Fall 1999

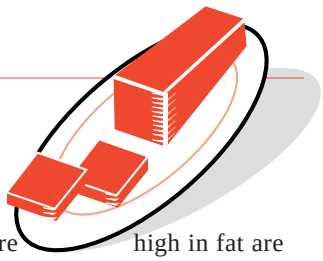
The Monell Connection

The Monell Connection... from the Monell Chemical Senses Center, a nonprofit scientific institute devoted to research on taste, smell, and chemosensory irritation.

What's The Skinny On Fat?

Sensory appeal of dietary fat:

flavor and function



Creamy mayonnaise, moist cake, rich and flavorful olive oil, succulent steak, crispy french fries, tender and flaky pie crust... What do all these foods have in common?

All of these highly palatable — and desired — foods owe much of their appeal to fat. In some cases, the fat contributes a desirable mouthfeel or texture, in others fat enhances the flavor. Regardless, as scientists, food professionals, and nutritionists know, the sensory characteristics of fat play an important role in determining food preferences and intake.

Fats serve a variety of functions in food. In addition to heightening texture and taste, fats absorb and blend flavors, transfer heat, aerate batters, and act as emulsifiers. Different fats have different properties that determine how they're used. For example, vegetable shortening is often used when baking pie crusts because it doesn't contain water to mix with gluten and toughen the dough.

Fats can also contribute flavor to food. Most of the flavor associated with fat comes from the aroma of so-called impurities. In some cases, such as with olive oil, flavors can be subtle and complex. Instructions for "tastings" using extra-virgin olive oils include recommendations to slightly warm the oils to release aromas, and suggest descriptors as evocative as those used for fine wines, such as 'fruity,' 'peppery,' 'sweet,' and 'grass.'

Foods that are high in fat are often over-consumed. Even though excess levels of dietary fat have been linked to chronic disease, including obesity, coronary heart disease, hypertension and certain cancers, the average American consumes approximately 35% of total calories as fat. This is despite the recommendation of many experts that a healthy diet should contain no more than 30% of calories as fat. However, while many individuals need to reduce fat intake, they often find it difficult to do so. To help achieve this goal, over 1000 reduced-fat and fat-free products have been introduced onto the American market every year since 1990.

Some fat is necessary for optimal health. Fats provide energy, and help promote absorption of certain vitamins and maintain healthy skin. They act as precursors for substances important in regulation of body processes. Essential fatty acids, which are not made by the body, are required for proper growth and development.

What is it about fat that makes it so appealing? The exact reasons remain elusive. The search to unravel this mystery has become more pressing as the need and demand

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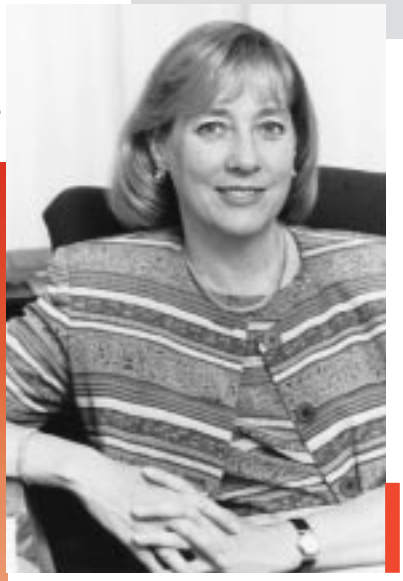
Another Perspective...



Paola Taglamonte

Mary M. Chatterton, J.D.
Director of Resource Development

Industrial Research Partnerships

Getting Back to Basics

About two years ago, Monell launched an extensive search for a Director of Resource Development. The Center wanted an individual who could induce "culture shock" in the scientific staff by way of sensitizing them to the business needs of corporate sponsors, while being mindful of Monell's basic research mission. For this reason the search focused on applicants from industry with an extensive business background. These qualifications were regarded as essential to achieving a maximum synergy between Monell and our sponsors. I was happy to fill the position.

As it turns out, I have experienced multiple episodes of my own culture shock during the past year. Coming from the pharmaceuticals industry, which is geared toward secrecy and proprietary information, it was challenging to adapt to an environment where the goal is dissemination of information through conferences and publications. Academia moves at a pace unfamiliar to me, with a focus on multiple-year research plans as opposed to immediate product application, market opportunities and sales goals.

One incentive for coming to Monell was the diversity of the sponsoring companies. Having spent my career in one industry, the opportunity to work with world-class companies in the food, beverage, fragrance, chemical, and many other industries was irresistible. Giving up such corporate perks as a car and bonus caused a moment of hesitation, as Monell operates on a "lean and mean" budget that would impress any corporate CEO. However, weighed against the opportunity to work with the world's leading chemosensory scientists, the decision was not difficult. Linus Pauling once stated that "the best way to have a good idea is to have lots of ideas," and that is a Monell specialty. With no divisions or departments, and scientists coming from remarkably diverse backgrounds, there is a constant flow of ideas.

