Observational Conditioning of Food Valence in Humans

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It has been suggested that the observation of a model consuming a food (CS) and facially expressing either to like or to dislike (US') the food, may be a sufficient condition to bring about a change in the valence of the food for the observer. Unfortunately, up to now this hypothesis has not been investigated in a straightforward manner. In this study, during acquisition, children consumed a series of evaluatively neutral colored and flavored drinks, while simultaneously they watched a videotaped model synchronically drinking identical drinks and facially expressing his evaluation (neutral or dislike) of the liquids. In one condition, the presence of a particular flavor in the drinks was designated to function as the CS+ or the CS−, whereas in the other condition it was the color of the drinks which was the critical CS+ or CS−. Next, the children evaluated a series of drinks containing the critical CSs. A clear evaluative learning effect was obtained when the flavor but not when the color of the drinks was systematically paired with the model's facial expression of dislike. Moreover, the flavor conditioning effect was dependent on the presence in the test drinks of the local context cues (c.q. the colors of the drinks) which were used during acquisition. Finally a double dissociation was observed between explicit beliefs and the "evaluative knowledge" expressed in the ratings of the drinks, in that none of the children in the CS=Flavor groups evidenced any explicit knowledge about the crucial CS-US' contingency but showed evaluative conditioning, whereas the majority of the children in CS=Color groups were aware of the CS-US' relation but failed to demonstrate an evaluative CS+ /CS− differentiation.

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INTRODUCTION

The seemingly trivial question why humans eat what they eat, requires an answer of amazing complexity and involves a lot of hitherto unanswered issues (Rozin, 1984). Apart from obvious factors such as economical cost and availability, acceptance or rejection of a food may be based on beliefs about the dangerous or beneficial short- or long-term consequences of eating it, or on ideational factors involving beliefs about the source of a food. However, probably most of the within-culture variance of what is accepted or rejected as a food, should be accounted for in terms

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of the affective evaluation (like/dislike) of the sensory effects (taste, flavor, appearance, texture) produced by the food stimulus. All other things being equal, humans tend to eat the foods they like and to refuse the foods they do not like (Rozin & Vollmecke, 1986; Rozin & Zellner, 1985). In humans, most of these evaluative reactions toward foods are not fixed and innate, but are largely the product of learning. Flavor evaluations are generally acquired through experience, and shaped by individual learning histories which are embedded in the structure of one's socio-cultural surroundings (Baeyens, Eelen, Van den Bergh & Crombez, 1990; Baeyens, Crombez, Hendrickx & Eelen, 1995; Rozin, 1988; Rozin & Vollmecke, 1986).

**Pavlovian Conditioning and the Acquisition of Food (Dis)likes: Direct, Non-social Exposure to CS-US Contingencies**

Pavlovian associative learning, which is the focus of this paper, constitutes one plausible route to acquired likes and dislikes for flavors (Baeyens et al., 1990; 1995; Rozin & Zellner, 1985). In general terms, this amounts to the idea that the valence of a flavor (CS) may be altered by the valence (positive or negative) of stimuli or events (US) which are presented contiguously or contingently with the target flavor. The positive (e.g. satiety) or negative (e.g. nausea and sickness) post-ingestional consequences of food intake constitute one important class of USs which have been demonstrated to be effective in altering the valence of contingently paired flavor CSs (e.g. Arwas, Rolnick & Lubow, 1989; Booth, Mather & Fuller, 1982). Another class of effective USs for the modification of flavor valence are other flavors, which already evoke clear reactions of liking or disliking. For example, in the standard evaluative flavor–flavor conditioning paradigm first used by Zellner, Rozin, Aron and Kulish (1983) and extended at our laboratory, the research participants are exposed during acquisition to a series of flavored and colored water solutions containing the appropriate CS+/US and CS− contingencies. We repeatedly observed that, after an originally neutral fruit-flavor A (CS+) has been presented several times in simultaneous compound with the very bad-tasting substance Tween20 (Polysorbate 20; US), whereas a similar fruit-flavor B (CS−) has been presented equally often in plain water, participants develop a clear dislike for flavor A relative to flavor B (e.g. Baeyens et al., 1990; 1995). In the original paradigm, Zellner et al. (1983) obtained positive evidence for the acquisition of flavor likes due to contingent flavor–sugar pairings, even though the effect seems more fragile than the negative Tween-effect (Baeyens et al., 1990).

