What We Remember About Odors

By William S. Cain, John B. Pierce Foundation Laboratory and Yale University, New Haven, Connecticut

Fine fragrances are created to have a positive emotional impact on people. Sometimes the positive impact occurs upon first exposure. In some cases a fragrance may actually seem strange and not particularly appealing at first, but might grow in fascination and positive impact over time. These changes imply that our interpretation of odors is hardly static.

There has been very little research on the subject of how people react to fine fragrances. There are, however, some facts about immediate reactions to odors and memory for odors that can help us appreciate the dynamic, yet still somewhat mysterious relation of human beings to their odor environment.

Lability of Preference

The affective or hedonic reaction to odors is labile. That is, what we like or dislike can change with age, with simple exposure, and with context. Infant human beings are generally indifferent to most odors, but become progressively more discriminating with time. The youngster who plays with feces at 2 yrs. will not do so at 7 yrs. In a more positive vein, the smell of a flower, previously quite neutral, may lure the 7 year old. The differentiation of the odor world into pleasant and unpleasant seems to take place by elaborate conditioning, some of it social and some biological.

At no time do odor preferences become absolutely fixed. If they did, we would never learn to accept exotic food, for instance. Wines and liquors, which may be quite unpalatable to the child, would never be among our more treasured beverages. Just as one can learn to find joy in the bouquet of a wine, one can learn to hate it. Aversive learning to flavor cues is perhaps the most potent kind of learning insofar as it may take place in one trial and may last years. Almost everyone has at one time or another developed a

 0272-2666/84/0003-1701$02.00/00—

conditioned aversion after becoming ill. Among students who have developed conditioned aversions in college, many have developed them to alcoholic beverages after becoming sick from overindulgence. One such trial can cause the smell of beer, for instance, to be nauseating for months or years. It is easier to develop displeasure in "bad" things (i.e., the things that have seemed to make us sick) than to develop pleasure in good things. Learning to find pleasure in the good things usually proceeds more slowly and requires some psychological investment.

There are many other examples of the lability of odor preference. Rather than dwell on them, we can simply admit that the odor world is a

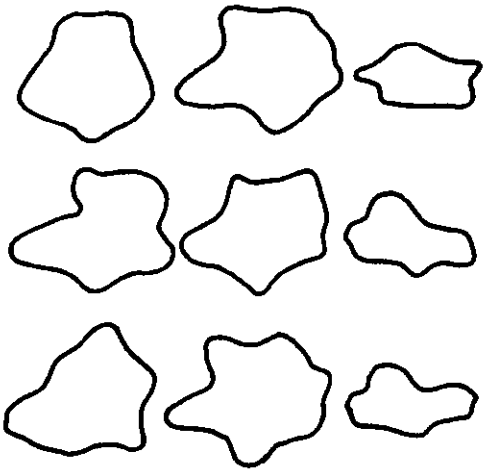

Figure 1. Examples of free-form shapes that behave like odors in experiments on recognition memory. (From H. T. Lawless, Recognition of common odors, pictures, and simple shapes. Perception & Psychophysics, 24, 493-495 (1978).)

labile one—a conditionable one. Persons in the fine fragrance business are, in a manner of speaking, in the conditioning business. In scientific terms, such persons need to figure out the contingencies of conditioning that will make a particular product succeed with the consumer.

Memory

Any discussion of conditioning in human beings will eventually get around to memory. Memory entails the storage and retrieval of information, a process so complicated as to have defied complete analysis despite decades of research. There has been relatively little attention to odor memory, but what attention has been

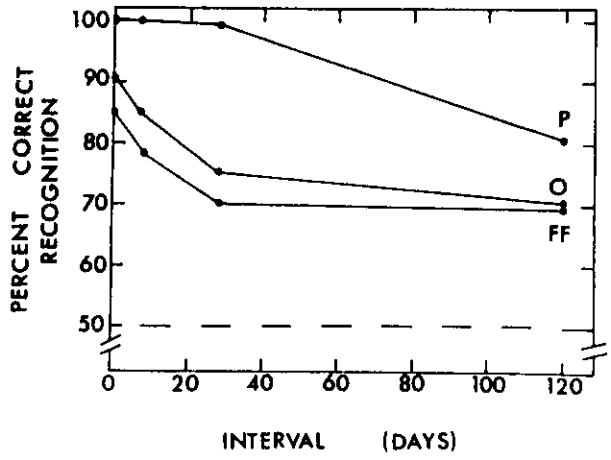

Figure 2. Recognition memory, i.e., distinguishing an "old" from a "new" stimulus, for pictures clipped from a travel magazine (P), common odors (O), and free forms (FF). (From H. T. Lawless, op. cit.)

