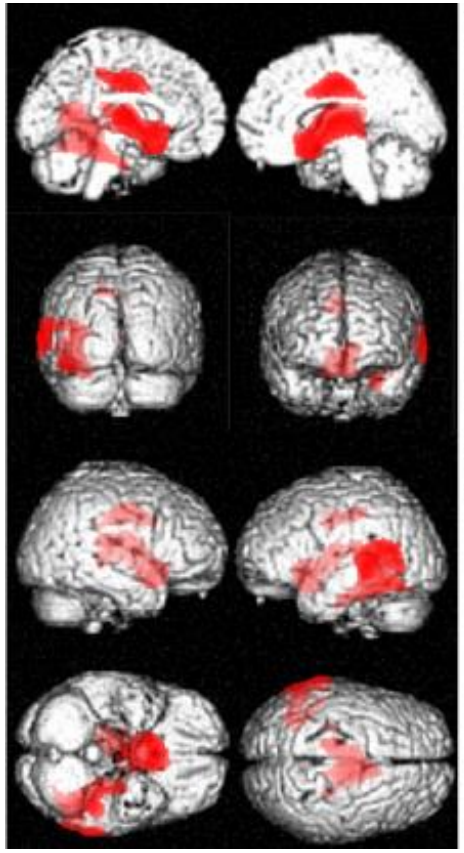
IV. Anxiety

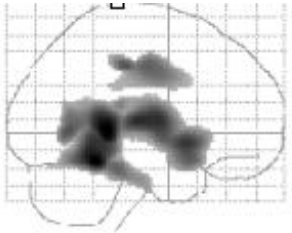
- Agitation
- Anxiety Psychic
- Anxiety Somatic
- Hypochondriasis

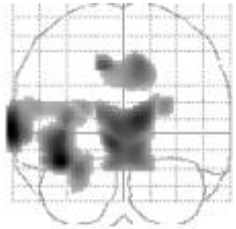
V. Insomnia –
early / middle / late

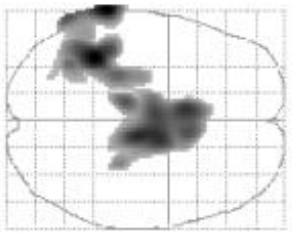
Milak M, Parsey R, Keilp J, Oquendo M, Malone K & Mann JJ. *Arch Gen Psych* 2005

