

Chapter 4

The Biology of Personality

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INTRODUCTION

The relative importance given to environmental and biological factors in determining personality has fluctuated throughout history. The western medical tradition has tended to emphasize biological factors in explaining human behavior. Many of the theories presented a simplistic and even prejudiced view of human behavior. However, there now exists an extensive body of data from disparate fields of research that supports the concept that biology contributes significantly to personality.

This chapter will briefly review the history linking biology to personality. It will then discuss the evidence for the importance of biological factors influencing behavior. Current biological theories will be examined and research on these theories presented. Finally, an attempt will be made to link biology of personality with current medical and psychiatric practice.

DEFINITION

The word “personality” has been described as one of the most abstract words in our language. Its exact meaning generally varies within the context in which it is used. The concept of personality discussed in this chapter might be more properly labeled temperament. Temperament may be seen as simple, nonmotivational, noncognitive, stylistic characteristics. Such behaviors appear early in childhood, show substantial stability over time, and reflect a significant heritable bias. This contrasts with the “higher nervous system”, which through language, thought, memory, and other cognitive processes, shapes the expansion of the underlying temperamental dispositions.

MODELS OF PERSONALITY

The history of formal personality characterization can be traced to the Greeks. The two major theories to explain personality were based on the concepts of constitution and temperament. Both have continued in one form or other until the present. Constitution is equivalent to the “conformation of the body” and relates behavioral style to physical attributes. Physiognomy or “character writing” was possibly the first constitutional classification system and was brought to its finest form by Theophrastus. He presented brief descriptions delineating a particular trait to highlight major features in an individual. Many of these descriptions are

often based on physical appearance of various animals (hence the expression “sly as a fox”) as well as on facial expressions or racial stereotypes.

The concept of temperament has been even more influential. The Hippocratic view, later elaborated by Galen, classified behaviors into four temperaments—sanguine, phlegmatic, choleric, and melancholic. These were related respectively to excessive blood, phlegm, yellow bile, or black bile. Galen elaborated the behavioral manifestations so that sanguine temperament had a leaning toward optimism, the phlegmatic temperament was associated with an apathetic disposition, the choleric temperament was related to irascibility, and the melancholic temperament was inclined to sadness.

Attempts to appraise others by observing facial expressions, postural attitudes, and style of movement have continued until the present. The first widely practiced systematic attempt to relate psychological functioning to external morphology was phrenology, introduced by Gall in the late eighteenth century. Contending that the brain is the central organ of thought and emotion, Gall concluded that the intensity and character of thought and emotion should correlate with variations in the size and shape of the brain’s encasement, the skull. Despite the transparent weakness of Gall’s system, it was widely accepted for several decades. Earlier this century, Kretschmer and Sheldon developed systems of describing personality based on body shape. Sheldon’s typology postulated on three basic types, endomorphy (a predominance of roundness of the body), mesomorphy (predominance of bone and connective tissue), and ectomorphy (fragile body build).

The humoral theory of temperament has had a more profound impact on medical tradition, and the principle of psychophysical substances being seen as the determinants of behavior survives in a modified form in our current era of empirical research.

While the dominant paradigm within the literate medical tradition has been that biology and personality are linked, there have always existed folk and magical views, which ascribed human behavior to external malevolent agents. By the nineteenth century, the medical literature had become reoccupied with the relative weight to be attributed to physical and to moral (roughly psychological) determinants of behavior and insanity. Some believed that moral causes, centering on an individual’s lack of moderation and on excesses of all kinds were important. Others favored physical causes, especially hereditary endowment. A philosophical movement, Associationism, proposed by Hobbs, Locke and others, argued that the mind was an empty slate and that behavior were acquired due to what was seen and heard and which habits were practiced or encouraged.

These ideas were given a further boost by the growth of psychoanalysis around the turn of the century. Personality was believed to be related to the frustrations and indulgences of instinctual drives associated with specific stages of psychosexual maturation. Early behaviorists also appeared to exclude the concept of temperament altogether—the most dogmatic arguing that even human sexual

behavior has no basis in biology. There was therefore no need to measure or explain concepts such as temperament or personality.

