LEARNING AND MOTIVATION 26, 116–140 (1995)

Odors Can Change Preferences for People in Photographs: A Cross-Modal Evaluative Conditioning Study with Olfactory USs and Visual CSs

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Evaluative conditioning is a form of Pavlovian conditioning in which the "CR" is a change in preference or liking for the "CS." It is probably a major cause of development of likes and dislikes in humans. This research introduces a new, cross-modal evaluative conditioning procedure using odors as USs and photographs of people's faces as CSs. When liked, neutral, and disliked odors that were plausibly connected with people were contingently presented with photographs of neutral people, subjects shifted their preference ratings for the people in the photographs presented subsequently without odors in the direction of their preference ratings for the odors. Subjects who developed personality sketches of someone "who looked and smelled this way" showed similar shifts as those who simply studied the odor–picture combinations. Results also suggest that a plausible connection between odors and people may play a role in the success of this conditioning. © 1995 Academic Press, Inc.

Evaluative conditioning applies Pavlovian conditioning principles to the acquisition and modification of human likes and dislikes. Real-world con-

We thank F. Baeyens for providing the photographs and A. Gilbert of Givaudan-Roure for providing the "plausibly human" odors. Special appreciation and thanks to K. Cassidy and to Northeastern University colleagues, M. Block for consultations on designing the method for presenting the odors, A. Reeves for providing laboratory space, and A. Skavenski for assistance in recruiting subjects. This work was completed in partial fulfillment of the requirements for Josephine Todrank's degree of Doctor of Philosophy at the University of Pennsylvania. Reprint requests should be addressed to Dr. Paul Rozin, 3815 Walnut Street, Philadelphia, PA 19104.

0023-9690/95 $6.00

ditions may give rise to evaluative conditioning when contingent encounters with affectively valenced and non-valenced events change people's attitudes toward the event that was originally neutral. Especially in recent years, successful laboratory models for studying evaluative conditioning and its properties have been developed, most notably by Baeyens and his collaborators (see, e.g., Baeyens *et al.*, 1988, 1989, 1990, 1992). Most of the literature on evaluative conditioning, beginning with the original studies and formulation of the concept by Martin and Levey (1978; Levey & Martin, 1975, 1983, 1990), is based on contingent presentation of two visual events, usually neutral and valenced faces or pictures. Within this paradigm, conditioning occurs after 5 to 10 pairings, is resistant to extinction, works well with simultaneous presentation of the stimuli, and does not depend on subject's awareness of the CS–US contingency (Baeyens *et al.*, 1988; Baeyens *et al.*, 1992; Stuart, Shimp, & Engle, 1987). Evaluative conditioning may differ from most types of Pavlovian conditioning studied in the laboratory in that the signal (predictive) function of the conditioned stimulus (CS) does not seem to be the primary basis for conditioning (Levey & Martin, 1983; Baeyens *et al.*, 1989). Rather, evaluative conditioning seems to involve the acquisition of properties of or associations with the unconditioned stimulus (US) by the CS.

Given the salient affective properties of odors, it is surprising that very few studies have incorporated odors into evaluative conditioning paradigms. People often engage in activities that are intended to produce or reduce odors. These odors seem to give meaning to and take meaning from their associations with particular people and places. There are many anecdotal reports that odors, especially those associated with emotional events, can trigger powerful memories from the distant past (see Engen, 1991). There is a wide-spread conviction in advertising that odors play an important role in the success or failure of social relationships. This is exemplified by the wide range of scented products that are available to consumers. However, there is surprisingly little research to question or support these notions. It is difficult to demonstrate many of these olfactory phenomena in a laboratory: it is virtually impossible to duplicate the unique combination of odors that creates the olfactory context necessary to surface the long-lost memory or to produce an appropriately potent emotional event or ambiance to establish a new olfactory memory of that depth when most odors already possess prior affective associations. Furthermore, in comparison to visual or auditory stimuli, it is very difficult to manipulate and control odor presentation in the laboratory. These problems may help explain Baron's equivocal results on the effects of pleasant scents on interpersonal attraction and social perception (1981) and physical aggression (1980). Recent reviews discuss the scant literature on human olfaction and memory (Schab, 1991), cognition (Richardson & Zucco, 1989), and emotion (Ehrlichman & Bastone, 1992).

Odors, outside of the domain of flavors, have been rarely employed in human conditioning paradigms. In an unconscious odor conditioning study, subjects were exposed to a low intensity of an inconspicuous, neutral odor while they were engaged in a stressful block-design task. Only the female subjects became more anxious in the presence of the odor during a second non-stressful session when they evaluated a series of photographs (Kirk-Smith, Van Toller, & Dodd, 1983). In the only study of traditional human classical conditioning using odors, Marinkovic, Schell, and Dawson (1989) conditioned skin conductance responses to olfactory CSs using electric shock as the US and found that the conditioned response occurred only when the subject was explicitly aware of the CS–US contingency. Neither the Kirk-Smith nor the Marinkovic studies qualify as evaluative conditioning, because they did not measure liking for the odors in question. There is one study of evaluative conditioning with odors as CSs. Six-, 8-, and 10-year-old children were exposed for one trial to a specific odor paired with either a pleasant or unpleasant picture (Hvastja & Zanuttini, 1989). The odor paired with the pleasant picture was rated more favorably on a 9-point hedonic scale than the odor paired with an unpleasant picture by 6- and 8-year-olds, but not by 10-year-olds.

The present experiments were designed for three purposes: (1) to investigate human evaluative learning in a cross-modality olfactory–visual paradigm, (2) to determine whether liked and disliked olfactory stimuli can change subjects' evaluative responses to neutral visual stimuli, and (3) to determine the conditions under which liked and disliked olfactory stimuli can change subjects' evaluative responses to neutral visual stimuli. These studies differ from prior work on human evaluative conditioning in that odors are used as USs, and they differ from much prior work in that the CSs and USs involve two different sensory modalities. In this classical conditioning protocol, photograph CSs of people's faces (rated by the subjects as people they feel relatively indifferent toward) are trained with valenced odor USs. The outcome of interest is whether the evaluation of the CSs, specifically hedonic value, changes as a result of the conditioning. The basic paradigm involves asking subjects to rate a series of photographs of people and a series of odors, selecting neutral photographs to be contingently presented with liked, neutral, and disliked odors, presenting the odor–photograph combinations eight times, and then asking subjects to reevaluate the photographs and odors to determine whether their preference rating for the people has changed as a result of the contingent presentation.

Unlike traditional evaluative conditioning protocols, this procedure included instructions for subjects to pay attention to the odor–photograph combinations. The source of an odor seems to take on the affective quality of the odor only when there is an explicit association between the odor and the source, thus, successful evaluative conditioning using olfactory

stimuli may depend upon the subject's awareness of the contingency between the odor and its apparent source. Stimulus presentation and instructions were designed to maximize the connection between the odor and the person in the photograph. Odors that were likely to emanate from people were used in the initial experiments because a plausible connection between the odor and its apparent source could facilitate the association between the odor and the person and thereby enhance the evaluative conditioning effect.

