Psyke & Logos, 1997, *18*, 457-474

MOLECULAR MAN IN A MOLECULAR WORLD:*) Applied physicology

Helmuth Nyborg

All psychological explanations of (human) nature involve by definition references to psychic or mental qualities, presumed to exist above the material world. They come principally in three different versions, none of which are in accord with a proper scientific approach, however. The chapter therefore first illustrates some of the insurmountable problems that face the psychological approach, and then suggests an alternative solution in form of a physicological research program. (Human) nature (and society) is, according to this program, better described in terms of the underlying molecular processes that carry them. Examples of application of the physicological analysis are demonstrated, one via a molecular model for genius, another by a critical discussion of various forms of consciousness and moral. The chapter finally touches on relevant aspects of thermodynamics, on how traditional physics relates to physicology, and on why the mentalist critique of physicology as reductionism totally misses the point.

Introduction

The major problem with all psychological accounts of human nature is their obligatory incorporation of psychic or mental qualities to be found above the material level(s) of description. In principle, psychological explanations come in one of the three versions outlined in the upper part of figure 1. The three models typically involve quite different assumptions about the optimal research strategy, the nature of causal agents, their functional mechanisms, and forms of interaction. However, common to the models is an accept of the active role of causal agents in the form of abstract intervening variables and hypothetical constructs. Phrased differently, a choice among any of the three top models reflects one's basic underlying psychological or philosophical view on (human) nature as partly determined by, or affecting, psychic or superorganismic factors.

---

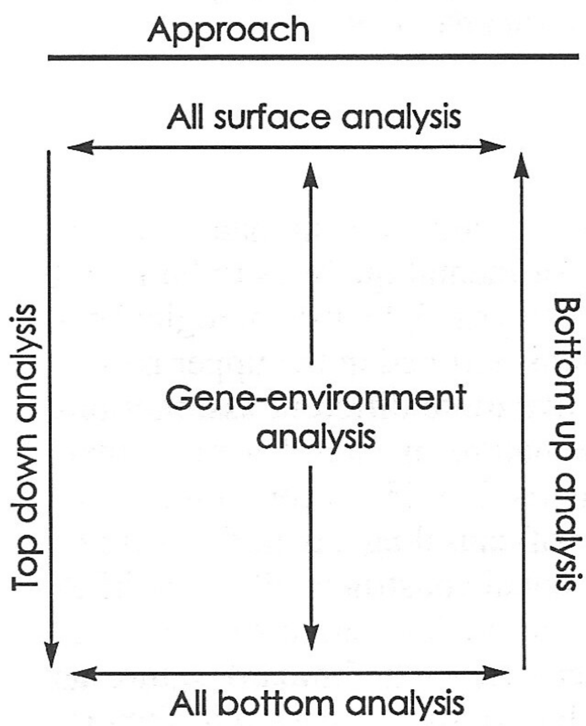
*) Invited chapter for *Psyche & Logos* in connection with the Danish »Year of the Brain Initiative«, 1997.

Helmuth Nyborg, dr. phil., er Director, Professor ved International Research Centre for Psychoneuroendocrinology, Institute of Psychology, University of Aarhus.

Such a view seems incompatible with a scientific approach to the study of (human) nature. I will therefore first illustrate the scope of the problem, and then suggest a scientifically more satisfactory solution to the dilemma.

Psychological surface models

The topmost surface model typically implies that one (psychological, mental, cognitive) trait or state explains another. For example, a trait psychologists may assume that »I am happy because I am extravert«; an information process theorists may explain output behaviour in terms of high-level information input, coding, transduction and store of information; a psychometrician is basically interested in the surface product (e.g. intelligence, cognition) rather than the processes leading up to it; a social learning theorist may explain child development in terms of correlations between parental rearing strategies and children´s phenotypic responses or by accumulated internalisations of new high-level social norms that modify existing norms, abstract attitudes or motives, the end product of which results in establishing new norm-regulated behavioural repertoires.



Type	Level(s)	Examples
Non-hierarchical, linear cause-effect relations	One: Variances, correlations, behavior, mental operations, symbols, norms, verbal responses	Psychometrics, behaviorism, information theory, social learning, phenomenology, cultural anthropology, descriptive trait psychology
Hierarchical, linear cause-effect relations	Many: From motives, desires, goals to cell assembles, genes, etc. or vice versa	Biological trait psychology, physiological psychology, behavior genetics
Non-hierarchical, non-linear dynamic cause-effect	One: Molecules - DNA, body chemistry, environmental physics	Physicology

Figure 1: Types of analytic approaches to abilities and personality

Surface modelling has one obvious advantage. It entirely escapes the threat of running into otherwise insurmountable body-mind problems, precisely because it either keeps the level of explanation at the top hierarchy of abstractions or refers only to the top level in the final description. The major disadvantage of surface solutions is a hefty price tag: The modelling scientist can pay only lip service to the role of biological factors in the face of growing evidence for their vast importance for (human) nature. Modern brain sciences demonstrate, for example, that ignorance of the massive body of evidence for tremendous individual differences in kind of brain processing and capacity inevitably results in incomplete or directly misleading results. Pure surface modelling is, quite like social learning, descriptive trait psychology and behaviourism, extremely vulnerable to this sin of omission, and most of their results can accordingly be questioned.

Psychological top down and bottom up models

The top down and bottom up models in figure 1 refer to psychological descriptions that, in contrast to surface models, do take biological factors into account. The top down analysis typically begins with isolation of an interesting aspect of phenotypic development or behaviour, and then attempts to explain it in terms of some brain structure or function. Bottom up analyses typically first identify and manipulate some biological structure or function, and then use favoured psychological behaviour as the dependent variable. Classical behaviour genetics uses top down as well as bottom up models, by typically either controlling for genetic relatedness (e.g. comparing monozygotic with dizygotic twins, or with first, second and third degree relatives, etc.) and then examines phenotypic variation, or control the environment (e.g. reared together or apart) and then examines phenotypic variation in the light of genotypic differences, or use a combination of both approaches.