given has stressed its uniqueness. Odor memory is different, some say, from memory for sights and sounds. They say that this is because olfaction is primitive. It is an old system (in evolutionary terms) with weak attachment to cognitive processes of thought, language, etc. An alternative and equally appealing explanation is that odor memory is simply appropriately matched to the odor stimulus.

Memory entails taking in information and encoding it in one way or another. Some information is more easily encoded than other informa-

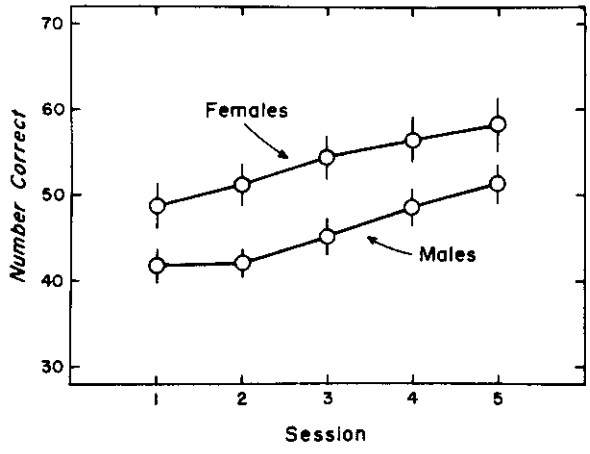

Figure 3. Performance of young women and young men at identification of 80 everyday odors in successive tests. Improvement in performance came about from corrective feedback. (From W. S. Cain, Odor identification by males and females: Predictions vs performance. Chemical Senses, 7, 129-142 (1982).)

tion. This depends largely on the structure of the memory stimulus. Things with high structure, such as a visual scene, are generally more readily encoded for subsequent recognition or recall than things with low structure. A realistic visual scene has what we call high spatial modulation (i.e., the elements of the scene vary from point to point) and, in real life, high temporal modulation (i.e., the scene usually changes in some details from moment to moment). There is much to be encoded in such scenes, but much redundancy also. A person can extract certain details, relate them to past experience and priorities, and retrieve the salient features at some later point in time. Retrieval of some of those features will, in a sense, allow retrieval of other features. That is, some things go with others and retrieval of one part can allow us to retrieve other parts more readily. (Horses pull wagons. If they also pulled buildings, airplanes, ships, etc., remembering what a horse was pulling in any particular instance would be more challenging.)

In contrast to the highly organized spatially and temporally modulated visual scene, an odor is an experience of the *moment* without the grain of time and space. There are visual forms that, in memory, behave like odors. They have spatial modulation of necessity but these spatial features are hard to encode. Figure 1 shows such free forms and figure 2 shows forgetting curves for those forms, for odors, and for magazine pictures of customary detail. Odors, like the forms, are not remembered as well as structured pictures but those particular odors (and forms) that are initially remembered have a distinct durability. The durability of odor recognition memory is, in fact, legendary, an outcome confirmed in laboratory studies.

Those who study information processing will often say that odors are encoded holistically. The use of the term encoding may require some clarification. The following phrase can illustrate the point:

PAS DE LIEUX RHONE QUE NOUS

If this phrase were to be flashed briefly and then presented later for recognition among various other phrases, a person's ability to remember it would depend on how well it was encoded. The person could try to encode it as a whole, or letter by letter, or perhaps in terms of critical features (e.g., a key word). The person could also seek to encode it in terms of its meaning. That kind of encoding, semantic encoding, would entail knowledge of French. The phrase is actually just a string of words and gives no message. Hence, even semantic encoding would not guarantee subsequent recognition among other strings of French words. One rather unique way to encode it, however, would be acoustically. Anyone who knows how to pronounce French words will realize that the phrase can be encoded as

PADDLE YOUR OWN CANOE

The encoding of any information will entail drawing upon whatever information a person already has in storage. The more a person has in storage, the more encoding strategies he or she has. This is just as true of odors as of anything else. Our research on odor memory and odor identification has led us to conclude that encoding odors is much like encoding faces. In fact, a face is perhaps the best perceptual analogue for an odor.

