16 Personality, psychology, and the molecular wave: Covariation of genes with hormones, experience, and traits

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Sex hormones guide the appearance, stasis, flow, and disappearance of many important body, brain, ability, and personality traits. It therefore becomes an important task to identify the cause-effect relationships as well as the mechanisms, through which sex hormones harmonize sex-related trait development. The General Trait Covariance - Androgen/Estrogen (GTC) model (see Figure 1) is an attempt to bring these perspectives into a formal context, by generating testable predictions about various trait patterns from plasma hormone values.

The left side of the model predicts male covariant trait development by androtype, and the right side predicts female trait development by estrotype. In other words, the model requires that a sex chromosomal male is first classified according to his androtype with the low testosterone (t) male = A1 and high t male = A5, and a sex chromosomal female in accordance with her estrotype with the low estradiol (E_2) female = E1 and high E_2 female = E5 (for details of hormotyping, see Nyborg, 1994a, 1994b). Generally, intermediate plasma hormone levels relate, according to the model, in each sex to optimum expression of Spearman's *g* ability and weak expression of sexually differentiated body and personality traits. High hormone values lead to a different gene switching, to depression of an individual's familial disposition for *g*, and to reinforced secondary sexual differentiation of body and personality traits.

Test of the GTC model

Data taken from a Centers for Disease Control study (CDC, 1988) of middle-aged Vietnam veterans will serve as an example of a limited analysis, based exclusively on knowledge of a man's androtype.

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Figure 1:

The General Trait Covariance-Androgen/Estrogen (GTC-A/E) model for development. Males are classified in accordances with plasma testosterone (t) concentration into hormotypes A1 to A5, where A1 is low t and A5 is high t individuals. Females are classified in accordance with plasma estradiol (E_2) concentration into hormotypes E1 to E5, where E1 is low E_2 and E5 is high E_2 individuals. The GTC-A/E model generates predictions for the various hormotypes with respect to coordinated comatic, psychological, and behavioral trait development (see text for details).

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About half the 4,462 veterans examined served in Vietnam during the war, and the other half served elsewhere during the years 1965-71. The veterans were examined in 1985/86, that is, 15-20 years after the conclusion of their active service, at which time the racial and socio-economical distribution of the sample was close to that for the general United States population. Plasma log(t) values were divided into 5 equidistant 20 percentile androtype groups, after the upper and lower one percentile values were excluded (N=37 and 36, respectively). Each androtype group then contained more than 700 veterans. Only a summary of the comparison of selected traits in high t A5 and low t A1 males will be provided here (for more details, see Nyborg, 1994a, 1994b, 1995a). As predicted by the GTC model, the low t A1 male tends to be slightly taller than the A5 male, much fatter, and to score higher on general IQ (Army General Technical Aptitude test), and also on the Information and Block Design subscales of the WAIS-R. The A1 males tend to spend more time with formal education than A5s, and earn more money at time of discharge and 20 years later. Eysenck's personality dimensions can be extracted from the MMPI-II data in the CDC material (Nyborg, 1995b). It appeared that A1 males tend to score lower on Extraversion and Neuroticism than A5 males, higher on social desirability, and lower on Psychoticism. In other words, the low t A1 male tends to be tall, fat, intelligent, well educated, well paid, introvert, stable, and probably can be found in large numbers in society's cognitive elite (Herrnstein & Murray, 1994). He scores low in Psychoticism and high in social desirability. Many of the high t A5 males tend to show almost the opposite pattern of traits. More A1 than A5 males suffer from allergies or are on a diet. A1s drink and smoke less than A5s. A1 and A5 males differ with respect to life-time prevalence as well as past year psychopathology. DSM-III was administered to the veterans, and the data were analyzed according to androtype. There are more depressed, single-episode depressed, bipolar, dysthymic, and manic individuals among A5s than among A1s, as well as more criminal offenders and presently unemployed. An overall analysis of body, abilities, and personality data suggests that the fairly simple plasma hormone measure accounts for 3-18% of the variance, depending on the trait in question. It is worth keeping in mind that measures of hormones are only a minor part of a complete analysis. The individual's unique DNA information and genotypic values need to be known as well, as hormones can switch only genes present in the karyotype, and individuals differ with respect to allelic gene frequencies. Also missing from the above analysis is an examination of fast nerve cell membrane changes by hormones, and a mapping of significant life-history events affecting the highly interdependent dynamic molecular processes.