Traditional top down and bottom up modelling inevitably invites a hierarchical (typically linear) cause-effect solutions. This may not be bad in principle, but disaster is certain when the psychological top down or bottom up explanation in the hierarchical description crosses the sharp and unforgiving line between the world of material biological causal factors and the world of inferred abstract mental or superorganismic (e.g. psychic, social, cultural) intervening variables and hypothetical constructs, (Nyborg, 1994a; 1997a). The fact is that all *psychological* top down and bottom up solutions must fall victim to the classical body-mind problem: How on earth can something mental possibly affect the material brain or vice versa. Nobody has ever come up with a scientifically acceptable solution to the problem, although many have tried to. Psychologists nevertheless often continue to operate with some sort of implicit or explicit hierarchical psychological model, while closing their eyes and tacitly hoping that somebody will soon come up with a solution to this ancient problem. Unfortunately, hope is not the ideal bedfellow for serious science, and the regrettable fact that psychology is a more fuzzy discipline than most should actually urge for increased precision rather than hopeful neglect.

The basic dilemma

The purpose of the above discussion was to indicate that widely used psychological surface, top down and bottom up descriptions inevitably trap their users in a cul-de-sack from which there is no scientifically acceptable way out. There simply are no known empirical tool for causally connecting mental, psychic, and superorganismic socio-cultural events with events at the material level. A comparison of ancient and modern sources suggests that this regrettable state of affairs has lasted for millennia only because philosophers, many psychologists, sociologists, cultural anthropologists or humanists and popular metaphor-makers like Freud and Jung have demonstrated a surprisingly consistent lack of interest in applying stringent empirical criteria in their analyses. They generally disregard methodological rigor and show only rudimentary interest in verification, falsification, and the urge to operationalise and design tough experimental procedures. Many horizontal surface and vertical hierarchical psychological models are based more on intuition, meaning, reason and logic than on empirically verifiable (or falsifiable) operations and the identification of causal agents and mediating mechanisms. This becomes all the more conspicuous at the high end of the hierarchical explanatory dimension of abstraction. On the surface most purely psychological explanations look rather convincing, but scientifically they are not worth their money.

Among those who long time ago realised that widespread use of metaphysics causes devastating problems for psychology was William James (e.g. 1890; 1969). He strove desperately to reconstruct psychology as a natural science as he realised that psychology could not really be a science but only »the hope for a science« where »the waters of metaphysics leak at every joint«. When reanalysing James's historic arguments in the light of the ensuing one hundred years of psychological research, I came to an even more disheartening conclusion. Psychology is, here at the brink of the twenty-first century, not any longer even the hope for a science ... »it is a hopeless science, and it will remain so until the time when it has been totally liberated from all forms of abstract psyche, cognitions and the unconsciousness, symbolisms, mentalisms, and anthropocentrisms. But then it will no longer be psychology as we know it today, and its name would be an oxymoron« (Nyborg, 1997b, p. 585). Provided that this dim view of psychology is justifiable, we are stuck with an unbearable situation: No other discipline has succeeded like psychology in bringing forth useful systematic classifications and diagnoses of the normal and abnormal development and behaviour of very complex systems like humans, but the explanatory side of the discipline is a total disaster.

The solution

There may be only one way out of this dilemma: To disarm mentalism and turn the study of (human) nature into a science. We thus first have to effectively dissolve the ancient body-mind hierarchy problem and thus avoid continued commission to catastrophic Rylean category errors by neglectfully mixing mental and material phenomena as if they were equals in the description or explanation. We then have to establish a coherent account of the actual causal basis for (human) nature that brings it within the reach of natural science methodology, as advocated long ago by William James and others, and finally co-ordinate it with the tremendous recent advances in modern brain sciences. Let me suggest that the fourth possibility in figure 1 – the all bottom solution – will enable us to take some fairly broad steps in that direction in the history of the study of (human) nature. The following section elaborates on a framework designed specifically to achieve this.

The physicological research program

A new all bottom science program – physicology – strives to circumvent the problem associated with using »mental stuff«, meaning and logic as possible explanation of (human) nature, while at the same time providing a causally coherent model for describing it in terms of intra-, inter-, and extrasystemic molecular interaction (Nyborg, 1994a; 1997a). Physicology is a general research program for the evolutionary and ontogenetic analyses of all complex systems in constant exchange with each other and with other environmental factors. Carbon-based systems like humans are, for reasons discussed elsewhere (Nyborg, ibid.), the prime research target, but other complex organic or non-organic systems are equally open for physicological analysis.

Physicology tentatively accepts the descriptive use of mentalist terms like attention, motives, consciousness, cognitions or intentionality, as well as superorganismic terms like social norms, cultural stereotypes etc., as the practical shorthand references they are for complex molecular events. This vocabulary is useful when referring to complex events, but it is also completely empty rhetorics unless the terms can be given proper attributive physico-chemical addresses in the body, the brain or elsewhere.

The principal focus for causal analysis is molecular adhesion and what follows from it. Molecular interaction is treated in terms of non-linear dynamics (Nyborg, 1994b; 1995a; b; 1996; 1997c; 1998a; b). The choice of the molecular level for causal analysis is admittedly to some extent arbitrary, even if based on the following observations. Molecular interaction is sufficiently close to the human scale to be of practical experimental interest in the analysis of evolution, development, structure, function, behaviour and interaction. Yet molecular mass-interaction is far enough removed from the level of particle physics to avoid that one gets stuck with problems in the peculiar world of quantum mechanics, that may have only a minor bearing on the analysis of, say, development, brain, behaviour or pathology. Another advantage is that molecular interaction lies at a practical distance below the level of overall cell structure and functionality on a scale of complexity, so that molecular analysis may account in causal terms for events leading up to cell characteristics and behaviour.