By the middle decades of this century, the medical tradition widely endorsed an overwhelmingly environmental view of personality, particularly in the United States. Neonates were considered psychological nonentities, a bundle of reflexes and therefore totally malleable. "Heredity" was widely misinterpreted to mean determined, or fated, as it sometimes is now. In addition, the distortion of racial and behavioral characteristics by Nazi ideology and the horrific consequences this brought about further strengthened the case of those who put forward an overwhelmingly environmental view of personality. Genetics steered clear of behavior even as they found gene after gene that was intimately involved in most other aspects of human metabolism and functioning. Differences in children's moods and behaviors were seen primarily the result of early family experiences. Excessive timidity or aggressiveness in a child was a sign that the family had done something wrong. The dangers inherent in a primarily psychosocial model of personality should not be underestimated. Assuming that any child can become schizophrenic and that all cases of panic or antisocial behavior are psychologically traceable to parental failures 20 years earlier is just as flawed and simplistic as the racial eugenics arguments. These theories generated a great deal of suffering and undeserved guilt in patients and their families.

THE BIOLOGY OF PERSONALITY

The change from antipathy to acceptance of biological factors with regard to personality has occurred rapidly. Today's scientific and popular presses are fueled with claims that biology plays a role in everything from sexual attraction to shyness. The reason for this shift in attitude is related to a number of factors. These include the resurgence in interest in behavioral genetics, studies of child temperament, neurochemical studies, and a number of sociopolitical factors.

Genetics

As discussed previously, the eugenics movement and Nazi Germany had meant that, for a long time after World War II, geneticists avoided the search for genes linked with behavior. Eventually the evidence became too much to ignore. The huge accumulation of data about hereditary influences in animal behavior could not be overlooked. Nor could the larger and more sophisticated twin and adoption studies of human beings that were consistently reporting that between 40 and 60% of observed variance in personality was due to genetic factors. Behavioral genetics is now a major field of research and there is general acceptance that genetics play at least some role in determining personality and behavior.

Temperament

The modern study of child temperament began with the New York Longitudinal Study initiated in the 1950s by Thomas and Chess. Rather than focusing on parent–child interactions, the study focused on individual differences in the child as an active agent in its own environment with an emphasis on emotional rather than cognitive aspects of development. This study and several others made it increasingly clear that individual children differ from each other in a host of ways that can be reliably measured. These measures include concepts such as activity level, autonomic activity, behavioral inhibition, sociability, and impulsivity. These differences are relatively stable and matter in terms of later psychological development: More recent studies have shown that infants have relatively sophisticated sensory discriminations at birth, that they have learning abilities, and that they already display substantial interindividual variability.

Neurobiology

The third influence results from the study of central neurotransmitters and their relationship to observable behavior. Forty years ago, mapping behavior onto existing models of the brain was impossible. Noradrenaline and acetylcholine were the only chemicals known to act at the synapse. There is now a large literature on the chemistry of the brain that is full of apparent contradictions and lacks compelling heuristic models. Nevertheless, there is some consensus on the behavioral functions of the central neurotransmitters and explanations for the apparent contradictions are becoming clearer. Methodology is becoming more sophisticated and there is now copious evidence that altering neurochemical pathways, either pharmacologically or anatomically, affect behavior in quite specific ways.

Sociocultural

Finally, the influence of sociopolitical factors in augmenting acceptance of the importance of biology and personality should not be underestimated. There is arguably less need at present to promote a view of humankind as being shaped almost exclusively by culture. This is not to say that some social scientists and others do not still argue forcefully for the basic similarity of all human groups and the capacity of humans to change their personal qualities through experience. What is often not appreciated is that temperamental differences are malleable by experience. Temperament does not imply a rigid determinism. While major brain pathways are specified in the genome, neural connections and levels of neurotransmitters reflect socially mediated experiences as well.

