

lysis area in mm²/tissue section). Prostacyclin formation was examined according Moncada¹³, as described earlier by us^{14,15} in ng/mg/min PG I₂ by quantification of the platelet aggregation inhibiting effect. The reference substance of PG I₂ was kindly supplied by Dr John E. Pike, Upjohn Company, Kalamazoo, Michigan, USA).

Results. Our results from 16 human controls clearly indicate that the fibrinolytic activity between the normal and atherosclerotic vessel wall is different over the endothelial surface. Similar results can be obtained for prostacyclin formation by human aorta. The prostacyclin generation of implanted Dacron prosthetic grafts (0.0055±0.00125 ng/mg/min PG I₂) is comparable with the values of the atherosclerotic artery (0.0070±0.00125 ng/mg/min PG I₂) in the vicinity. The fibrinolytic activity expressed in mm² endothelial lysis area per tissue section between the vascular tissue (1.59±0.37 mm²) and the implanted grafts (1.29±0.46 mm²) is also not significantly different (the results are quantitatively summarized in the table).

Discussion. The values obtained demonstrate that the fibrinolytic activity and prostacyclin formation potency in the newly formed tissue of a vascular prosthetic graft in general are running parallel. Similar results of a different fibrinolytic activity of normal and atherosclerotic vessel wall^{9,11,12} can be found for prostacyclin formation in human^{16,17} and experimental animals^{18,19} aorta also. The fibrinolytic activity and prostacyclin formation of dacron grafts and arteries is comparable, which means that the newly formed endothelial layer built up by cells derived from the blood stream²², and grown per continuitatem²³, exhibits similar metabolic properties for haemostasis as the endothelium in the neighbourhood²⁴. The data confirm the results obtained

by the group of de Gaetano⁹ who first reported a relation between fibrinolytic activity and PG I₂ formation. The haemostatic properties of dacron grafts cannot explain the high frequency of parietal thrombus formation leading to graft occlusion.

Tissue	Endothelial lysis area (mm ² /tissue section)	PG I ₂ generation (ng/mg wet wt/min)
Artery	1.59 ± 0.37	0.0070 ± 0.00125
Dacron	1.29 ± 0.46	0.0055 ± 0.00125

± SE.

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Maternal behavior in two rat lines selected for differences in the acquisition of two-way avoidance¹

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Summary. The maternal behavior of Roman high- and low-avoidance (RHA/Verh and RLA/Verh) rats was studied, using a time-sampling method. It was concluded that: a) RLA/Verh mothers spent more time with their young, b) RHA/Verh mothers were more active, and c) the mothers of both lines mostly 'blanketed' their young during nursing, although the RHA/Verh mothers assumed the side-nursing position more often than their counterparts.

Originally developed by Bignami in Rome², the Roman high- and low-avoidance rats selected and bred at our institute (RHA/Verh and RLA/Verh), in addition to extreme differences in the acquisition of 2-way avoidance in a shuttle box³, also differ in other behavioral tests such as exploratory activity and locomotion patterns⁴, Hebb-test performance and open-field defecation⁵. These results may be partly due to emotional differences and perceived stress-levels between these selected lines³. Since certain connections have already been established between emotionality and activity/avoidance^{5,6}, and between emotionality and maternal behavior^{7,8}, it was decided to also study the

maternal behavior patterns of RHA/Verh and RLA/Verh rats, in order further to investigate these connections. Wishing to observe the litters in an undisturbed condition, we have developed and made use of a time-sampling method for these types of experiments which avoids, as much as possible, manipulation of the rats and other interventions.

Methods. 55 RHA/Verh and 51 RLA/Verh litters were observed during the first 14 days of life and, from these, 29 RHA/Verh and 26 RLA/Verh litters were observed for an additional 7 days until weaning. This was the first mating for the female rats used, all of which were about 120 days

old at the time of parturition. All rats were housed in the same temperature- and humidity-controlled room, with 12 h of light (06.00–18.00 h). They were kept in 37×21×17 cm plastic cages with grid covers, with food and water ad libitum. The males used for breeding (1 male to 1 female) were removed after 10 days, at which time the feeding of special breeding food was initiated and maintained until weaning. The female's cages were cleaned at 20 days, provided with fresh sawdust, and 64 strips of newspaper torn from a page 33×49 cm in size were placed in the rear left corner of the cage as nesting material. Apart from counting the young on the day of birth, and replenishing food and water periodically, the cages were left completely undisturbed until weaning.