Physicology is *not* just another theory or philosophy. The distinction is essential for understanding why the program differs fundamentally from all behavioural sciences as wells as from much traditional physics. In sharp contrast to the usual »grand theories« in psychology or philosophy, physicology thus refers to a minimalist research program, where minimal is to be taken in its truest sense. It explicitly excludes the attributive use of metaphysics terms like meaning, logic, reason or purpose. Physicology is accordingly based entirely on only two very meagre and probably empirically verifiable (or falsifiable!) a priori assumptions: 1) Molecules show differential stereotaxic affinity and, 2) Evolution, development, behaviour and reproduction reflect changes in the distribution of energy (the pattern of which depends on time, place, concentration, temperature and the stereotaxic characteristics of available molecules (Nyborg, 1994a, p. 20)). All structures and functions in the macroscopic part of the universe, organic as well as non-organic (but, of course, not abstract mental or superorganismic entities) can, at least in principle, be described in terms of intricate molecular interactions at the sub-microscopic level, leading up to self-organising dynamic events at the microscopic level, and to behaviour at the (human) macroscopic level, according to the physicological research program. It is basically an entirely empirical task for qualified technicians to carefully map or simulate what happens – in a step-by-step fashion – when molecules of different stereotaxic affinity meet and react with each other in accordance with their atomic structure and associated electric bonds and with their entirely molecular environment, and gradually evolve and develop into you and me – or creates a star. Traditional psychologists, philosophers and humanists are by training and credo total aliens in the study of these processes. Obviously, there is too little space here to present even essential details of the physicological research program, but interested readers might consult Nyborg (1994a; 1997a; b; d; 1998a; b).

Application of physicological analysis

This section provides a couple of examples of how physicology allows a strictly causal focus on complex systems evolution, development and behaviour by operating at one level of analysis, just two basic a priori assumptions, and through three analytic windows. The first example takes point of departure in a model for the molecular basis for developing, maintaining or loosing body and brain states of extremely high creativity or genius. The other two examples add a physicological angle to an ongoing discussion about the role of brain consciousness in explaining general, scientific and moral behaviour.

Analysis of the development, maintenance or loss of extremely high creativity or genus

There are several traditional ways to explain the development of extremely high creativity. One is that it is a natural inborn talent that unfolds essentially by itself. Another suggestion is that creativity is a product of society or culture. Some explanations combine both hypotheses. Commonly used methods for studying creativity are the anecdotal-historical, the psychometric, and the psychological-sociological approach. It is an unfortunate fact, however, that these explanations as well as the methods are all inadequate. For example, genius typically appears in a family without a previous genetic warning in the form of extremely talented parents or grand parents. Eysenck (1995) provided a thorough discussion of the increased tendency for psychopathology in relatives to genial individuals, though, and suggested that previous investigations of family eminence may have put the genetic argument on its head. Socialisation theory about extremely high creativity must also be at least insufficient, because genius unfolds in a surprisingly large number of cases despite deliberate and often harsh attempts to suppress or redirect it. Nobody have yet succeeded in identifying either the genes or singled out the particular social factors made responsible for geniality. Contemporary creativity research has thus neither created the much needed clarification of the causal agents nor of their precise mechanisms of action, and it seems only fair to conclude that the important field of creativity research reflects a regrettable but highly visible sign of degeneration (Eysenck, 1995; Glover, Ronning & Reynolds, 1989; Nyborg, 1997d).

Figure 2 provides the alternative physicologically based molecular model for the development, maintenance, or loss of extremely high creativity or genius.

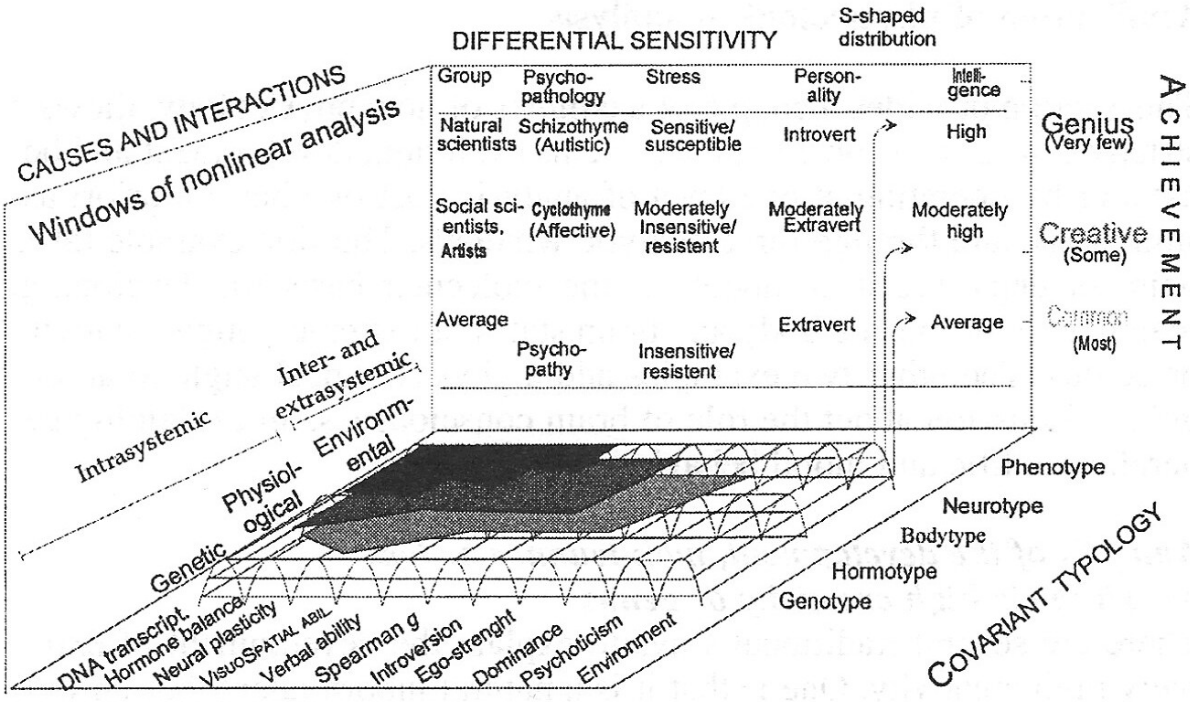


Figure 2. A nonlinear, dynamic, multifactor, multiplicative, multidimensional molecular (ND4M) model for common, creative, genial, or pathologic development. Creativity/sensitivity/susceptibility is a combined function of particular gene constellations, moderate plasma sex hormones, low sexual differentiation and high adult neural plasticity. Schizothyme development is a function of low hormone and incomplete subcortical development, whereas cyclothyme development is a function of high hormone and cyclic instability among molecular parameters. The model mimics multidimensional mass molecular space-time-phase (*x, y, z* + time + phase) changes over long phylo- and shorter ontogenetic periods.