Studies of human learning have usually been conducted using visual and auditory stimuli. Developing protocols for using olfactory and visual stimuli together requires both practical and theoretical modifications to the standard procedures to accommodate the special challenges of working with odors. The techniques developed for this study overcame many of those challenges.

EXPERIMENT 1

This experiment investigated whether repeatedly presenting a liked or disliked odor with a photograph of a neutral person of the opposite sex would shift the preference rating for the person in the picture in the direction of the rating of the odor. Subjects developed a personality sketch of a person who smelled and looked like each person–odor combination with the aim of facilitating the odor–person link. The personality sketch was included in this experiment because this type of odor–person conditioning has not been demonstrated before and it was thought that this strategy for strengthening the connection between the stimuli may improve the chances of finding a conditioning effect.

Methods

Subjects. Twenty students from a large urban university (5 men, 15 women) ranging in age from 19 to 25 years were recruited to participate as subjects in an experiment on "psychophysiological responses to visual and olfactory stimuli." All subjects described their olfactory acuity as average or better; many were psychology majors with prior experience in psychology experiments. Subjects provided written informed consent and received $6 for their participation. This research was approved by the committees on research involving human subjects at the University of Pennsylvania and Northeastern University.

Stimuli. The visual stimuli were 36 of the 4″ × 6″ color photographs of faces of men and women selected from the series used by Baeyens *et al.* (1988) in their evaluative conditioning research. Subjects were asked to evaluate only the 18 opposite sex pictures. Pictures of people were chosen as the visual stimuli because they produce a wide spectrum of preference responses and because subjects would not have previous expectations about what type of odor should be associated with an unfamiliar

person. The people in the photographs were known to be unfamiliar because the pictures were of European origin. In order to maximize the opportunity for an association between the olfactory and the visual stimulus, it was important to choose a visual stimulus without prior olfactory associations; this precluded most visual stimuli because most people have already learned which odors are appropriately connected with which objects.

The olfactory stimuli were 11 odorants selected from a series provided by Givaudan-Roure (Teaneck, New Jersey) to the specification that the odors be identifiable by their panel of perfumers as "people-related" odors (soaps, shampoos, lotions, sweaty, musty, etc.) but not identical to odors used in products currently available in retail stores. This enabled presentation of a spectrum of odors that were plausibly connected with people but that did not have any specific prior associations which might interfere with establishing connections between the odor and the person in the picture presented in the experiment. The odors were familiar enough to be categorized as plausibly human but not so familiar as to be specifically identified. Moderate intensities were used because stronger odors, like familiar odors, are less likely to be rated as neutral or indifferent. It was difficult to find odors that were rated as very pleasant yet not very familiar; repulsive odors can easily be rated as very unpleasant whether they are familiar or not. While the chemical composition of some of the stimuli is proprietary information, the stimuli were labeled: antibacterial soap (10% in dipropylene glycol, i.e. DPG), baby oil/powder (10% in DPG), baby shampoo (10% in DPG), body talc (10% in DPG), civet artificial—animal/urinous (5% in diethyl phthalate, i.e. DP), cuminyl alcohol—sweaty (100%), ethylene brassylate—musky (100%), hand and body lotion (10% in DPG), hand lotion (10% in DPG), shave cream (10% in DPG), and skatole—fecal (5% in DP). These odors, presented at the same moderate intensities as they were presented in the experiment, were also deemed "plausibly human" by an informal group of university undergraduate and graduate students who indicated that the odors could emanate from people, either as natural or as applied scents.

To facilitate the association between the person and the odor, the odors were presented on sheeting material in Ziploc plastic freezer bags. Lining the bags with two-ply vinyl prevented the odors from leaking through the bags. Each bag contained a 6″ × 13″ piece of cloth (folded in the form of an M) such that the ends of the cloth were flush against the walls of the bag and outside the vinyl lining. The middle part of the cloth (where the odorant was placed) looped between the vinyl liners such that when the bag was opened the odorous part of the cloth was draped across the area where the subject would be sniffing.

Procedure. To avoid possible demand characteristics, an elaborate cover story was presented. This particular cover story was similar to Baeyens

et al. (1988) in that it used supposed skin conductance measurements, but was modified and expanded to provide a plausible explanation for each piece of the experiment and to contain many elements that were actually germane to the study. Subjects were told that the experiment was designed to determine whether there is a relationship between preferences for sensory stimuli and physiological (skin conductance) responses to those stimuli, whether the skin conductance responses change when two sensory modalities are stimulated together, and whether the changes depend upon the preferences for the two stimuli. A transcript of the basic story is included as an Appendix.

An 8-mm silver–silver chloride electrode was attached to the subject's right forearm and the method of measuring skin conductance responses was explained. The electrode was connected to a conversion box and then to a personal computer that was ostensibly collecting the skin conductance response data. Throughout the experiment, the experimenter appeared to monitor the progress of the experiment on the computer screen, which was shielded from the subject's view, and typed commands on the computer keyboard.

Subjects were instructed that they should evaluate the photographs of the people based on how much they think they would like the person if they actually met them. The experimenter explained that in order to avoid effects of possible social or racial prejudice the people in the pictures were all white men and women who were "pretty much matched for socioeconomic status." They were told that male subjects evaluate photographs of women and female subjects evaluate photographs of men. Subjects were also told that there would be some variety in the physical appearance of the people in the photographs and that each person is posing to present a particular personality that may or may not be his or her actual personality, so that when they evaluated the pictures they would actually be evaluating the person as they would evaluate the character that an actor portrays in a movie or play.

A 21-bin sorter sat on the table between the subject and the experimenter. The bins were labeled from −10 on the farthest left bin, through 0 on the middle bin, to 10 on the bin farthest to the right. No other labels appeared on the scale. Subjects were instructed, "the more you think you would like the person, the higher the rating should be (the most positive bins were indicated), the more you think you would dislike the person, the lower the rating should be (the most negative bins were indicated), and pictures of people you feel ambivalent toward or have no particular feelings about should be placed somewhere in the middle (the middle of the sorter was indicated)." The experimenter also explained that the subject should evaluate the photographs one at a time on an absolute scale rather than relative to each other. The sorter was used so that subjects were able to indicate their preferences without writing them down

and without having to tell the ratings to the experimenter. The experimenter explained that she must remain aloof and that they must not talk during the data collection because any interaction between the subject and experimenter could alter the skin conductance responses. The photographs were placed face down in front of the subject. The subject looked at them one at a time, placing each photograph in the appropriate bin in the sorter. The experimenter removed the photographs from the bins and recorded the preference ratings on a data sheet.

Next, subjects were asked to smell the cloth in the bag and to rate how much they liked or disliked the odor on the same scale that they had used to rate the photographs. Subjects were cautioned that the intensity of the odors could vary from person to person and that if there were any bags that had no odor or if the odor was weak, that these bags should be set aside and not rated because a weak odor would produce a weak skin conductance response and it would not be appropriate to use these odors in the second part of the experiment. A clear distinction was also made between a weak odor and a neutral odor. Subjects were permitted only two sniffs prior to rating the odor and took at least three breaths between each odorant to ensure that all traces of the previous odor had been cleared from the nose.