Factor I. Psychic Depression



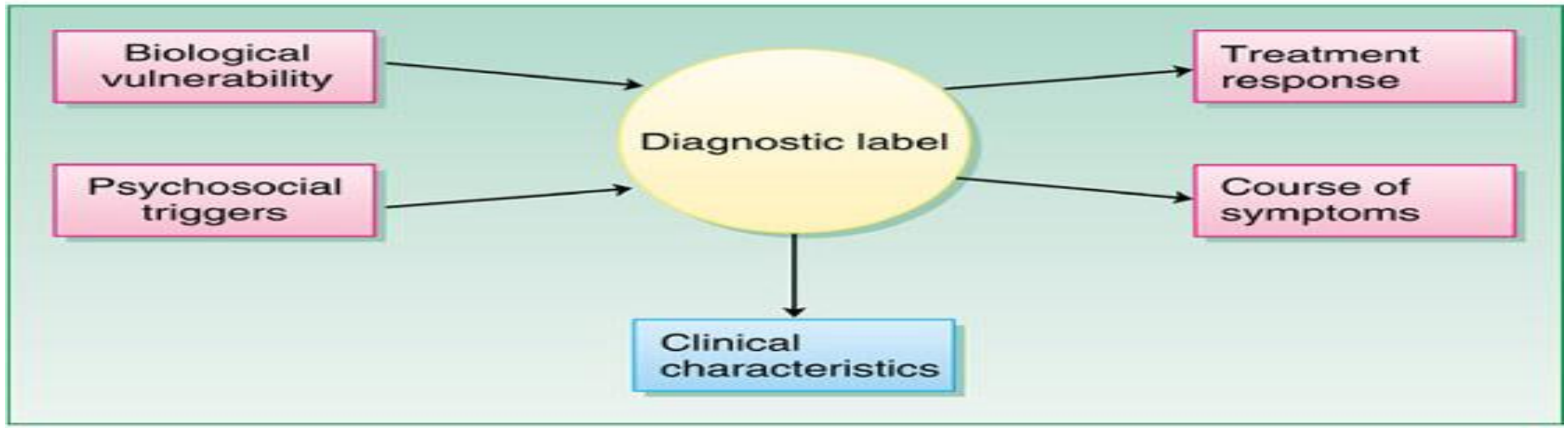




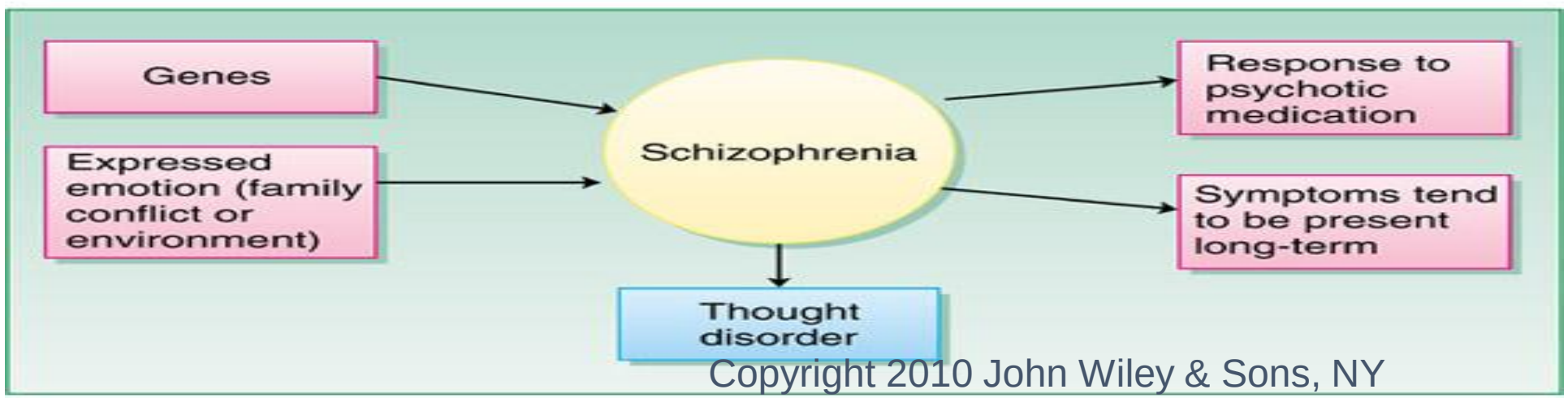


Positive correlation with Cingulate Gyrus, Thalamus & Basal Ganglia

Milak M, Parsey R, Keilp J, Oquendo M, Malone K & Mann JJ. *Arch Gen Psych* 2005



(a)



How are these abnormalities inter-related?

Anticipation of threat (Anticipation social events task)

Explanatory style (ASQ)

Self-esteem (Nugent & Thomas)

Emotion (HADS)

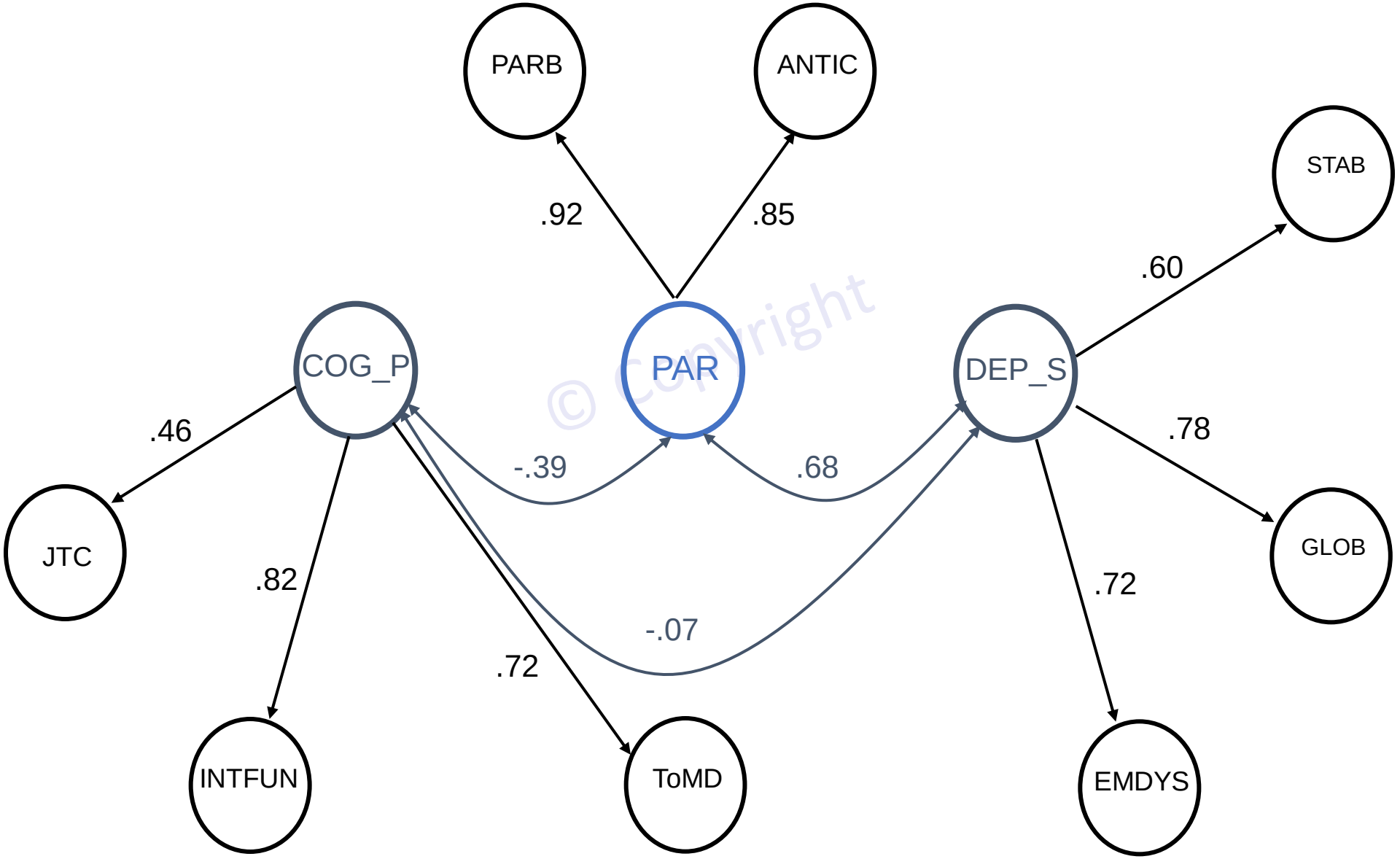
ToM (intentional deception to 2nd order level)