Covariant development of (body and brain) structure and function is (in the animal case) seen by the model as the combined product of (DNA-body) physico-chemical environment interaction. The model is named *ND4M* for short. The capital letters refer to the *N*onlinear, *D*ynamic, *M*ultifactor, *M*ultiplicative, *M*ultidimensional nature of mass-*M*olecular interaction (for details, see Nyborg, 1997d).

Structural genes on chromosomal DNA bring about the production of protein molecules needed for body and brain development. The biological fate of these proteins depends very much on the presence of neighbouring operator genes and molecular interaction in general with many other proteins in the complex body-brain chemistry environment. The end product of these processes also depends to a significant degree on impacts from the environment. It is worth noting, that physicology defines not only the »inner« but also the »outer« surrounding environment entirely in physico-chemical terms. This adds the needed coherence to the analysis of various casual agents, their mechanisms of action, loci of action, and effects. There is no reason to deny that presently we are technically very far from being able to practice exhaustive analyses of such complex molecular systems with our notoriously imperfect contemporary tools (see later).

The left yz-axes in figure 2 depict the analytic windows that can be opened (preferably simultaneously) in order to perform the three different types of analyses: The intrasystemic (e.g. examinations within the skin), the intersystemic (e.g. examination of social interaction including teaching and love), and the extrasystemic (e.g. examination of the molecular impact of nutrition, stress, etc.) scrutiny. The analytic boundaries between intra-, inter- and extrasystemic molecular interactions are in part arbitrary as there are molecules interacting in all dimensions. Obviously, the borders serve practical rather than principal purposes. The important point here is, as elsewhere in physicology, that the analyses of intra-, inter-, and extrasystemic aspects are kept at the same or closely related molecular level(s), not involving hierarchical solutions that involve psychic, mental, social or superorganismic parameters at any time.

The front x-axis reflects a number of metric body and brain state or trait parameters, commonly discussed in the literature on extreme creativity. Clearly, if phenomena other than creativity were under investigation, other states or traits would figure here in the rather general ND4M model. Each of the metric parameters in the front row refer to a more or less well-defined molecular mass-action process.

The multidimensional nature of the model takes into account that complex behaviour typically depends on many molecular processes running in parallel and/or serially. The model for extreme creativity is further curvilinear and multiplicative. The curvilinear nature of the creativity model emphasises the point that the state of genius cannot be attained unless all the inverse U-shaped molecular parameters behind the metric front row indicators reach optimal values. By optimal is meant intermediate – neither too high nor too low. Multiplicativity refers to the fact that high Spearman general intelligence factor g (roughly above IQ 120) would be wasted for extremely high creativity unless the person in question also presents with an almost obsessive work-pattern so characteristic for most geniuses, and vice versa. In other words, optimal tuning of most but not all key parameters would prevent extreme creativity, and mistuning of just one of the obligatory molecular parameters spells loss of the state of geniality. The left y-axis points to the most likely space-time-phase coordinates for interaction of relevant molecular events, and the right y-axis summarises the expected covariant typologies.

The right xz-axes depict intersystemic creative achievement in an entirely molecular extrasystemic world manned by organic as well as non-organic structures. Studies by Roe (1952) suggest that highly creative natural scientists tend to have very high g (about 3 SDs above average), are introverted and sensitive, and have low gonadal hormones, whereas creative social scientists score about one SD lower g, are relative extraverted, insensitive and aggressive, and have relatively higher sex hormone levels than the natural scientists, thought lower than the general population (Nyborg, 1997d).

The ND4M model rests, as mentioned previously, on a notion of nonlinearity, a phenomenon that is commonly observed in studies of molecular mass-action processes and which receives increased interest in modern physics. The three layers of performance at the bottom of figure 2 each reflect the combined differential outcome of various nonlinear interactions among the molecular processes referred to by the metric state/trait indicators at the x-axis. The term genius refers to the very rare case where all necessary and sufficient molecular parameter values are optimally tuned. The dynamic nature of the ND4M model is obvious, and is reflected in the notion that geniality is not seen as an essentially permanent trait but rather as an unstable state. If just one optimal molecular parameter drifts out of tune, we have a former genius before our eyes. The model implies that many might have brilliant insights from time to time, but will never benefit from it unless they combine it with relentless stubbornness and disrespect for prevailing rules, in order to push the idea forward in a usually quite sceptical world. Only with optimal tuning of all necessary parameters will anybody ever accomplish this.

It is very fortunate that we need not keep track of every single molecule during the analysis, or we would never get anywhere. It suffices to monitor the massive but luckily also orderly cascades of mass-molecular events. The basis for this order is to be found in the principle for thermodynamics. The fluid molecular species are thus not free to go everywhere intrasystemically, because their behaviour is restricted by other molecules »frozen« temporarily in space-time co-ordinates. These molecules form structural boundaries such as cell walls, penetrated by channel proteins. The walls and the temporary (and often co-ordinated) opening or closing of channel proteins restrict the molecular flow pattern and this brings a certain degree of order to the system. Further order is attained through restrictions with respect to where and how many receptor molecules can be induced locally, and thus translate the general potential of a given protein to a local biological event. All this combines, together with a host of temporally conditioned as well as more permanent enzymatic processes, and puts severe restrictions on what can and will happen in the system. It creates a very high degree of local intrasystemic order in complex systems, some of them goes under the name of life, in an otherwise much more chaotic world. We can exploit this systemic order as it greatly simplifies the analytic task. Thus, a physicologist would not despair in face of the fact that it is clearly impossible today to dissolve creativity into its molecular constituents. He would be encouraged by the possibility that the remaining obstacles seems to be of practical-technical-temporary rather than principal nature.