After the subject completed the ratings, three "neutral" pictures were selected from the stimuli that the subject rated in the middle of the scale. When three or more pictures received ratings of 0, three of these were randomly selected. In accordance with Baeyens *et al.*'s (1988) original procedure, there was no explicit procedure for selecting among more than one alternative picture of the same value to assign to any particular condition. When there were not at least three 0-rated pictures, a picture rated 1, or if necessary 2, was selected at random to be presented with the liked odor, and a picture rated -1, or if necessary -2, was selected at random to be presented with the disliked odor. When no pictures were rated as 0, a 1 or -1 was selected at random to be presented with the neutral odor. This procedure was used in the first three experiments and a more explicitly randomized procedure was used in Experiment 4.

Three odors—one strongly liked, one relatively neutral, and one strongly disliked—were selected. The most positive and negative were selected unless the most negative odor seemed very offensive to the subject, in which case a slightly less negative odor was chosen. Subjects were asked to smell them again to be sure that they could distinguish between them easily. If the subject had difficulty distinguishing between the odors, the next most appropriate odor was used instead. The odors and pictures were prepared for presentation by slipping the pictures into clear vinyl pockets attached to one side of the bag. Three additional pictures (one liked, one neutral that was rated as close to 0 as possible, and one disliked) were selected at random from the remaining photographs and presented

without odors to ensure that simple exposure to the picture did not result in changes in rating.

Subjects were told that in order to get a clear response pattern when the two sensory modalities are stimulated together, the odors and pictures must be presented together several times. They were instructed that on each trial they should smell the odor in the bag and then look immediately at the picture. They were also told that they would be asked at the end of the experiment to match which odor had been presented with which picture so they should pay attention each time to the particular odor–picture combinations. The odor was presented before the picture to ensure that subjects could not anticipate which odor they were about to smell by remembering which odor went with which picture. Subjects were permitted to smell the odor a second time on each trial to help them remember which odor and picture went together. The bags were always presented to the subject with the picture side down. The pictures presented alone were explained as necessary controls for possible effects of habituation or sensitization to the individual stimuli that were not due to the pairing. Subjects were asked to look at these pictures for about the same amount of time as they looked at the pictures that were presented with odors. The three odor–picture combinations and the three pictures without odors were presented in eight blocks without pausing between blocks. The series was presented in a different order in each block.

Subjects were told that in order to make the process of repeatedly smelling and looking more enjoyable, that they would develop a personality sketch of a person who "looks and smells this way" by answering a question about the person on each trial. On the first trial, subjects gave the person a name. Each time the series of odor–picture pairs and unpaired pictures was presented, the subject enhanced the story by answering another question about the person: What kind of work do they do? Where do they live? Where did they grow up? What's their favorite hobby or leisure activity? What kind of car do they drive? What kind of movies do they like? What is their favorite food?

After these stimuli had each been presented eight times, subjects were told:

> Simply being exposed to a stimulus repeatedly could change your physiological response to that stimulus. To control for this possibility, I need to get a second measure of your skin conductance responses to the stimuli presented singly rather than together. To get the most accurate comparison, you must be doing the same thing that you were doing when I measured your skin conductance responses before, namely rating them, so I would like you to rate the odors and the people again on the same scale you used before while I continue to monitor your skin conductance responses.

After subjects provided the second preference ratings for the six pictures

and three odors and the experimenter had written the ratings on the data sheet, the electrode was removed. The six pictures were placed on the table. The subjects were given the bags with odors and asked to match which odor had been presented with each picture. They were then given an opportunity to ask questions about the purpose of the experiment and the procedure and to offer their comments about what it was like to be a subject in this type of experiment. They were also asked whether they thought "there is anything else going on in the experiment beyond what we have already discussed" to ensure that they had not determined the true purpose of the research. The decision to eliminate a subject due to possible demand characteristics was made during the debriefing prior to knowing whether or not the subject showed the predicted effect. The session lasted approximately 1 h.

Data analysis. Differences in preference ratings (second rating minus first rating) for the people in the pictures were calculated in units of the 21-category scale. The changes in ratings were compared to determine whether the pictures of the neutral people presented with the liked odors (designated the "LN" people [the first letter indicates the odor valence and the second letter indicates the initial neutrality of the photograph valence]) or disliked odors (the "DN" people) were rated more positively or negatively than pictures of the neutral people presented with the neutral odors (the "NN" people) and the pictures of neutral people presented without an odor (the "−N" people). Repeated measures analysis of variance (ANOVA) and a priori contrasts (calculated using SYSTAT) were used to determine whether there were significant changes in the ratings of the people as a result of presenting their photographs with the valenced odors. These analyses were done first for all of the subjects (except those eliminated because of demand) and then for the group (explained below) of subjects who would be most likely to show the expected conditioning.

Two types of controls were used to be sure that the changes in rating for the people in the photographs were the result of the conditioning by the valenced odors and not due to random variability of ratings or mere exposure to the pictures or the odors. Contrasting the change in rating for the LN and DN photographs with the change in rating for the −N photographs ensured that the rating changes were not due simply to repeated exposure to the photograph; contrasting the change in rating for the LN and DN photographs with the change in rating for the NN photographs ensured that the rating changes were due to the valence of the odor and not simply to repeated presentation with any odor. Contrasting the change in rating for the NN photographs with the change in rating for the −N photographs ensured that the neutral odors did not significantly change the rating of the photograph.

Changes in preference ratings for the odors were calculated to ensure that the odor ratings had not changed substantially from their initial

ratings. In most types of conditioning experiments, USs are chosen that will maintain their strength throughout the experimental session and it is not necessary to select subjects for the data analysis on the basis of the stability of the USs. This is a problem in experiments using odors as USs because odor preference ratings are often unstable after repeated exposure within an experimental session, with pleasant odors becoming less pleasant and unpleasant odors becoming less unpleasant (Cain, 1978), because preference rankings for odors are fairly stable from session to session (Moncrieff, 1966) except in the "indifferent range" (Young, 1923, Kenneth, 1928), and because currently there is no way of predicting which subjects will maintain stable odor ratings. If the rating for one or more of the odors changed more than 4 units on the rating scale or if the rating for the odors changed sufficiently that they were no longer in their original order on the rating scale, i.e. disliked < neutral < liked, the subject was eliminated from the "expected" group. Prior to running the first experiment it was not known how much the odor ratings could shift without interfering with the conditioning. All subjects with shifts of 4 or less showed the predicted conditioning while only 2 subjects out of 15 with shifts of 5 or more showed the predicted effects. The maximum allowable shift for the odor ratings was set at 4 after inspecting the data from the first experiment and the same criteria were applied in the subsequent experiments. Subjects with any unstable odor ratings were not included in the expected group ANOVA because conditioning would not be expected when CSs were presented with USs that lost or changed their valence.