JTC (beads in bottle and social variant)

IQ (WAIS vocabulary, matrix reasoning, digit span)

Bentall, Archives General Psychiatry, in press

The cognitive structure of persecutory delusions across diagnoses



consciousness state space (CSS)

CSS suggests that three dimensions, time, awareness, and emotion, create a state-space encompassing all possible total system behaviors, i.e., a repository of all potentially accessible phenomenological states. These, in turn, fall into two large categories of consciousness, each with its respective sense of self. Section A Dual Organization of the CSS describes the dual orga- nization of the CSS, as well as its neural space. Section The Three Dimensions of the CSS describes the three dimensions of the CSS. Section The Dynamics within the CSS describes the typical antagonistic dynamic behavior of the system, as well as atypical behavior of the CSS, when the typical antagonistic relationship between the two categories is reduced, for example during the experience of flow and in meditation.

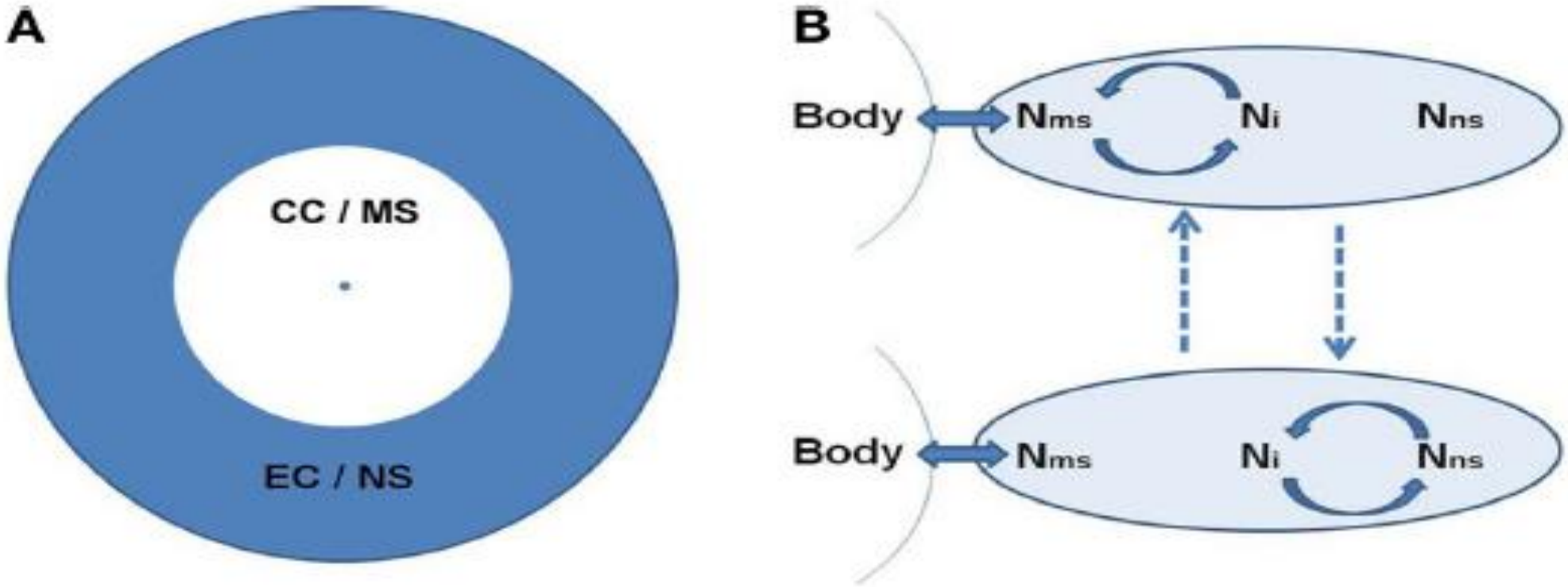


FIGURE 1 | (A) The concentric organization of the Consciousness State Space (CSS). The central point denotes the body. Around it is the core-consciousness (CC) and minimal-self (MS) sphere in white, surrounded by the extended-consciousness (EC) and the narrative-self (NS) sphere in gray. This circular organization depicts a shorter and longer