Physicological analysis of the Block-Shepard dilemma

This section follows up on a recent discussion among Block (1995) and Shepard (1995) about the role of consciousness for the brain. The purpose is basically to illustrate that the notion of a conscious brain can now safely be returned to philosophers, who first invented this mentalist construction and since infected science with it. Physicology bases this conclusion on the observation that much modern (brain) science documents beyond reasonable doubt, that (human) nature is better examined without reference to hypothetical mental constructs and abstract intervening variables.

Block (1995) ignited the discussion by arguing that we better be careful and distinguish phenomenal (P-consciousness) from access (A-consciousness) if we really want to understand the proper workings of the brain. Physicology suggests, on the contrary, that we first ponder another perhaps more interesting empirical question before digging into the linguistic side of the matter: Does mentalist concepts like consciousness really explain anything? Is it possible or even likely that the whole notion of consciousness reflects a tangled web of intractable anachronistic philosophical pseudoproblems (Nyborg, 1994a). Despite its enormous subjective appeal and an almost desperate search for it, neither have philosophy nor modern (brain) sciences ever evidenced the slightest trace of consciousness in the human brain or, for that sake, anywhere else in the world. Everything measured properly seems so far to entirely obey the ordinary principles of natural science. Obviously, we still have much to learn about the brain's intricate processing, but this is no license for continued linguistic sophistry over mentalist dogmas like different kinds of abstract consciousness. Perhaps we *may* one fine day find mental stuff in the brain, but right now this possibility seems of too little heuristic value for us to continue to try and track it down after more than two thousand years of search in vain.

Shepard (1995) responded critically to Block's suggestion by asking him: Who (or what) are the entities or agents to which Block ascribes P-consciousness? Could it be Block himself, or other persons, other species, the brain, neurones, synapses, physical components in the surroundings, molecules, atoms, or even electrons? Where along this scale do we find entities that enjoy (or suffer!) P-consciousness? asks Shepard. I suspect the Shepard knew all the time, that Block could come up with no good answer to this, but the question nevertheless illustrates perfectly well the major problem with all mentalist abstractions. They are homeless. They have no causal address at all. They are purely descriptive terms with no attributive reference whatsoever. If we go low on the scale of complexity and attribute to the electron consciousness (P or other), the term becomes literally meaningless. If we go up, and require a higher phylogenetic standing for consciousness, we easily become locked in the intractable problem that met Popper and Eccles (1977), when they felt forced to postulate that honeybees probably have consciousness and chimpanzees and upwards may enjoy (or suffer!) self-consciousness. What is their proof? A subjective interpretation of reactions to smears on fur. Modern science certainly asks for more than this.

On the constructive side, physicology reformulates Shepard's question about the home and life of consciousness in terms of three empirically testable hypotheses. 1) Block's consciousness (A or P) is actually an intrasystemic representation of separate or covariant mass-molecular series of fluid events taking place within idiosyncratic constraints (such as molecules temporarily »frozen« in space in the form of cell membranes etc., that form the structural elements of Block's body and brain); 2) These complex intrasystemic molecular processes are under the very dynamic influence of, and at times reciprocally bounce back on, the intersystemic molecular processes emanating from, say, »social«, »linguistic« or »scientific« encounters between more or less similar carbonbased systems exchanging physico-chemical stimuli (could be Shepard-Block perceptual interaction, Shepard's »other people«, or »other species«); and 3) The intrasystemic processes (and by dynamic covariant implication also the intersystemic processes) are further mended by »non-social« extrasystemically dictated restraints, such as the nature of parental DNA instructions that codetermine, among many other things, the development and function of Shepard's and Block's bodies and brains, intelligence, personality and related niche-picking tendencies (e.g. taste for good science). Extrasystemic restraints further include prevailing »external« physico-chemical conditions like nutrition, temperature, or reading particular scientific articles (could be Shepard's »physical components in the surroundings«).

It obviously confers considerable methodological advantages to keep the primary analytic focus on systemic molecular interaction when rigorously testing the above hypotheses. The single level analysis thus prevents us from committing internal category error, like trying to explain consciousness in terms of molecules, or vice versa. It prevents us from making intern-extern category errors, because we can now describe both »social« exchanges among people and people-object interaction in general in terms of uniform reciprocal molecular interactions.

On a more global note, the molecular level of analysis allows us to determine, in a precise empirical step-by-step manner, the development and function of causal pathways that connect molecular events like »how Block's finger type arguments in favor of consciousness«, to cite Shepard. First, on the structural side, Block's brain structures, efferent nerves, fingers, and even his word-processor, *are* all molecules frozen temporarily in local space-time-phase co-ordinates in accordance with their specific stereotaxic affinity and the gene-environment interaction. Second, on the more dynamic side, these local structures restrict the moves of more mobile molecules, that also associate in accordance with their particular affinity into, say, species of neurotransmitters, enzymes, or peptides, which relate causally to build-up of nerve potentials or bursts of impulses. This total molecular arrangement actually reflects the two sets of increases in local negentropy that ***are*** Block and Shepard plus their behaviour, as manifested in terms of space-time-phase transitions of molecules and associated patterns of energy change.