The flavor–post-ingestional consequences paradigm and the flavor–flavor paradigm have in common that participants directly experience both the CS flavor and the US. Even though it is definitely the case that both paradigms have their natural equivalents in the world outside the laboratory (e.g. Casey & Rozin, 1989; Logue, Ophir & Strauss, 1981; Pelchat & Rozin, 1982), one should not forget that, as a fundamentally social animal, the human omnivore acquires probably most of its food likes and dislikes through processes of enculturation or socialization (Rozin, 1988). In this sense, direct, non-social experience with the Pavlovian contingencies of the type described above probably accounts for only a limited part of the variance of humans' acquired food likes and dislikes. This should not necessarily imply, however, that the contribution of Pavlovian conditioning is equally limited. Namely, it has been suggested that observational Pavlovian learning might contribute im-
importantly to the acquisition of human food likes and dislikes (e.g. Birch, 1980, 1986; 1987; Rozin, 1988).

_Pavlovian Conditioning and the Acquisition of Food (Dis)likes: Observational Learning_

Observational Pavlovian conditioning refers to the situation in which someone (the observer) is exposed to CS-US co-occurrences in an indirect manner, i.e. by means of observation of another person (the model) really or purportedly being exposed to a CS-US contingency and reacting to the US. Alternatively, the observer may be exposed to a model who reacts in a specific manner to the CS due to her/his learning history with that stimulus\(^1\). The outcome of this may be that the CS acquires an emotional meaning for the observer congruent with the emotional meaning of the CS for the model. There exist several human and animal models in which observational or vicarious Pavlovian learning, mostly of rather articulated negative emotions has been demonstrated. For example, using the standard “tone-shock” paradigm, a whole research programme has been devoted to the analysis of observational Pavlovian conditioning of autonomic nervous system and skeletal responses in humans (Berger, 1962; for a review, see Green & Osborne, 1985). In this type of experiment, it is standardly demonstrated that when participants observe a model who (supposedly) is exposed to a tone–shock (CS-US) contingency, the tone CS acquires the potential to evoke increased autonomic nervous system activity (heart rate, SCR), or facial expressive (skeletal) responses in the observers, just as if they would have been directly exposed to the tone–shock contingency (Bandura, 1977; Craig & Lowery, 1969; Hygge & Öhman, 1978; Vaughan & Lanzetta, 1980, 1981). At a process-level, several theoretical accounts have been proposed for observational Pavlovian learning (see Green & Osborne, 1985; Mineka & Cook, 1988). Whereas some argue for the role of higher-level social inference processes, a simple and elegant alternative account proposes that the overt components of the unconditioned (or conditioned) responses of the model (bodily motor reactions and especially the facial display), in turn act as a US\(^1\) for the observer. Due to the spatio-temporal co-occurrence of this US\(^1\) with the CS, Pavlovian conditioned responses to the CS are induced in the observer. Without any explicit commitment to one of these alternative process assumptions, we will further refer to the model’s expressive behavior as the US\(^1\) for the observer.