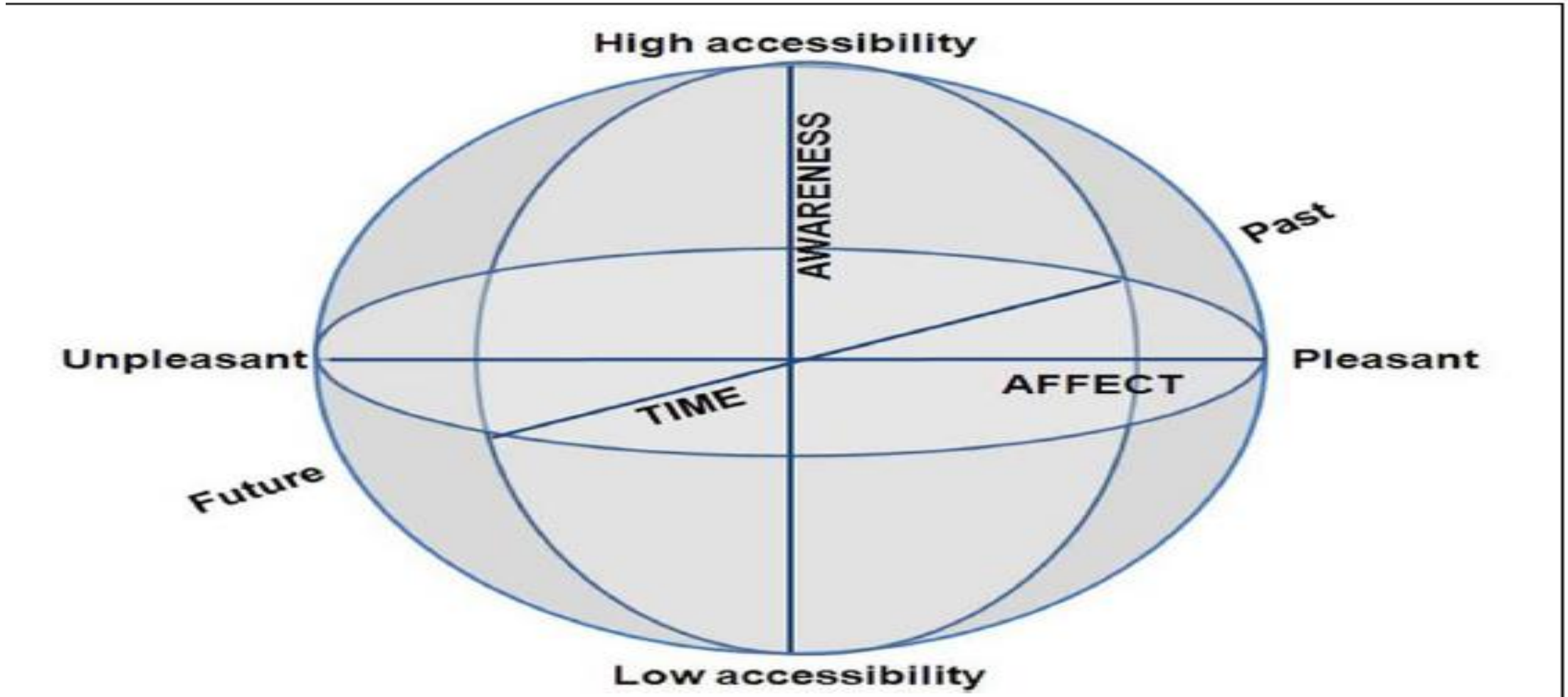


FIGURE 2 | The Consciousness State Space (CSS), depicting a phenomenological space with three psychological dimensions.

Non-linear chaotic dynamics and brain

Human brain is a highly complex non-linear system which may show chaotic dynamics [1]. Diminished chaos in the brain may lead to serious pathology, such as epileptic seizures [2]. So it is not surprised that in analysis of EEGsignal, which represents overall electric activity of the brain, the methods of non-linear dynamics and deterministic chaos theory may be used to analyse pathological changes in the brain, and to assess the impact of applied therapy

Summary of Fractal Properties

Self-Similarity

Pieces resemble the whole.