THE CURRENT ERA

We have now reached a point where some matters are less controversial. Today, few would dispute that children are temperamentally different from one another and that some of this difference is genetically determined. It is also generally accepted that brain pathways affect behavior. The major challenges lie in measuring these neurophysiological changes and constructing a model of temperament with which to test possible relationships.

The logical place to look for biological correlates of temperament is in brain anatomy and brain physiology. At this point, it appears most likely that temperament will be related to physiological differences, particularly those involving neurochemistry. However, there is some evidence, in animals at least, that neuroanatomy may be linked with behavior. Domesticated strains of horses and pigs, for example, have smaller brains than wild varieties and are much less fearful. Animals who are reluctant to explore novel environments have larger hippocampus projections than those who are highly exploratory.

Neurophysiological Studies

Exploring brain physiology in humans presents a number of problems. A fundamental difficulty is that the activity of the central nervous system (CNS) pathways can only be measured indirectly. Using the electroencephalogram (EEG), early studies related electrical activity to arousal level or used evoked potentials and event-related potentials to study the nervous system's reaction and response to environmental stimuli. The studies particularly focused on measures of introversion and neuroticism and they also often used "psychopaths" (contrasting their responses to nonpsychopathic individuals). Unfortunately, despite a considerable number of studies, the results have been inconsistent. Similarly, studies of autonomic functioning, including electrodermal activity and heart rate, which have attempted to relate these to measures of psychopathy and various personality scales, have been disappointing. Although there appears to be a trend for decreased electrochemical activity and lower tonic heart rate in psychopaths, the studies remain inconclusive. Theories have been advanced to explain the variable results, but little consensus is emerging.

Neurochemical Studies

Another area of study is CNS neurochemical measures, particularly monoamine oxidase systems. Studies use cerebrospinal fluid (CSF) measures, probes that exploit monoamine-mediated functions such as hormone release, receptor studies, and timed urine collections. These indirect measures have significant shortcomings. Lumbar puncture is invasive and difficult to justify in normal subjects, and the trauma of the procedure may bias measures. Measurement of the concentra-

tion of catecholamines and their metabolites in humans has not yet yielded uniform results across laboratories.

Seasonality, time of day, diet, age, sex, and weight may also affect measures. Despite this, some results are beginning to emerge with reasonable consistency. Most studies, until now, have centered on the three main monoamines and their role as neurotransmitters.

Serotonin

Reasonable agreement has been reached on the role of the serotonergic system. Most regard it as a behavioral inhibition system, which acts in opposition to the two catecholamine systems, noradrenaline and dopamine. Human studies have linked the 5-HT metabolite (5-hydroxyindol acetic acid, 5-HIAA), with measures of aggression, impulsivity, and disinhibition in humans. Low CSF 5-HIAA has been linked to violent suicide, impulsivity, arson, and aggressive behavior. This evidence has been supported by more recent studies using serotonin probes, such as prolactin release, with several studies reporting that indices of serotonergic function are negatively correlated with impulsivity and aggression.

Noradrenaline

The role of noradrenaline is less clear. Animal studies suggest that noradrenergic neurones play a reinforcement role assisting in reward-associated learning. Several studies have demonstrated impaired learning in animals with noradrenaline depression. Recent studies in rats and moles report that highly affiliative animals showed distress in response to social isolation, a phenomenon be reduced by the administration of oxytocin. There have also been hypotheses that noradrenaline mediates general arousal of all motor systems. Human studies looking at noradrenaline blood levels are uncommon. Some have shown that compulsive gamblers may have significantly higher levels of noradrenaline metabolites than controls, and alcohol craving has been linked with low levels of the neurotransmitter.

Dopamine

There is more consensus on the role of dopamine. This monoamine appears to be related to behavioral activation. Dopamine-depleting drugs reduce active behavior, whereas facilitation of dopaminergic neurotransmission increases motor activity, exploratory behavior, and approach to novel stimuli. Studies on rodents link highly active behavior with independent hippocampal fiber terminal fields containing high levels of dopamine. Human studies indicate that low basal dopaminergic activity is associated with suicidal behavior. There is also some evidence that decreased dopamine β -hydroxylase has been associated with unsocialized conduct disorder in boys, and this may reflect a disorder of CNS dopaminergic transmission.

