

Temperamental Contributions to Social Behavior

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ABSTRACT: *About 15% of Caucasian children in the second year of life are consistently shy and emotionally subdued in unfamiliar situations, whereas another 15% are consistently sociable and affectively spontaneous. A majority of the children in these two groups retain these profiles through their eighth year. In addition, the two groups differ in physiological qualities that imply differential thresholds in limbic sites, especially the amygdala and the hypothalamus, suggesting that the two temperamental groups are analogous to closely related strains of mammals. However, the behavioral profiles of the children are influenced in a major way by environmental conditions existing during the early years of life.*

The word *temperament* is used by most, but not all, behavioral scientists to refer to those psychological qualities that display considerable variation among infants and, in addition, have a relatively, but not indefinitely, stable biological basis in the organism's genotype, even though the inherited physiological processes mediate different phenotypic displays as the child grows. It is reasonable to suggest that some of the temperamental differences among children are analogous to the biobehavioral differences among closely related strains of dogs, cats, or monkeys (Adamec & Stark-Adamec, 1986; Clarke, Mason, & Moberg, 1988).

The temperamental qualities that are most obvious to contemporary American parents, and that are investigated most often by psychologists, include irritability, smiling, motor activity, and adaptability to new situations. These qualities are popular, in part, because they have implications for the ease with which parents can socialize their infant. It is not clear at the moment how many temperamental qualities will be discovered; it certainly will be more than 6, but hopefully less than 60. We will have to wait for history's answer.

Inhibited and Uninhibited Children

Steven Reznick, Nancy Snidman, and I, together with Cynthia Garcia-Coll, Wendy Coster, Michele Gersten, and many others in our laboratory, have been studying two categories from the larger set of temperamental qualities (Garcia-Coll, Kagan, & Reznick, 1984; Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984; Kagan, Reznick & Snidman, 1987, 1988; Kagan, Reznick, Snidman,

Gibbons, & Johnson, 1988; Reznick et al., 1986). The original behavioral referent for each of the qualities was the response profile of 20- to 30-month-old children when they were in unfamiliar situations. Some children consistently become quiet, vigilant, and restrained while they assess the situation and their resources before acting. Others act with spontaneity, as though the distinctions between familiar and novel situations were of minimal psychological consequence. The situations that best reveal these two qualities in young children are encounters with unfamiliar children or adults, perhaps because other people are the most frequent basis for categorizing most settings as unfamiliar. Of course, it is rare to find a large number of children who are consistently shy and affectively restrained or outgoing and spontaneous regardless of the social context. There is, however, a small group of children (my colleagues and I estimate it to be about 10% to 15%) who usually bring one or the other of these behavioral styles to new situations. We call the shy children *inhibited* and the sociable children *uninhibited*.

Our current studies of inhibited and uninhibited children trace their beginnings to an early collaboration with Howard Moss, which was summarized in 1962 in the book entitled *Birth to Maturity* (Kagan & Moss, 1962). A large group of families was participating in the Fels Institute's longitudinal project, which began in the early 1930s. The children in these families were observed from birth to adolescence in their homes, the Institute's nursery school, and their own school settings, and they were tested and interviewed regularly. Moss rated each child on a set of variables for consecutive, chronological epochs, using as evidence the extensive corpus of information available on each subject. I was in another room interviewing these same subjects, who were then in their 20s, and administering a relevant battery of tests, but I was unaware of the early information Moss was reading. It is of interest that the most important discovery of the Fels study was that the only psychological quality preserved from the first three years of life through adulthood was the characteristic we now call behavioral inhibition, although we called it passivity in 1962. Although Moss and I suggested that this predisposition might be a partial function of biological variables, the Zeitgeist during the early 1960s was not prepared to award much formative power to temperamental factors. Unfortunately, our faith in a temperamental interpretation of these data was not suf-

ficiently strong, and neither of us pursued this phenomenon.