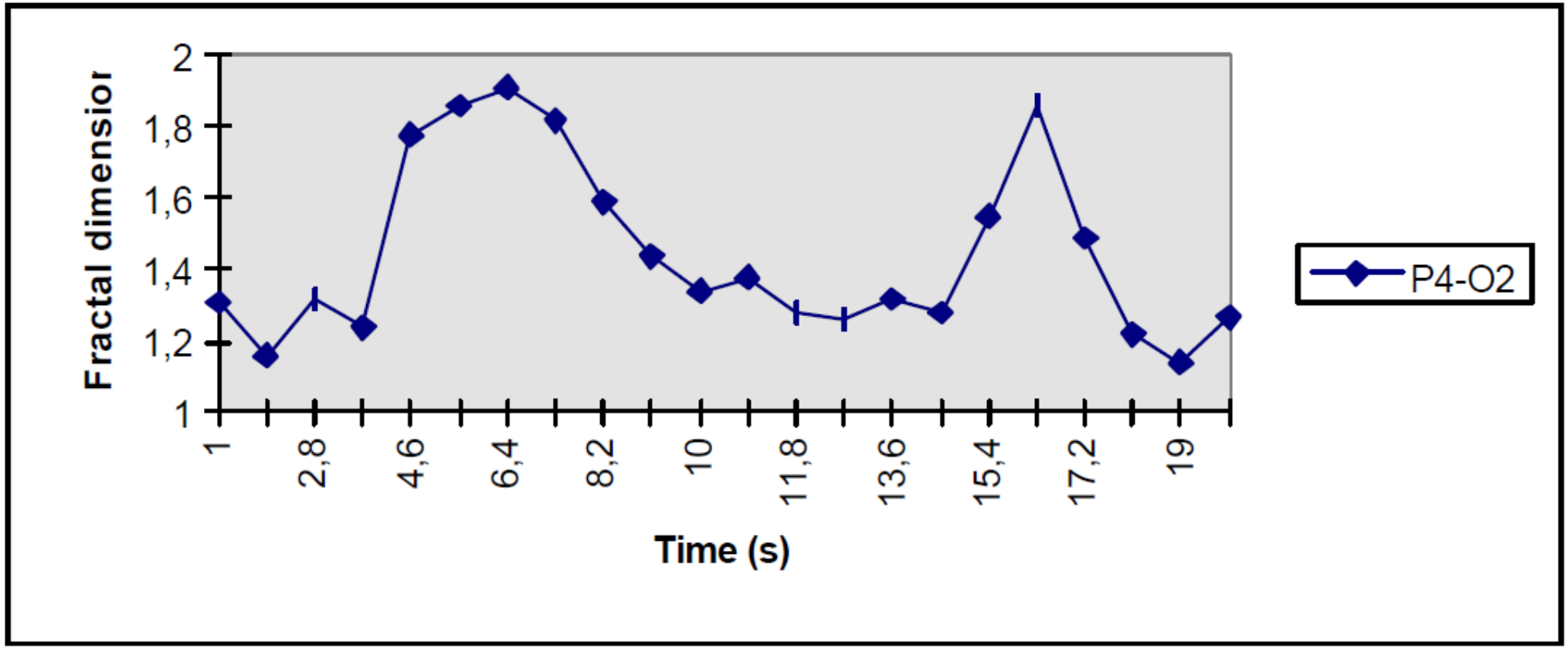
Summary of Fractal Properties

Scaling

The value measured depends on the resolution.

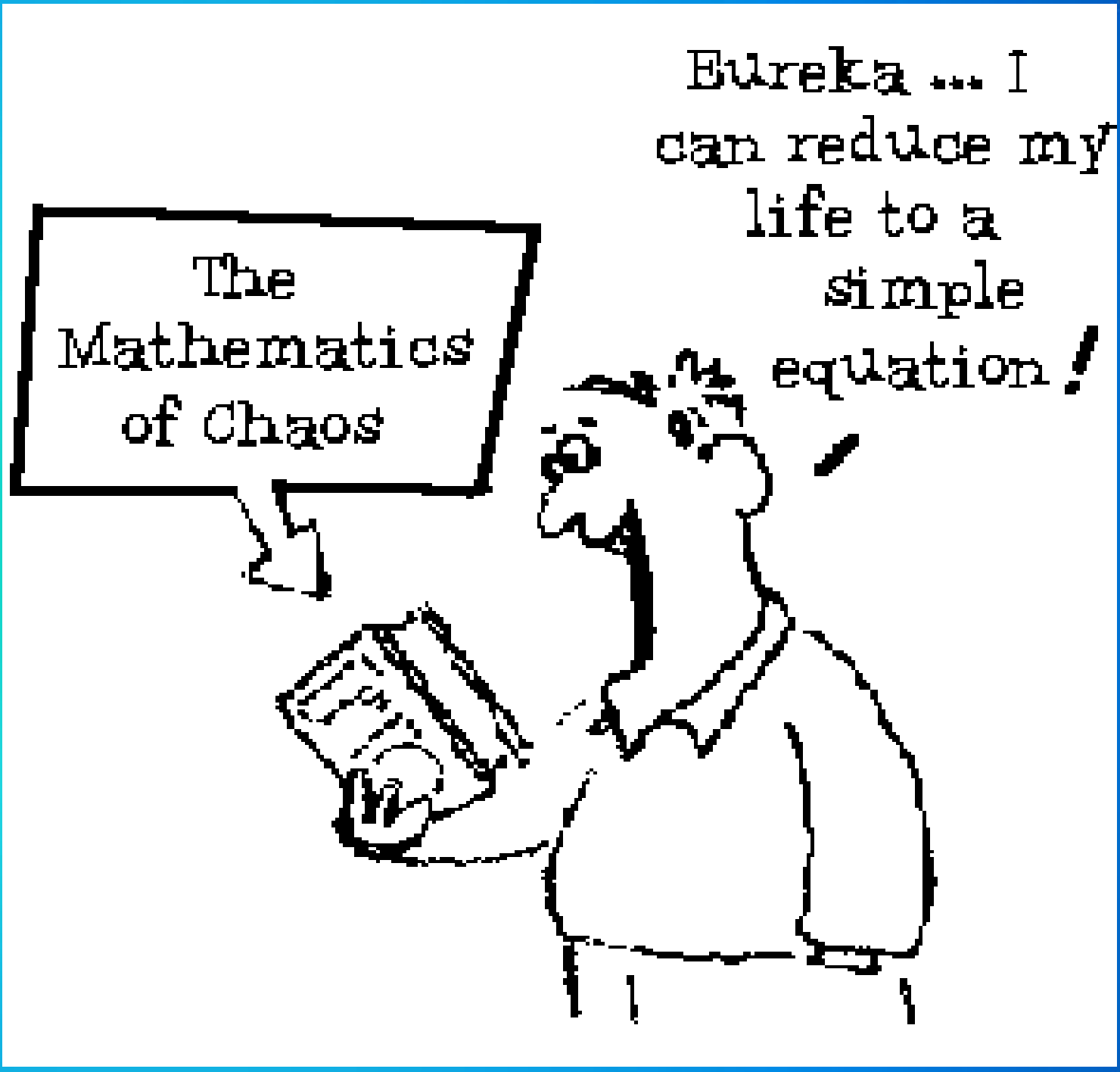
Statistical Properties

Moments may be zero or infinite.