A critical test of the GTC model was carried out in a recent study of young girls with Turner's syndrome (i.e., lack of X chromosome material: female psychosexual infantilism and typically infertile) (Nyborg, Nielsen, Naeraa, & Kastrup, 1995). Such girls need sex hormone substitution therapy in order to promote body growth and to induce secondary sexual differentiation. One year with minute doses of E_2 sufficed to accelerate body and brain development and to restore their previous defective visuo-spatial abilities to a normal female control level. However, two years with androgen treatment led the girls into the normal male control range of abilities. Had the results come out differently, the GTC model would have been falsified. Moreover, a substantial number of other studies now confirm that hormones affect body, brain, abilities, and personality (e.g., Hoyenga & Hoyenga, 1979, 1993), although not in an 1:1 linear fashion.

DISCUSSION

Clearly, much work remains to be done in order to properly understand the interplay of human abilities and personality, and much more is required as a starting point for analysis than a simple indication of middle-age plasma sex hormone level. However, what has already been found with simple means, suggests that an entirely molecular approach to abilities and personality would, in fact, be scientifically superior to prevailing speculative psychological theory. It is argued elsewhere that humanistic sciences, including major parts of psychology, are in need of a paradigmatic shift, and a call was made for extended use of empirically testable molecular causal models in accordance with a research program called *physicology* (Nyborg, 1994a). According to physicology - but somewhat simplified - all that is needed is a description of which molecules went where in a given person with what consequences on tissues and function. Apparently many A5 males tend to be depressed, and many A1 males tend to be introverted. Logically, the next step would then be to map step-by-step the neuroarchitectural and neurofunctional consequences of ample or low exposure to androgens. The GTC model generates, for example, testable predictions of the consequences for specific personality traits of natural or manipulated changes in endogenous molecular processes, obviously with a keen eye simultaneously on genetic and experiential mechanisms of importance for individual stasis or flow in personality. Clinical neuroendocrinology already provides many examples of how hormonal intervention profoundly changes significant personality parameters in ways exactly predicted by the GTC model (e.g., Morris, Adeneyi-Jones, Wheeler, Sonksen, &

Jakobs, 1984). Anabolic steroids affect personality traits, and may even result in psychosis. A few premenstrual women experience devastating changes of personality with declining E_2 levels, and recover as soon as E_2 production goes up again, or if properly treated with steroids. Androgen exposure of the prenatal brain profoundly influences adult development of male sexual identity as demonstrated in 5-alpha-reductase deficient boys (Imperato-McGinley, Peterson, Gautier, & Sturla, 1980). These genotypic boys present phenotypically as girls at birth, and are reared accordingly. Then, suddenly at age 12 the boys begin to produce an enzyme needed for completing male genital development, and they begin to exhibit stereotypic male behaviour and sexual identity. The molecular interpretation is, that the brain was primed in a male direction prenatally by the intact androgen production, and that female rearing has little effect on male personality development.

It may be possible to sketch the outlines of a fully developed molecular approach to human abilities and personality, and to begin to consider trait development, stasis, flow, and harmonization of traits in terms of molecular events. At least six steps must be taken before such a program can be implemented in ability and personality research. First, the traditional huge number of hypothetical constructs and intervening variables must be reduced to a few necessary but testable *a priori* assumptions. Second, population averages must give leeway to person-specific data. Third, single level analysis must replace multi-level analyses. Fourth, a mapping of empirically verifiable proximate causes, mechanisms, and locus of biological action must replace lexical and other meaning-dependent explanations. Fifth, the analytic window(s) must be specified in detail. Sixth, covariant body, brain, intelligence, and personality development must be analyzed in terms of testing causal models for underlying gene-neurochemistry-experience relationships. Each of these steps will be discussed below in some details in terms of the physicological research program.

The *first step* in the molecular approach to personality research is a radical reduction in the number of hypothetical constructs. According to physicology, psychology's worst sin is that it extends the explanatory role of hypothetical constructs and intervening variables far beyond empirically reasonable limits. Physicology operates, in contrast, on two simple and testable *a priori* assumptions. The first is that molecules display differential stereotaxic affinity. The second is, that changes in molecular positions reflect flow of energy. According to physicology, nothing more is needed because flow and stasis of energy reflects body and brain development, structure and function, and thus covert and overt behaviour.

