The effect of handling rats on their growth and behaviour

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It has been claimed by a number of workers that handling rats during the early part of their lives makes them grow faster (Weininger, 1954, 1956; Weininger, McClelland & Arima 1954; Ruegamer, Bernstein & Benjamin, 1954; Ruegamer & Silverman, 1956; McClelland, 1956; Levine, 1957; Mogenson, McMurray & Jaques, 1957; Levine & Otis, 1958), though others have not invariably obtained this result (Scott, 1955; Mogenson & Ehrlich, 1958). The term 'handling' in this connexion has implied gentle treatment. In most instances it has involved stroking the animals; some American authors have preferred to use the word 'gentling'. Levine (1957), however, pointed out that simply moving the animal from the nest for a period of 3 min had the same effect.

If it is true that this 'gentling' in some way increases the growth rate, the situation has human implications, for it is well known that extra 'tender loving care' may be all that is needed to make babies thrive when they are parted from their mothers and live in institutions and hospitals. Part of this 'tender loving care' undoubtedly involves taking more time and trouble over feeding, and consumption of more food may be why some of these babies grow faster. On the other hand, a psychological reason may predominate, for Widdowson (1951) found that schoolchildren living in an orphanage in Germany gained weight and height less rapidly when they were anxious and unhappy than when they were not and grew less rapidly than children of similar age distribution in another orphanage where the atmosphere was congenial and happy, although the unhappy children in fact ate more food. The analogy with children, however, cannot be drawn too closely. Some workers have suggested that the effect on the young animal is one of disturbance and mild stress, caused perhaps by its removal from the warm nest. Further, handling of animals by man involves two species, and it may well be that stimulation of some sensory organ, for example the olfactory one, is as important as the tactile stimulation of the skin.

The object of our experiments was to try to confirm and at the same time to explain the observations of Levine and others. Three experiments have been made. In the first, male rats were handled daily from weaning at 3 weeks till they were 9 weeks old, and their growth and behaviour were compared with those of unhandled litter-mates. In the second and third, all the members of some litters were handled daily during the suckling period and their progress was compared with that of the young in other undisturbed litters.

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EXPERIMENTAL

First experiment

Ninety-six male rats of a black and white hooded strain, originally obtained from the Lister Institute, were used. The parents were random-bred. The young were suckled in litters of eight, generally four males and four females; when they were weaned at 3 weeks of age the males in each litter were weighed and allocated to one of four treatments:

(1) housed one in a cage and handled daily;
(2) housed one in a cage and not handled;
(3) housed three in a cage and handled daily;
(4) housed three in a cage and not handled.

All the rats were given water and unlimited amounts of a stock pellet diet (diet 41 B; Bruce, 1963). The food intakes were measured. The animal room was artificially lit, and the cages were distributed on the shelves so that no group received more or less light than the others.

The rats were 'handled' by being held in the palm of the left hand and stroked gently for 0·5 min every day for 6 weeks. The others were not touched during that time except for being weighed once, when they were 6 weeks old.

At 6 and at 9 weeks of age all the animals were weighed. Between 9 and 10 weeks they were tested three times in the open field (see below).

Second experiment

In this experiment handling was begun on the day after birth. Fourteen pairs of litters were used. Two litters born on the same day were mixed on the day they were born; eight rats (generally four males and four females) from this pool were given to each of the two mothers, and this was repeated through twenty-eight litters. Any surplus animals were killed. Wood wool formed the nesting material. All the young in one of each pair of suckling groups were stroked individually for 0·5 min each day in a constant-temperature room at 21°. The young rat was allowed to lie on the middle finger of the left hand and was held loosely between the thumb and first finger. It was stroked with the first finger of the right hand. All the young in the suckling group were placed in a container on cotton wool until all members had been handled, then all were returned to the nest together. Those in the other one of the pair of suckling groups were not disturbed. The weights of the mothers after delivery and at the end of suckling were recorded, and their food intakes were measured over this time. At 14 days the young in half the handled and half the unhandled suckling groups were examined, and a note was made of whether the eyes were open and whether the animal responded to a sharp sound. Each animal was placed separately in a small illuminated field and rated for limb co-ordination (Cowley & Griesel, 1963) and for lifting of the head. At 21 days after birth all the young were weighed and weaned. They were housed in groups of six, the sexes separately, and weighed at 4, 5, 6, 9 and 12 weeks of age, but they were not handled daily after weaning. No tests of behaviour were applied.