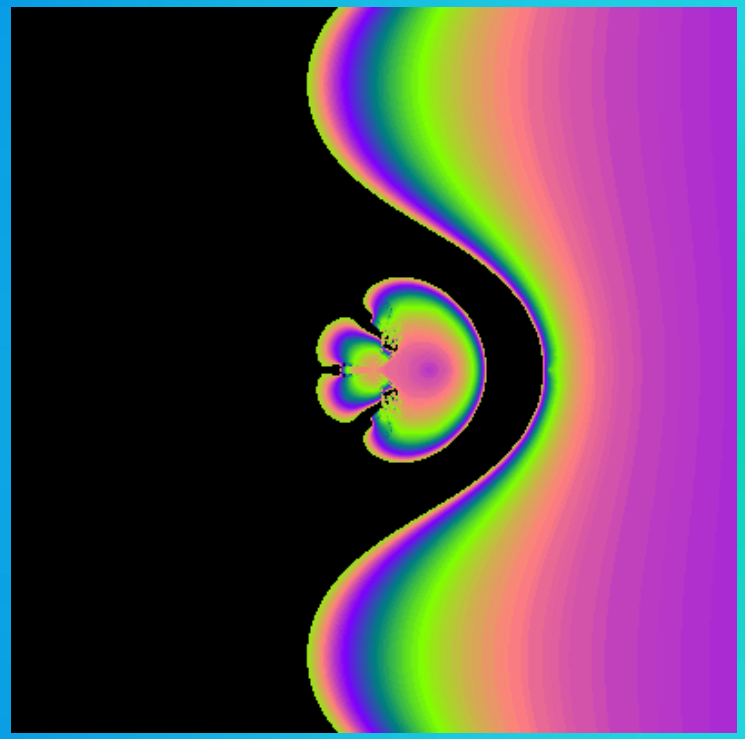


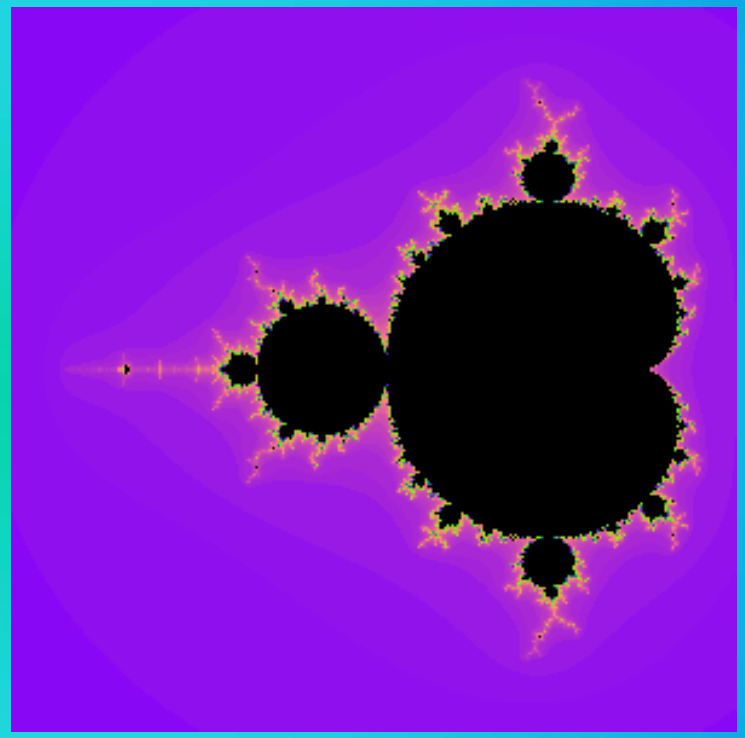
1. Fractal dimension of 19 seconds epoch with eyes-opening (in 4. s.) and eyes-closing (in 15. s.).

Chaos Theory



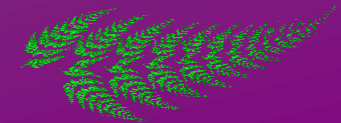
Fractals – the delight of Chaos Theory.





A fractal expression looks like Z = Fn1(Z); Z = Z*Z + Fn2(C)

Dynamical approach to neurology/psychiatry

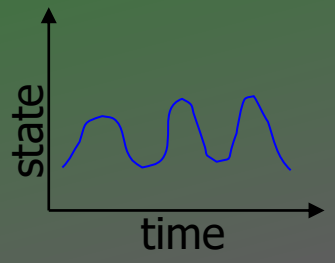


Dynamical approach to neurology/psychiatry

Schizophrenia

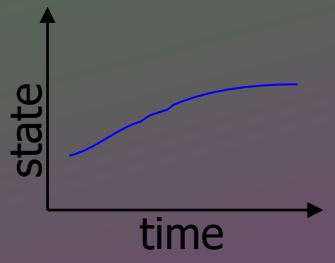
positive and negative symptoms

hallucination



'waving'

uncomplicated actions and speech
decreased motivation

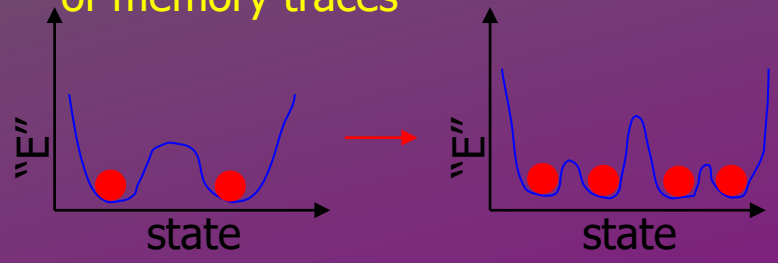


'steady'