Similar processes might play a role in the acquisition of likes/dislikes for foods or flavors (Birch, 1986, 1987; Rozin, 1988). In nonhuman social animals, e.g. the Norway rat, the social induction of food preferences is a well-documented phenomenon: After a naive observer rat interacts with a recently fed conspecific (the demonstrator), the observer exhibits an enhanced preference for whatever food or flavor(s) its demonstrator has eaten (e.g. Galef, 1989, 1993; Galef, Iliffe & Whiskin, 1994; Galef, Kennett & Wigmore, 1984; Galef & Whiskin, 1992, 1994, 1995). A

\(^1\)From the experimenter’s and from the model’s point of view, it might be useful to distinguish between (a) the situation in which the model is really exposed to a CS and a contingent US, evoking a genuine unconditioned response; (b) the situation in which the model/the actor is exposed to a CS and behaves as if (s)he is exposed to a US; or (c) the situation in which the model reacts to the CS with a conditioned response, due to her/his learning history, e.g. her/his previous exposure to a CS-US contingency. From the observer’s point of view, this distinction is probably artificial and irrelevant. In all three situations, what matters is the model’s overt behavioral reaction (referred to as the US\(^1\)) contingently or contingently with the CS.
possible way to conceptualize this social learning process is to treat the food odor carried on the demonstrator rat as a CS, and some hard-to-specify aspects of (the behavior of) the model rat as a US' for the observer (but see Galef & Durlach, 1993, for some problems with this view).

A conceptually clearer example of observational evaluative learning about food might be the following. Suppose that a human observer watches a model biting in a green unripe apple (CS) and facially expressing (US') a strong dislike for the sour taste (US). This might result in the acquisition of a dislike for (the sight of) green unripe apples in the observer, without she or he having had any direct experience with a green apple—sour taste contingency. Hence, the model's facial expression of likely/dislike might act as a US', the valence of which might transfer to the paired and originally neutral flavor or food for the observer. Until recently, however, this observational evaluative conditioning model remained a "reasonable, but largely unproven model of food socialization" in humans (Rozin, 1988). In a previous study at our lab, we obtained probably the first clear experimental evidence for human observational evaluative conditioning of food-related stimuli (Baeyens, Kaes, Elen & Silverans, 1996). In this study, during acquisition participants watched videotaped sequences of an actor drinking a glass containing a liquid and facially expressing either liking or disliking (US') the drink. The stimulus element which was systematically paired with the actor's facial expression of liking or disliking, was whether the glass contained a "foot" or no "foot" (CS), while other characteristics of the scenes (e.g. color of the drinks, background color) were systematically varied and paired equally often with an expression of like and dislike. In the test phase, palatability ratings were obtained for pictures of food objects in which the CS element (foot/no foot) was embedded. A clear observational evaluative learning effect could be demonstrated when the feature CS was embedded in objects identical to those presented during learning (glasses containing drinks), but not when it was embedded in new objects (e.g. egg in egg-cup). The evaluative learning effect was obtained even when participants (the majority) did not consciously notice the crucial CS-US' covariation. One might correctly argue that the Baeyens et al. (1996) study did not yet demonstrate that the observational conditioning procedure had any impact on (dis)liking flavor or taste stimuli proper. Therefore, the main purpose of the present research was to investigate the possibility of changing the evaluation of food stimuli by means of an observational conditioning procedure.

In short, during acquisition children consumed a series of neutral colored and flavored drinks containing the target CS, while simultaneously they watched a videotaped actor synchronically drinking identical drinks and facially expressing his evaluation (neutral\(^2\) or dislike) (US') of the liquids. Two conditions were run, CS = Flavor and CS = Color, varying on which stimulus attribute (flavor or color) of the drinks functioned as CS+/CS -. In the CS = Flavor condition, consumption of the CS + flavor was always followed by an expression of dislike by the actor, whereas consumption of the CS - flavor was followed by a neutral facial expression. In order