Third experiment

Females that had not been handled during the suckling period in the second experiment provided the mothers of the animals in the third experiment. Eighteen were mated when they were 12 weeks old. The number of young born to each mother was recorded; she was allowed to suckle all and their weight was recorded at weaning. After several weeks, the eighteen females were mated again, and the second litters were used for the third experiment. Again two litters were mixed on the day of birth, and eight animals were returned to each of the two mothers, all males being kept and the number made up with females. As in the second experiment, all the young in one of each pair of suckling groups were stroked individually, but the time of stroking was increased to 1 min each day. The handling was again done in a constant-temperature room at 21°, but the young were all separated from the mother for 10 min on each occasion. The young rats in the other one of the pair of suckling groups were not disturbed. Handling was continued for 2 weeks. The food intake of the mothers was measured during the 2nd week of lactation, and the mothers were weighed after delivery and when the young were weaned at 3 weeks. The young were weighed; then the males, which provided the material for this experiment, were housed in groups of six and were not touched again until they were 9–10 weeks old. They were then weighed and exposed three times to the open-field test. They were weighed once again when they were 19 weeks old.

The open-field test

The field was made of aluminium sheeting. It measured 75×75 cm, and the surrounding wall was 30 cm high. It was divided into twenty-five equal squares and a 200 W frosted electric light bulb in a white shade 40 cm in diameter was suspended 75 cm above the centre; this provided even lighting over the whole field.

The apparatus was placed on a table, in a room maintained at 21°, shut off as far as possible from extraneous noises, and a fan was kept running which provided a uniform background noise.

The rat was placed in one corner of the field facing away from the field. A record was kept of the number of squares it entered in a standard time (2 min) and of the number of times it stood up on its hind legs. The number of stools passed during the test was also recorded. Each rat was tested on 3 consecutive days.

RESULTS

First experiment

Mortality. All the rats survived to the end of this experiment.

Gain in weight and food intakes. Fig. 1 shows that rats housed individually gained a little more weight than those housed three in a cage but handling made no difference to the gain in weight, whichever way the animals were housed. Table 1 shows that those housed individually ate more and possibly used their food a little less efficiently than those housed in groups of three; again, daily handling made no difference to the food intakes or to the food intakes/g gain in weight.

Behaviour in the open field. Handling made a striking difference to the behaviour of the animals in the open field. Table 2 shows that the handled rats explored the field more extensively and that they stood up more frequently.

There was no significant difference between the number of handled and unhandled

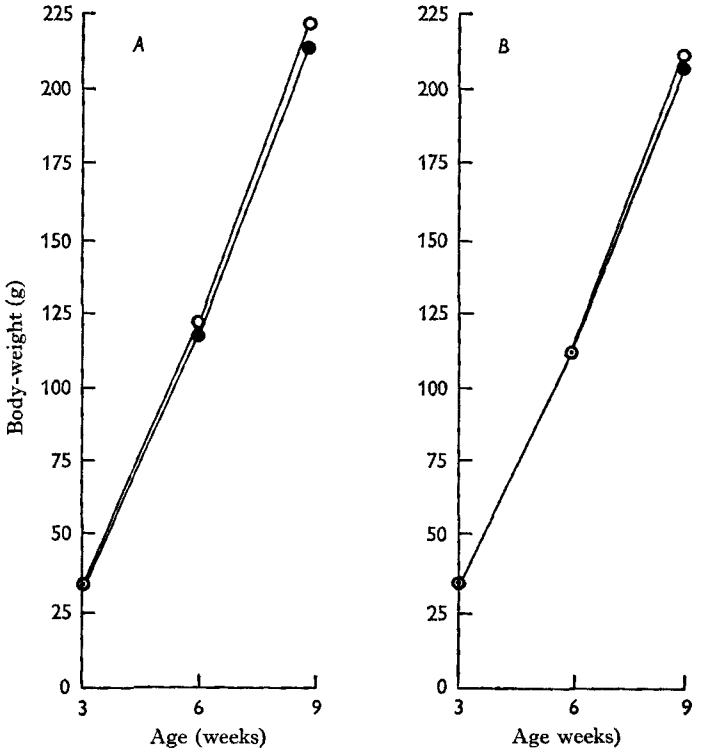

Fig. 1. Effect of handling rats from the 3rd to the 9th week after birth on their body-weight. A, housed one in a cage; B, housed three in a cage; ●, handled; ○, unhandled.