A recent study reported that striatal dopamine re-uptake site densities were markedly lower in nonviolent alcoholics than in those who were violent.

In summary, human studies show some degree of consistency with animal studies. There is considerable evidence that serotonin and behavioral inhibition are linked. Depletion of this neurotransmitter leads to general disinhibition of behavior. Dopamine has been associated with activating an incentive function in animals, and it is possible that it is related to exploratory and possibly antisocial behavior in humans. The role of noradrenaline in both animals and humans is much less clear.

MODELS OF TEMPERAMENT

As we have seen, there is now strong evidence that individual differences appear to be relatively stable, genetically influenced temperamental traits that are related to CNS neurotransmitter functioning. A major problem impeding further research is a lack of an agreed upon cohesive psychobiological model. An ideal model of temperament would be useful at a number of levels. Firstly, at the descriptive level, it would situate individuals in a unique multidimensional personality space. Ideally the measures obtained would also relate to current concepts of psychiatric illness. Secondly, the measured dimensions would reflect the underlying genetic structure, and thirdly, the dimensions would reflect the underlying biological causal mechanisms.

A number of descriptive models have been proposed. It is probable that a model involving three to seven measurable dimensions would be most useful. If, as seems likely, multiple genes are responsible for genetic influences on behavioral dimensions, a continuum of genetic risk is likely to extend from normal to abnormal behavior. Therefore, such dimensions should be reasonably normally distributed in a general population. In addition, neurochemical measures that are related to behavior appear to follow a dimensional pattern and cut across categorical boundaries. Although there have been some interesting links between categorical classes of personality disorder and biological measures, this is unlikely to be fruitful in the long run.

Models using factor analytic techniques reduce down to two to five major independent dimensions of variation (besides intelligence) in personality space. The most influential are Eysenck's model of personality and the so-called "big-five" or five-factor model (FFM), which overlap to some degree. The FFM has received extensive psychometric evaluation and has arguably the most compelling empirical support as a dimensional model of normal personality functioning. The five factors are called neuroticism (N), extroversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). (See Table 1 below for further explanation of what these terms mean). Unfortunately, there has been very little theoretical or empirical work relating these measures to biological factors. This does not seem to have been a priority for those using the model to study personality. There have

Table 1. Five Main Determinants of Personality

<i>Extraversion</i> Is outgoing, decisive, persuasive, and enjoys leadership roles	Is retiring, reserved, withdrawn, and does not enjoy being the center of attention
<i>Neuroticism</i> Is emotionally unstable, nervous, irritable, and prone to worry	Quickly gets over upsetting experiences and is stable and not prone to worries and fears
<i>Conscientiousness</i> Is playful, organized, responsible, practical, and dependable	Is impulsive, careless, irresponsible, and cannot be depended upon
<i>Agreeableness</i> Is sympathetic, warm, kind, good-natured, and will not take advantage of others	Is quarrelsome, aggressive, unfriendly, cold, and vindictive
<i>Openness</i> Is insightful, curious, original, imaginative, and open to novel experiences and stimuli	Has narrow interest, is unintelligent, unreflective, and shallow

Note: Modified from Bouchard, 1994.

been some studies looking at the heritability of the five factors and this is reported to be between 40% to 50%, which is similar to most other dimensional behavioral measures. The FFM is difficult to relate to current psychiatric categories. Neuroticism has been well studied and is increased in most psychiatric illnesses, but the other dimensions are less closely linked. There have been attempts to relate the dimensions to personality disorders, but the results are mixed.

Eysenck’s model has three dimensions: extroversion/introversion (E), neuroticism (N), (which is similar to but not identical to the FFM neuroticism scale), and psychoticism (P). The central core of Eysenck’s work was his hypothesis that the ease of acquiring a conditioned response was related to an individual’s location on the axes of extroversion and neuroticism. Introverted (low E) subjects conditioned more rapidly and extinguished more slowly than extroverts; these effects were exaggerated if they were also neurotic (high N). A number of biological measures—galvanic skin response, salivation, eye blinks, and so forth—were related to these differences. However, intercorrelations were modest and the effects of these measures were small. Eysenck’s attempts to relate his dimensions to the CNS, particularly the ascending reticular activating system and the limbic system, were less successful .

