Olfactory Perception in Infants

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The research reported here was undertaken to develop new methodology for evaluating olfactory perception in infants. Prior research has shown that, while newborn infants are capable of making fine olfactory discrimination, adult-like odor preferences and aversions are not apparent until five years of age.

The failure to observe adult-like hedonic reactions prior to the age of five led to the claim that all odor preferences and aversions are acquired through experience. We believed, however, that the failure to observe adult-like hedonic reactions to odors in young children and infants may have been due, in part, to methods that were insensitive to some of the behavioral and communication limitations of young children.

Our goal was to explore age-appropriate methods for assessing infants' reactions to odors and then to use these methods to investigate:

1) the origins of hedonic responses to odors,
2) the origins of sex differences in responsiveness to odors, and
3) the effect of odor on infant behavior.

We expected that the development of this new methodology would contribute to our understanding of the potentially important role of olfaction in psychological development during the formative years. Furthermore, these methods would open the doors to the study of how amount and kind of odor experience in infancy may affect the development and modifiability of fragrance preferences and aversions.

Background Information

The predominant scientific view is that adult-like hedonic reactions to odors are not evident until five to seven years of age, although young infants can detect and discriminate amongst odorants (e.g. Stein, Ottenburg and Roulet, 1958; see Engen, 1982 for review). The failure to observe odor preferences and aversions in children younger than this has led some researchers to the radical claim that all hedonic responses to odors (including to the smell of skunk) are acquired through associational learning, and that there is no natural relationship between a smell and its perceived pleasantness. This conclusion is based on remarkably few studies and is not without controversy.

Our recent work at the Monell Center challenges the premise that adult-like olfactory preferences are absent in preschool children. Previous failures to

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This article is an informal description of one of the research projects supported by The Fragrance Research Fund. This fund has as its main objective the financing of research related to the impact of fragrances in humans.

It studies the sense of smell and human reaction to olfactory stimulation. The research is of an interdisciplinary nature, including anatomatical and ultrastructural observations, physiological and biochemical studies as well as psychological and behavioral reactions to fragrance.

This research is expected to clarify how fragrances operate and how they impact, via the central nervous system and hormonal mediators, on moods, mental attitudes and general physical health.

The President of The Fragrance Research Fund is Dr. Jack Mausner, Senior Vice President Research and Development, Chanel, Inc. For further information on the research and educational activities of the Fragrance Research Fund and of the Fragrance Foundation contact: Annette Green, The Fragrance Foundation, 142 East 30th Street, New York, NY 10016, USA.

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demonstrate hedonic reactions in young children may have been due to inappropriate methods, or to stimulus sets that were too limited to capture discriminations. Using newly developed age-appropriate methods, we have demonstrated adult-like odor preference patterns in three-year-old children.

Other recent studies suggest that hedonic odor experience may begin in earliest infancy. For example, two-week-old, breast-fed infants will selectively orient toward the smell of their own mother when it is paired with the smell of another lactating mother. Infants less than five days old will turn away from the smell of ammonia. Furthermore, newborn girls will selectively orient toward an odor to which they have been exposed for only a brief period during the first few days of life.

Although behaviors such as these may reflect a tendency to avoid novel or strong olfactory stimuli, they may also be associated with, or mediated by, hedonic reactions. Some researchers have rejected this latter interpretation because newborns 1) fail to produce reliable and appropriate facial expressions in response to pleasant and unpleasant odors, and 2) they do not show differential heart-rate or respiratory responses to odors with different hedonic values.

Neither observation however, provides convincing evidence that infants do not experience emotional reactions to odors. First, spontaneous adult facial expressions do not provide a reliable index of the hedonic quality of an odor and are not reflexive responses to odors. If adult odor-continent facial expressions are not reflex-like, their absence in newborns cannot imply an absence of hedonic odor experience. Second, it has proved extremely difficult to relate systematic heart-rate or respiratory changes to emotional responses of any kind in infants, and therefore it seems tenuous to assume such responses would be indicative of hedonic odor reactions in newborns. In short, it is possible that infants experience a range of emotions in responses to smells.