In a later collaboration, Richard Kearsley, Philip Zelazo, and I enrolled Chinese-American and Caucasian infants from similar social class backgrounds in a longitudinal study of the effect of day care across the period from 3 to 29 months of age. We noted in our 1978 monograph, called *Infancy* (Kagan, Kearsley, & Zelazo, 1978), that although the effect of day care on the children was minimal, the Chinese infants, whether attending our day care center or raised only at home, were, relative to the Caucasians, more subdued, shy, and fearful when they met unfamiliar adults or children, and they cried more intensely when their mothers left them for a brief separation. In addition, the Chinese children consistently showed more stable heart rates than the Caucasians during the laboratory episodes. This association implied a biological basis for the inhibition among the Chinese children.

The unexpected association between shy, timid behavior and a minimally variable heart rate provoked me to pursue this phenomenon more directly. Cynthia Garcia-Coll and Nancy Snidman, in independent dissertation research, selected from large samples of young Caucasian children (aged 21 months for Cohort 1 and 31 months for Cohort 2) those who were either consistently shy and fearful (behaviorally inhibited) or sociable and fearless (uninhibited) when they encountered unfamiliar people or objects in unfamiliar laboratory rooms. They had to screen over 400 children in order to find 54 consistently inhibited and 53 consistently uninhibited children, about 15% of the children screened, with equal numbers of boys and girls in each group. These children have been seen on three additional occasions; at the last assessment at 7½ years of age, there were 41 children in each of the two cohorts—a loss of about 20% of the original sample.

In each of the assessments, the children were observed in different situations. Usually the assessments included a testing session with a female examiner and, on a different day, a play situation with an unfamiliar child of the same age and sex. At 5½ years of age the aggregate index included observations of the child's behavior in his or her school setting (Gersten, 1986). Details of the procedures can be found in previously published articles (see Garcia-Coll et al., 1984; Kagan et al., 1988; Reznick et

al., 1986; and Snidman, 1984). We computed aggregate indexes of inhibition at each age, based on the child's tendency to be quiet, shy, and emotionally subdued in each of the different contexts.

The indexes of inhibition at 7½ years were based on behavior in two laboratory situations. The first was a play situation involving 7 to 10 unfamiliar children of the same age and sex. The two critical variables were number of spontaneous comments to the other children or supervising adults and proportion of time spent standing or playing apart from any other child in the room during the free-play intervals.

The second assessment context was an individual testing session with an unfamiliar female examiner who did not know the child's prior status. The two critical variables were latency to the sixth spontaneous comment to the examiner and the total number of spontaneous comments over the 90-minute session. The aggregate index of inhibition represented the average standard scores for the indexes from the two assessment situations. The intercoder reliabilities for these behavioral variables coded from videotapes were above 0.90.

Preservation of Behavior

There was moderate but significant preservation of the inhibited and uninhibited behavioral styles from the first assessments, at either 21 or 31 months, through 7½ years of age. The correlation between the original index of inhibition (21 months for Cohort 1 and 31 months for Cohort 2) and the aggregate index at 7½ years was .67 ($p < .001$) for Cohort 1 and .39 ($p < .01$) for Cohort 2. About three fourths of the children in each cohort retained their expected classification, based on whether their standard score on the aggregate index at 7½ years was positive or negative. Furthermore, the children who exhibited most extreme behavior initially were most likely to maintain their behavioral style. Although one half of the original group of inhibited children from both cohorts no longer displayed an extreme degree of shyness at 7½ years, most (80%) had still not acquired the unusually spontaneous demeanor characteristic of the typical uninhibited child. A smaller number of uninhibited children became shy; 10% of the original group of uninhibited children had become very timid at 7½ years of age (see Figures 1 and 2).

Additionally, about three fourths of the inhibited 7½ year olds, compared with only one fourth of the uninhibited children, had one or more unusual fears, such as speaking voluntarily in the classroom, attending summer camp, remaining alone in the home, taking out the rubbish at night, or going to their bedroom alone in the evening. Furthermore, one third of the siblings of the inhibited children, but not one sibling of an uninhibited child, had one or more of these unusual fears.