The Tridimensional Model of Temperament

A more recent biosocial model of temperament was the tridimensional model of personality proposed by Cloninger. This was a theoretical model specifically designed to encompass current knowledge about the biology of behavior.

Cloninger began by postulating brain systems and then worked outward to their behavioral manifestations. There are three temperament dimensions named novelty seeking (NS), harm avoidance (HA), and reward dependence (RD). Variation of each of these dimensions was held to be associated with activity in a specific monoamine pathway. Novelty seeking (NS) was hypothesized to effect heritable individual differences in the behavioral activation system. High novelty seeking manifested itself in exploratory and active avoidance of monotony and was associated with low basal firing rates of dopaminergic neurons. In contrast, individuals with high spontaneous firing rates would be expected to be relatively placid and content regardless of external circumstances. Harm avoidance (HA) reflects heritable individual differences in the activity of the behavioral inhibition system. High harm avoidance manifests itself as a tendency to respond intensely to aversive stimuli and to learn to avoid punishment, and it is associated with high basal firing rates of serotonergic neurones. Individuals with low spontaneous firing rates would be expected to be confident, bold, risk-taking, and disinhibited.

Finally, reward dependence (RD) is supposed to reflect heritable individual differences in the behavioral maintenance system. High reward dependence manifests itself with an intense response to signals and reward, as well as with maintaining or resisting extinction of behavior. It is associated with low basal noradrenergic activity. Reward-dependent individuals may be described as dedicated, committed, loving, and emotionally dependent.

There is a pleasing simplicity about the way Cloninger’s model relates each dimension to a single monoamine, but it is probably preferable to think of three monoamines as “emblematic” neurotransmitters that might reflect overall CNS activity. Multiple other substances including amino acids, neuropeptides, second

Table 2. The Tridimensional Model of Temperament

Brain System (Related Temperament Dimension)	Principal Monoamine Neuromodular	Behavior	
		High Scorers	Low Scorers
Behavioral Activation (Novelty Seeking)	Dopamine	exploratory & curious; impulsive; extravagant & enthusiastic; disorderly	indifferent; reflexive; frugal & detached; orderly & regimented
Behavioral Inhibition (Harm Avoidance)	Serotonin	worrying & pessimistic; fearful & doubtful; shy; fatigable	relaxed & optimistic; bold & confident; outgoing; vigorous
Behavioral Maintenance (Reward Dependence)	Noradrenaline	sentimental & warm; dedicated & attached; dependent	practical & cold; withdrawn & detached; independent

messengers, and so on, are also important in regulating behavior. Cloninger's model, like Eysenck's, has been made operational by the construction of a hundred-item self-report—the tridimensional personality questionnaire (TPQ), which generates scores for novelty seeking, harm avoidance, and reward dependence.

Research Using the TPQ

At a descriptive level, results using the TPQ have been promising. Internal consistency and factor analysis suggest that there are three normally distributed independent measures. The findings were problematic for reward dependence and this has resulted in a subsequent fourth dimension—persistence, which was extracted from reward dependence. Personality disorders are related to the temperament extremes in a logical way. DSM 111 cluster A personality disorders (paranoid, schizoid, and schizotypal) have low reward dependence, cluster B personality disorders (antisocial, borderline, narcissistic, and histrionic) have high novelty-seeking, and cluster C personality disorders (avoidant, dependent, and obsessive compulsive) have high harm avoidance. Recent revision has seen the addition of three character measures to the original four temperament measures, but their relevance to biological measures is less obvious and they will not be discussed here.

Genetic analysis of data from 2680 twin pairs demonstrated that the genetic contribution accounts for 54% to 61% of the stable variation in the traits of novelty seeking, harm avoidance, and reward dependence. Further analysis suggests that the TPQ is measuring other (although still incomplete) descriptors of heritable personality that are different from those measured by Eysenck or the FFM. There have been two reports of a modest association between the dopamine D4 receptors and the trait of novelty seeking, but these were not replicated.