The *second step* in a causal analysis is to bring the individual into

sharper focus than hitherto, and to consider population averages as a perhaps necessary but insufficient point of departure. To avoid misunderstanding here, physicology readily acknowledges the potential value of the common *individual differences* approach of calculating a population average and then of determining individual variation around it. The problem is, however, that averages and variances only very indirectly reflect person-specific causes and never indicate person-specific loci of causal actions, even though this information is essential for the description of cause-effect relationships in personality. Physicology, therefore, recommends for future studies, the use of the *different individuals* approach and thereby maintains that the exact source of a general trend can be safely deduced only when enough individuals share empirically documented common causes and effects (Nyborg, 1977). This proposal is in accordance with Pervin (1993), who fears that an exclusive emphasis on the *individual differences* approach and on aggregation over situations misses the essence of personality. A physicologist recommends the *different individuals* approach instead (Nyborg, 1987), because the only sensible point of departure for a truly causal analysis is the study of the single individual. Averaging over individuals may call our attention to the possible existence of a specific mechanism behind trait patterns, but averages are of little help in the identification of the precise nature of the mechanism. Obviously, single individual intrasystemic analyses must be supplemented with information about person-specific inter- and extrasystemic events.

The *third step* is to introduce single-level analyses in personality research. Typically, surface level personality researchers collect cultural, social, historical, or lexical data, operate at several different conceptual levels, and then begin to wonder how all this relates to perception, abilities, temperament, or genes. Bottom level researchers typically operate at molecular, genetic, physiological, anatomical, or neurofunctional levels and then wonder how all this relates to higher level personality, society, or culture. The major problem with both approaches is, that they lack a translation table for how material causes and effects map onto psychological, social, or cultural levels, and vice versa. Top and bottom level data, therefore, remains incommensurable, and devastating body-mind problems keep popping up. The only workable solution for this problem is to turn to single level analysis, and physicology recommends addressing the molecular level in future studies. This is not because it is the only possible level but rather because it is the most practical level. Moves of molecules are, for example, closer to the human development and behaviour scales than are moves of sub-atomic particles, even if the two are related. Neuroendocrine studies of relevance for personality research already proceed within a molecular perspective (e.g., Hoyenga & Hoyenga,

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1979, 1993; Imperato-McGinley *et al.*, 1980; McEwen, 1988). Few psychologists encounter problems with accepting that personality is influenced by genes, but this really means that body and brain tissues are influenced by proteins generated according to DNA instructions, with the undeniable implication that personality has to be studied in terms of moving molecules. Many would agree that basic body and brain function is a matter of chemistry, but what about socialization? Physicology defines socialization as a purely molecular phenomenon. Instead of seeing socialization as an interpersonal exchange of abstract norms, concepts, or cultural information, physicology redefines it in terms of the skilful exchanges of patterns of reflected light, sound, smell, and other plainly physical parameters. Instead of seeing people as mindful users of symbols and representations, or as internalizers of rules and attitudes, physicology redefines people in terms of relatively open carbon-based multimolecular systems capable of emitting, receiving, and storing complex physical stimulus patterns. In other words, physicology recommends that social learning be studied in terms of material intersystemic exchanges leaving physico-chemical traces in the systems involved. The effectiveness of social learning will then be determined by internal physico-chemical flexibility, stability, complexity, and intensity (by some called intelligence and personality), and by the salience of the external physical impacts. Physicology thus brings both endogenous and exogenous information within the scope of single-level molecular analyses and enables us to perform truly interdependent dynamic analyses of interactions among genes, body chemistry, and experience. Details of the program are presented in Nyborg (1994a).

The single-level molecular analysis may seem offensive to some psychologists, but it actually confers a number of advantages over more traditional approaches. It brings the complete intra-, inter-, and extrasystemic information on a common footing, and allows for genuine integration of data without running the risk of committing category errors. It allows for seamless step-by-step causal analysis of, say, the role of t in personality. We can then ask questions about the origin of t: Maternal, from a male co-twin through placental transfer (e.g., Miller, 1994), or own secretion? We can label t molecules by radioactivity and follow in the smallest details their way through the system, including induction of receptors and the hormone-receptor complex on its way into the cell nucleus. We can then monitor how the hormone affects the transcription of androphilic genes, note which proteins or neurotransmitters they later give rise to, and examine the complex systemic consequences they may have. We can study in microscopic details the effects of all this on the cell nucleus or cell assemblies, or at the level of organs, and then begin to project all these organizational or activational effects on to pheno-

typic body and brain development, and note changes in neural functions related to the expression of abilities, personality, or psychopathology.

