

# Competition Between Maternal Nursing Behaviour and Appetitive Behaviour in Lactating Female Rats

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## Summary

Eighteen lactating Wistar-Imamichi rats habituated to drinking 1 M sucrose-solution were divided into three groups. Appetitive and maternal behaviour was observed during 30 minutes. Group 1 had access to sucrose solution and their pups, Group 2 had access to distilled water and their pups, and Group 3 had access to sucrose solution but not pups. The maternal behaviour seen in Group 2 was effectively inhibited by the presence of the sucrose-solution, in Group 1 where, during the observation period, the rats exhibited appetitive behaviour exclusively. We conclude that maternal appetitive ingestive behaviour is undiminished by the presence of pups.

## Introduction

In female rats, food intake is reduced during the period in the estrous cycle when the rat is sexually receptive and ovulation is imminent (*Wade and Gray, 1979*). By contrast, food intake is increased during lactation in the postpartum period (*Linden et al, 1990*) and sexual behaviour and ovulation are inhibited (*Sodersten et al, 1983*). There are several examples demonstrating that the neuroendocrine control mechanisms of ingestive and sexual behaviour are linked to each other. For example, lesions in the ventromedial hypothalamus (VMH) disrupt sexual behaviour (*Pfaff, 1980*) and stimulate food intake (*Shimizu et al, 1987*). Administration of estrogen into the VMH stimulates sexual behaviour and decreases food intake in ovariectomized female

rats (*Wade and Gray, 1979*). The ingestive behaviour of male rats is suppressed by the presence of sexually receptive females and the sexual behaviour of males is not affected by the presence of a bottle of sucrose when a sexually receptive female is present (*Saito et al, 1999*). This suggests that the presence of a sexual partner inhibits appetitive ingestive behaviour, i.e. the responses used by male rats to obtain food.

Lactation is a state characterized by extensive neuronal and hormonal plasticity. Maternal behaviour is induced, there is a marked hyperphagia and significant increase in plasma levels of prolactin (PRL), and the normal estrus cycle is suppressed. It is well known that PRL also has numerous effects in mammalian brain functions including induction of maternal behaviour (*Bridges et al, 1997*), increased food intake (*Sauve and Woodside, 1996*), and inhibition of GnRH secretion (*Bohnet et al, 1976*). During lactation, rats become more aggressive to intruders, less emotionally responsive to novel situations and clearly demonstrate reduced anxiety (*Neumann, 2003*). Exposure to pups enhances the foraging ability of primiparous as well as nulliparous rats in foraging task tests (*Lambert et al, 2005*), and the aim of the present study was to initi-

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ate investigations of the potential conflict between maternal nursing behaviour and appetitive ingestive behaviour.

### **Materials and Methods**

#### *Animals*

Pregnant rats of the Wistar-Imamichi strain were obtained from Imamichi Institute for Animal Reproduction (Tsuchiura, Ibaraki, Japan) ten days prior to expected parturition. The animals were singly housed in individual cages and kept at  $24 \pm 2^\circ\text{C}$  in a light-controlled room (12 hr. light, 12 hr. dark; lights off 12:00). Pelleted diet (Oriental MF, Oriental Yeast Co., Ltd., Tokyo, Japan) and tap water were available *ad libitum*. The day of parturition was designated as day 0 of lactation and the number of pups per litter was adjusted to eight (four males and four females) on day 1. All procedures were in accordance with the NIH Guide for the Care and Use of Laboratory Animals and were approved by the Institutional Animal Care and Use Committee of the Nippon Veterinary and Animal Science University.

#### *Ingestive behaviour test*

On days 1, 2 and 3 of lactation, food pellets were removed at 07:00, but water was available at all times. Tests were conducted 6 hr later, i.e. 1 hr after the lights were switched off. The lactating females were placed in a circular (30 cm diameter) plexi-glass arena with filter paper as bedding, and trained to ingest 1 M solution of sucrose from a bottle protruding into the test cage.

#### *Maternal behaviour test*

On day 4 of lactation, the rats were tested individually and maternal and appetitive behaviour observed for 30 minutes at the same time and in the same arenas as used in the sucrose ingestion tests under low-level red-light illumination. To be scored as exhibiting nursing behaviour, a dam was required not only to retrieve all the 8 pups (1 point), but also to build a nest (1 point), assume a nursing posture (1 point), lick the young and keep them warm (1

point). Using this system a female can score from 0 to 4 points depending on the number of nursing behavioural traits shown during the observation period.

#### *Choice tests*

The lactating female rats were allowed to commence ingesting sucrose or distilled water from the drinking spout, and 10 sec later the 8 pups belonging to the respective female were introduced, and the dams were studied for 30 min.

