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Clinical Usefulness of Maternal Odor in Newborns: Soothing and Feeding Preparatory Responses

Key Words
Maternal odor
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Feeding preparation
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Olfaction
Crying

Abstract
This study assessed the responsiveness of newborn breast- and bottle-fed infants to presentations of maternal odor. Maternal odor was presented for 1 min to crying, sleeping or awake newborns. The odors were: (1) *own mother*'s odor – presentation of a hospital gown worn by the baby's mother, (2) *other mother*'s odor – presentation of a hospital gown of another newborn baby's mother, (3) *clean gown* – presentation of a clean hospital gown and (4) *no gown* – no gown presented. The results indicated that crying babies stopped crying when either *own mother* or *other mother* odor was presented. Awake babies responded specifically to their own mother's odor by increasing mouthing. These results suggest that the practice of presenting the mother's odor to a distressed infant is of clinical usefulness since it was capable of attenuating crying. The results also characterized a role for maternal odor with respect to feeding since presentation of the infant's *own mother* odor increased mouthing. Thus, presentation of maternal odor may also be useful in enhancing nipple acceptance and feeding in newborns.

Introduction

One technique used by newborn nursery staff to soothe a crying or distressed infant is to provide the infant with the mother's odors, usually in the form of an article of clothing worn by the mother. However, there is no experimental evidence to support this practice. The results of the present paper provide the necessary experimental evidence to support the clinical use of maternal odor as a technique to soothe infants.

As early as the 1st day of life, newborns respond to both natural odors [11, 15–17, 20–

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Table 1. Descriptive statistics of crying infants' odor stimulus

	Own mother's gown	Other mother's gown	Controls			Total
			total	clean gown	nothing	
Subjects	15	26	14	7	7	55
Feeding						
Breast	8	11	4	2	2	23
Bottle	7	11	9	5	4	27
Both	0	4	1	0	1	5
Sex						
Male	8	17	6	2	4	31
Female	7	9	8	5	3	24
Mean age, h	25.9 ± 4.1	24.1 ± 3.4		21.6 ± 5.9	29.2 ± 4.9	
Mean weight, g	3,443 ± 111	3,560 ± 119		3,171 ± 104	3,664 ± 185	

23, 31] and artificial odor [2, 4–6, 10, 12, 14, 26–29; for review see ref. 8, 13, 16, 19, 21, 24, 25]. Newborn infants will turn their head towards a breast pad which has been worn by a lactating mother and a moving baby will decrease its activity when the maternal odor is present [11, 20, 23]. The present experiments further characterize newborns' responses to maternal odor by assessing a wide range of behaviors during maternal odor presentation (own mother vs. another mother's odor vs. controls) in crying, sleeping and awake newborn infants.

Materials and Methods

Subjects. The subjects were male and female newborn human infants (at least 2.5 h old) born at the University Hospital at the University of Oklahoma Health Science Center. All infants had an Apgar score of at least 7 and 9 at 1 and 5 min, respectively, following birth [1] and were assessed as normal during routine postnatal examinations. Tables 1–3 supply additional subject variables.

There were a total of 55 stimulus presentations given to 44 *crying* infants (33 of the infants received 1 stimulus presentation and 11 received 2 stimulus presentations). The 64 *awake* (noncrying) infants received a total of 81 stimulus presentations (47 infants received 1 odor presentation and 17 infants received 2 odor presentations). The 49 *sleeping* infants received 62 stimulus presentations (34 infants received 1 stimulus presentation, 11 infants received 2 stimulus presentations and 2 babies received 3 stimulus presentations). Some infants were used in more than one behavioral state. Thus, with all state data combined, the distribution of the number of odor presentations received by infants was: 99 infants received 198 stimulus presentations (39 infants received 1 stimulus presentation, 32 infants received 2 stimulus presentations, 21 infants received 3 stimulus presentations, 3 infants received 4 stimulus presentations and 4 infants received 5 stimulus presentations). Infants receiving multiple stimulus presentations never received more than 1 presentation in an odor/state condition and the presentation sequence was randomly determined. Other than experimental odor exposures, infants' exposure to maternal and hospital odors (such as the smell of laundered items, clean gown, blankets) were completely uncontrolled.

