precocity are conditioned by genetic factors; and the manner in which these genetic factors exert their age-linked influence presumably follows the pattern that Thompson and Grusec described (*7*): "Thus the expression of certain genes may be so timed that certain types of behavior and certain capacities for discrimination and for articulated response will emerge at particular times." Further, while this conclusion is limited to the infancy period by the present data, we believe that the rate of gain throughout the preschool years will also be found to depend upon genetic factors.

Besides the significantly higher level of concordance for MZ twins, another equally important feature of the twin data is the relatively high degree of concordance for overall developmental level in DZ twins. It signifies that the differences within DZ pairs produced by gene segregation and different life experiences are comparatively small in relation to the sizable differences between pairs. What inference about the role of genetic and environmental factors might be drawn from these results?

The primary source of genetic variance in any nonrandom mating system is between families (technically, between parental mating combinations); and in a nuclear family society, the primary source of environmental variance is also between families. The reference behavior exhibited by offspring from each family is jointly affected by both sources of variance, but the proportion of influence from each source is not necessarily equal.

The influence of home environment will be considered first. The families in this study range from the welfare case to the wealthy professional family, and each family was assigned a socioeconomic status score (SES) by the classification system of Reiss (*8*). When the correlation was computed between SES scores and overall level of development for each year, the relation was very weak for the first year ($r = .11$) and improved only slightly for the second year ($r = .20$). Comparable results were reported by Bayley for her large norm sample (*3*); and taken on balance, both sources of data argue against a significant linkage between precocity of infant mental development and the socioeconomic quality of the home.

Stated more broadly, the conclusion is that the caretaking and stimulation needed to support infant mental development are sufficiently supplied by most home environments that fall above the level of impoverished. In all likelihood, however, there may be a cumulative latent influence absorbed from the home environment during infancy that combines with genetic predisposition and gradually becomes manifest as school age approaches; since the child's measured IQ becomes increasingly related to his parents' IQ, educational level, and socioeconomic status as he gets older (*9*).

Aside from these variables, there are other dimensions of the parent-child relationship that do have some immediate influence upon infant mental development, notably maternal love and acceptance as opposed to hostility and rejection (*10*). The effects of these maternal behaviors are inconsistent by age and sex, however; females develop more precociously during infancy under the shelter of a warm maternal attitude but lose their advantage by school age, whereas the opposite is true for males. A satisfactory explanation is still awaited for these sex differences in response to maternal care; and in any event, the demonstrable relation between maternal care and infant mental development is modest in size and falls below the concordance level for twins.

Therefore, the hypothesis is proposed that these socioeconomic and maternal care variables serve to modulate the primary determinant of developmental capability, namely, the genetic blueprint supplied by the parents. On this view, the differences between twin pairs and the similarities within twin pairs in the course of infant mental development are primarily a function of the shared genetic blueprint.

Further, while there is a continuing interaction between the genetically determined gradient of development and the life circumstances under which each pair of twins is born and raised, it requires unusual environmental conditions to impose a major deflection upon the gradient of infant development. For example, there will be some pairs where development of one or both twins is suppressed by serious prematurity or an impoverished environment; and there will be some pairs where the twins become discordant because of deviant prenatal conditions, birth trauma, or sharply differentiated life experiences. But for the great majority of pairs, life circumstances fall within the broad limits of sufficiency that permit the genetic blueprint to control the course of infant mental development.