#### *Experimental procedure*

Eighteen lactating female rats, that had established a stable intake of sucrose solution in the preliminary test, were randomly divided into three groups of 6 dams. The dams in Group 1 were provided with a bottle of sucrose solution and their 8 pups aged 4 days; the dams in Group 2 with a bottle of distilled water and their 8 pups aged 4 days; and the dams in Group 3 with a bottle of sucrose solution only.

#### *Analysis of data*

Statistical analyses were performed using commercially available software (Stat-View, SAS Institute, Cary, NC, USA). For statistical analysis, Student's t-test or the generalized Wilcoxon test were used where appropriate.

### **Results and Discussion**

Prior to the study of the competition between ingestive and nursing behaviour, all 18 lactating rats were habituated to drink the sucrose solution from a spout for 3 days. During these three days the daily intake of sucrose solution increased gradually (day-1:  $6.6\text{ml} \pm 2.8\text{ml}$ , day-2:  $10.6\text{ml} \pm 2.4\text{ml}$ , and day-3:  $11.1\text{ml} \pm 3.2\text{ml}$ ).

There was no significant difference between the volume of sucrose ingested between the lactating rats with their pups present (Group 1) and the lactating rats which did not have their pups in the arena (Group 3) (Figure 1).

The lactating rats without access to the sucrose solution (Group 2) exhibited the full range of nurs-

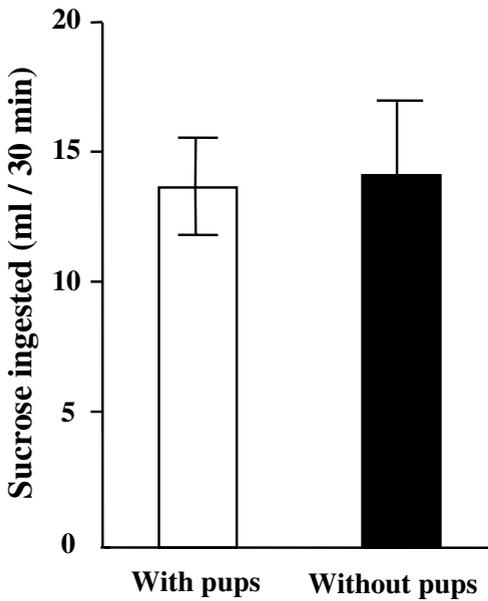


Figure 1: Amount of sucrose ingested from a drinking spout by 6 dams in the presence or absence of their pups. Data are expressed as means  $\pm$  S.E.M.

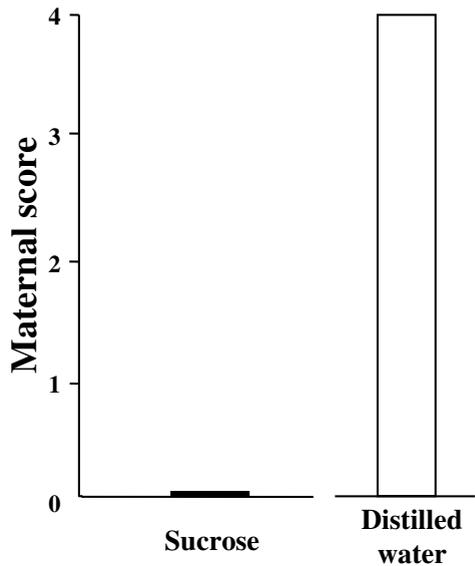


Figure 2: Effects of the presence of a bottle filled with a 1M solution of sucrose or distilled water on maternal behavior in lactating mothers.

ing behaviours (Score 4). By contrast the Group 1 animals, which had their pups in the arena and also access to sucrose solution exhibited no maternal behaviour (Score 0) during the 30 min observation period (Figure 2). This difference was highly significant ( $P < 0.001$ ).

The present study demonstrates that the maternal nursing activity of lactating rats was suppressed by the presence of a bottle of sucrose solution (Figure 3), as compared with a bottle of distilled water, which did not influence the normal maternal behaviour. In a study of appetitive ingestive behaviour (i.e., the responses used to obtain food) as opposed to consummatory ingestive behaviour (i.e., the responses used to ingest food), Saito and co-workers (1999) found that the ingestive activity of male rats was suppressed by the presence of sexually receptive females but not by non-receptive females. The sexual activity of males paired with a sexually receptive female was not influenced by the presence

of the sucrose solution.

In conclusion, the present study indicates that the appetitive behaviour takes precedence of maternal nursing behaviour.



Figure 3: Arena with sucrose containing water bottle.

This agrees well with the findings of (Lambert *et al* 2005) who found that exposure to pups stimulates and enhances the foraging abilities of female rats. Studies are in progress to investigate the relationship between sexual and maternal behaviour under neurophysiological conditions associated with energy depletion and repletion.

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