The importance of contingency awareness in human conditioning paradigms using olfactory stimuli has not been adequately explored: in the Marinkovic, Schell, and Dawson study (1989), only the subjects who were aware of which odor predicted the electric shock showed the conditioned response, while in the Kirk-Smith, Van Toller, and Dodd unconscious odor conditioning study (1983), only the female subjects showed the predicted response. While evaluative conditioning can occur in subjects who are not explicitly aware of the CS–US contingency (e.g., Baeyens *et al.*, 1992), the results from olfactory conditioning studies suggest that this may not be true in olfactory evaluative conditioning. In the first experiment, none of the seven subjects who failed to match the CSs with the appropriate USs at the end of the experiment showed the predicted conditioning, but because five of these subjects also had unstable odor ratings, it was not possible to determine whether the lack of conditioning was due to weak USs or to subjects being unaware of the CS–US contingency. Because the importance of contingency awareness could not be determined from these results, but because there was a suspicion that contingency awareness may play a role in olfactory evaluative conditioning, the expected group analysis was done twice, first with all the subjects with stable

odor ratings and then eliminating subjects who mismatched the odors and pictures ("expected-aware").

Data from subjects who indicated during the debriefing that they suspected that there was a relationship between the way people smell and preferences for those people and those who discussed this type of research as "conditioning" or as affecting subjects' preferences were not included in the data analysis because they may have been responding to demand characteristics. No more than two subjects were eliminated due to demand characteristics in any of the experiments in this study.

The mean initial rating ± the standard error of the mean (SEM) and the mean final rating ± SEM for the odors in the three US categories were calculated to demonstrate the strength of the odor USs prior to and following training.

Results

The data from two subjects, who commented that they had been studying "this type of research" in their Social Psychology class and described how ambient odors in a room affect how much you like or dislike people you meet there, were not included in the analysis because they may have been responding to demand characteristics. The mean initial rating (±SEM) for the disliked odor was −8.06 (±.42), for the liked odor, 6.33 (±.52), and for the neutral odor, −.11 (±.30). The mean final rating (±SEM) for the disliked odor was −6.72 (±.88), for the liked odor, 5.44 (±.49), and for the neutral odor, 1.83 (±1.02).

In this experiment (n = 18), the mean change in preference ratings (±SEM) for the people in the photographs were: DN person, −3.56 (±1.08); LN person, 1.50 (±1.31); NN person, .28 (±1.05); and −N person, −.28 (±.95). The repeated measures ANOVA was significant ($F(3, 51) = 4.10$; $p < .01$). The significant contrasts were between the DN person vs the NN person ($F(1, 17) = 5.78$; $p < .03$), and the −N person ($F(1, 17) = 6.63$; $p < .02$). The LN person vs the NN person ($F(1, 17) = .60$; $p = .45$), and the −N person ($F(1, 17) = 1.09$; $p = .31$) and the NN person vs the −N person ($F(1, 17) = .16$; $p = .69$) were not significant.

There were seven subjects in the first expected group. They showed the following mean rating changes (±SEM): DN person, −4.29 (±1.06); LN person, 1.14 (±2.11); NN person, 1.57 (±0.57); and −N person, .0 (±1.40). The repeated measures ANOVA showed a significant effect of change in preference rating ($F(3, 18) = 6.19$; $p < .005$). The contrasts showed that the DN person was significantly different from the NN person ($F(1, 6) = 4.29$; $p < .01$) and the −N person ($F(1, 6) = 5.86$; $p < .001$). The LN person was not significantly different from the NN person ($F(1, 6) = 2.71$; $p = .09$) and the −N person ($F(1, 6) = 1.14$; $p =$

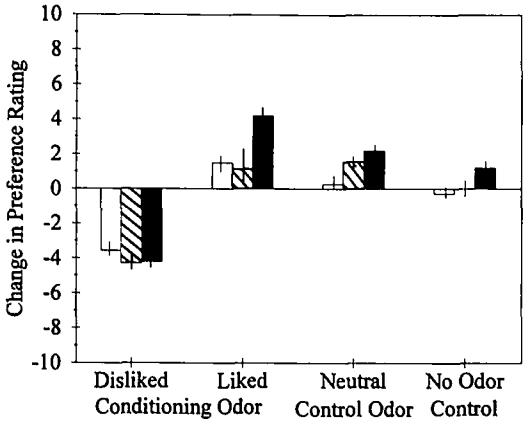

FIG. 1. Mean change in preference ratings on a 21-point scale for people in initially neutral pictures presented with disliked or liked conditioning odors, neutral control odors, or presented alone (no odor control) for all subjects in Experiment 1: personality sketches (white); subjects who maintained stable odor ratings (stripes) and subjects who matched the odor–picture combinations at the end of the experiment and maintained stable odor ratings (black).

.46). There was not a significant difference between the NN person and the −N person ($F(1, 6) = 1.57$; $p = .32$).

The five subjects in the expected-aware group showed the following mean rating changes (±SEM): DN person, −4.20 (±.58); LN person, 4.20 (±.73); NN person, 2.20 (±.58); and −N person, 1.20 (±.58). The repeated measures ANOVA showed a significant effect of change in preference rating ($F(3, 12) = 28.23$; $p < .001$). The contrasts showed that the DN person was significantly different from the NN person ($F(1, 4) = 32.51$; $p < .001$) and the −N person ($F(1, 4) = 33.91$; $p < .001$). The LN person was not significantly different from the NN person ($F(1, 4) = 5.71$; $p = .08$) and the −N person ($F(1, 4) = 6.92$; $p = .06$) although the contrast was in the predicted direction. Because both the NN person and the −N person became more positive, it was more difficult to demonstrate a positive conditioning effect (see Fig. 1). There was not a significant difference between the NN person and the −N person ($F(1, 4) = 2.50$; $p = .19$). The data from this experiment are presented in Fig. 1 and are summarized in Table 1 under the category of "Story."

Discussion

The results of this experiment demonstrate that when a liked or disliked odor was presented repeatedly with a photograph of an initially neutral person of the opposite sex, the preference rating for the person in the photograph can shift in the direction of the preference rating for the odor.

TABLE 1

Summary of Data for All Subjects (All), Subjects Who Maintained Stable Odor Ratings (Expected), and Subjects Who Maintained Stable Odor Ratings and Matched the Odor–Person Pairs Correctly (Expected-aware) from All Experiments Including Type of Experiment

		Mean initial odor			Mean final odor			Mean preference rating change			
Experiment	Subjects (*n*)	US_D	US_L	US_N	US_D	US_L	US_N	ΔCS_D	ΔCS_L	ΔCS_N	ΔCS_U
Story	All (18)	−8.06	6.33	−.11	−6.72	5.44	1.83	−3.56	1.50	.28	−.28
	Expected (7)	−7.86	6.14	.43	−8.00	5.86	2.14	−4.29	1.14	1.57	.0
	Expected-aware (5)	−8.20	6.20	.0	−8.20	6.20	1.80	−4.20	4.20	2.20	1.20
No story	All (14)	−8.00	6.57	−.14	−8.71	5.00	3.35	−4.64	2.79	2.64	−.57
	Expected (7)	−8.27	6.71	−.14	−9.29	6.14	2.43	−6.00	4.71	1.71	−.86
	Expected-aware (6)	−8.50	6.83	−.33	−9.16	6.16	2.33	−7.00	4.83	1.67	.0
Non-plausible	All (13)	−7.15	5.54	−.54	−6.15	3.92	.15	−1.38	1.38	.85	−.62
	Expected (7)	−6.00	4.14	−.43	−5.57	3.71	.14	−1.29	.0	1.57	−.70
	Expected-aware (6)	−5.50	3.83	.67	−5.00	3.83	.17	−.33	−.17	1.33	−.17
Replication	All (21)	−6.61	5.57	−.04	−7.70	4.92	2.61	−3.05	1.76	2.10	1.00
	Expected (12)	−6.83	5.42	−.50	−7.42	4.92	1.00	−2.42	2.08	1.58	.75