The *fourth step* consists of a precise identification of proximate causes. Much personality research assumes multiple different-level proximate or reciprocal average causal determination. Genes, social, or cultural factors are all said to mark personality, but traits, motives, attitudes, temperaments, beliefs, thoughts, and desires do so too. The molecular approach to personality simplifies this view. Instead of assuming average effects of unidentified genes on personality at the population level, physicology asks for person-specific identification of which DNA structures produce which relevant proteins through which mechanisms, having an effect on which particular body and brain structures and function. We now know that sex hormones switch genes on or off throughout the life-span (e.g., McEwen, 1988) The best known example of this is when the genetic apparatus of the sexually neutral (except with respect to the karyotype) fetus is differentially activated to transcribe proteins needed for either female or male body and brain development, or for something in between. An important future task for physicology is to identify the hormophilic genes in question, and to minutely map the essential molecular consequences of their transcription. Physicology thus asks questions about, say, the time-tables for when particular hormone surges are needed to procure the development of distinctively male or female personalities, and about which concentrations rather result in an androgynous personality (e.g., Nyborg, 1983, 1984, 1994a). Physicology strives, more generally, to formalize the molecular basis for all sorts of individual differences in body, brain, abilities, and personality. It strives to identify changes in relevant exogenous physical parameters during prenatal and later periods, and examines whether the changes left traces in the peripheral molecular machinery or in the purely molecular central phenomenon presently called memory. Physicology also examines the molecular wonders behind the surprising fact that physical systems like people can adapt quite well to even quite unfavourable physical environments, sometimes including nasty people. In other words, physicology strives through an exclusively molecular single level approach to expose the bolts and nuts of personality to merciless step-by-step natural science check-up procedures and to empirically outlaw unfounded and unrestrained speculations about whether abstract concepts, motives, or traits explain stasis or flow in personality. Research on genes, body, brain, ability, personality, experience, and society would then truly be brought on a common footing. A change in any of these now separate worlds could immediately be translated to molecular events in related areas. The interactive nature of all these molecular processes obviously raises the question of the level of proxi-

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The *fifth step* would be a precise specification of the window(s) used for analysis of a particular aspect of the molecular processes. Personality researchers typically simultaneously open a plethora of analytic windows. If one window is open to lexical aspects, other windows may be opened to an analysis of concepts, emotions, or temperament, or simultaneously to thoughts, feelings, needs, goals, plans, motives, values, or attitudinal aspects. Sometimes the analytic situation becomes so complex that researchers feel forced to concomitantly take into account whole organizations or dynamic interplay among trait complexes, multiple dispositions, and elaborate motive systems. The mastering of such situations may even call upon assistance from vague psychodynamic principles or notions of multidetermination, equipotentiality, or equifinality (e.g., Briggs, 1989; McAdams, 1992; Murray, 1938). These complex analytic situations amply demonstrate the following point: With multiple windows open simultaneously to multiple incompatible levels of analysis, the chance of making empirical sense of the observations will be minimal. All, that multi-area-multi-level approach leaves behind is nice words, nice boxes connected by nice arrows indicating potential causal directions, but no license whatsoever to empirical operationalisation and verification. This is probably the main reason why the traditional psychological/philosophical approach will never put us in the position to prune overly imperialistic or dead wrong personality theories.

To improve this situation, future physicological analyses should begin with a specification of the active analytic window(s). Physicology operates with three windows, each opening to different locations in the person-environment space. Each of the windows allows for gradually focusing in on narrower aspects of the interdependent molecular processes. The three windows are the intrasystemic, the inter-systemic, and the extra-systemic window. The *intrasystemic window* opens up to the molecular machinery of the single individual. This is where ontogenetic analyses of molecular interactions among gene products, neurotransmitters, and other molecular elements take place. Intrasystemic analyses typically proceed in step-by-step falsifiable ways and map endogenous molecular events and their permanent or transient effects on body and brain structure and function. Some of these events become immediately visible in behaviour, some never, and others only show up years later.