Assessing Infant Reactions

We have two methods for assessing infants responses to odors; one is aimed at evaluating six- to nine-month-old infants who are capable of reaching for and manipulating toys, and the other is aimed at evaluating the responses of prereaching infants less than five months of age.

For six- to nine-month old infants we have developed an 'object-odor' exploration task. In essence, this method involves analyzing the videotaped reactions of infants as they play with and explore rattle-like toys that have been odorized with different smells.

In our first study we videotaped the reactions of infants as they explored three rattles that were identical in appearance, but differed with respect to odor. As judged by adults, one had an unpleasant smell, one had a pleasant smell, and the third had no smell.

To evaluate whether or not infants experience hedonic reactions to the odors, naive adults view the videotaped reactions and attempt to judge the hedonic quality of the odor based solely on the behaviors of the infants. We reason that if infants do discriminate amongst the odors, then their behaviors should convey their preferences.

In subsequent studies we have modified this procedure to ask whether an odor influences the interest value of an object for infants. In this procedure we familiarize infants with rattles which are similar in size and shape, but which have different colors and odor properties. The familiarization period (90 seconds with each toy in succession) is intended to allow infants to determine the relationship between the visual and odor properties of the objects.

Following familiarization we place both objects side by side in front of the baby and allow him to freely explore and choose between the two objects. We record the amount of time that the infant spends with each object during this phase, reasoning that the amount of time spent with each object provides an index of which one is preferred. In one experiment we compared an odorized rattle to a non-odorized

rattle, and in another we compared a pleasantly odorized rattle to a foul smelling rattle.

In addition, we analyze specific behaviors directed toward the objects, such as mouthing and facial expression, to investigate whether an odor can influence specific behaviors.

To assess younger infants' reactions to odors, we are exploring the possibility that sucking patterns may be affected by the presentation of odors. We have adapted a device which allows digital recording of infants sucking patterns for this purpose. In addition, we have built an olfactometer which allows us to present an odorant just below an infant's nostrils while he is sucking. Thus far we are exploring how the familiar smell of the mother influences sucking patterns, and how novel odors affect sucking patterns.

Findings to Date

Thus far we have completed several experiments using these new methodologies. Using the odor-object exploration task, we have demonstrated that infants of 9 months respond to pleasantly and unpleasantly odorized objects with bodily, facial, and/or exploratory behaviors that are consistent with the hedonic valence (as perceived by adults) of the odor. Adults who viewed the videotaped reactions of infants were significantly better than chance in judging the odor quality (pleasant, unpleasant or neutral) of each of three rattles that infants explored and played with in a series of trials.

In contrast to the long-standing view that odor preferences are not established until approximately five years of age, this finding demonstrates adult-like odor preferences in early infancy. Demonstration of these reactions in young infants raises the possibility that some hedonic odor reactions are innate.

Using this modified method we have also demonstrated sex differences in responsiveness to odors, suggesting that genetic differences underlie the olfactory sex differences that have been documented in adults.

Specifically, we found that female infants (eight to ten months) pay more attention to an odorized rattle than a non-odorized rattle, when offered a simultaneous choice between them, while male infants do not. When offered a choice between two odorized rattles with different hedonic valences, male infants exhibit a strong preference for the pleasantly odorized rattle, while female infants respond with high and equal interest to each.

In addition, these experiments demonstrate that certain behaviors such as mouthing (putting an object in the mouth, licking etc.) are more prevalent when infants are exploring odorized rattles relative to non-odorized rattles. This phenomenon appears to be independent of the hedonic valence of the odor, mitigating the utility of using unpleasant odors to prevent infants from ingesting toxic substances.

Preliminary data suggests that younger infants' (two to six months) sucking patterns may be differentially affected (inhibited or enhanced) by odors with different qualities. The odor of the mother's breast may increase the rate of sucking of some infants to a sucrose solution (0.15 molar), while the odor of wintergreen may inhibit sucking altogether. These results, however, are tentative since too few babies have been tested to draw definitive conclusions.

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