Table 1. *Expt 1. Food intakes of rats handled from weaning onwards compared with those of unhandled litter-mates*

(Mean values for twenty-four animals)

Description of rats	Total food intake (g)		Food intake (g)/g gain in weight over 3 weeks	
	Age 3–6 weeks	Age 6–9 weeks	Age 3–6 weeks	Age 6–9 weeks
Handled 3–9 weeks, housed individually	259	421	3·01	4·45
Unhandled, housed individually	257	437	2·91	4·28
Handled 3–9 weeks, housed in groups of three	227	390	2·91	4·03
Unhandled, housed in groups of three	223	398	2·93	3·91

rats defaecating during the 2 min of the test, nor was there any difference between the number of stools passed by the animals in the two groups.

Second experiment

Mortality. Of the 112 rats that were handled, 32% died during the suckling period. The mortality among the 112 not handled was 10%.

Gain in weight. The large number of deaths in this experiment, particularly among the handled rats and, in consequence, the small number of young remaining in some of the suckling groups, has made the interpretation of the results rather difficult. Table 3 shows the mean weights at 3 and 12 weeks of age of the young in all litters in which at least six rats survived to weaning. Males and females are shown separately. In this experiment the high mortality did not permit a comparison between the paired

Table 2. *Expt 1. Mean number of squares entered and number of times rats stood up on hind legs in open-field test*

(Mean values with standard deviations for twenty-four animals 9 weeks old)

Description of rats	Mean no. of squares entered	SD	*t*	*P*	Mean no. of times standing	SD	*t*	*P*
Handled 3–9 weeks, housed individually	73·7	48·7	4·967	< 0·001	24·3	15·0	5·033	< 0·001
Unhandled, housed individually	18·7	24·0			7·8	5·8		
Handled 3–9 weeks, housed in groups of three	82·8	42·9	6·209	< 0·001	28·0	9·7	5·905	< 0·001
Unhandled, housed in groups of three	21·9	20·9			12·5	8·5		

Table 3. *Expt 2. Effect of handling rats daily during the suckling period on their body-weight*

(Only litters of six, seven and eight at weaning included)

Description of rats	No. of litters	No. of rats	Mean weight at 3 weeks ± SD (g)	Mean weight at 12 weeks ± SD (g)
Males				
Handled 0–21 days	8	25	32·8 ± 3·70	243 ± 17·2
Unhandled	12	43	32·0 ± 4·44	242 ± 29·0
Females				
Handled 0–21 days	8	30	29·5 ± 4·35	173 ± 19·1
Unhandled	12	40	31·0 ± 4·94	173 ± 20·7

Table 4. *Expt 2. Motor development of rats at 14 days*

Motor activity	No. and % rated 'high'		No. and % rated 'low' or 'absent'	
	Handled	Unhandled	Handled	Unhandled
Limb co-ordination	36 (72·0)	31 (57·5)	14 (28·0)	23 (42·5)
Head lifting	23 (46·0)	2 (3·7)	27 (54·0)	52 (96·3)

means, but it is clear that handling made no difference to the gain in weight. If all rats that survived are included, then the mean weight of the handled animals was slightly higher than that of the unhandled at each age but the difference was never statistically significant.

Opening of the eyes and ears and growth of the fur. Of the handled rats examined at 14 days, seventeen out of fifty still had unopened eyes, and of those unhandled fifteen out of fifty-four. Five of the handled and eight of the unhandled animals did not respond to sound. There was no significant difference between the two groups in either instance. The rats could not be differentiated on the basis of the growth of their fur.

Early motor development. Table 4 shows that the handled rats, by the time they were 14 days of age, gave evidence of better motor activity than the others. They moved their heads and necks much more ($\chi^2 = 23{\cdot}31$; df = 1; $P < 0{\cdot}005$) and had better limb co-ordination ($\chi^2 = 5{\cdot}43$; df = 1; $P < 0{\cdot}025$) in a small illuminated field (Cowley & Griesel, 1963).

Third experiment

The third experiment was essentially a repetition of the second, but (in the last part) males only were studied.

Mortality. Of the seventy-two handled rats in the experiment, seventy survived till weaning. The two that died were both males. Of the seventy-two unhandled, seventy-one survived, and the one that died was also a male. Fifty-four male rats in each group were weaned and were available for further study.