The *intersystemic window* opens for analysis of interpersonal physico-

chemistry. Instead of asking how people impress each other by abstract signs, symbols, norms, traits, or attitudes, the intersystemic molecular analyses focus on how complex physical systems like people often succeed in effectively exchanging information by systematically manipulating reflected light, sounds, smells, and other entirely physical parameters. All internal and external aspects of producing, transmitting, sensing, and storing signals can, at least in principle, be subjected to step-by-step intersystemic physico-chemical analysis. The intersystemic window, obviously, combines aspects of intrasystemic and extrasystemic molecular circumstances, but deserves particular attention because interactions among people often leave important traces in personality and offspring.

The *extrasystemic window* opens for analysis of molecular exchanges between the individual and the remaining non-social part of its physical world. Subject for analysis in this window is, for example, effects of prenatal and birth events (clearly also of relevance for an intersystemic analysis). Postnatal stress arising from a mismatch between the child and its physical environment is one among many other relevant factors here. The extrasystemic window is of particular importance because relatively open and flexible carbon-based physical systems like people depend critically on adequate nutrition (i.e., the break-down of higher-order molecular structures to replete loss of energy due to organismic build-up and maintenance processes) and on geo-climatically favourable external circumstances in order to survive, reproduce, and rear offspring. The extrasystemic window also opens to evolutionary aspects, but explicitly excludes norms, tradition, culture, and history as effective selective pressures. The reason for this is simple. There is no empirical way to establish the (f)actual existence or causal status of such abstract superorganismic concepts. However, the physicological program makes possible post hoc studies of the most likely evolution of traits like aggression, extraversion, sociability, and impulsivity, by analysing the evolution of generations of neutered animals subjected to careful hormone manipulation and ensuing "natural" or sexual selection in experimental situations believed to imitate pressures of primitive times (Nyborg, 1994a).

Obviously, the full implementation of the physicological program presumes many future advances. The Vietnam veteran and the Turner´s syndrome studies provided only a rude and very incomplete picture of the broad scope of physicological analysis, and were little suggestive of how genes, biochemistry, and experience work in close company and complex ways to harmonize body, brain, ability, and personality development. For example, the Vietnam study opened only the intrasystemic window and then only in a very restricted way. Nevertheless, even these preliminary hormoty-

pic approaches to the molecular machinery pointed to an important source of individual variance in sex-related traits. The next step would be to collect information about individual DNA structures, to specify individual variations in the mechanisms through which sex hormones modulate DNA transcription, to monitor individual receptor sensitivity, and to incorporate specific family influences and effects of prenatal events through the intersystemic window, and to open extrasystemic windows to test for degree of individual plasticity and adaptive capabilities for adjustments to ecological requirements. By simply making obvious which analytical windows were open at a given step in the analysis - and which were not - one would be in a better position to judge what is still missing from the final analysis.

Zuckerman (1991) has emphasized that traits are not inherited but rather differences in nervous system structure and function relevant for personality. Physicology is concerned with the origin of these differences in terms of systematic moves of various species of molecules procuring the similarities and differences in body and brain structures and functions that accounts for the hardware as well as for the software in personality. Physicology answers Pervin´s (1993) cry for an account of flow in personality with intrasystemic analyses of changing hormones and other neurotransmitters, and further offers a careful mapping of the intrasystemic molecular responses to inter- and extrasystemic physico-chemical variation. For example, environmentally induced hormonal changes may affect gene expression and can thus alter significant body and brain functions, with either transient or permanent effects on personality. The molecular approach explains, in other words, stability as well as dynamics in the development and function of body and brain tissues and the consequences for abilities and personality. Such a natural science analysis of causes and effects in molecular pathways needs no hypothetical constructs like motives or introversion to account for direction, frequency, intensity, or stability of personality. Most males show pervasive overall masculinization of body, brain, and personality, and most females show traits at the polar end of sex-dimorphic dimensions. However, the diversity of molecular actions guarantees that this is not always so. The molecular approach, therefore, accounts just as well for individual deviation from modal male or female trait development in terms of demasculinisation or defeminisation. It allows for identification of the causal basis for the appearance of a few distinctively female stereotypic personality traits within an otherwise predominantly male phenotype, or vice versa, in terms of genetic or experiential variation, or by variations in the time-tables for hormone surges or in receptor sensitivity or receptor induction during development. A personality model not capable of accounting, at least in principle, for both

modal trait development (species-specific stable development), individual variations, and for a systematic mix of, say, distinctively masculine and feminine traits within one person is simply not worth its money.