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6. Another reason for performing a separate analysis for each year is that the analysis requires test scores from both members of the pair at all ages, so if any score is missing, the pair is excluded. The sample shrinkage in each zygosity group due to exclusions is within tolerable limits for the set of scores obtained within each year, but it becomes prohibitive when the entire age range is covered.
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14 April 1971; revised 12 October 1971

Age, Location, and Stability of Ecosystems

In their examination of the relationship between the "age" and stability of ecosystems, Hurd *et al.* (*1*) used unreplicated fields of two ages, thereby confounding age with location. Two factors suggest that this confounding is significant. First, *Poa compressa* and *Hieracium pratense*, species characteristic of impoverished sites, are important only in the less productive field, even though both could be expected to be prominent in either field on the basis of age alone;

and second, there is a twofold difference in the productivity of the vegetation on the control plots. Odum *et al.* (2) observed comparable differences in productivity during old field succession, but these were attributable to previous fertilization and changes in the growth forms of the dominants, factors not adequately discussed by Hurd *et al.* We have also observed significant differences in the primary production of herbaceous communities among fields of different quality, but not among fields differing principally in age (3). These data suggest that site quality rather than age may have been the more important of the confounded variables in the experiment of Hurd *et al.*

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1 November 1971

We do not feel that we have confounded age with location in our studies. As we said, "we studied two adjacent abandoned hayfields," and "macroclimate and soil series are identical." Both fields were planted in timothy (*Phleum pratense*) and are slowly decaying into "natural" ecosystems characteristic of upstate New York. Since timothy is hardly a species characteristic of impoverished sites (1), we assume that whatever impoverishment leads to invasion of *Poa compresa* and *Hieracium pratense* arises out of the successional aging process. We have extensive soil data on the two fields as well as a description of their previous land usage from the land's owner. These data could not be included in a report in *Science*.

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29 December 1971

Tree Seedling Growth: Effects of Shaking

Neel and Harris (1) reported an interesting effect of shaking on growth of *Liquidambar* seedlings and proposed that a hormonal mechanism was involved. They also discussed the effects of wind on leaf size.

First, they quoted experiments showing reduced growth of vine leaves subjected to breeze (2). Such a reduction could, however, be caused by partial drying of the leaves through two known mechanisms. Lowered turgor could prevent cell expansion directly. Stomatal closure could also occur, with a reduction in photosynthesis. These kinds of interpretation have been applied to the results of similar experiments (3).

Second, Neel and Harris stated that the larger leaves found on seedlings grown indoors (compared with those grown outside) are somehow "in line with" their observations. But the increase of leaf size with decreasing light is also well known (4) and could be involved in the present case. Moreover, differences in water stress could again occur between plants in the two environments with resulting differential growth similar to that outlined above. In addition to the fact that those outside might be less well watered or exposed to drier air, different ventilation conditions need to be considered. The effect of wind alone on transpiration rate is complex and, depending upon water availability and net radiation, can lead to either an increase or a reduction in water loss.

Thus, neither of these points necessarily supports the argument that a hormone is involved. The introduction of a comparison between staked and unstaked plants is more relevant. However, even if conditions for exchange of water, carbon dioxide, and radiation were not influenced by shaking, it is still possible that the movement of water in the stem can be affected. The incidence of blocked vessels due to cavitation (5) would probably be higher in the shaken trees and the water supply to the shoots would therefore be lower. This latter hypothesis could be tested with a pressure chamber (6). Growth in height and setting of terminal buds could both be moderated by water status.

A shaking effect certainly seems to exist and cavitation is not necessarily involved in it. Although hormonal control would be a plausible evolutionary adaptation, alternative explanations are available for all of the other effects quoted by Neel and Harris in support of their claim and they have not given sufficient evidence that hormonal effects are actually involved.

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21 October 1971

The purpose of our report (1) was to describe the marked influence on tree growth of daily short periods (30 sec) of trunk movement.

Parkhurst and Pearman's comments that shoot growth and reduction of leaf size could be the result of wind (and trunk movement) affecting moisture relationships, including cavitation, are well taken. However, three observations indicate that cavitation was not a factor in reducing shoot growth.

This dramatic influence on shoot growth was first noted in a light-quality experiment in which the terminal 30 cm (12 inches) of some of the trees were

Fig. 1. Corn plant shaken 30 seconds daily for 25 days (left); not shaken (right). Plants were grown in greenhouse. Arrow, height of plants at beginning.