The inhibited children also displayed characteristics indicative of caution and motor tension. For example, when they were 5½ years old an examiner asked them, as part of a play episode, to fall backward onto a mattress. Significantly more inhibited than uninhibited children

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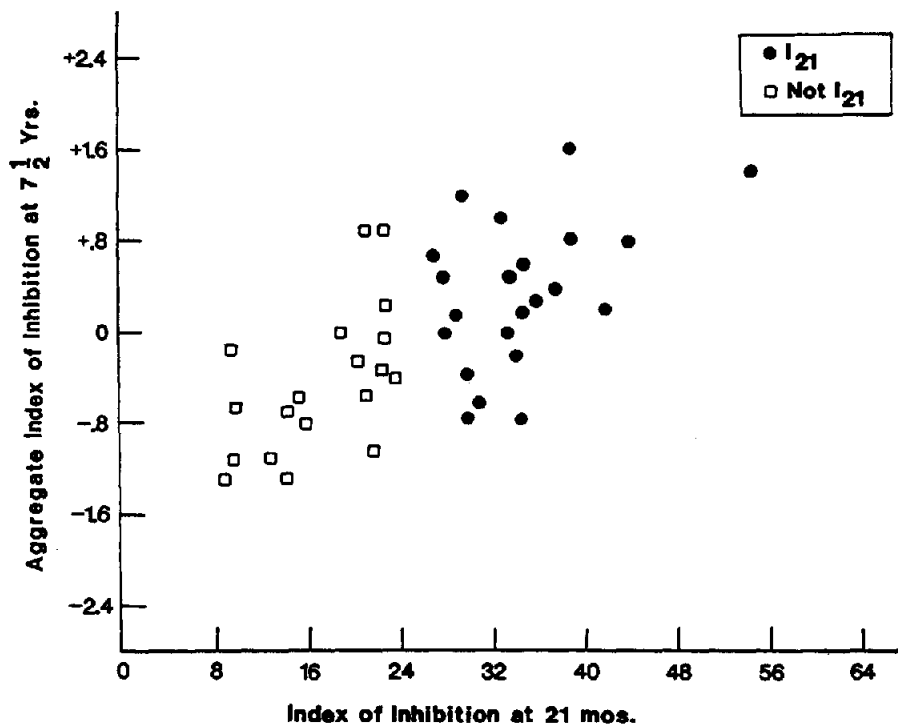
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Figure 1

Relation Between Original Index of Inhibition at 21 Months and Aggregate Index of Inhibition at 7½ Years for Cohort 1



fell back to a sitting position or refused to conform to the request, whereas a majority of the uninhibited children spontaneously fell in a free motion so that their head hit the mattress after the fall.

In a subsequent task, the examiner brought in a box and a ball and told the children they were to throw the ball into the box. However, the child had to decide whether the box should be placed near to him or her (less than 12 inches), a moderate distance (18 inches), or far from the child (three feet) on each of three trials. The inhibited children more often asked that the box be placed very close to them. The 5½ year olds also were asked during the testing session to simulate facial expressions of happiness, sadness, surprise, anger, and fear. The inhibited children showed significantly more motor restraint in their expressions than uninhibited children (Coster, 1986). In sum, the inhibited children were quiet with unfamiliar adults, shy with unfamiliar children, cautious in situations of moderate risk, and motorically tense.

Types or a Continuum?