The molecular analysis favours notions of biological and behavioral continua at the expense of discrete distributions, and this applies to abnormal as well as normal personality development. The GTC model predicts, for example, that abnormally low prenatal t exposure predisposes a low t introverted A1 male for a slightly higher risk of developing schizophrenic symptoms, such as marked social withdrawal, whereas the slightly higher t A2 may appear introvert as well, but remaining within socially accepted limits. The high t extravert A4 is expected to show dysthymic symptoms, but the very high t A5 male is at risk for developing full-blown affective psychosis (Nyborg, 1992). The model considers, in other words, abnormal personality development as an extreme individual variation over modal continuous normal development. In this, the GTC model conforms to ideas long ago suggested by Kretschmer (1925), Eysenck (1990), and others.

Physicology is neither a behavioral science in the usual sense nor does it equal behaviourism. It operates with covert as well as overt behaviour, and molecular events may not show up in immediate behaviour but may preset the sensitivity of the neural apparatus for events that take place in a moment, such as sex, or only much later in life. The only way to find out is to focus on the intrasystemic molecular events that give rise to behaviour.

Physicology calls for revision of the traditional nature-nurture model (Nyborg, 1987). In particular, the assumptions of independence, additivity, and linearity are demonstrably wrong (Nyborg, 1989, 1990). Thus, many life-history events of environmental origin induce hormonal changes that selectively switch genes on or off. This means that the idea of genes having phenotypic effects independent of environmental factors is inappropriate. Moreover, an individual's perceptual systems may be particularly tuned to seemingly minor environmental events that may have tremendous systemic effects on body chemistry, whereas truly major events may fail to induce noticeable intrasystemic effects in less sensitive systems. In each of these cases, the notions of universal sensitivity, additivity, and linearity in cause-effect relations are of more than dubious value. Hormones influence genes in non-linear non-additive ways and then secondarily exert non-additive non-linear systemic cascades of effects on neural systems remotely positioned relative to the locus of first molecular actions. This implies that basic assumptions about linear causal gene-environment link are simplifications in need of precision and quantification in terms of molecular analysis. Such a move would probably result in the appearance of more flexible and dynamic

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References

Briggs, S.R. (1989). T
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Eysenck, H.J. (1990).
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nature-nurture models than those presently available. It is worth noting here in passing, that the non-linear nature of biological cause-effects relations and of nature-nurture relationships is presently poorly understood (Nyborg, 1995c).

The evolutionary perspective is an important aspect of physicology. Modern male and female personalities most certainly have origin in an evolutionary past, and cannot be accounted for without it. Besides its emphasis on molecular interaction, physicology envisions male and female personality patterns as important intrasystemic molecular adaptations to the survival in ecological niches that differed according to various selective pressures in primitive times and to the different reproductive roles of males and females. Classical Darwinism is seen as a special case of universal selection for the most economic molecular system given circumstances (Nyborg, 1994a). Physicology provides in this way a natural science angle on the study of the origin of sexual and geographically dictated differences in behaviour, as well as on within-sex and within- and between-race variations over these general developmental themes, and that on a strictly material basis. Whereas the molecular approach offers empirically obvious and verifiable alternatives, the traditional psychological approaches only offers extensive use of further hypothetical construct and speculative intervening variables. Whereas brain development and evoked molecular brain events can be examined with various scanners, and the data used in future natural science inspired personality research of single individuals, universal hypothetical constructs and intervening variables come out to too easily of the theorist's mouth and allow examination only in terms of their meaning, correlation, or truth value.

References

Briggs, S.R. (1989). The optimal level of measurement for personality constructs. In D.M. Buss & N. Cantor (Eds.), *Personality psychology: Recent trends and emerging directions* (pp. 246-260). New York: Springer.

CDC (Centers for Disease Control). (1988). Health status of Vietnam veterans. I: Psychosocial characteristics. *Journal of the American Medical Association, 259*, 2701-2707.