Using a schedule similar to that of Sharpe⁹, the present experiment encompassed 6 daily observation periods spaced between 07.00 and 19.00 h. During each of the periods, all of the cages were observed for 30 sec each by the same observer (H.F.), and the following categories of maternal behavior were noted: a) Nest quality. As illustrated in figure 1, a point-scoring system was used, depending upon the location and orientation of the newspaper scraps in the cage. b) Location of the nest in the cage, to determine the frequency of the changing of its position. c) Nursing position of the mother in relation to the pups. d) Licking of one or more pups. e) Self-grooming. f) Sleeping. g) Individual pups separated from the nest. h) Eating or drinking. The raw data for the nest quality parameter were obtained by averaging the daily point scores for both selected lines (RHA/Verh, RLA/Verh) separately, and those for nest location changes were obtained by treating the daily totals for that behavioral trait in the same way. For the other categories, the daily value of the given behavior was calculated in the total number of observations for each selected line. All data were collected into weekly groupings, and an analysis of variance was used to compare the RHA/Verh and RLA/Verh rats in regard to each behavioral parameter. The data for the day of birth were excluded from the statistical analysis, due to potentially uneven behavioral effects caused by variations in the time of birth during the day.

Results. The average numbers of live births, with the S.D. in parenthesis, were: RHA/Verh 12.2 (±2.3) and RLA/Verh 10.5 (±2.2). Nest quality progressively declined for both groups during the course of the study. The RHA/Verh mothers tended to build better nests during the 1st week than did the RLA/Verh mothers, and the RLA/Verh mothers built better nests during the 2nd and 3rd weeks ($p < 0.05$). A seemingly related parameter was that of the frequency of change of nest location. That behavior occurred infrequently during the 1st week, but progressively more during the 2nd and 3rd weeks, and the RHA/Verh mothers were observed to change the location

of their nests more often than the RLA/Verh mothers from the 2nd week onward ($p < 0.05$).

The 2 typical nursing positions are illustrated in figure 2, and the table shows the comparative scores for this parameter. As our observations have indicated that neither of the positions seemed to be more 'active' than the other, we have adopted the terminology 'blanket' and 'side' positions in place of the terms 'active' and 'passive' which have been used previously^{8,10}. Whereas the total nursing time was about the same, it was seen that the RHA/Verh mothers nursed more in the side position and less in the blanket position than did the RLA/Verh mothers ($p < 0.001$).

Self-grooming and sleeping, which were considered to be typical indicators of activity and inactivity, respectively, are also summarized in the table, illustrating the generally significant differences seen in favor of higher activity levels

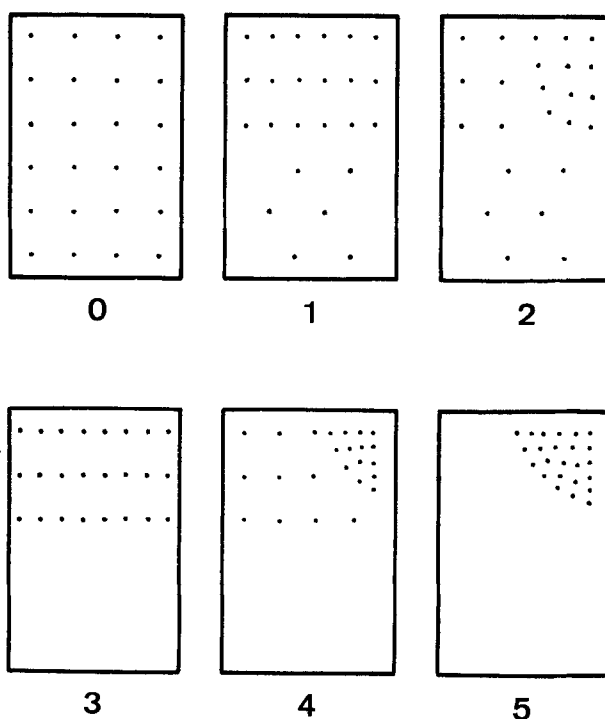


Fig. 1. Schematic representation of the scoring system used to evaluate nest quality, depending upon the orientation of the nesting material in the cage. 0 Paper completely dispersed and/or buried, 1 paper dispersed, but mostly on 1 side of the cage, 2 paper dispersed, but partly collected in 1 corner, 3 paper only on 1 side of the cage, 4 paper on 1 side of the cage and partly collected in 1 corner, 5 paper forming a nest in 1 corner.

Mean frequencies of occurrence of several behavioral traits which showed consistent differences between the 2 selected lines of rats

		Contact w/young		Self-grooming		Sleeping		Blanket nursing position		Side nursing position
1st week	RHA/Verh (55)	65.0		22.4		28.8		47.7		15.6
	RLA/Verh (51)	69.7	*	14.6	**	42.2	**	67.2	***	4.6
2nd week	RHA/Verh (55)	51.4		17.8		23.2		26.1		24.2
	RLA/Verh (51)	59.9	**	11.0	**	32.5	**	49.7	***	10.2
3rd week	RHA/Verh (29)	35.1		12.3		20.8		14.8		20.2
	RLA/Verh (26)	34.9	n.s.	7.3	**	27.1	**	24.4	***	8.4

Number of litters observed given in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