Infant State. Infant responsiveness to maternal odor was assessed in three different states, which were subjectively determined based on experimenter observations: (1) *crying* – infants were subjectively determined to be crying by the experimenter. An infant was used in this condition only if it had been crying for 1–3 min and not longer. The reason for a specific infant's cry was not determined and the potential reasons for crying were not a condition for inclusion in the study; (2) *sleep* – infants were determined to be asleep

Table 2. Descriptive statistics of awake infants' odor stimulus

	Own mother's gown	Other mother's gown	Controls			Total
			total	clean gown	nothing	
Subjects	24	29	28	19	9	81
Feeding						
Breast	6	3	1	0	1	10
Bottle	15	24	22	14	8	61
Both	3	2	5	5	0	10
Sex						
Male	13	16	12	6	6	41
Female	11	13	16	13	3	40
Mean age, h	18.8 ± 2.9	25.2 ± 2.8		19.8 ± 2.2	20.6 ± 5	
Mean weight, g	3,327 ± 111	3,346 ± 87		3,308 ± 145	3,359 ± 117	

Table 3. Descriptive statistics of sleeping infants' odor stimulus

	Own mother's gown	Other mother's gown	Controls			Total
			Total	clean gown	nothing	
Subjects	18	21	23	17	6	62
Feeding						
Breast	2	3	4	3	1	9
Bottle	15	16	17	13	4	48
Both	1	2	2	1	1	5
Sex						
Male	11	13	12	9	3	36
Female	7	8	11	8	3	26
Mean age, h	10.46 ± 2.5	21.1 ± 3.4		14.2 ± 2.9	14.68 ± 3.7	
Mean weight, g	3,259 ± 93	3,516 ± 117		3,477 ± 136	3,501 ± 160	

when eyes were closed, when they were lying relatively motionless and respiration was regular. An infant was used in this condition only if it had been sleeping for at least 5 min, and (3) *quiet awake* – infants were determined to be quiet awake when they were in behavioral states III and IV. Infants had their eyes open with low activity level. Infants in sleep-wake transition were not included in the study. The state of the baby was assessed based on Prechtl's state categories [18], as well as those described by Thoman et al. [30].

Odor Presentations. Presentations were given in a relatively quiet area of the nursery under conditions normally experienced by the newborn. Infants were randomly assigned to an odor condition and under most situations, the experimenter did not know which odor the infant was receiving. The odor conditions were: (1) *own mother* – infants received a 1-min presentation of their own mother's nightgown, (2) *other mother* – infants received a 1-min presentation of another mother's nightgown (generally, it was the nightgown of another subject's mother), (3) *clean* –

infants received a 1-min presentation of a clean nightgown and (4) *nothing* – infants received no nightgown presentation. The *clean* and *nothing* conditions were included to control for nonmaternal odors and other stimuli (i.e. visual).

After receiving an informed consent from the mother, the infant was moved to another room in order to control the maternal odor presentation. If the mother requested to watch the procedure she was asked to stay in another room and view the procedure through a window (the infant could not see the mother). The experimenter presented the odor from behind the infant's head so that the infant could not see the experimenter and the odor presentation was video taped.

The maternal odor was presented on a hospital gown worn by the mother for at least 2 h. Furthermore, a gown was used only if it was clearly worn by the mother (i.e. wrinkled and had an odor detectable by the experimenter). When the mother removed her gown, it was placed in a clean plastic bag and used within 4 h. During an odor presentation, the gown was held so that the area of the gown which had been in contact with the breasts and axillary area were exposed to the infant. The gown was held approximately 10 cm from the infant's nose to the side of the infant's face. The odor remained in this relative position to the infant's nose with the gown moved to accomodate the infant's movement. Thus, the intensity of the odor was not influenced by the infant's behavior. The clean gown was handled in a similar fashion and consistent with all gowns, had been laundered by the hospital's laundry. All infants remained in their bassinet throughout the odor exposures.