At a biological level, results using the TPQ have been mixed. Studies using traditional methods of measuring CNS monoamines have been unable to show any significant relationship between such measures and the TPQ dimensions. This was the case whether the biological examples were obtained using imipramine binding, prolactin response to alcohol, CSF monoamine metabolite concentration, or sensitivity to diazepam. On the other hand, there have been some more promising findings. One study showed a significant correlation between dopamine uptake in the left caudate and TPQ novelty seeking as would be predicted. It also reported that patients with Parkinson's disease have less novelty-seeking behaviors, an observation consistent with expectations since patients with Parkinson's disease have low dopamine turnover. High plasma GABA levels, which are related to anxiety proneness, have been correlated with low harm avoidance. Low levels of urinary 3-methoxy-4-hydroxyphenylglycol (MPGH), the metabolite of noradrenaline, have been reported in alcoholic patients with high reward dependence.

Which Model of Temperament

It emerges that the major difficulty in constructing a model of temperament is that there is an infinite number of alternative ways of summarizing temperamental traits and placing them in a three-dimensional space. Factor analysis can help determine the minimum number of measured dimensions but cannot decompose the underlying causal structure. Any useful biological model needs to be validated at the genetic and biological level as well as at the descriptive level. Presently, it seems fair to say that models are based on authority or tradition. Cloninger's tri-dimensional model is a qualified success at the descriptive level since the dimensions are independent, stable, conceptually attractive, able to be related to animal models, and reasonably easy to integrate with psychiatric diagnoses. At the genetic level, the TPQ measures appear genetically homogeneous and independent. However, it remains limited at the biochemical level.

A fundamental question is whether there is a significant problem using questionnaires to measure temperament. There may be serious differences between an adult self-evaluation and direct observation of that person. For example, many more adults answer to being shy than those who inherit a temperamental bias to be unusually shy. The items in questionnaires are restrictive and reflect the beliefs of the individuals who designed them. Factors that emerge depend on the questionnaire containing several items that reflect the same quality. Unfortunately, the alternative strategy of prolonged close observation of infant (or adult) behavior means that only small samples can be used. This may result in subtle differences in temperament being missed or in exaggerated importance being placed on a few unusual cases. Computer technology has begun to provide a middle road. In these systems, the way a questionnaire is scored as well as the answer to individual items are considered. For example, if individuals answer questions rapidly, then this is taken into account when scoring dimensions such as novelty-seeking or impulsivity.

There have also been new animal models for studying the biology of temperament, and this gives a further strategy to tackle the problem. Rather than measure behavior and relate this to biological variables, genetic manipulations of transporter genes allow highly specific alterations of CNS neurochemistry, and the resultant behavioral change can then be carefully observed. For example, a recent study produced a strain of mice in which the gene encoding the dopamine transport gene (DAT) had been disrupted—so called “DAT knockout mice”. This resulted in CNS dopamine persisting at least 100 times longer in the extracellular space. The mice were extremely hyperactive and exploratory, gained weight more slowly than the control mice, and had impaired maternal behavior—something akin to extreme novelty seeking.

Another study produced mice lacking monoamine oxidase A (MAO-A), an enzyme that degrades serotonin and norepinephrine. In pup brains, serotonin concentrations were increased and pup behavioral alterations including trembling and

fearfulness (resembling increased behavioral inhibition or harm avoidance) were reversed by a serotonin synthesis inhibitor. Adult mice had a different pattern of behavioral alterations consisting of offensive, aggressive behavior. Deficiency in MAO-A was shown to be associated with aggressive behavior in men in a Dutch family, so this parallel is interesting. The problems in these models include the common one of translating animal behavior to human behavior and also the fact that the genetic manipulations result in extreme biochemical abnormalities rather than a variance on normal CNS biochemistry. Such extremes may result in categorical behavioral differences rather than representing one end of dimensional continuum.