I recently heard a quote from Morley Kare, Monell's founding director, regarding our relationships with corporate sponsors: "Monell plows the field and the sponsors pick up the worms." In plowing through basic research, we turn up many a worm of real value to our sponsors. Corporate application of Monell's research findings and methods has resulted in new and improved products on the market and greater profitability for the sponsors. This is particularly important as corporate research resources are being increasingly marked for targeted projects, with measurable product-related goals and timelines. Monell continues to answer the basic research questions.

Because of this, Monell remains a valuable asset to companies interested in devoting their resources to more applied projects. We offer many advantages. Monell's federally-negotiated overhead rate is significantly lower than those of most universities. Our Chemosensory Clinical Research Center, located in Center City Philadelphia, is a resource for sponsoring companies interested in clinical testing of pharmaceutical products. In addition, Monell's human testing facility is available at our main location for all types of taste, smell and environmental studies.

Members of our staff are frequently contacted by consultants hired by companies to find experts in consumer taste preferences and other areas of interest. Because Monell consults only with corporations who sponsor our research through an annual unrestricted grant, we typically are unable to assist these consultants. On occasion, we have later discovered that the consultant was working for one of our sponsors. It is unfortunate that expenditures are made to obtain information and locate expertise that is already directly available to the sponsor. Often this duplication occurs because not all the departments of a sponsoring company know that Monell's expertise is available to them. A goal of mine is to make our sponsors more aware of the numerous benefits associated with their Monell partnership.

Recognizing that the primary resource Monell has to offer our sponsors is the collective expertise of our scientific staff, we have recently invested in new communications technology that will allow greater availability for consultation at significant savings of time, travel and money. We can now participate in audio conferences with or without visual aids; videoconferences can be scheduled at minimal expense to our sponsors. We anticipate providing CD-ROM summaries of scientific meetings along with abstracts in the near future. Our conference facility has been upgraded to function better and provide greater comfort to visitors. Plans are underway for a complete redesign of our web site to make it a more useful resource for our sponsors.

We hope that our sponsors will take full advantage of all we have to offer in the coming century. Our interest is in true research partnerships, with each organization contributing its greatest strengths toward the advancement of academic and applied research concepts. ■

Insights *Into Development*

Paola Tagliamonte

Julie Mennella, Ph.D.

Exploring the effects of experience... on flavor preferences and science education

▲ Research Technician Saadia Khan uses Sesame Street characters to help an indecisive six-year-old indicate whether he likes the flavor of a drink.

New mothers often become extremely confused during the first months of parenthood. They can feel overwhelmed by conflicting advice: How is it best to feed a baby? Breast or bottle? Which formula? When to start solids? What foods should be the first? Is it safe to drink alcohol or not? Giving new parents an established foundation of fact to assist them in making informed decisions is central to the work of Dr. Julie Mennella. Research that began in 1988 as a postdoctoral investigation on the role of the chemical senses in human development quickly sprouted into numerous projects with infants, and has now blossomed into experiments on flavor preferences of toddlers and preschoolers. Although fundamental science is a priority in Mennella's laboratory, her work extends into the realm of providing answers to the very real questions facing parents, health professionals, and industry.

One of Mennella's most significant findings came about quite by accident. She and her research team were trying to determine whether food flavors — specifically garlic — were transferred into human breast milk. A sensory panelist remarked that one of the milk samples, collected on a placebo day, "smells like it's fermenting," and indeed, the mother had consumed a beer less than an hour before giving the sample. Through additional experiments, Mennella was able to show definitively that alcohol changes the flavor of breast milk. This serendipitous finding launched an extensive research program exploring the effects of alcohol in breast milk on infant behavior and women's health.

Contrary to the old wives' tale that drinking helps promote lactation, babies actually consume less milk after a mother has consumed alcohol. "The babies aren't rejecting the milk because they don't like the flavor," Mennella explains. Rather, she has found that women produce slightly less milk on the days they drink alcohol.

Mennella says she often finds new directions for research during her frequent meetings with sponsors from industry and with health professionals, such as lactation consultants and nutritionists. She comments, "I've always enjoyed talking with people who deal with parents and children on a daily basis. They're the ones on the forefront, working directly with the mothers and identifying the issues they're facing."