Scoring Video Tapes. All data were video taped. Except for the *nothing* condition (in which no gown was presented) it was not possible to determine which odor the infant was receiving simply by observing the tape. The infant behaviors assessed were divided into the following categories: hand to mouth, suck, tongue protrusion, mouthing, grimace, fussy, crying, head turns towards the odor, head turn away from the odor and a general behavioral activity score. Behaviors were continuously assessed using bins of 20 s in which the occurrences of behavior were noted and or the total seconds engaged in that behavior (i.e. mouthing). Only behaviors that were statistically modified by the experimental treatments are included in the results. General activity was scored using the following scale which is based on the vigor of the baby's movement, with 0 indicating no movement and 3 indicating vigorous movement of multiple body elements (i.e. arms and head).

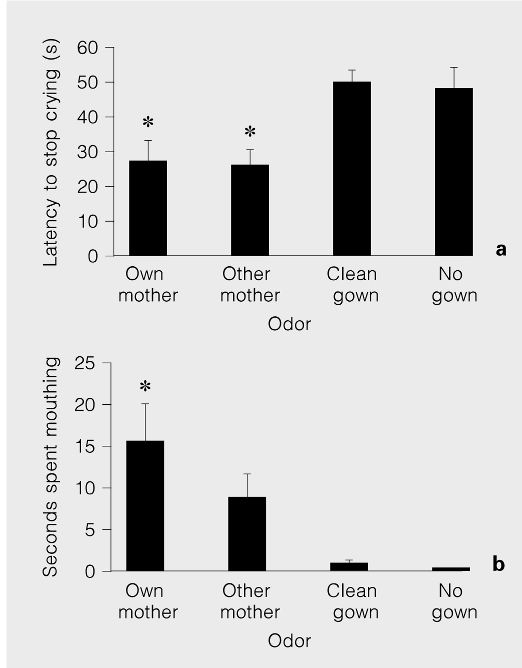

Fig. 1. Crying infants. **a** The mean (± SE) latency to stop crying as a function of odor presentation. Asterisks represent a significant difference from the *control clean gown* and *nothing* (no stimulus presentation) groups. **b** The mean (± SE) change in mouthing as a function of odor presentation in crying infants. Asterisks represent a significant difference of the own mother's odor group versus each of the control conditions.

Results

Crying Infants

Both breast- and bottle-fed infants responded to the maternal odor by terminating crying sooner than control infants (fig. 1a). Both the infant's *own mother*'s odor and *other mother*'s odor appeared capable of terminating crying [$F(3,51) = 4.51$, $p < 0.01$]. Post hoc Fisher tests revealed that the *own mother* and *other mother* groups were both statistically different from the *nothing* group at the $p < 0.05$ level. Infants presented with their *own mother*'s odor or *other mother*'s odor spent

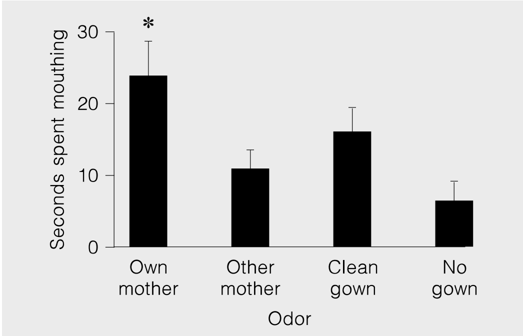

Fig. 2. Awake infants – the mean (± SE) change in mouthing as a function of odor presenation in non-crying infants. Asterisk represents a significant difference of the *own mother*'s odor group from the no gown and *other mother* conditions.

less time crying during the odor presentation [$F(3,51) = 3.23$, $p < 0.05$]. Post hoc Fisher tests revealed that the *own mother* and *other mother* groups were both statistically different from the *clean* group at the $p < 0.05$ level.

Latency to stop crying in breast- and bottle-fed infants was not statistically different from one another (latencies to stop crying for breast- and bottle-fed infants were: *own mother* 28.7, 27.0; *other mother* 33.6, 21.0, and controls 40.0, 54.0, respectively). Infants appeared to respond similarly to *other mother* gowns from breast- and bottle-feeding mothers.

No group differences were found for head turns towards the odor or activity level. There was no significant correlation between the amount of time spent with the mother, time of day, the age of the infant and the ability of the maternal odor to stop crying. Also, no statistical difference was found between infants in the *other mother* group based on their feeding method and the feeding method of the other mother.