THE IMPORTANCE OF THE BIOLOGY OF TEMPERAMENT

An obvious question is that, given the serious problems in measuring both temperament and biology, why bother to pursue this area of research? The obvious answer is that this research is important. Most models of medical and psychiatric research have assumed specificity from a nosological/categorical perspective. Researchers have studied symptoms and biological measures within diagnostic categories in an attempt to guide treatment and predict the course of illness. Measuring temperament affords an additional strategy that proposes that behavioral traits are present across categories. It is these traits that have biological relationships rather than symptom measures. For example, serotonin disturbances have been reported in a variety of illnesses including major depression, antisocial personality disorder, obsessive-compulsive disorder, schizophrenia, and disruptive behavior disorder in children. The reason for this may be that such disturbances are nonspecific from the illness perspective but specific from a functional/dimensional perspective in that they correlate with particular temperament dimensions (in this case, impulsivity and aggression) across diagnoses.

The evidence also suggests that temperament differences within diagnostic categories may help explain the contradictory biological findings and diverse treatment responses. Cortisol hypersecretion, for example, which is present in many depressed patients, may be more related to measures of temperament than depressive symptoms. Hence, this biological marker is not especially specific for depression and may not be reported in some samples of depressed patients. Patients within categories may also respond differently to specific treatments. Depressed individuals with extreme temperaments often respond less well to tricyclic antidepressants. One study has found that temperament measures were much more significant in predicting the response to antidepressants than were any clinical symptoms or signs.

The finding from many studies that different psychiatric illnesses exist in one family might reflect a pedigree based on vulnerable temperamental traits rather than implying that these illnesses are directly related in some way. It may be more

fruitful to map genes contributing to temperament, which has a relatively simple genetic architecture, than to attempt to map genes to a disease such as schizophrenia, which is probably caused by multiple susceptibility dimensions, each of which may be oligogenic. If it is possible to successfully map temperament, subsequent susceptibility to complex disorders like schizophrenia and alcoholism could be evaluated in the terms of risk from heritable temperament traits and possible disease-specific factors.

CONCLUDING REMARKS

This chapter offers a selected review of the literature in the field of biology and personality. It has done little more than hint at the confusion inherent in the large quantity of pertinent data that exists. However, this confusion should not obscure the fact that there is now overwhelming evidence to suggest that biology and personality are linked. Temperament traits appear to be relatively stable, measurable, genetically influenced, and related to CNS neurotransmitter functioning. Classification is a necessary step for this science to proceed. It is currently not clear whether research should proceed with animal models using genetic manipulation of CNS neurochemistry and analysis of resultant behavior, with human models using simple questionnaires, or with prolonged observation of small children. All have significant problems related to measurement and the meaning of the measured behavior.

It is hoped that all methods of research continue. New theoretical models are needed to help link biology and temperament. These models will overlap to some extent with the proposed current models but, until then, the existing models must serve for the coherent formulation of available data and the generation of testable hypotheses. It is now clear that it is no longer tenable to ignore the biological aspects of temperament in research or clinical practice.

SUMMARY

Historically, models of personality have generally postulated a link with biology. This century has witnessed a major revision of these ideas, with behavioral and psychoanalytic theorists emphasizing life experiences as being mainly responsible for behavior as adults. Challenges to this assumption have come from genetic studies, infant temperament studies, and neurobiological research. An extensive body of data now exists that suggests that biology contributes significantly to individual variability. This biological contribution occurs at a relatively low level in the central nervous system and is better defined as temperament. This biological contribution has suffered from the lack of a cohesive psychobiological model. A number of models are reviewed; all of them have significant shortcomings.

Alternative strategies of observing infant behavior or using genetically modified animals are discussed. The importance of continuing research into the biology of personality for psychiatry is reviewed. Biological abnormalities in psychiatric illness may be related to temperament traits instead of diagnostic categories. Such traits may predict treatment response. Genetic vulnerability to psychiatric illness may be via heritable temperamental traits rather than disease-specific factors. It is no longer reasonable to ignore the biological aspects of personality in research or clinical practice.

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