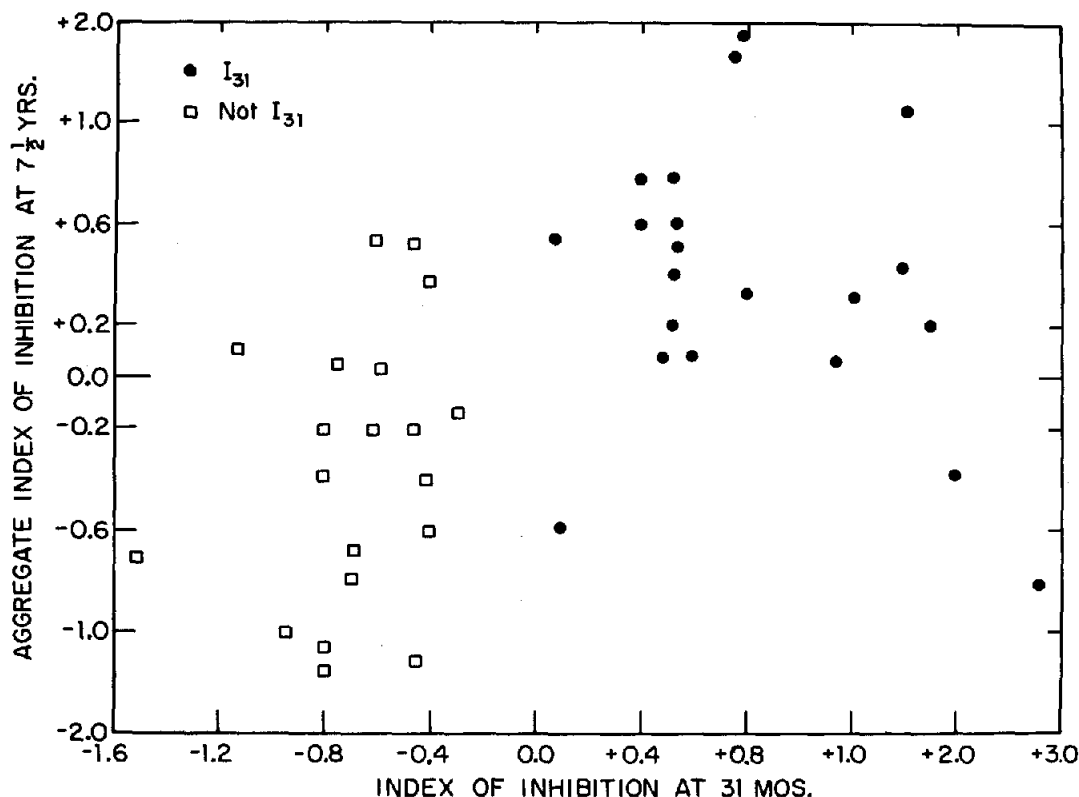
It is important to note that these results were found for children who had been selected to be extreme on inhibited and uninhibited behavior. Some investigators believe that these qualities form a continuum; hence, it is important to determine whether these two groups of children lie on a continuum of sociability or whether they represent two qualitative types. During this century, behavioral scientists

who study behavior, thought, and emotion have favored continua over categories and linear over nonlinear relations. These suppositions dominate the psychological laboratory, partly as a consequence of the introduction and dissemination of statistical procedures, such as the correlation coefficient, *t* test, and analysis of variance, in the interval between the two world wars. The only frequent exceptions to this practice are gender, age, and, occasionally, social class. However, most biologists assume that natural phenomena are the product of classes of entities and the specific processes in which the entities participate. The entities are conceptualized as patterned structures, qualitatively different from members of related classes, even though it is possible to invent at least one quantitative dimension on which to place members of the different classes. However, it is the entire profile of dimensions, considered together, that defines each entity. The concept of species, which is fundamental in evolutionary biology, is a qualitative category.

We believe that the two temperamental types we call inhibited and uninhibited are analogous to biological strains. Each type refers to a class of children who share a genotype, an environmental history, and a set of correlated behavioral and physiological characteristics. Support for this claim comes from a study of a third longitudinal cohort of Caucasian middle- and working-class children of both sexes who were not selected initially to be extreme on either of the two behavioral profiles (see

Figure 2

Relation Between Original Index of Inhibition at 31 Months and Aggregate Index of Inhibition at 7½ Years for Cohort 2



Reznick, Gibbons, Johnson, & McDonough, in press, for details). These children represent the typical youngsters child psychologists study in their research. The children in this third cohort were observed initially at 14 months ($n = 100$), and again at 20 ($n = 91$), 32 ($n = 76$), and 48 months of age ($n = 77$). The indexes of behavioral inhibition at 14 and 20 months were based on behavior with an unfamiliar examiner and with unfamiliar toys in laboratory rooms. The index of inhibition at 32 months was based on behavior in a 30-minute free-play situation with two other unfamiliar children of the same sex and age with all three mothers present. The index at four years was based on behavior with an unfamiliar child of the same sex and age, with an unfamiliar examiner in a testing situation, and in an unfamiliar room containing objects suggestive of risk.