Models:

- 'lesion models': does not explain waving
- neurotransmitter model (DOPA)
- disconnection hypothesis ⟶ Friston
- NMDA: delayed maturation of NMDA receptors
- cortical pruning (synaptic depression)

storage and recall
of memory traces



changes in attractor structure
'pathological attractors'

Dynamical approach to neurology/psychiatry

The NMDA Receptor Delayed Maturation Hypothesis

E. Ruppin

Spontaneously occurring NMDA receptor hypofunction

↓

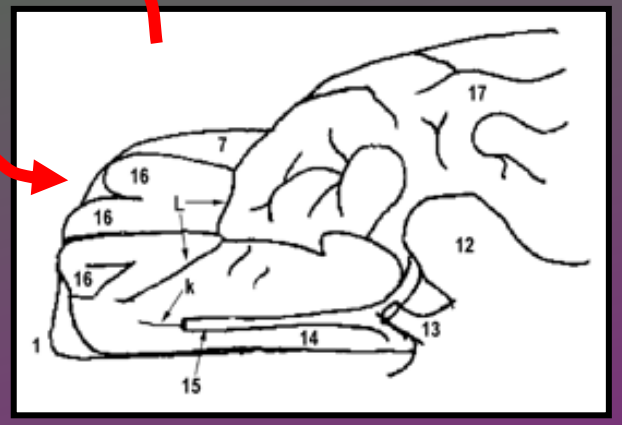
SCHIZOPHRENIA

↑

increase in the expression of the "immaturate" NR2D receptor subtype

↓

Excessive growth of synapses



Frontal cortex, basal view

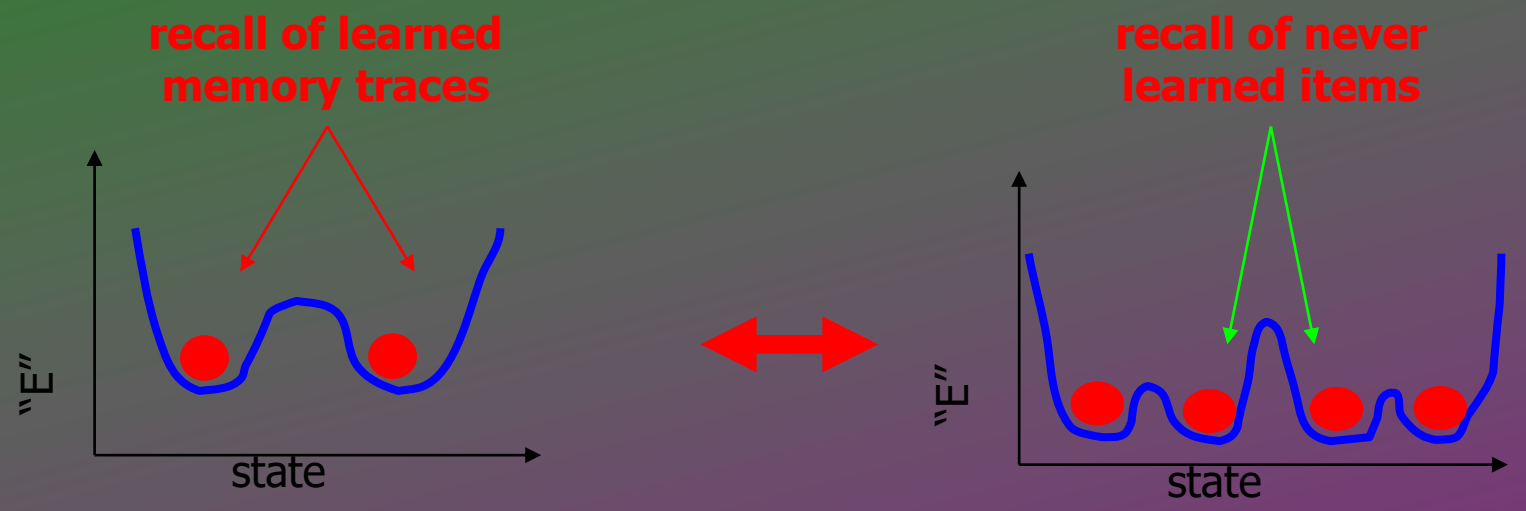
↓

Reactive anomalous sprouting

Dynamical approach to neurology/psychiatry

The NMDA Receptor Delayed Maturation Hypothesis

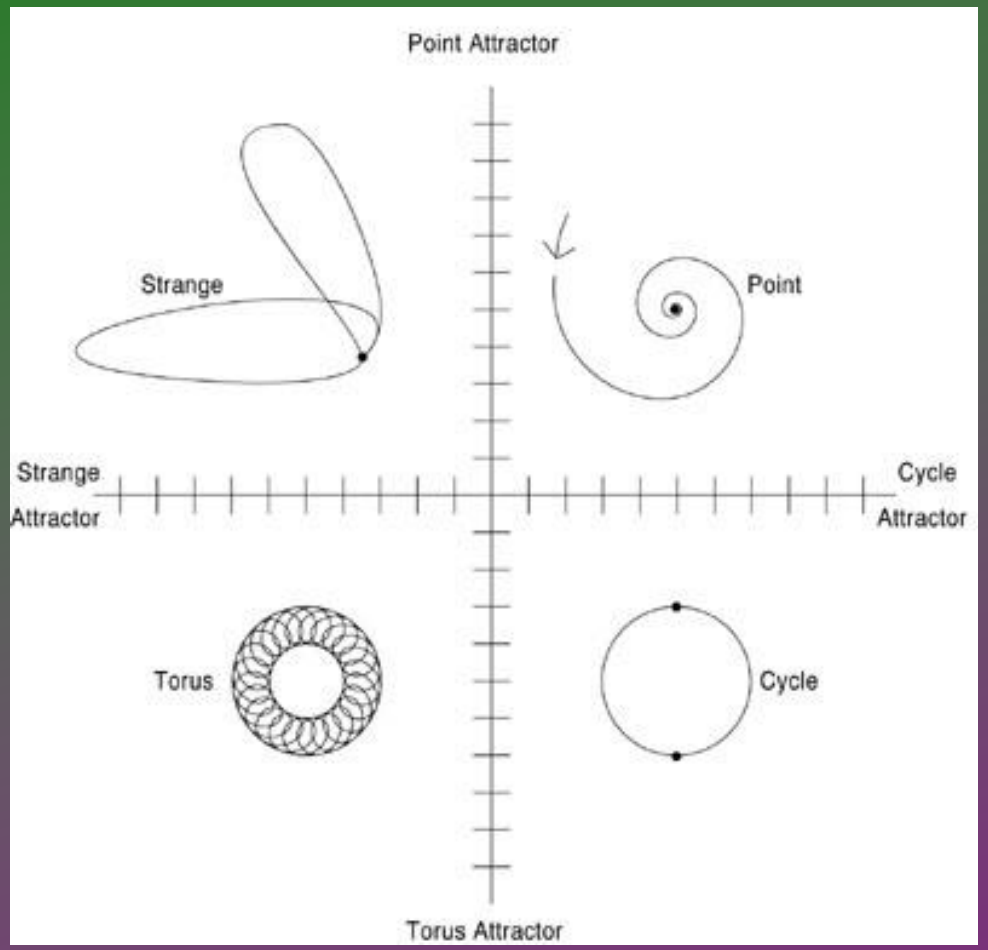
Pathological attractors appear



"delusion"
"hallucination"

Dynamical approach to neurology/psychiatry

Introduction to Attractors



As Michell (2001) points out, there is no pre-ordained necessity for variables within psychology to possess a quantitative structure.

Psychology may remain a science yet deal with both quantitative and qualitative (non-quantitative) variables.

Quantity is not synonymous with mathematics. If mathematics is considered as the science of abstract structure then it is obvious that not all structures studied using mathematics are quantitative. For example, the structure of communication and social networks, graphs, language grammars, therapeutic interactions, automata networks, etc. are essentially non-quantitative. The study of them may remain scientific, in that the method of investigation and critical reasoning is applied in accordance with scientific principles, but the variables are a mixture of the quantitative and non-quantitative.