Note. Story, subjects develop personality sketch; No Story, basic protocol without personality sketch; Non-plausible, basic protocol and non-plausibly human odors; Replication, basic protocol and random assignment of photographs), mean initial and final preference ratings for the disliked (US_D), liked (US_L), and neutral (US_N) odors, mean change in preference rating for person in photograph presented with disliked (ΔCS_D), liked (ΔCS_L), and neutral (ΔCS_N) odors, and unpaired picture (ΔCS_U).

Seven of the subjects did not match the odors and photographs correctly at the end of the experiment and none of these subjects showed the predicted shifts in their preferences for the pictures. Because five of these subjects also had unstable odor ratings, it is impossible to determine whether the conditioning was ineffective due to their failure to remember the contingencies between the odors and the photographs or to the instability of the odor ratings.

EXPERIMENT 2

This experiment was designed to investigate the importance of cognitive factors, specifically the effect of developing a personality sketch, on the magnitude of the rating changes for the people. Because the subject's attitude toward the odor was likely to affect the content of the personality sketch, the development of a positive or a negative personality description could contribute to a greater rating change. The prediction was that subjects who simply smell the odors and look at the pictures together and do not develop a personality sketch would show smaller shifts in their ratings of the photographs presented with liked or disliked odors. This is an important issue for future research using this protocol, because the procedure would be simplified considerably if it were possible to eliminate the personality sketch.

Methods

Subjects. Fifteen students (4 men, 11 women) ranging in age from 19 to 29 were recruited from the same university community to participate in the experiment. There were fewer psychology majors than in Experiment 1, but otherwise these subjects were comparable to those in the first experiment.

Stimuli. The same stimuli were used as in Experiment 1.

Procedure. Subjects in the second experiment were told the same cover story and received the same instructions as subjects in Experiment 1 with one exception. During the second phase of the experiment when the odors and people were presented together, subjects were told that they would be asked at the end of the experiment to match which people had been presented with which odors, and that they could use whatever strategy they liked to help them learn the odor–person pairs. They were told that assigning labels to the odors and connecting them with some characteristic of the people may help them remember which odors and pictures were matched (Rabin, 1988).

To minimize adaptation to the odors in the second phase, the picture was presented before the odor, and the odors were sniffed only once. Subjects then were permitted to look again at the person to help them remember which odors and people were matched. The liked and disliked control pictures were presented in the first experiment in order to add

breadth to the personality sketches; only one unpaired control picture was presented in the second and subsequent experiments, because the subjects were not developing personality sketches. At the conclusion of the experiment, subjects were asked to describe their strategy for learning the odor–person pairs to determine whether they were developing personality sketches on their own.

Results

One subject was excluded from the analysis because she commented during the debriefing that the odors would probably affect subjects' ratings for the people, but that she tried not to let it affect her. The mean initial rating (±SEM) for the disliked odor was −8.00 (±.47), for the liked odor, 6.57 (±.55), and for the neutral odor, −.14 (±.46). The mean final rating for the disliked odor was −8.71 (±.51), for the liked odor, 5.00 (±.98), and for the neutral odor, 3.36 (±.84). The data were analyzed by the same method described in Experiment 1.

The mean change in preference ratings for the people in the photographs were: DN person, −4.64 (±.76); LN person, 2.79 (±1.08); NN person, 2.64 (±.58); and −N person, −.57 (±.61). The repeated measures ANOVA was significant ($F(3, 39) = 21.56$; $p < .001$). The significant contrasts were between the DN person vs the NN person ($F(1, 13) = 104.04$; $p < .001$) and the −N person ($F(1, 13) = 13.41$; $p < .001$), the LN person vs the −N person ($F(1, 13) = 8.65$; $p < .01$), and the NN person vs the −N person ($F(1, 13) = 13.40$; $p < .001$). The LN person vs the NN person ($F(1, 13) = .02$; $p = .90$) was not significant.

Seven subjects maintained stable odor ratings according to the criteria established in the analysis of Experiment 1. One of these subjects mismatched the odor–person pairs and did not show the predicted conditioning. Because the results from this subject do not significantly change the results from the expected and the expected-aware groups, only the expected group results are presented here. The mean changes in preference ratings for the people in the photographs were as follows: DN person, −6.00 (±1.19); LN person, 4.71 (±.84); NN person, 1.71 (±.78); and −N person: −.86 (±1.03) (see Fig. 2). The repeated measures ANOVA was significant ($F(3, 18) = 19.94$; $p < .001$). The significant contrasts were between the DN person and the NN person ($F(1, 6) = 4.29$; $p < .01$), the DN person and the −N person ($F(1, 6) = 6.86$; $p < .001$), the LN person vs. the NN person ($F(1, 6) = 6.43$; $p = .001$), and the LN person and the −N person ($F(1, 6) = 3.86$; $p < .02$). The NN person vs the −N person ($F(1, 6) = .86$; $p = .56$) was not significant. The data from this experiment, including the results from the expected-aware group are summarized in Table 1 under the category of "No Story."

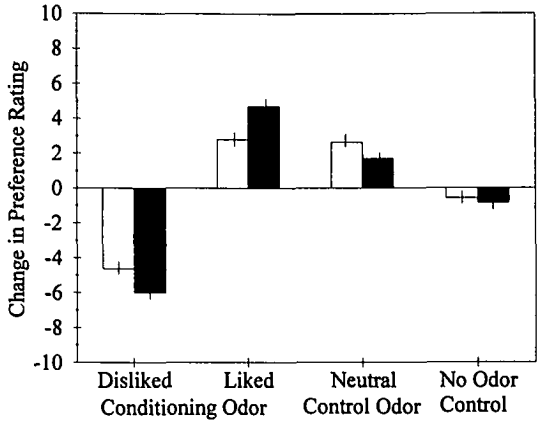

FIG. 2. Mean change in preference ratings on a 21-point scale for people in initially neutral pictures presented with disliked or liked conditioning odors, neutral control odors, or presented alone (no odor control) for all subjects in Experiment 2: without personality sketches (white) and subjects who maintained stable odor ratings (black).

Discussion

These results demonstrate that developing a personality sketch was not necessary to produce the shift in preference for the people. The strategies subjects described were all variations of the experimenter's suggestion to choose a label for the odor and match it with a characteristic of the person in the picture. Presenting the odor after the picture, rather than before, was also effective in shifting the rating of the person. The evaluative conditioning results from the expected sample in this experiment, based on eight presentations of the CS–US pair, constitute one of the largest evaluative changes demonstrated in the literature.