The original variation in the continuous index of inhibited behavior at 14 months across the entire group was correlated with analogous variation at 20 months ($r = 0.52$) and 32 months ($r = 0.44$). However, the indexes of inhibition at 14 or 20 months did not predict differences in behavior at four years of age. Only when we restricted the analysis to those children who fell at the top and bottom 20% of the distribution of behavioral inhibition at both 14 and 20 months (13 children in each

group), did we find significant differences in behavior between the two extreme groups at four years of age ($t = 2.69$, $p < .01$).

These results, together with the evidence from the preselected children in Cohorts 1 and 2, imply that the constructs inhibited and uninhibited refer to qualitative categories of children. These terms do not refer to a behavioral continuum ranging from extreme shyness to sociability in an unselected sample of children, even though such a phenotypic continuum exists. Psychiatrists also differentiate between bipolar depressive patients and a random sample of adults, even though self-reports of sadness from both the patients and nonpatients form a continuum. The IQ scores of children with Down syndrome and a random sample of normal children also fall on a continuum, but most psychologists regard the two groups as qualitatively different.

Physiological Correlates of Inhibited and Uninhibited Temperaments

One reason we believe that the two groups of children are different genetically is that they differ in physical characteristics (Rosenberg & Kagan, 1987) as well as peripheral psychophysiological profiles, in ways which imply that the inhibited children have lower thresholds of reac-

tivity in the limbic system, especially the amygdala and hypothalamus. If this supposition is correct, inhibited children should show greater reactivity in the target organs of the sympathetic nervous system, skeletal motor system, and the hypothalamic-pituitary-adrenal axis. The data we have reported support this prediction. The inhibited children have higher and more stable heart rates, larger pupil diameters, greater motor tension, and higher levels of morning cortisol (see Kagan, Reznick, & Snidman, 1988). The most extensive information is for signs of sympathetic influence on the cardiovascular system. For example, at every age the inhibited children in both cohorts were more likely to show an increase in heart rate, about 10 beats per minute, across the multiple trials of a test as well as across the entire battery of tests. The inhibited children were also likely to attain their maximal heart rate early in the testing session, usually during the first cognitive procedure following an initial baseline. The consistent tendency to show cardiac acceleration to mild cognitive stress on each of the assessments suggests greater sympathetic influence on the cardiovascular function of inhibited children.

Hypothalamic-Pituitary-Adrenal Axis

In order to assess activity in the hypothalamic-pituitary-adrenal axis, we gathered three samples of saliva at both 5½ and 7½ years from the children in Cohorts 1 and 2 in the early morning on three different days. The children with early morning mean cortisol values above the median for their age group at both 5½ and 7½ years were more likely to have been classified as inhibited originally than were the children who were below the median on both cortisol values. Furthermore, the children from the unselected cohort who had been extremely inhibited at both 32 and 48 months of age had high cortisol values at both ages. When we combined the data from all three cohorts, we found that more inhibited than uninhibited children had high cortisol values across two ages ($p < 5 \times 10^{-5}$).