The physicological research program illustrates, in other words, how the analysis of molecular structures and functions unite smoothly in a potentially exhaustive causal description of what happens in the universe. Some of Block's more or less transient dynamic molecular brain states (called arguments, consciousness, intentions, or whatever by mentalists) relate to his moving fingers through motor activation via redistribution of »efferent« brain molecules (directional flow of energy or information – the precise terms are not terribly important here), to his word-processor (under perceptuo-motor feed-back control, rather than by »Collecting, recoding, revising, or decoding symbolic structures or abstract representations in accordance with cognitive operations«, as neo-mentalist cognitive psychologists like to say), to the spatio-temporal distribution of electric impulses in the computer (with its local structural silicon restrictions and open-closed state of electronic gates constraining the flow of electrons, thus creating local non-organically based negentropy), to printed pages in a scientific journal (systematic distribution of perceptible black-and-white dots). This stimulus pattern may in turn affect Shepard through his perceptive eyes, and cause changes in his already »experienced« intrasystemic molecular brain processing, and make his fingers and word-processor go berserk in a fierce response to Block, and so forth. Perhaps, in the final analysis all this may actually be described as guided dynamic patterns of flow of energy through various carrying media.

As said before, we do not have to keep track of each molecule's move along the causal pathway. Molecular mass-interaction analysis may suffices, as I will try to illustrate in broad outlines with an example from the area of moral behaviour.

Moral behavior

Shepard (1995) wonders in »frivolous moments« whether moral behaviour could be guided by phenomenal consciousness. »Perhaps«, asks Shepard, »humans come in two types: Hostile automata (because they have no access to subjective experiences), and friendly people (because they have access to consciousness)?«

Such frivolous mentalist-inspired questions has to be redefined, according to the physicological research program, in order to allow for proper causal analysis. A basic requirement would be that the presumed causal agents can be properly operationalised and then related in the cast of predominantly empirical (as opposite to predominantly speculative, intuitive) hypotheses. We must further demand that the hypotheses are testable with respect to both the cause and effect sides as well as with respect to the presumed interactive mechanisms, and that at a coherent level of analysis and preferably in the form of nonlinear molecular dynamics.

To give an example of how this could be accomplished, the reader is referred to the General Trait Covariance (GTC) model for development (Nyborg, 1994a; 1997a). The GTC model predicts, for example, that males with above average blood concentrations of so-called male sex hormone (testosterone – t) tend to behave more impulsively, aggressively, immorally, less ethically, and less intelligently than males with low t, who in general would show the opposite traits. The predictions are in fairly good accordance with the data (e.g. Dabbs and Morris, 1990; Nyborg, 1995a; b; 1996).

How would philosophers and psychologists explain such observations? Most likely, they would have to lean back and wonder how on earth testosterone molecules could dissolve their hypothetical »phenomenal consciousness« or »moral«, or etch away or degrade internalized »cultural prescriptions«, »social norms«, or »categorical imperatives«? The situation looks completely different for the physicologist. He or she would begin to monitor – step-by-step and under careful experimental scrutiny – the workings of the particular molecular mechanisms that apparently translate high concentrations of t in the blood into what is termed »noxious« or »immoral« behaviour, perhaps by altering certain intrasystemic biochemical pathways with an effect on various body, brain, and behavioural processes. The physicologist would then systematically take task with the mechanisms that seems to relate low t to systemic states characterised phenotypically by controlled, non-aggressive, »moral«, »ethical«, or intelligent processes.

The point I want to drive home here is not at all that moral behaviour is just a matter of male sex hormones. Obviously, it takes much more to fully examine this complicated phenomenon. The thrust of the argument is rather a more intricate one: Molecular affinity, mechanisms and mass-actions can, even by imperfect contemporary techniques, be demonstrated to relate in orderly and causal ways to what mentalist see as higher-order phenomena like moral or consciousness, but for which they have no scientifically satisfactory but only philosophical explanation or intuition. The physicologists needs only to look briefly at the (carbon-based) molecular dynamics, and lawful connections among body, brain, and environmental parameters and pheno-typic behaviour become apparent, not involving any need to call upon anything abstract, hypothetical or immaterial.

Philosophy, mentalism, and the future science of complex systems

Clever philosophy, eloquent linguistics, logic, or empty rhetorics may no longer suffice to address the fascinating problem of how to study (human) nature. The real challenge of tomorrow is rather to examine behaviour, good or bad, scientific or not, in terms of its molecular basis and to use the proper scientific tools for this task. According to the physicological research program, the way goes through precise identification of proximal physico-chemical agents, through a mapping of their systemic loci of action, and by monitoring their non-linear dynamics in the light of individual inner and outer structural constraints. These constraints are partly genetic in origin, but they can also be profoundly affected by idiosyncratic life-history events. They may even emanate as a function of future systemic molecular engineering, a speciality that undoubtedly will grow in importance as techniques for biological or electronic trans- or implantation become more available. According to physicology, the term molecular engineering might even apply to what happens today during traditional »psychotherapy« or »learning in school«. Changes in behaviour might here reflect the systemic modification of brain development, structure or function as a result of such exposure (Nyborg, 1994a; 1997a).

The physicological enterprise is enormous and individual approaches are necessarily limited. It is therefore hoped, that efficient brains will soon stop wasting costly energy on continued discussions of what may in the end show up to be pseudo-problems and weird off-spin of misguided mentalism, cognitive psychology, social constructivism or reductionism. The energy is probably better redirected towards the exploration of flow of energy in the rich world of frozen and moving molecules in sometimes turbulent non-linear systemic time-space-phase transition in organic and non-organic systems. Philosophy, sociology, cultural anthropology, psychology, and the mentalism and anthropocentrism they by definition or in practice epitomise make them less well equipped to face this challenge. That is precisely why they are not sciences at all, and why they have stalled for centuries while repeating multi-level anachronistic body-mind mantras. The physicological all bottom approach may dissolve the ancient body-mind problem and make high-level philosophical concepts redundant in the process. Philosophy is based on meaning, rationality and logic, but nothing of this is of any use in a molecular analysis. Molecules may associate more or less well. This reflect the way they are build and determine the flow of energy in the system. To entangle this is a matter for laboratory technicians rather than for philosophers or psychologists.

