

The importance of maternal care in shaping an individual's phenotype in health and disease is becoming more and more apparent in both human and animal studies. A series of rat studies showed that maternal care influences emotionality and stressor reactivity in adulthood and that a change in maternal care is partly responsible for the impact of early life manipulations on adult behaviour [1,2]. However, in mouse studies using inbred strains or knockout mice to analyze the genetic influences on the development of normal and aberrant behavioral phenotypes, cross fostering is frequently applied, but maternal behavior is very poorly characterized and often ignored. However, gene-environment interactions are key-determinants of an individual's phenotype and changes assigned to a gene of interest might instead reflect differential maternal care received [3].

We performed an extensive analysis of spontaneous maternal behavior of inbred mice in three conditions [4]. We first analyzed the maternal behavior of two of the most commonly used mouse strains, C57BL/6J (C57) and DBA/2J (DBA), toward their biological offspring. Second we analyzed the impact of fostering pups from the same strain (*intra-strain* cross-fostering) on C57 and DBA dams. Finally we analyzed the impact of fostering pups from a different strain (*inter-strain*

cross-fostering). We chose AKR and C3H/HeN dams for this *inter-strain* cross-fostering, since they exhibit important differences in their maternal care [5]. Pups from the C57 and DBA strains were fostered to these mothers in order to determine whether the genetic background of the mother or that of the pups is determinant in defining maternal behavior (see figure 1).

MONITORING AND ANALYSIS OF MATERNAL BEHAVIOR

The breeding cages were placed in sound safe video-equipped chambers to record maternal behavior. An infra-red camera was placed facing the back wall of the breeding cage where the nest compartment was located. During both the day and the night phase a clear view of the dam-pups dyad was available, and the different maternal behaviors could be clearly distinguished. Given that maternal behavior is rhythmic and might be differently organized in different mouse strains, analyses were performed over the entire light-dark cycle. Continuous recordings were thus made on postnatal days 2, 4, 6 and 9. Scoring of maternal behavior was performed off line using The Observer®. To obtain a reasonable estimation of behavior, we chose to make an observation (instantaneous sample) every 2.5 min, which means 24 observations per animal per hour, or 552 observations per animal per postnatal day.

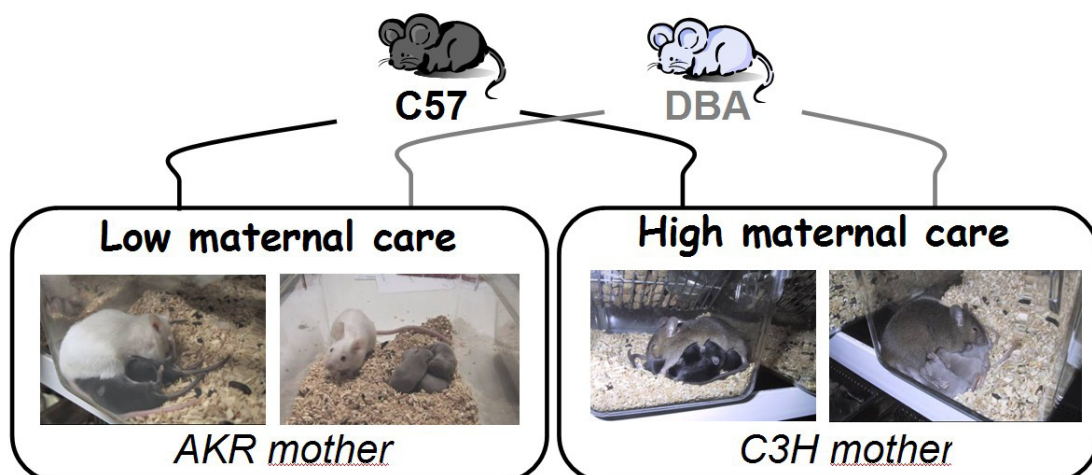


Figure 1. Pups from the C57 and DBA strains were fostered to mothers showing a low and a high maternal care in order to determine whether the genetic background of the mother or that of the pups is determinant in defining maternal behavior.

The following behaviors were scored:

- *Pup licking*: Licking any part of the pups' body, including anogenital parts.
- *Nursing posture*: Immobile arched-back posture over the pups, with the abdomen actively elevated from the floor and pups attached to the nipples.
- *Nest reorganizing*: Nest disturbance and pup scattering by a push forward movement of the mothers' head in the sawdust.
- *Self-grooming on the nest*: Self-grooming while being in contact with the pups.
- *Passive nest presence*: Being in contact with the pups without showing any of the other behaviors.
- *Nest absence*: Not being in physical contact with the pups.

With The Observer software, each behavior was assigned to a certain key on the computer keyboard, which made it possible to score directly on the computer and score 12 animals at the same time. Subsequently, data could be easily analyzed with The Observer.

RESULTS AND CONCLUSIONS

After a thorough study of spontaneous maternal behavior with biological and fostered pups we report that C57 and DBA dams exhibit a comparable maternal behavior towards their biological offspring, and that their behavior is not considerably changed after intra-strain cross-fostering. We also show that inter-strain cross-fostering does not modify the maternal style of the foster mothers -i.e. highly-maternal mothers display higher amounts of maternal care than poorly-maternal mothers independently of the foster strain-, but that the pup strain does influence the amount of maternal behavior a mother shows. Therefore, both mother strain and pup strain are key determinants of maternal behavior. In further studies we have shown that these early maternal environments differentially affect behavior in the adult C57 and DBA mouse [6].

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CONTACT INFORMATION

Rixt van der Veen. Department of Medical Pharmacology, Gorlaeus Laboratories, Leiden University-LACDR, Leiden, The Netherlands. (veenrvander@lacdr.leidenuniv.nl).