Table 5. *Expt* 3. *Effect of handling male rats during the first* 14 *days of the suckling period on their weight at* 3, 9 *and* 19 *weeks*

Description of rats	No. of rats	Age (weeks)	Overall mean weight (g)	SD of the difference between paired means (nine pairs of litters)	t	P
Handled 0–14 days	52	3	36·4	5·68	3·22	< 0·02
Unhandled	47	3	33·1			
Handled 0–14 days	52	9	201	28·36	2·54	< 0·05
Unhandled	46	9	186			
Handled 0–14 days	50	19	317	39·22	2·14	< 0·1
Unhandled	42	19	299			

Gain in weight. The difference between the mean weights of the litter pairs at 3, 9 and 19 weeks was calculated and the variance of these differences was used to test whether the overall mean difference was significant. The results are set out in Table 5. There was a difference between the weights at each age in favour of the handled group, and the difference was statistically significant at 3 and 9 weeks and approached statistical significance at 19 weeks, although mortality in this experiment was negligible. It is well known that the size of the young at weaning depends upon the capacity of the mother to suckle them, and the group being suckled by any one mother really constitutes the unit in any experiment on growth during the suckling period, not the

individual animals. Our experience has been that all the young suckled by one female tend to be about the same size at weaning, although they may originally have come from two different mothers; there may, moreover, be a big difference between the weights of rats suckled by different mothers, and this had nothing to do with handling at all. Among the unhandled litters for example the mean weights at weaning have varied from 24 to 41 g. Since the reproductive history of the mothers of the rats in this experiment was known, it has been possible to compare the growth of handled and unhandled rats with those of the first litters suckled by the same mothers.

Table 6. *Expt* 3. *Weight at* 3 *weeks of males in first and second litters of ten mothers. The second litters of five of the mothers were handled (group A); those of the other five mothers were not (group B). None in the first litters were handled*

Description of rats	No. of litters	No. of rats	Mean litter size	Mean weight at 3 weeks (g)	SD	*t*	*P*
First litters							
Group A (unhandled)	5	24	11	29·5	2·7	0·678	NS
Group B (unhandled)	5	28	11	26·8	5·5		
Second litters of same mothers							
Group A (handled)	5	29	8	37·0	3·3	0·946	NS
Group B (unhandled)	5	28	8	32·7	6·9		

NS, not significant.

Table 7. *Expt* 3. *Mean number of squares entered and number of times rats stood up on hind legs in open-field test*

Group	Mean no. of squares entered	SD	*t*	*P*	Mean no. of times standing	SD	*t*	*P*
Handled 0–14 days	70	41·4	3·1	< 0·01	20·6	9·9	3·64	< 0·001
Unhandled	45	27·6			12·8	8·4		

Table 6 shows the mean weight at weaning of the young of the first litters from five of the mothers whose young were handled during their second lactation (group A), and the mean weight of the first-litter young of five whose second-litter young were not handled (group B). The five mothers in each group were paired for number of young suckled during the first lactation. The number suckled during the second lactation was also the same. The mean weights of the second litters are also shown.

The mothers in group A whose second litters were handled and grew faster had first litters that also grew faster, although the first litters were not handled at all. Analysis of variance shows that the variance due to differences between litter-mates was negligible compared with that due to differences between mothers.

Behaviour in the open field. The behaviour of the rats in this experiment, in which handling was confined to the first 2 weeks after birth, was similar to that observed in the first experiment, in which handling began at 3 weeks of age and continued until 9 weeks, when the test in both experiments was made. The handled rats stood up

more frequently in the open field, and they explored the floor of the field more extensively (Table 7). There was no statistically significant difference between the number of handled and unhandled rats defaecating in the field or in the mean number of stools passed by the rats.

Weights and food intakes of mothers in the second and third experiments

Table 8 shows the weights of the mothers of the handled and unhandled litters after delivery and after 21 days of lactation, when the young were weaned. Mothers rearing fewer than five of their young in the second experiment have been excluded from the mean. The table also gives the same information about the first lactation of the mothers of the animals in the third experiment. These last values are closely similar to those for the second experiment, which suggests that most of the mothers in that experiment were probably suckling their first litters. The mothers weighed just over 200 g after delivery and gained 13–20 g during lactation. In the third experiment, in which the mothers were known to be suckling their second litters, the mean weight was greater after delivery, and there was very little change in weight during lactation.

Table 8. *Expts 2 and 3. Body-weights and food intakes during lactation of the mothers of the rats used in these experiments*

	Expt 2		Expt 3	
	Litters handled	Litters unhandled	Litters handled	Litters unhandled
No. of mothers	12	14	9	9
Mean weight of mother after delivery of litter used for experiment (g)	206	203	242	242
Mean weight of mother after 21 days' lactation (g)	219	220	243	247
Change in weight (g)	+13	+17	+1	+5
Food intake (g): week 1	180	172	—	—
week 2	271	269	271	267
week 3	333	331	—	—
Mean weight of mother after delivery of first litter (g)			206	206
Mean weight of mother after first lactation (g)			222	226
Change in weight (g)			+16	+20

Mean food intakes of the mothers are also shown in Table 8. The food intake during the 2nd week of lactation was almost identical in the second and third experiments. The results for the 3 successive weeks in the second experiment show almost a twofold increase between the 1st and the 3rd week.