Anecdotal reports from pediatricians prompted Mennella to look at the flavor preferences of infants who were fed a special formula made of pre-digested proteins. Most

adults find these protein hydrolysate formulas extremely unpalatable. Physicians often comment that even though younger infants will gladly accept this formula and continue to drink it for many months, when it is introduced beyond a certain age, infants will have nothing to do with it. "Our research confirmed that once they reach three to four months of age, babies reject this formula if they've never had experience with it," Mennella explains. However, babies who started drinking the protein hydrolysate formula earlier don't go through this rejection phase and will continue to accept it without a fuss. She continues, "We're using this as a model system to try to tease apart how these early experiences affect preferences both during infancy and down the road." Accordingly, Mennella is now looking at preferences for sweet and sour flavors in children who were fed the hydrolysate formula as infants.

"From a basic science point of view, the response to hydrolysate formula provides probably the best example of a sensitive period in flavor perception in humans that we know of."

The American Academy of Pediatrics recommends children consume a variety of foods. As many parents know, this can be a difficult objective to achieve. Mennella's research is helping to show why kids like and eat certain foods but not others. Early studies she conducted at Monell showed that different flavors are transmitted through amniotic fluid during pregnancy and human milk during lactation, perhaps introducing a "flavor bridge" to the mother's cuisine. More recently, working with postdoctoral fellow Carolyn Gerrish, Mennella found that infants exposed to a variety of flavors are more willing to accept a new food. And a cross-cultural study being conducted with a scientist from Japan is exploring the role that different cultural traditions play in forming a child's odor preferences. "All of the research builds on a developmental perspective of trying to figure out why we like the things we do," Mennella explains.

With a research plate as full as Mennella's, she obviously needs a lot of help. She speaks glowingly of her three dedicated full-time assistants and numerous student interns. Her face also lights up when discussing Monell's extensive internship program, which she oversees. "They're great kids," she says, referring to the hundreds of high school and college students, many of whom are minorities, who have been trained at the center as part of a program designed to encourage careers in the sciences. "My colleagues at Monell are wonderful mentors and the relationships that form here often last a long, long time." Mennella is especially proud of the fact that 90 percent of past Monell high school interns have gone on to college and majored in the sciences. Though government funding for the minority internship program ended in 1998, Mennella managed to secure funding from a private foundation for this summer's interns and is hopeful the program will be able to continue through additional funding.

Mennella's assistants take a break to pose with a friend.

Whether studying facial reactions of infants, using Sesame Street characters with older children or turning to different candy flavors with preschoolers, the goal is to get a direct response from children. "Of course we ask the mothers about their perceptions, but we also always try to find ways to ask the child the question," Mennella says.

It was a desire to do interdisciplinary research that brought Mennella to Monell eleven years ago to work with Gary Beauchamp. After completing her undergraduate work at Loyola University and a masters degree in Biology at DePaul University, she earned a second masters and then her Ph.D. in Biopsychology at The University of Chicago. Mennella, who was the first recipient of the Morley R. Kare Fellowship — a fund established to promote promising careers in the chemical senses — is now a full Member at the Center. She and Beauchamp continue to work closely together in a productive research partnership.

Mennella credits her father with nurturing a passion for problem-solving and introducing her to the excitement of discovery. As her research continues to reveal insights into how early experience affects preferences across a lifetime, the students who come through Monell's internship program have the opportunity to observe, and hopefully to perpetuate, her legacy. ■

What's The Skinny On Fat?

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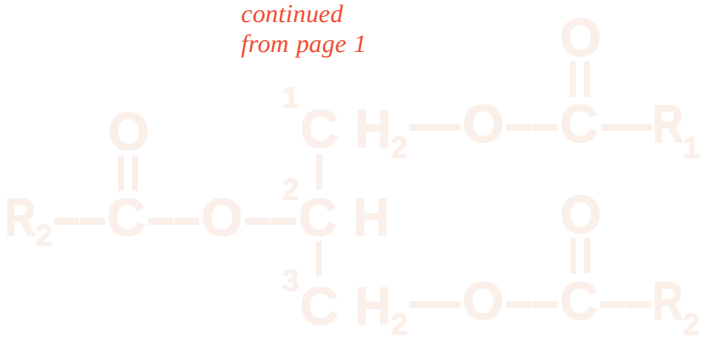

for acceptable fat replacers continues to rise. Researchers at Monell and elsewhere are striving to determine how we sense fat content in food, and are trying to identify the factors responsible for its sensory appeal.

How does the mouth know the difference between fat and a fat replacer? The answer depends on understanding how fats are detected. Certain fatty acids — the primary building blocks of dietary fat — can modulate ion channels in taste receptor cells, suggesting a direct biochemical mechanism for detecting fat. However, most researchers believe that fat content of food is primarily discriminated through its textural properties. These textural properties include attributes such as creaminess and moistness. Thus, scientists are trying to identify the physical factors that underlie creaminess. Do fat globules stimulate mechanoreceptors in the mouth that mediate the sense of touch? Is the size of the fat globule important? Or, is viscosity the critical variable? It appears that viscosity alone can not explain creaminess, as fat replacers that match viscosity still do not capture the full sensory appeal of real fat.