Critics may question whether physicology is a necessary and sufficient program for the study of (human) nature? They may, for example, quarrel with the apparent reductionistic nature of the program. This critique is invalid, however, until the time when the critics have demonstrated beyond reasonable doubt that there is something mental to be reduced in the first instance. To the best of my knowledge nobody has ever come up with the slightest empirical evidence for the existence of mental stuff residing above brain stuff. They may further question whether the molecular analysis of (human) nature provides a sufficient framework. An individual is an immensely complex self-organising molecular system in need of constant interaction with an entirely molecular environment, in order to extract the energy needed for development, behaviour, repair, and reproduction in order to stay in front in the evolutionary race. Seen in this overall perspective it should be sufficient to study how molecules associate and how this is reflected in related changes in the flow of energy through the system(s).

Molecular association reduces, as said, the local thermodynamic entropy by creating structures that guide the fluid dynamics in the system. The task of locally countering a general tendency towards entropy is expensive for complex systems, and requires the intake of much higher-order energy. This calls in turn for potentially dangerous behavioural expeditions for food and mates in often tough competition with other complex systems with similar demands, and implies collective transport of many molecules, often called behaviour.

The goal of physicological analysis is, in summary, to examine the structure and chemical kinetics of the systems under study, man, beast, or inorganic structures alike. This includes an estimation of the type and rate of reactions in complex, non-linear and unstable (human) systems on basis of the properties of available molecules (i.e. their mass, diameter, moments of inertia, vibrational frequency, binding energy, and so on (Castellan, 1973)). Such processes are sensitive to temperature, pressure, concentration, and the presence of catalysts, so they have to enter the final formula.

Traditional physics seems eminently suited to take hand on these type of analyses, so why not stop there and declare that the study of (human) nature equals physics? Why the need for invoking a specialised research program like physicology? There are several major reasons for this. The first is that traditional physics is typically concerned with rather simple systems, whereas physicology focuses in particular on the working of extremely complex structures like the brain. Second, the analysis of complex systems calls for methods that are specifically adapted to this task, and most of these are still in an early developmental phase. Physicology profits, in distinction to physics, from the fairly well-developed classification and diagnosis of complex behaviour found in psychology. Fourth, whereas much traditional physics is based on linear dynamics, much modern physics and physicology focus on nonlinear dynamics in relatively open and unstable systems. Fifth, not a few modern physicists have in recent years reopened the case for what looks like quite mysterious and speculative (almost psychological or philosophical) views on the state of the universe. The bonus is triple: A creative boost, a relaxation from stringent science, and an obvious protection from the brutal field of exact measurements and testing. This is perhaps exactly what in particular worried Nobelist Glashow (1988), so he wrote an article critical of some aspects of modern physics and titled it: *»Tangled in superstring: Some thoughts on the predicament physics is in«.*

For these and other reasons there seems to exist a need to establish a specialised discipline side by side with physics, dealing with the dynamics of very complex systems like the brain. To keep track of just the more important events in such systems in a non-linear perspective by simultaneously looking through the three intra-, inter-, and extrasystemic windows is a formidable task. The potential reward is also formidable: We could eventually reach a stage of describing what drives evolution, life, learning, love and other complex energetic events in an otherwise probably rather chaotic universe.

REFERENCES

BLOCK, N. (1995) On a confusion about a function of consciousness. *Behavioral and Brain Sciences,18:2*, 227-287.

CASTELLAN, G.W. (1973) *Physical chemistry* (Second Ed.). Reading, MA: Addison-Wesley.

DABBS, J.M. & MORRIS, R. (1990) Testosterone, social class, and antisocial behavior in a sample of 4.462 men. *Psychological Science, 1:3,* 209-211.

EYSENCK, H.J. (1995) *Genius: The natural history of creativity.* Cambridge: Cambridge University Press.

GLASHOW, S. (1988). Tangled in superstring: Some thoughts on the predicament physics is in. *The Sciences*, 22-25.

GLOVER, J.A., RONNING, R.R. & REYNOLDS, C. R. (Eds.) (1989) *Handbook of creativity.* New York: Plenum Press.

JAMES, W. (1890) *The principles of psychology*. New York: Holt.

JAMES, W. (1969) *Psychology (briefer course)* (4^{th} edn.). Toronto: Macmillan.

NYBORG, H. (1994a) *Hormones, sex, and society: The science of physicology.* Westport, CT.: Praeger.

NYBORG, H. (1994b) The neuropsychology of sex-related differences in brain and specific abilities: Hormones, developmental dynamics, and new paradigm. Chapter 4. In: P.E. Vernon (Ed.), *The Handbook of the Neuropsychology of Individual Differences.* New York: Academic Press, p 59-113.

NYBORG, H. (1995a) Intelligence and personality is when genes, hormones, and experience exchange molecules in body and brain. Paper presented at the VIIth Congress of the International Society for the Study of Individual Differences, Warsaw, Poland, July 15-19.

NYBORG, H. (1995b) Androtyping male sexual development. Paper presented at the International Symposium on Behavioral Development: Biological Basis of Sexual Orientation and Sex-Typical Behavior, Minot State University, Minot, North Dakota, May 25-27.

NYBORG, H. (1996) Does personality and intelligence interact?. Paper delivered at the 8th. European Conference on Personality, University of Ghent, Belgium, July 8-12.

the universe. The bonus is triple: A creative boost, a relaxation from stringent science, and an obvious protection from the brutal field of exact measurements and testing. This is perhaps exactly what in particular worried Nobelist Glashow (1988), so he wrote an article critical of some aspects of modern physics and titled it: *»Tangled in superstring: Some thoughts on the predicament physics is in«*.

For these and other reasons there seems to exist a need to establish a specialised discipline side by side with physics, dealing with the dynamics of very complex systems like the brain. To keep track of just the more important events in such systems in a non-linear perspective by simultaneously looking through the three intra-, inter-, and extrasystemic windows is a formidable task. The potential reward is also formidable: We could eventually reach a stage of describing what drives evolution, life, learning, love and other complex energetic events in an otherwise probably rather chaotic universe.