You might say "But a face has a lot of features, a lot of spatial modulation, and reasonable redundancy." This is true, but yet a face is encoded largely as a configuration. There is something ineffable about it. Block the eyes or the nose or ears and the face may go from highly identifiable to nonidentifiable. If faces did not have this emergent property, it would be much easier to use police Identikits to reconstruct the face of an assailant. (Even in exercises where the person whose face is to be copied is present, laypeople using Identikits produce poor likenesses and rather diverse likenesses.) For the layperson, features are important, but the whole is somehow more than just the sum of the parts.

The artist of course takes a much more analytic perspective and can "see" the features better, just as the perfumer can "smell" features of a fragrance.

A person will sometimes, perhaps often, see a face that seems familiar, but difficult to identify. When this happens, the person will generally feel uneasy or anxious. And, depending on how familiar the face seems, the person will feel more or less anxiety. If it is simply the face of a historical figure, e.g., Herbert Hoover, the person will experience only minor discomfort, but will still try to connect the face with other stored information, such as whether the face belonged to an artist, a politician, a good guy, bad guy, etc.

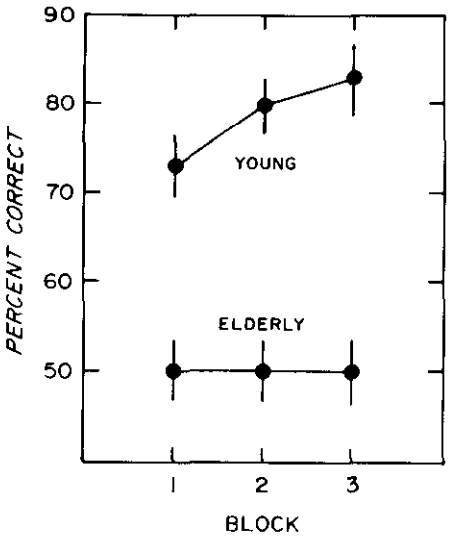

Figure 4. Performance of young women and elderly women at identification of 40 everyday odors over successive blocks of trials in a single test. (From T. Schemper, S. Voss, and W. S. Cain, Odor identification in young and elderly persons: Sensory and cognitive limitations. Journal of Gerontology, 36, 446-452 (1982).)

If the face seems more familiar, the process will become more agonizing. The face of a schoolmate may cause a person to race through a memory file of situations from school. This will often bring back feelings. These may be rather structured or not. (If you want to get even richer emotion-laden memories, show the face of a brother of the schoolmate or another look alike.)

Seeing a picture of a face, and not being able to identify it, but yet being able to say something else meaningful about it is an example of what has been called paramnesia. Every time paramnesia occurs, emotion comes with it. It seems as if the feelings are as much a part of the stored information as are the other bits of information. Paramnesia for odors occurs surprisingly often, even for the smells of everyday life.

When we have asked people to identify highly familiar odors, they start off at about 50% performance and get better at one or another rate depending on the circumstances of the experiment.

