Behavior in Chimeric Mice Combining Differently Behaving Strains

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A/J and C57BL/6J mice behave differently in tests for alcohol preference, open-field activity, defecation in the open field, cricket attacking, and rope climbing. Chimeric mice, i.e., mice containing both A/J cells and C57BL/6J cells, were constructed and tested for these behaviors. Patterns of behavior among A/J → C57BL/6J chimeras are such as to suggest that none of these behavior differences is controlled by a single cell or clone and that the same cell population that gives rise to the strain difference in alcohol preference also gives rise to the differences in open-field activity and defecation, while separate cell populations control cricket killing and rope climbing.

KEY WORDS: inbred strains of mice; C57BL mice; A mice; chimera; alcohol preference; open field activity; open field defecation; cricket attacking; rope climbing; factor analysis.

INTRODUCTION

Mice of the C57BL inbred strains differ from mice of the A strains with regard to a great array of characteristics, including a number of behavioral traits. Chimeras of the A ↔ C57 type are mixtures of A and C57 cells, with the two cell types in varying proportions and distributions. We have studied

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the behavior of a number of A ↔ C57 chimeras in an attempt to discover (1) whether any of the behaviors in which A and C57 mice differ are controlled by single cells or clones and (2) how many discrete, separately controlled differences underlie the several phenotypic behavioral differences between A and C57 mice.

We limited our study to four rather easily measured behavioral categories in which A and C57 mice differ: open-field activity (McClearn, 1959, 1960), alcohol preference (McClearn and Rodgers, 1959; McClearn, 1972), cricket attacking (Butler, 1973), and rope climbing. In our open-field test conditions (see Methods), C57BL/6J mice run across an average of 205 ± 69 (SD) squares and rarely defecate at all, whereas A/J mice run across 62 ± 21 squares and defecate 5 ± 1 times. The physiological basis of this difference between C57BL and A mice is unclear. The genetic basis of variation in open-field activity is complex. The albino locus has been implicated (albino homozygotes tend to have a low open-field activity), but other loci must also be involved (DeFries and Hegmann, 1970).

A and C57BL mice also differ sharply in the test for alcohol preference. A mice have an alcohol preference of 0.21 ± 0.09 in our conditions (they avoid alcohol), while C57BL mice prefer alcohol to water (preference of 0.79 ± 0.11). It has been suggested (Sheppard et al., 1968) that the levels of liver alcohol and aldehyde dehydrogenases account for some of the variation in alcohol preference among mice, but the major part of the variability remains unexplained. Fuller and Collins (1972) have calculated that two loci control the difference in alcohol preference between DBA/2 (avoiders) and C57BL mice. It is not clear, however, whether A mice differ from C57BL in precisely the same way as DBA/2 do.

When a cricket is introduced into the home cage of an isolated C57BL mouse which has not previously seen a cricket (Butler, 1973), the mouse will usually quickly attack and eat the cricket (median latency to attack is 4 min for males and 9 min for females). A mice, in the same situation, usually fail to attack the cricket at all during a 30-min trial period. The physiological basis for this difference is unknown. If the cricket test is repeated on a given mouse on the day following the initial test, the latency to attack is less in the second than it was in the first test, presumably as a result of learning done by the mouse during its first encounter with a cricket. During the second exposure the latency to attack averages 1.3 min for male and 1.4 min for female C57BL mice. A mice still usually fail to attack.

In the rope-climbing test, A and C57BL mice differ by two criteria. The latency to climb is longer (102 ± 42 sec) in A mice than in C57 mice (16 ± 9 sec). The same can be said for the length of time spent climbing, after initiating the climb (A = 8.7 ± 1.45 min, C57 = 1.7 ± 0.2 min). The A and C57 strains do not, however, differ significantly in terms of how frequently their members move up vs. down the rope.