EXPERIMENT 3

In the first two experiments, the olfactory stimuli were odors that were plausibly connected with people. That is, it would not be surprising if someone actually smelled like or wore one of these odors. This experiment was designed to explore whether liked or disliked odors that were not plausibly human odors would also be effective in shifting ratings for photographs of initially neutral people. Because "plausibly human" and "non-plausibly human" are intuitive and vague terms, a clarification of the distinction between them may be helpful: A "plausibly human" odor is one that is either naturally produced by people or is typically applied to people through the use of scented products such as cosmetics and perfumes; a "non-plausibly human" odor is one that is more typically associated with objects other than people or scented products used by peo-

ple, even though people may under certain circumstances take on the odor of these objects through contact with them.

Method

Subjects. Fourteen students from the same university (5 men, 9 women) ranging in age from 19 to 24 years participated in the experiment.

Stimuli. The visual stimuli were the same as in the other experiments. The olfactory stimuli were 12 odorants that were rated by a group of university psychology faculty and graduate students as non-plausibly human odors according to the criterion described in the introduction to this experiment. The odorants were α-pinene [International Flavors and Fragrances (IFF)], benzyl acetate (IFF), cedrenyl acetate (IFF), citronellol (IFF), conifer (Quest International), geraniol (IFF), green (Quest International), lavender (Quest International), d-limonene (IFF), methylsalicylate (Sigma), "mouthwash" (Givaudan-Roure), and storax (The Body Shop, Berkeley, California). They were selected to be comparable in familiarity and pleasantness to the odorants used in the other experiments and were presented at comparable, moderate intensities. The stimuli were presented to the subjects on sheeting material in plastic freezer bags as described in Experiment 1.

Procedure. The procedure was the same as described in Experiment 2.

Results

The data from one subject have not been included in the analysis because she commented during the debriefing that "good smells make you like people and bad smells make you dislike people." The mean initial rating ($\pm$SEM) for the disliked odor was -7.15 ($\pm.73$), for the liked odor, 5.54 ($\pm.63$), and for the neutral odor, $-.54$ ($\pm.27$). The mean final ratings ($\pm$SEM) for the disliked odor was -6.15 ($\pm.89$), for the liked odor, 3.92 ($\pm.79$) and for the neutral odor, .15 ($\pm.98$).

In this experiment, subjects showed mean preference rating changes for the people in the photographs as follows: DN person, -1.38 (±1.24); LN person, 1.38 (±1.02); NN person, .85 ($\pm.86$); and $-$N person, $-.62$ ($\pm.77$). The repeated measures ANOVA was not significant ($F(3, 36) = 1.58$; $p = .21$).

Seven subjects maintained stable odor ratings and six of these matched the odor-person pairs correctly, but they did not show the predicted significant rating changes. The rating changes for the expected group were: DN person, -1.29 (±1.23); LN person, .0 (±1.05); NN person, 1.57 ($\pm.78$); and $-$N person, $-.70$ ($\pm.61$) (see Fig. 3). A repeated measures ANOVA showed no main effect of change in preference rating ($F(3, 18) = 2.29$; $p = .11$).

One possible account for the lack of significance of the non-plausible odor manipulation was that the odors were less valenced, rather than less

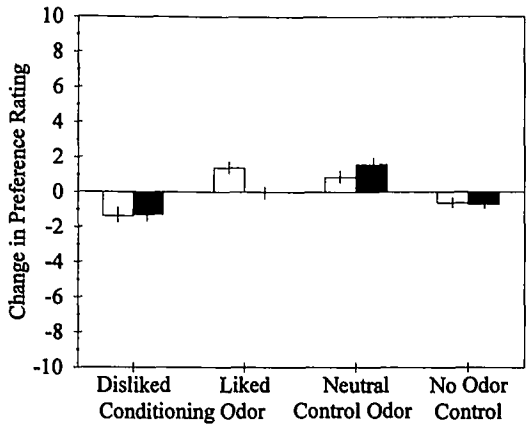

FIG. 3. Mean change in preference ratings on a 21-point scale for people in initially neutral pictures presented with disliked or liked conditioning odors, neutral control odors, or presented alone (no odor control) for all subjects in Experiment 3: non-plausible odors (white) and subjects who maintained stable odor ratings (black).

plausible. The mean initial odor ratings for subjects in this experiment were compared with the mean initial odor ratings for the subjects in Experiments 1 and 2 using an independent t test (disliked odor: -7.15 vs -8.03, $t = -1.32$; liked odor: 5.54 vs 6.44, $t = 1.27$) and no significant difference was found ($p > .10$). This suggests that it was not simply the strength of the preference for the USs that was responsible for the differences between these results and those of the other experiments. A two-way repeated measures ANOVA comparing the expected samples from Experiments 2 and 3 (the only difference in these experiments was the odor series) showed a significant difference between the groups ($F(3, 30) = 20.92$; $p < .001$). The data from this experiment, including the results from the expected-aware group, are summarized in Table 1 under the category of "Non-plausible."

Discussion

When these "non-plausibly human" liked and disliked odors were presented with photographs of initially neutral people, subjects did not show a significant change in their ratings of the people in the photographs in the predicted way. While the intention was to make the series of odorants used in this experiment comparable in familiarity, intensity, and pleasantness to those used in the other experiments, it is possible that there is some other characteristic of these odorants, such as the extent to which they stimulate the trigeminal nerve, that is responsible for these findings. The results suggest that some odors are more effective in shifting preference ratings in this procedure than in others. They also suggest that

when there is not a believable connection between the odor and its apparent source, an inconsistent preference shift for the source will result. Further research will be necessary, particularly in the classification of odorants as plausibly vs non-plausibly human and in equalizing the odor valences, to sort out whether a plausible link to humans is a critical variable in this type of conditioning.

EXPERIMENT 4

There are a substantial number of failures to replicate specific studies in evaluative conditioning. Because this series of experiments is only the second to study cross-modal evaluative conditioning with olfactory stimuli (the first was Hvastja & Zanuttini, 1989), it seems particularly important to confirm that the findings could be reproduced with different experimenters and in a different laboratory. The purpose of this experiment was to replicate the procedure in Experiment 2 at a different university with different experimenters.

Experiment 4 is not a precise replication, because it includes some changes in the way the pictures were assigned to olfactory USs. The original procedure followed Baeyens *et al.* (1988). In their earlier work, when "0" rated pictures were not available, slightly positive faces were assigned to the positive condition and slightly negative faces to the negative condition. This produces a possible bias. (Note: This has been eliminated from the later studies by Baeyens *et al.*, as well.) In this experiment, the four most neutral pictures are randomly assigned to the four conditions.

To investigate whether some of the effects reported in Experiments 1, 2, and 3 might have resulted from a minor bias in stimulus assignment, (this bias could only be present for subjects who did not supply four "0" rated pictures), the data were reanalyzed from Experiments 1, 2, and 3. The −N people that were initially rated as slightly positive were more likely to be rated slightly negative in the final rating, and those that were initially rated as slightly negative were more likely to be rated slightly positive in the final rating. While this suggests that the change in ratings for the people presented with odors could not be attributed to the effects of repeated exposure to slightly positive or negative stimuli, the current procedure was used to ensure that there was no bias.