With the exception of heart rate and heart rate variability, the correlations among the remaining physiological variables were low and ranged from $-.2$ to $+.3$. This phenomenon has been noted by others (Nesse et al., 1985). However, an aggregate index of psychophysiological activity might be highly correlated with inhibited behavior because any single variable could be the result of a factor unrelated to the hypothetical processes mediating inhibited and uninhibited behavior. Consider the following analogy. High body temperature, fatigue, thoracic discomfort, and pneumococci in the sputum are not highly correlated in a random sample of the population, but persons with high values on all four variables meet the criteria for a specific disease category. We averaged the standard scores for eight peripheral psychophysiological variables gathered at 5½ years on Cohort 1 to create a composite index of physiological arousal. This aggregate included heart rate, heart rate variability, pupillary dilation, total urinary norepinephrine activity, cortisol level at home and in the laboratory, and two measures of vocal

tension. There was a substantial positive relation between this composite physiological index and the index of behavioral inhibition at every age ($r = .70$ with the index at 21 months, $r = .64$ with the index at 7½ years). Furthermore, the inhibited children with the highest values on this index were more likely to remain inhibited than were the inhibited children with low values (see Figure 3).

Prediction of Temperamental Style From Infancy

Nancy Snidman and I are currently attempting to find qualities in young infants that might predict inhibited and uninhibited behavior in the second year by evaluating the behavior of Caucasian infants longitudinally at 2, 4, 9, and 14 months of age and obtaining sleep heart rates at two weeks and at 2, 4, 6, and 14 months. We have seen 75 infants at 2, 4, and 9 months of age, and 50 children at all four ages, from an anticipated sample of 120 children. The infants are presented with discrepant visual and auditory events at each age while we record heart rate and behavior. For example, at four months, the episodes include a series of mobiles with differing numbers of elements and of tape recordings of a female voice speaking syllables that vary in loudness. In addition, at 9 and 14 months, we observe the children in an unfamiliar play setting and during encounters with unfamiliar adults and objects.

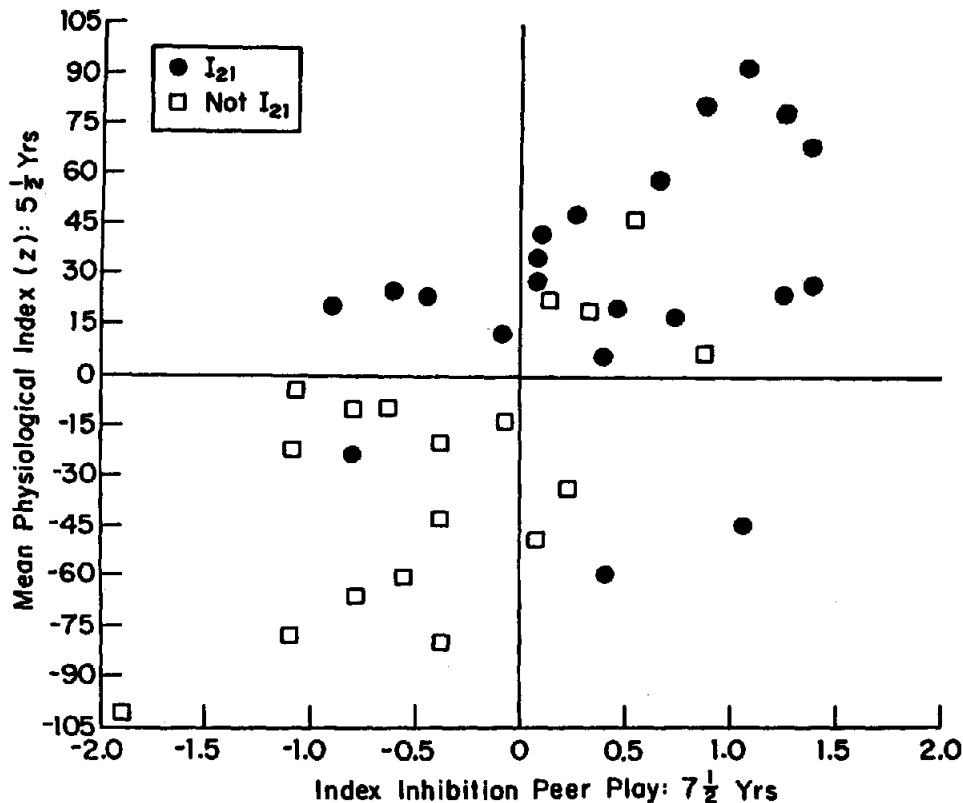
Two stable behavioral differences among the two- and four-month-old infants are (a) degree of motor arousal to the visual and auditory stimuli, as reflected in repetitive vigorous movements of the limbs and protrusion of the tongue, and (b) frequency of crying. However, there is not a high correlation for the entire sample among motor arousal, irritability, and laboratory or sleep heart rate at two and four months, even though the direction of the relations is in the expected direction. However, about 14% of the infants show a pattern of very high motor arousal, high irritability, and high heart rate at two and four months whereas another 28% show the complementary pattern of low motor arousal, low irritability, and low heart rate.