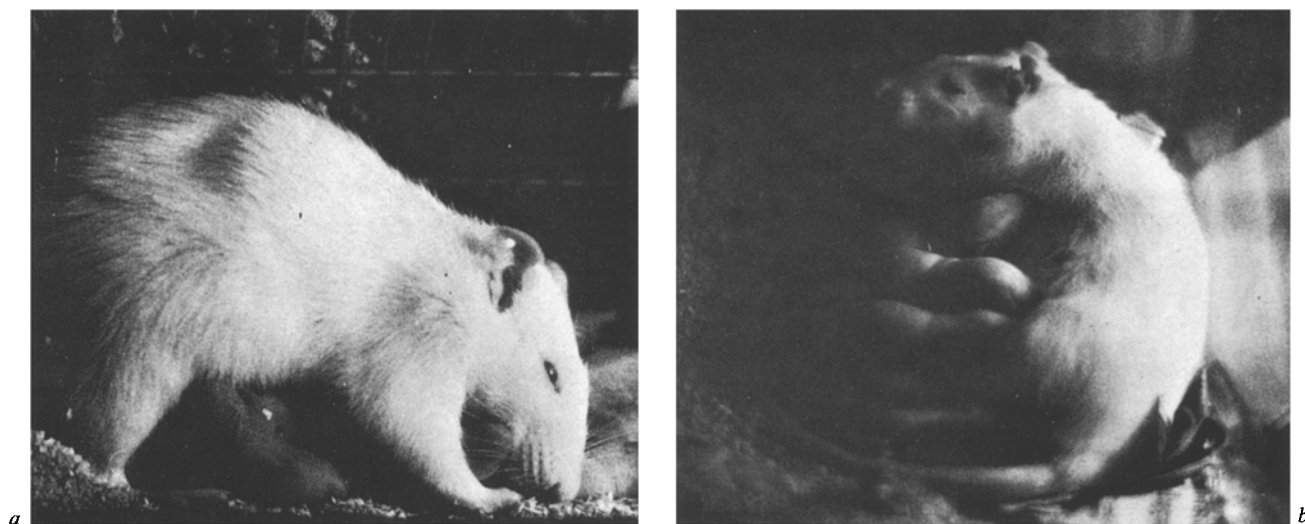


Fig. 2. *a* Typical 'blanket' nursing position, *b* typical 'side' nursing position.

for RHA/Verh rats³⁻⁵. The data for individual pups separated from the nest, which might be considered to be a form of spontaneous retrieving behavior in this study, or at least until the 10th day of age (when the pups can propel themselves adequately), showed no consistent differences between the 2 selected lines, as did the data for pup licking, eating and drinking. In regard to the amount of physical contact between the mother and (at least 50% of the) pups, it can be seen in the table that the RLA/Verh mothers spent more time with their young than did the RHA/Verh mothers, especially during the 2nd week.

Discussion. Our results, using the time-sampling method, conform to those of others derived from the use of other behavioral observation methods. For example, per cent of grooming time, time spent with the pups, pup licking and nursing time were about the same as in other studies¹¹, and a sharp, progressive decline in nest building as a factor of time has also been observed previously¹². At the same time, time-sampling is usually less time-consuming and permits the observation of more types of behavior. We have not measured retrieving behavior, as such, in order to avoid any handling of the litters, which would have disturbed the observation of other behaviors and which might have risked differential reactions of the RHA/Verh and RLA/Verh mothers to the manipulations involved. In addition, previous studies have debated the value of retrieving manipulations as a sole indicator of maternal behavior patterns^{9,13}.

A difference in activity levels is one of the known characteristics of these 2 selected lines^{3,4}. Consideration of the results for grooming, sleeping and frequency of nest location change has thus indicated that the RHA/Verh mothers were more active than the RLA/Verh mothers in the present study, also. That RLA/Verh mothers spent more time with their pups than did the RHA/Verh mothers was also interesting in that RLA/Verh rats are considered to be more emotional than RHA/Verh rats on the basis of open-field defecation scores⁵. It has been previously observed that stocks of rats considered to be more emotional on the same basis have also consistently spent more time with their young in maternal behavior studies^{7,8}. Holland's Maudsley reactive rats, in addition to resembling the RLA/Verh selected line in that same maternal behavior trait and in comparative defecation scores, have also been shown to resemble them in regard to open-field ambulation

and to acquisition of the conditioned avoidance response⁶, when compared to Maudsley nonreactive and RHA/Verh rats, respectively⁵.

We have also seen, in the present study, that significant differences existed between the RHA/Verh and RLA/Verh mothers in regard to the relative frequency of both nursing positions. Apart from also knowing that litter size plays almost no role in this phenomenon (Fümm and Driscoll, in preparation), we do not yet know why the RHA/Verh mothers use the side position more than the RLA/Verh mothers do. That this may have something to do with thermoregulatory processes or emotional differences is possible, but further studies are necessary to provide a definitive answer to this question. Unpublished maternal behavior experiments, conducted concurrently to the present study at this laboratory, have indicated that any differences in F₁ generation (cross-bred) pups or cross-fostered pups which may exist at the preweanling age have virtually no influence on all facets of that behavior, lending support to earlier findings along those lines⁸.

- 1 This work was partly supported by a research grant from the Swiss Association of Cigarette Manufacturers. Reprint requests should be addressed to P. Driscoll at the given address.
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