Methods

Subjects. Twenty-three students (7 men, 16 women) ranging in age from 18 to 20 were recruited from the University of Pennsylvania community to participate in the experiment. The subjects were comparable to those in the previous experiments.

Stimuli. The same stimuli were used as in Experiments 1 and 2.

Procedure. The procedure was the same procedure as in Experiment 2, except that the neutral pictures were assigned randomly to the odors.

As in the other experiments, selection of the four CSs was done to maximize the number of "0" CSs with "±1" CSs and, finally, "±2" CSs being added if necessary. The final set of four CSs was randomly assigned to the four conditions.

Experiment 4 was carried out by two experimenters (D. B. and A. W.), while J.T. carried out Experiments 1, 2, and 3. J.T. taught the new experimenters the procedure before the experiment commenced, but had no contact with the actual subjects in Experiment 4.

Results

The data from two subjects were not included in the analyses because they may have been responding to demand characteristics. The mean initial ratings for the odors (±SEM) were disliked, −6.61 (±.39); liked, 5.57 (±.31); and neutral, −.04 (±.26). The mean final odor ratings (±SEM) were disliked, −7.70 (±.43); liked, 4.92 (±.34); and neutral, 2.61 (±.54).

In this experiment, subjects showed mean changes in preference ratings as follows: DN person, −3.05 (±.69); LN person, 1.76 (±.84); NN person, 2.10 (±.63); and −N person, 1.00 (±.42). The repeated measures ANOVA was significant ($F(3, 60) = 13.92$; $p < .001$). The significant contrasts were between the DN person vs the NN person ($F(1, 20) = 26.54$; $p < .001$) and the −N person ($F(1, 20) = 29.54$; $p < .001$). The contrasts between the LN person vs the NN person ($F(1, 20) = .12$; $p = .73$) and the −N person ($F(1, 20) = .76$; $p = .39$) and between the NN person vs the −N person ($F(1, 20) = 3.11$; $p = .09$) were not significant.

In this experiment, there were 13 subjects in the expected group, and they all matched the odors and photographs correctly. The mean rating changes of the CSs were as follows: DN person, −2.46 (±.79); LN person, 2.15 (±1.11); NN person, 1.85 (±.64); and −N person, 1.15 (±.64) (see Fig. 4). The repeated measures ANOVA was significant ($F(3, 36) = 7.20$; $p < .01$). The significant contrasts were between the DN person and the NN person ($F(1, 12) = 14.71$; $p < .001$) and the DN person and the −N person ($F(1, 12) = 13.50$; $p < .001$). Contrasts between the LN person vs the NN person ($F(1, 12) = .05$; $p = .74$) and the −N person ($F(1, 12) = .84$; $p = .26$) were not significant, again due at least in part to the NN person and the −N person becoming more positive. The contrast between NN person vs the −N person ($F(1, 12) = .62$; $p = .40$) was not significant. The data from this experiment are summarized in Table 1 under the category of "Replication."

Discussion

The results from this replication demonstrate again that when liked and disliked odor USs are presented with neutral people CSs, the ratings of

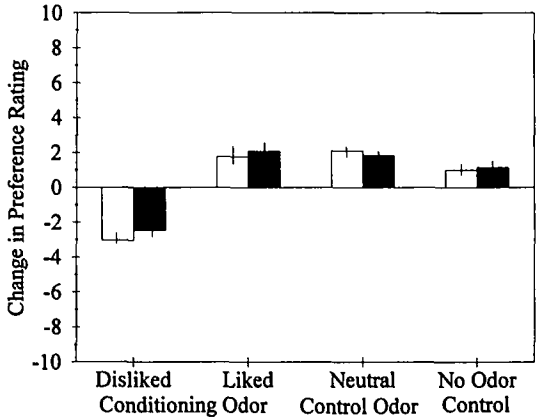

FIG. 4. Mean change in preference ratings on a 21-point scale for people in initially neutral pictures presented with disliked or liked conditioning odors, neutral control odors, or presented alone (no odor control) for all subjects in Experiment 4: replication with random assignment of CSs to USs (white) and subjects who maintained stable odor ratings (black).

the people in the pictures shifts in the direction of the odor rating. This effect appears even with random assignment of the neutral CSs to the USs.

GENERAL DISCUSSION

The results demonstrate the efficacy and potency of odors as valenced stimuli in conditioning studies. The person CS/odor US paradigm developed for this study emerges as sufficiently robust to produce conditioning in eight trials across three different studies (Experiments 1, 2, and 4), across variations in laboratory, experimenter, instructions, and randomization procedures. The only failure to get this effect was in a case where failure was predicted, with the use of odors that were not plausibly human in Experiment 3.

Presenting the photograph of an initially neutral person with a disliked odor produces a larger rating change than presenting the photograph with a liked odor. This may be because the disliked odors were more negative than the liked odors were positive. Because of mere exposure effects, the NN people and −N people sometimes became more positive over the eight trials, creating a positive valence in the control stimuli against which both positive and negative rating changes are compared. This reduces the magnitude of the rating change for the LN person. Even so, the absolute value of the rating change is usually smaller for the LN person than for the DN person.

While the plausible vs non-plausible distinction remains to be dem-

onstrated in a rigorous within-subject experiment, the rating change is greater when the odor is plausibly connected with the source as compared with when it is not. The results suggest that there may be some type of readiness for an enhancement of evaluative conditioning when there is a functional or real-life empirical link between CSs and USs. In this study, this was instantiated by the use of plausible or non-plausible human odors. As indicated in the discussion of Experiment 3, there may be alternative explanations for the lack of significant conditioning in this instance, but the results certainly encourage the hypothesis that a plausible connection between the US and the CS plays a role.

Assuming that the plausibility effect is replicable, it is open to two interpretations. One is that some odors are more effective as USs than others, and the second is that it is the relation between CS and US that is critical. One way to clarify this would be to use a double dissociation design: photographs of people's faces and photographs of various types of rooms could be used as the CSs, and plausibly human and ambient room odors could be used as the USs. If the plausibly human odors change the preference ratings for the people in the photographs more than the rooms, and if the ambient odors change the rating of the rooms more than the people's faces, this would suggest that the connection between the odor and the apparent source is an important aspect of the conditioning.

It is curious that so little work has demonstrated effects of odors on human behavior given the wide-spread conviction that odors play important roles in many people's lives. Most of what is known about human learning has been determined using visual and auditory stimuli. Perhaps olfactory stimuli have not been used in studies of human conditioning because there have not been techniques available that overcome the special challenges of working with odors. By addressing the unique properties of odors, the protocol developed for this study extends the possibilities for investigating human learning processes to include olfaction and enables exploration of other types of cross-modality research.

Whether or not there are any innately valenced odors (Bartoshuk, 1990), it is clear that most odors have a valenced quality for adults. This valencing is likely to be, at least in part, a result of evaluative conditioning with odors as the CS. These CS odors may then support second order conditioning. Because it is unlikely that most of the odors used in this study were innately positive or negative, this research appears to have demonstrated substantial conditioning with a "US" that is, itself, conditioned.