Fat replacers attempt to mimic the taste and texture of fat. There are three basic categories: protein-based, carbohydrate-based, and fat-based, each with functional advantages and drawbacks.

Understanding fat preference is made even more difficult by the wide variation for the preferred level of fat among individuals. Even in the same person, preference for fat in liquid and solid foods is often not the same. Some individual variation may be explained by research suggesting that both fat perception and preference may be linked to genetic and anatomical differences. And, cognitive factors may interact with oral sensory input to influence fat consumption. A recent study at Monell found that the taste or feel of fat in the mouth can increase the amount of fat eaten at a subsequent meal, but only in individuals who normally exert strict control over their food intake.

However, as is the case with salty taste, it appears that most people can learn to prefer a diet with lower levels of fat. Experiments at Monell have shown that limiting sensory exposure to fat can lead to a reduced preference for fat. When the diet contained fat replacers instead of real fats, fat intake decreased, but preference for fat did not change. This suggests that the sensory experience, and not the level of intake, is what determines preference for fat.

As with other flavor sensations, discrimination of and preference for dietary fat appears to be a complex phenomenon, influenced by genetic, anatomical and experiential factors. The potential health implications of excess fat intake makes it imperative that these factors be identified and understood. Continued research directed towards understanding the sensory appeal of fat may promote development of new fat replacers and suggest strategies to help people reduce intake of fat. ■

Monell Publications

Here are brief summaries of selected papers describing ongoing work of Monell scientists. For information about these studies or other research at Monell, call 215/898-4236.

Do Bubbles Make a Taste Difference?

Previous studies, designed under the premise that carbon dioxide (CO_2) is an irritant that only stimulates the trigeminal nerve, found little effect of the addition of carbonation on intensity of taste solutions. Because neurophysiological data suggest that CO_2 may also stimulate taste nerves, Dr. Cowart decided to look more fully into the question of whether CO_2 affects taste quality.

Subjects were asked to rate carbonated and uncarbonated solutions representing each of the basic tastes. In addition to giving intensity ratings, they characterized the relative taste profile of each solution by estimating proportions of sweet, sour, salty, bitter, and "other" tastes.

Adding carbonation produced dramatic alterations to the taste quality profiles of some solutions. For the sucrose (sweet taste) solution, carbonation reduced the relative proportion of sweetness, while sourness increased. Likewise, relative saltiness decreased and sourness again increased when carbonation was added to the NaCl (salty) solution. However, carbonation decreased sourness of the citric acid (sour) solution, making it more bitter, but did not change the taste profile of the quinine (bitter) solution. Overall taste intensity was only slightly affected by carbonation.

The results are consistent with a direct effect of carbonation on the taste system, although the exact identity of the taste stimulus associated with carbonation is still a mystery.

The addition of CO_2 to traditional taste solutions alters taste quality. Beverly J. Cowart. *Chemical Senses, 1998, 23, 397-402.*

The Origin of Odortypes

Odortypes distinguish one individual from another member of the same species. These odors are determined by certain groups of genes, particularly those in the major histocompatibility complex (MHC), and have been extensively studied in mice, which detect odortype based on cues found in urine.

Whether MHC odortypes play a role in human behavior has been difficult to establish. Although previous experiments failed to detect MHC odortypes in blood plasma, Dr.Yamazaki and his collaborators hypothesized that odorants might be unrecognizable because they were attached to carrier molecules.

Mice previously trained in a Y-maze to discriminate urines from two mouse strains with differing MHC odortypes were tested to see if they could also distinguish the odors of blood serum from the same two strains. Some serum samples were treated with an enzyme intended to liberate odorants from carrier proteins, while other samples were untreated.

The trained mice were able to use both the urine and the enzyme-treated serum — but not untreated serum — to distinguish the two strains of mice. The results demonstrate that the treated serum contains odorants similar to those found in urine that allow mice to distinguish MHC types of other mice.

The authors propose that odortypes are present in all species. Whether they are used by members of a species — such as humans — to identify mates or recognize relatives may depend upon the relative importance of olfactory cues to that species.

Odortypes: Their origin and composition. K. Yamazaki, G.K. Beauchamp. A. Singer, J. Bard (University of Arizona) and E.A. Boyse (University of Arizona). *Proceedings of the National Academy of Sciences USA, 1999, 96, 1522-1525.*

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