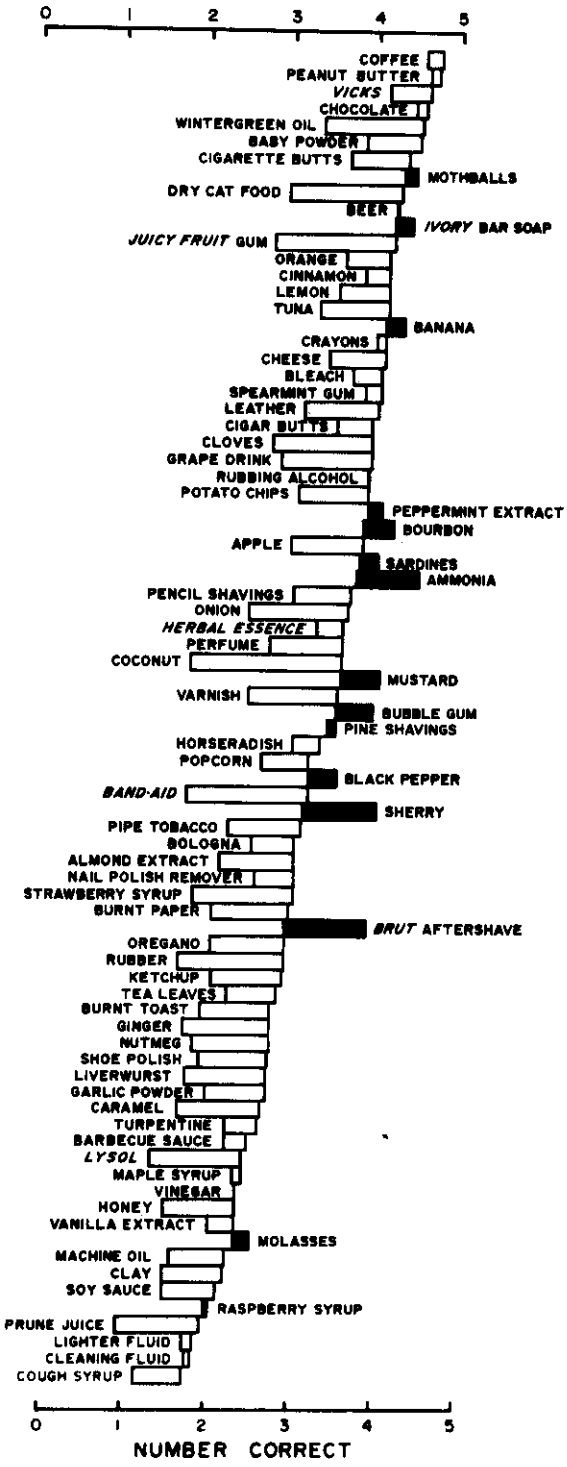

Figure 5. Item-by-item performance of women and men in odor identification. The width of the bars indicates the difference between female and male performance. For a light bar, the right edge indicates the average performance of females (number correct in five sessions) and the left edge indicates the average performance of males. For a dark bar, the right edge indicates the average performance of males and the left edge indicates the average performance of females. The preponderance of light bars illustrates the consistent superiority of women. (From W. S. Cain, op. cit.)

Our stimuli are such common substances as baby powder, cigarette butts, rubber, grape juice, etc. Some people are better at this than others. For instance, women are better than men (figure 3). The young are better than the old (figure 4). The blind are better than the sighted. In all of these cases, the better group is not just better in one or another class of odors, but is generally better across most odors (figure 5).

Not every case of failure to identify an odor is a case of paramnesia, but many are. As I have said, feelings, as well as other information, come forward. The feelings are as much a part of the information as the facts. It is when people are in the paramnesic state that they are most suggestible. Here is where fragrance can steal the moment. A balanced fine fragrance should be very difficult for the layperson to describe. The creator may want the fragrance to make some contact with memories but not heavy contact. To go back to the face analogy, the fragrance should be like a misty face.

Conclusions

In this very brief review of what we remember about odors, we have made the following points:

- Odor preferences are not inborn, but are made. They tend to develop as a result of conditioning.
- Odor preferences are never fixed but are always labile. Learning what is "bad" occurs much more rapidly than learning what is good. Positive preferences are acquired slowly.
- Odor memory is generally unlike memory for highly complex stimuli and has been shown to be like that for "poorly structured" forms. Odors are, to the layperson, very low in structure.
- Odors are encoded largely holistically, but then, surprisingly, so are faces.
- The key element in memory is *encoding*. When a memory item is encoded, it makes contact with whatever a person already knows or has stored, including feelings.
- Some people encode and identify odors better than others, e.g., women and young people.
- Failure to identify an odor is often an instance of paramnesia, which has feeling and emotion attached to it.
- The paramnesic state is often the time when people are most suggestible.

Address correspondence to William S. Cain, John B. Pierce Foundation Laboratory, 290 Congress Avenue, New Haven, Connecticut 06519, USA.

American Society of Perfumers Past Presidents: (front row, from left) John E. Porter, Simone A. Fedak, Edward J. Shuster, Harry A. Cuttler, (back row, from left) John K. Funesti, Jacques Masson, James S. Bell, and Morrison E. Patterson.

1984 American Society of Perfumers Symposium Committee Members: (front row, from left) Naomi White, Christine Baillifard, Edith Dronovsky, Margo Androulakis, (back row, from left) Malcolm Gibbs, Carl D'Andrea, and Felix Buccellato, Chairperson. Not pictured: Raman Patel, Co-Chairperson, John Mastrocola, and Patric Whelan.