Eysenck, H.J. (1990). Biological dimensions of personality. In L.A. Pervin (Ed.), *Handbook of personality. Theory and research* (pp. 244-276). New York: The Guilford Press.

Herrnstein, R.J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life.* New York: The Free Press.

Hoyenga, K.B., & Hoyenga, K.T. (1979). *The question of sex differences: Psychological, cultural, and biological issues.* Boston, MA: Little, Brown and Company.

Hoyenga, K.B., & Hoyenga, K.T. (1993). *Gender-related differences: Origins and outcomes.* Boston, MA: Allyn and Bacon.

Imperato-McGinley, J., Peterson, R.E., Gautier, T., & Sturla, E. (1980). Androgens and the evolution of male-gender identity among male pseudo-hermaphrodites with 5-alpha-reductase deficiency. In S. Chess, A. Thomas, & M.E. Hertzig (Eds.), *Annual Progress in Child Psychiatry and Child Development.* New York: Brunner/Mazel.

Kretschmer, E. (1925). *Physique and character.* (W.J.H. Spratt, trans.). New York: Harecourt (originally published, 1921).

McAdams, D.P. (1992). The five-factor model in personality: A critical appraisal. *Journal of Personality, 60*, 329-361.

McEwen, B. (1988). Steroid hormones and the brain: Linking "nature" with "nurture". *Neurochemical Research, 13*, 663-669.

Miller, E.M. (1994). Prenatal sex hormone transfer: A reason to study opposite-sex twins. *Personality and Individual Differences, 17*, 511-529.

Morris, D.V., Adeneyi-Jones, R., Wheeler, M., Sonksen, P., & Jacobs, H.S. (1984). The treatment of hypogonadotrophic hypogonadism by the pulsative infusion of LHRH. *Clinical Endocrinology, 21*, 189-200.

Murray, H.A. (1938). *Explorations in personality.* New York: Oxford University Press.

Nyborg, H. (1977). *The rod-and-frame test and the field dependence dimension: Some methodological, conceptual, and developmental considerations.* Copenhagen: Dansk Psykologisk Forlag.

Nyborg, H. (1983) Spatial ability in men and women: Review and new theory. *Advances in Human Research and Therapy*. Vol. 5. Monograph Series (whole number) (pp. 39-140). London: Pergamon Press.

Nyborg, H. (1984) Performance and intelligence in hormonally different groups. In G.J. De Vries, J.P.C. De Bruin, H.B.M Uylings, & M.A. Corner (Eds.), *Sex differences in the brain: Relation between structure and function*. Progress in brain research (Vol. 61, pp. 491-508). Amsterdam: Elsevier Science.

Nyborg, H. (1987). Individual differences or different individuals? That is the question. *Behavioral and Brain Sciences, 10*, 34-35.

Nyborg, H. (1989). The nature of nature-nurture interaction (abstract). *Behavior Genetics, 20*, 738-739.

Nyborg, H. (1990). Good, bad, and ugly questions about heredity. *Behavior and Brain Sciences, 13*, 142-143.

Nyborg, H. (1992). *Genes, hormones, maturation, and the etiology of psychoses: An application of the GTC - A/E model*. Paper presented at the International Symposium on "Rate of maturation, brain development, and behavior". University of Trondheim, Geilo, Norway.

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. In P.A. Vernon (Ed.), *The neuropsychology of individual differences* (pp. 59-113). San Diego, CA: Academic Press.

Nyborg, H. (1995a). *Individual, sex, and race differences in body, Brain, and specific abilities: The General Trait covariance - Androgen/Estrogen model for development* (in prep.).

Nyborg, H. (1995b). *Extracting Eysenck's personality dimensions from clinical MMPI-I and -II data* (in prep.).

Nyborg, H. (1995c). *Non-linear gonadal hormone modulation of brain and behavior along the life cycle* (in prep.).

Nyborg, H., Nielsen, J., Naeraa, R., & Kastrup, K.W. (1995). *Sex hormone therapy restores visuo-spatial abilities in young girls with Turner's syndrome* (submitted).

Pervin, L.A. (1993, July). *A critical analysis of trait theory*. Paper presented at the 6th Meeting of the International Society for the Study of Individual Differences, Baltimore, MD.

Zuckerman, M. (1991). *Psychobiology of personality*. New York: Cambridge University Press.

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