REFERENCES

BLOCK, N. (1995) On a confusion about a function of consciousness. *Behavioral and Brain Sciences,18:2*, 227-287.

CASTELLAN, G.W. (1973) *Physical chemistry* (Second Ed.). Reading, MA: Addison-Wesley.

DABBS, J.M. & MORRIS, R. (1990) Testosterone, social class, and antisocial behavior in a sample of 4.462 men. *Psychological Science, 1:3,* 209-211.

EYSENCK, H.J. (1995) *Genius: The natural history of creativity.* Cambridge: Cambridge University Press.

GLASHOW, S. (1988). Tangled in superstring: Some thoughts on the predicament physics is in. *The Sciences*, 22-25.

GLOVER, J.A., RONNING, R.R. & REYNOLDS, C. R. (Eds.) (1989) *Handbook of creativity.* New York: Plenum Press.

JAMES, W. (1890) *The principles of psychology*. New York: Holt.

JAMES, W. (1969) *Psychology (briefer course)* (4^{th} edn.). Toronto: Macmillan.

NYBORG, H. (1994a) *Hormones, sex, and society: The science of physicology.* Westport, CT.: Praeger.

NYBORG, H. (1994b) The neuropsychology of sex-related differences in brain and specific abilities: Hormones, developmental dynamics, and new paradigm. Chapter 4. In: P.E. Vernon (Ed.), *The Handbook of the Neuropsychology of Individual Differences.* New York: Academic Press, p 59-113.

NYBORG, H. (1995a) Intelligence and personality is when genes, hormones, and experience exchange molecules in body and brain. Paper presented at the VIIth Congress of the International Society for the Study of Individual Differences, Warsaw, Poland, July 15-19.

NYBORG, H. (1995b) Androtyping male sexual development. Paper presented at the International Symposium on Behavioral Development: Biological Basis of Sexual Orientation and Sex-Typical Behavior, Minot State University, Minot, North Dakota, May 25-27.

NYBORG, H. (1996) Does personality and intelligence interact?. Paper delivered at the 8th. European Conference on Personality, University of Ghent, Belgium, July 8-12.

NYBORG, H. (1997a) Hormoner, køn og samfund: Videnskaben om fysikologi. København: Dansk psykologisk Forlag (dansk oversættelse af Nyborg, 1994a).

NYBORG, H. (1997b). Psychology as Science. In H. Nyborg (Ed.), *The Scientific Study of Human Nature: Tribute to Hans Eysenck at Eighty.* (pp. 563-589). Oxford: Pergamon.

NYBORG, H. (1997c) Modelling complex non-linear gene-brain-environment interactions (submitted commentary for BBS)

NYBORG, H. (1997d). Molecular Creativity, Genius and Madness. In H. Nyborg (Ed.), *The Scientific Study of Human Nature: Tribute to Hans Eysenck at Eighty.* (pp. 422-461). Oxford: Pergamon.

NYBORG, H. (1998a) Personality, psychology, and the molecular wave: Covariation of genes with hormones, experience, and traits. In: J. Bermudez, B. de Raad, A.M. Perez, A. Sanchez-Elvira, & G.L. van Heck (Eds.) *VIth. Volume of Personality Psychology in Europe.* Tilburg, The Netherlands: Tilburg University Press (in press).

NYBORG, H. (1998b) Nonlinear gonadal hormone modulation of the brain and behavior along the life cycle. In: Uriel Halbreich (Ed) *Gonadal hormones, sex, and behavior.* Washington, DC, American Psychiatric Press, Inc. (in press).

POPPER, K. R. & ECCLES, J.C. (1977) *The self and its brain* (Parts I and II). Berlin: Springer-International.

ROE, A. (1952) A psychologist examines 64 eminent scientists. *Scientific American, 187,* 21-25.

SHEPARD, R.N. (1995) What is an agent that it experiences P-consciousness? And what is P-consciousness that it moves an agent? *Behavioral and Brain Sciences, 18:2*, 267-268.

NYBORG, H. (1997a) Hormoner, køn og samfund: Videnskaben om fysikologi. København: Dansk psykologisk Forlag (dansk oversættelse af Nyborg, 1994a).

NYBORG, H. (1997b). Psychology as Science. In H. Nyborg (Ed.), *The Scientific Study of Human Nature: Tribute to Hans Eysenck at Eighty.* (pp. 563-589). Oxford: Pergamon.

NYBORG, H. (1997c) Modelling complex non-linear gene-brain-environment interactions (submitted commentary for BBS)

NYBORG, H. (1997d). Molecular Creativity, Genius and Madness. In H. Nyborg (Ed.), *The Scientific Study of Human Nature: Tribute to Hans Eysenck at Eighty.* (pp. 422-461). Oxford: Pergamon.

NYBORG, H. (1998a) Personality, psychology, and the molecular wave: Covariation of genes with hormones, experience, and traits. In: J. Bermudez, B. de Raad, A.M. Perez, A. Sanchez-Elvira, & G.L. van Heck (Eds.) *VIth. Volume of Personality Psychology in Europe*. Tilburg, The Netherlands: Tilburg University Press (in press).

NYBORG, H. (1998b) Nonlinear gonadal hormone modulation of the brain and behavior along the life cycle. In: Uriel Halbreich (Ed) *Gonadal hormones, sex, and behavior*. Washington, DC, American Psychiatric Press, Inc. (in press).

POPPER, K. R. & ECCLES, J.C. (1977) *The self and its brain* (Parts I and II). Berlin: Springer-International.

ROE, A. (1952) A psychologist examines 64 eminent scientists. *Scientific American, 187,* 21-25.

SHEPARD, R.N. (1995) What is an agent that it experiences P-consciousness? And what is P-consciousness that it moves an agent? *Behavioral and Brain Sciences, 18:2*, 267-268.