These two profiles may represent early forms of the inhibited and uninhibited temperamental categories because all of the infants in the high arousal group were very subdued and cried in fear in response to two or more discrepant, unexpected events in the laboratory at 9 or 14 months of age. Thirteen of the 14 infants in the low arousal group were smiling and sociable with the examiner and showed no or minimal fear of the unfamiliar events at the two older ages.

Recent research by biologists and neuroscientists provides an initial interpretation of this interesting result. The basolateral nucleus of the amygdala has a major projection to the ventral striatum and ventral pallidum that projects, in turn, to the thalamus, the supplementary motor area of the cortex, and the skeletal muscles (Brooks, 1986). Infants with a low threshold of reactivity in the basolateral nucleus should show high levels of motor

Figure 3

Relation Between Aggregate Physiological Index at 5½ Years and Index of Inhibition From the Peer-Play Session at 7½ Years for Cohort 1



arousal to the stimuli presented at two and four months. The central nucleus of the amygdala appears to exert a significant influence on the sympathetic nervous system and heart rate function through projections to the lateral hypothalamus (Veening, Swanson, & Sawchenko, 1984). Furthermore, the basolateral nucleus synapses on the central nucleus, and therefore, activity in the former can excite the latter. Thus, an infant with a low threshold of arousal for the entire amygdala should show both high motor arousal and sympathetic activity.

However, the bases for a lower threshold in the amygdala are multiple. A low threshold could be due to higher levels of either central norepinephrine or corticotropin releasing hormone (the latter is secreted by the amygdala as well as the hypothalamus) or a lower density of receptors for opioids in the amygdala, which would lead to modulation of excitability of neurons in this structure. Each of these very different mechanisms could be influenced by genetic factors (Davis, 1986).

All newborn infants born with a limbic-hypothalamic circuit that is easily aroused by discrepancy and unfamiliarity do not grow up to be inhibited children. I believe the eventual display of inhibited behavior in the second year of life requires some form of environmental stress in order to actualize the temperamental disposition.

Relevant stressors include marital quarrels, illness in the family, or the presence of a dominating older sibling. In all three cohorts, more inhibited children were later born whereas more uninhibited children were first born. The presence of an older brother or sister can be a stressor to this special group of children because the older child teases and responds noncontingently to the infant. For an infant born with the biological qualities that favor inhibition, these daily events could function as the stress needed to actualize the temperamental disposition. However, first-born children with the same temperamental characteristics, but living in a minimally stressful environment, should be less likely to become inhibited children.

Conclusion

Attributing some of the variation in social behavior to inherited biological processes alters the traditional post-Enlightenment view of our relation to nature. It is difficult to resist the conclusion that temperamentally inhibited five-year-olds are potential victims of circumstances over which they have no control rather than agents who can, at will, alter their behavior toward others. A resolution of this tension is possible if we award to each child's conscious will the power to cope with his or her temperamental bias. I recall an adult subject in the Fels longitu-

dinal study who had been an extremely inhibited boy. He told me that as an adolescent he had been very apprehensive with girls but decided to overcome his fear by inviting the most attractive girl in the class to the senior high school dance. Human behavior is, some of the time, the product of the imposition of deliberative processes on the invisible, uncontrollable forces that both biology and history have created. Although Homer believed Odysseus could do little to subvert Athena's decision to beach him high on a rock in the middle of a storm, Dylan Thomas exhorted each of us to "rage, rage against the dying of the light" (p. 207).

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