DISCUSSION

This investigation has shown how easy it is to obtain results that seem to prove something, though they do not in fact prove it at all. The results of the third experiment appeared to confirm the observations of some earlier workers that handling rats during the suckling period increases their rate of growth, and the mean values for all the young in the second experiment were not inconsistent with this view. There is no doubt, however, that both these results were due to causes not the direct result

of the handling. In the second experiment the difference between the two groups disappeared when the effects of mortality were eliminated. Previous workers on this subject have rarely mentioned mortality, but if more of their handled rats died, as ours did, this may have been the reason why the handled animals—that is, the survivors of them—grew faster, for the mothers would have had fewer to suckle. In both the second and third experiments the mother and young formed the unit, and in the third experiment the young that grew best could be shown to have been suckled by mothers who had also suckled previous litters more successfully, irrespective of any handling at all. These results therefore were probably due to the chance selection of better mothers for the handled groups. Previous workers may have obtained their results in a similar way. Levine (1957), for example, had six litters of rats, which he assigned to three different treatments, so that his experimental group of fourteen animals, which included males and females, came from only two litters.

Handling rats does, however, have a marked effect on their behaviour in the open-field test. Rats that were handled during the postweaning period, or for the first 14 days after birth, walked about and stood up in the field more than did rats that had not been handled. These findings are in keeping with those of Bernstein (1952), Levine (1956) and Weininger (1956), though they have not always been obtained (Mogenson & Ehrlich, 1958). The handling of the animal does not evoke submissiveness but rather heightened curiosity, as expressed in its exploratory behaviour.

There was no statistically significant difference between the number of stools passed by the handled and unhandled rats in the open field, and the exploratory activity of the rats would appear to be independent of this frequently used index of 'emotionality'. The absence of an association between open field activity and stools passed in the field is in keeping with the work of Broadhurst (1958), though Hall (1936) and others have reported a negative correlation between the two.

The stimulation of the infant rat led to a contraction of the musculature of the body and limbs, and when the rat was observed as early as 14 days after birth the movements persisted in the absence of the stroking; it is our opinion that the heightened activity in the open field 7 weeks later was associated with these early effects on motor development.

Rats that were stroked from the age of 21 days did not show the isolated co-ordinated movements observed in infant rats, but a rather more generalized activation of the whole musculature. These rats also showed heightened exploratory behaviour in the open field, which indicates that the effect did not depend on stimulation during one particular period of early infancy any more than it depended upon handling up to the time of the test (Levine, 1956).

The handling has been described as stressful (Levine, 1956), but it is doubtful whether use of the term stress adds to our understanding of the rat's behaviour. The causal basis for the exploratory activity displayed by the handled rats is unknown, and the behaviour may not necessarily be adaptive for natural selection. We have suggested that the early motor responses initiated by the handling may become established (fixated) and that this in itself may in due course lead to an increase in the exploratory behaviour of the handled rats.

Further, if we regard the heightened exploratory behaviour of the handled rats in the open-field test as due to stress, we express a view contrary to that usually held in clinical psychology and according neither with everyday observation nor with the behaviour of the rats in the field. If the argument were extended to our own species we would have to expect that a child exposed to stress in infancy or childhood would be less frightened when exposed to stressful situations later in life than one more placidly nurtured.

SUMMARY

1. The effect of handling rats daily from weaning onwards, and during the suckling period, on their growth and on their behaviour in the open-field test has been studied.

2. When male rats were handled daily from 3 to 9 weeks of age they grew at the same rate as unhandled litter-mates. Rats that were stroked daily during the suckling period were slightly heavier at weaning than others not handled, but it is believed that factors other than the handling were responsible.

3. Rats that were handled, whether in the suckling period or afterwards, were much more active when exposed to the open-field test at 9 weeks of age than unhandled rats.

4. Rats that were handled during the first 2 weeks after birth showed better motor development at 14 days than others not handled. They moved their heads and necks much more, and they had better limb co-ordination. It is suggested that the heightened activity in the open field observed at 9 weeks of age is associated with these early effects.

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