As is illustrated in figure 1b, once crying stopped, infants receiving a presentation of their *own mother*'s odor were more likely to exhibit mouthing [$F(3,51) = 2.86$, $p < 0.05$] when compared to either of the *control* groups (post hoc Fisher tests revealed that the *own mother* group was statistically different from the *nothing* group at the $p < 0.01$ level. The *other mother*'s odor group did not differ significantly from any other condition).

Due to uneven numbers of subjects in the different treatment conditions, additional analyses were done using three conditions (*own mother*, *other mother* and *control*). The *control* condition combined *clean* and *nothing* groups which did not differ significantly from one another (nonsignificant t test). Latency to stop crying [$F(2,52) = 6.886$, $p < 0.005$]; time spent crying [$F(2,52) = 4.82$, $p < 0.001$]; post hoc Fisher tests revealed that the two mother odor conditions were not statistically different from one another and each was statistically different from the *control* condition. A significant ANOVA was also found for seconds spent mouthing [$F(2,52) = 4.38$, $p < 0.05$]; post hoc Fisher tests disclosed that the *own mother*'s odor group differed from the control group at the 0.05 level.

Awake Infants

Awake infants' responses were specific to their *own mother*'s odor (fig. 2); only the infant's *own mother*'s odor was capable of increasing mouthing [$F(3,77) = 3.23$, $p < 0.05$]. Post hoc Fisher tests revealed that the *own mother* group was statistically different from the *nothing* group and the other mother group ($p < 0.01$). No group differences were found between the other variables including the specific behaviors, activity level, amount of time spent with the mother and time of day the odor was presented. Also, no statistical difference was found between infants in the *other mother* group based on their feeding method and the feeding method of the *other mother*.

Due to uneven numbers in the different treatment conditions, statistics were also done using three conditions (*own mother*, *other* *mother* and control). The control condition was the combined *clean* and *nothing* groups which did not significantly differ from one another (nonsignificant t test). ANOVA on seconds spent mouthing was significant [$F(2,78) = 3.91$, $p < 0.05$]; post hoc Fisher tests revealed that the *own mother*'s odor group differed from the control group and the *other mother* group ($p < 0.05$).

Sleeping Infants

As shown in figure 3, no statistical differences were found between the odor condition groups in sleeping babies, including seconds mouthing which was significantly different in the awake babies (compare with fig. 2).

Fig. 3. Sleeping infants – the mean (± SE) change in mouthing as a function of odor presentation in sleeping infants. No statistical differences were found between any conditions.

Discussion

These results indicate that postpartum maternal odor soothes the newborn infant. Specifically, presentation of maternal odor was capable of shortening the latency to stop crying in distressed infants. The soothing effect of maternal odor appears not to be specific to the infant's own mother since an alien postpartum mother's odor also suppressed crying. However, there appears to be some specific component of the crying infant's response to maternal odor since infants were more likely to mouth to their own mother's odor.

Awake infants also responded to maternal odor as indicated by an increased mouthing response. In contrast to the soothing effects of maternal odor, the mouthing response appears to be specific to the maternal odor of the infant's mother. Since the alien maternal odor was generally the maternal odor of another subject's mother, intensity and other nonspecific variables probably cannot account for this effect. It is possible that this component of the response to maternal odor may be a preparatory response for feeding.

A neonate's olfactory experience begins in utero and continues postnatally [3, 7, 8, 13, 15, 19, 22, 24, 31]. There is evidence that olfactory-based responses in the newborn involve both biologically and prenatal/postnatal experience-dependent factors [2, 9, 10, 14–16, 29, 31]. This study does not present evidence regarding the role of experience in the infant's responses to maternal odor.

Conclusion

These results suggest that maternal odor represents a beneficial stimulus presentation which has clinical relevance in two specific situations. First, since maternal odor is capable of attenuating crying, these data support the practice of presenting maternal odor to soothe a distressed infant. Second, these results also suggest that maternal odor presentations may be of clinical use in situations when infants are not feeding well. The increased mouthing elicited by maternal odor may enhance nipple acceptance and feeding in certain newborns. These data reinforce the notion that maternal presence may be extremely beneficial to hospitalized infants.

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