A quantitative science is one that relies upon quantitatively structured variables for its measurement. A non-quantitative science relies upon variables that are mainly non-quantitative, using order relations, probabilities of occurrence of discrete behaviours, and structural analysis of data to provide explanatory coherence for its theories.

Guttman’s work with facet theory and the analysis of data structures.

Another approach to dealing with structure in data is that based upon cellular automata and the science of complex structures and evolved systems

(Coveney and High®eld, 1995; Holland, 1998; Wolfram, 1994, 2002). This approach to understanding how complex systems evolve is based upon both

mathematical and non-mathematical principles. An evolved system might well begin with a few simple rules that may be de®ned mathematically, but the evolutionary constraints can be qualitatively structured using order and category relations only, such that the system evolves in a highly non-linear fashion (no additive transformations are possible).

THE MERITS OF QUANTIFICATION

- Increases precision and generalizability, while minimizing prejudice,

favoritism, and nepotism in decision-making--the decontextualized and value free statistical analyses--objectivity, stability, and fair judgment--liberating and emancipatory effects?

- Quantification saves time, helps in making sense and analyzing large datasets,and facilitates large-scale research, planning, managing,

and decision-making.

Thorndike, “Anything that exists exists in a certain quantity and can be measured” (Custer 1996).

THE SHORTCOMINGS OF QUANTIFICATION

- sacrifices the substance and authenticity of the information.
- alienation and distances many groups from these experiences
- decision makers to escape accountability, as numbers and statistics become refuge from personal responsibility.
- quantification is actually a way of making decisions without seeming to decide, as decisions are left to the numbers.
- symbolizes the takeover of the market economy over social life, eliminating values of recreation and spontaneity.

THANKS FOR PATIENCE