While laboratory results often do not mirror life experiences, it is tempting to suggest that similar types of preference changes occur in the real world with remembered associations between people and the way they smell. For people who do not notice smells enough to make an association

between a person and an odor, bathing or applying a scent may have no effect. For people who notice odors and remember associations between people and odors, how people smell could actually make a difference in social relationships by changing affective responses.

APPENDIX: TRANSCRIPT OF THE COVER STORY

In order to make this an educational experience for you as well as a data-gathering opportunity for me, I would like to tell you about the theoretical basis of the experiment. When we process sensory stimuli we know that two things happen: one is the conscious perception of the stimulus, in other words, we are aware of what we are seeing, hearing, smelling, tasting, and feeling; the other is a physiological response that is not usually available to conscious awareness but is measurable using a skin conductance electrode. We also know that when we perceive sensory stimuli we have preferences about those stimuli, liking some more than others, disliking some more than others, and feeling indifferent or ambivalent to others. What we do not know is whether it is possible to predict from the physiological skin conductance response what the preference was for the stimulus that triggered it. In the first part of the experiment I will measure your skin conductance responses while you provide preference ratings for a series of photographs of people and a series of odors, and then later I will match your preference ratings with the computer processed wave forms and determine whether there are particular characteristics of the skin conductance responses that are indicative of liked, disliked, and neutral preferences in these two sensory modalities. I have chosen to use odors and photographs of people as the stimuli because if there is anything we know about an odor, it is whether we like it or not, so I will have the best chance of getting strong skin conductance responses to odors because they produce strong preferences; and of all the possible types of visual stimuli, we are most likely to have strong preference responses to pictures of people than to, for example, houses or trees or pieces of colored paper.

The second thing that I want to investigate in this experiment is what happens to the composite skin conductance response when two sensory modalities are stimulated at the same time, and I am particularly interested in knowing whether there are differences in the physiological response patterns when the preferences for the paired stimuli are the same (both are liked, neutral, or disliked) as compared with when the preferences are in opposition (one is liked and the other is disliked, one is neutral and the other is liked, etc.). Another reason for choosing pictures of people is that it is difficult to predict from the way someone looks how they would probably smell. This is partly due to the wide variability in our choices of applied scents. This means that it is possible to pair a novel picture of a person with an odor without your nervous system having a

learned expectation of what the odor should be. Whereas, if you liked oranges and disliked bananas, I could give you an orange that smelled like a banana, thereby pairing a liked visual with a disliked olfactory stimulus, but because your nervous system has already learned what oranges smell like, the physiological response would be confused. There are too many possible combinations of liked–neutral, disliked–liked, etc. for every subject to experience all the combinations so each subject will be exposed to only three types of the odor–picture pairs. By the time I have run all the subjects in the experiment, all the possible combinations will have been recorded a number of times. Does all this make sense?

REFERENCES

Baeyens, F., Crombez, G., van den Bergh, O., & Eelen, P. (1988). Once in contact always in contact: Evaluative conditioning is resistant to extinction. *Advances in Behaviour Research and Therapy,* **10**(4), 179–199.

Baeyens, F., Eelen, P., van den Bergh, O., & Crombez, G. (1989). The influence of CS-UCS perceptual similarity/dissimilarity on human evaluative learning and signal learning. *Learning and Motivation,* **20,** 322–333.

Baeyens, F., Eelen, P., van den Bergh, O., & Crombez, G. (1990). Flavor–flavor and color–flavor conditioning in humans. *Learning and Motivation,* **21,** 434–455.

Baeyens, F., Eelen, P., Crombez, G., & van den Bergh, O. (1992). Human evaluative conditioning: Acquisition trials, presentation schedule, evaluative style, and contingency awareness. *Behavior Research and Therapy,* **30,** 133–142.

Baron, R. (1980). Olfaction and human social behavior: Effects of a pleasant scent on physical aggression. *Basic and Applied Social Psychology,* **1**(2), 163–172.

Baron, R. (1981). Olfaction and human social behavior: Effects of a pleasant scent on attraction and social perception. *Personality and Social Psychology Bulletin,* **7**(4), 611–616.

Bartoshuk, L. M. (1990). Distinctions between taste and smell relevant to the role of experience. In E. D. Capaldi & T. L. Powley (Eds.), *Taste, experience, and feeding* (pp. 62–72). Washington, DC: American Psychological Association.

Cain, W. S. (1978). Lability of odor pleasantness: influence of mere exposure. *Perception,* **7,** 459–465.

Ehrlichman, H., & Bastone, L. (1992). Olfaction and emotion. In M. Serby & K. Chobor (Eds.), *Science of olfaction* (pp. 410–438). New York: Springer-Verlag.

Engen, T. (1991). *Odor sensation and memory.* New York: Praeger.

Hvastja, L., & Zanuttini, L. (1989). Odour memory and odour hedonics in children. *Perception,* **18,** 391–396.

Kenneth, J. H. (1928). A few odour preferences and their constancy. *Journal of Experimental Psychology,* **11,** 56–61.

Kirk-Smith, M. D., Van Toller, C., & Dodd, G. H. (1983). Unconscious odour conditioning in human subjects. *Biological Psychology,* **17,** 221–231.

Levey, A. B., & Martin, I. (1975). Classical conditioning of human "evaluation" responses. *Behavior Research and Therapy,* **13,** 221–226.

Levey, A. B., & Martin, I. (1983). Cognitions, evaluations and conditioning. Rules of sequence and rules of consequence. *Advances in Behavior Research and Therapy,* **4,** 181–195.

Levey, A. B., & Martin, I. (1990). Evaluative conditioning: Overview and further options. *Cognition and Emotion,* **4,** 31–37.

Marinkovic, K., Schell, A. M., & Dawson, M. E. (1989). Awareness of the CS-UCS contingency and classical conditioning of skin conductance responses with olfactory CSs. *Biological Psychology,* **29,** 39–60.

Martin, I., & Levey, A. B. (1978). Evaluative conditioning. *Advances in Behavior Research and Therapy,* **1,** 57–102.

Moncrieff, R. W. (1966). *Odour preferences.* London: Leonard Hill.

Rabin, M. D. (1988). Experience facilitates olfactory quality discrimination. *Perception and Psychophysics,* **44**(6), 532–540.

Richardson, J. T. E., & Zucco, G. M. (1989). Cognition and olfaction: A review. *Psychological Bulletin,* **105**(3), 352–360.

Schab, F. R. (1991). Odor memory: Taking stock. *Psychological Bulletin,* **109**(2), 242–251.

Stuart, E. W., Shimp, T. A., & Engle, R. W. (1987). Classical conditioning of consumer attitudes: Four experiments in an advertising context. *Journal of Consumer Research,* **14,** 334–349.

Young, P. T. (1923). Constancy of affective judgments to odours. *Journal of Experimental Psychology,* **6,** 182–191.

Received May 11, 1994
Revised November 11, 1994