\(^2\)In this study, a facial display of dislike was contrasted with a neutral display rather than with an expression of liking the drinks, as was the case in the "glasses" study (Baeyens et al., 1996). The major reason for this shift was that, whereas the model had no difficulties at all to express a strong dislike, he was clearly less successful to react with a distinct and natural facial expression of liking a drink. This probably reflects not so much an idiosyncratic characteristic of the model, but rather the more general fact that humans (and several other animals) are well equipped to facially express a disliked/disgust towards a food stimulus, but do not have an equally distinct and clear facial display to express liking of a food.
to mask the crucial CS-US' contingencies, these CS+ and CS− flavored drinks were presented in different colors, each of which was followed equally often by an expression of dislike or by the neutral face. The hypothesis was that the observers would acquire a dislike for test drinks containing the CS+ flavor relative to test drinks containing the CS− flavor. In the CS=Color condition, the function of the flavor and the color characteristics of the drinks was reversed, such that the colors of the drinks constituted the critical CS+/CS−, whereas each added flavor was followed equally often by an expression of dislike or by the neutral face. The CS=Color condition was included to investigate the generality of a well-established principle of non-observational flavor conditioning, namely that in animals which mainly rely on their chemical senses in identifying food, the visual attributes of food stimuli are a poor target for evaluative learning relative to the flavor characteristics. For example, exteroceptive sensory characteristics of food are much harder (or not at all) associated with nausea and/or vomiting than flavor characteristics (e.g., Domjan, 1982, 1983; García, Ervin & Koelling, 1966; García & Koelling, 1966; Lolordo & Droungas, 1989). Also, Baeyens et al. (1990) observed that a color-Tween contingency did not result in any evaluative learning effect. Hence, to the extent that this principle extends to the domain of observational learning, we expected that the CS-Color groups would demonstrate no or at least a weaker acquired CS+/CS− differentiation than the CS=Flavor groups.

At testing, the CS+/CS− flavors (or CS+/CS− colors) were presented not only in liquids containing the colors (flavors) which were present during acquisition, but also in colorless (flavorless) drinks. This manipulation allowed us to assess to what extent the acquired evaluative CS+/CS− discrimination would be dependent on the local context provided by the acquisition colors (flavors). Because previous research using the "direct", non-observational flavor-Tween paradigm (Baeyens et al., 1995) clearly demonstrated that the conditioned dislike for the Tween-paired flavor was not dependent on the presence of the acquisition color-context, we hypothesized that an eventually observed evaluative CS+/CS− differentiation would show up about equally strong with or without the acquisition context stimuli being present in the test drinks.

The final question of this study pertained to the relationship between the acquisition of an evaluative CS+/CS− differentiation and of explicit, verbalizable knowledge about the CS-US' relationships (Baeyens & De Houwer, 1995; De Houwer, Baeyens & Hendrickx, submitted). Previous research on evaluative learning, has clearly documented that the acquisition of both kinds of knowledge may proceed orthogonally (Baeyens et al., 1990; Baeyens, Eelen, Crombez & Van den Bergh, 1992; Baeyens, Heremans, Eelen & Crombeiz, 1993). For example, in a previous study (Baeyens et al., 1990) a double dissociation between evaluative learning and the acquisition of conscious knowledge was observed, in that in CS-Flavor groups, none of the participants demonstrated awareness of the stimulus relations, but they evidenced clear conditioning; on the other hand, in CS-Color groups a substantial number of participants was contingency-aware, but no evaluative conditioning was observed. In order to examine whether similar dissociations may be observed in an observational learning paradigm, a post-experimental CS-US contingency awareness questionnaire was included.
METHOD

Participants

A total of 74 pupils (aged 8–12) from four primary school classes (two third grade classes, \(N=16\) and \(N=15\), a fourth grade class, \(N=22\), and a sixth grade class, \(N=21\)) participated in the experiment. Forty-two children were female, 32 were male. Since cooperation with the school was dependent upon retaining the four existing classes as units, the following strategy was used to allocate the class groups to one of the four possible experimental contingencies (CS+/CS− = Flavor A/Flavor B; Flavor B/Flavor A; Color A/Color B; Color B/Color A). First, in order to obtain minimal confounding of the CS-type variable (CS = Flavor/Color) with grade and hence age of the children, one of the third grade classes was assigned to a CS = Flavor contingency, whereas the other third grade class was assigned to a CS = Color contingency. Next, the outcome of a toss of a coin resulted in the fourth grade class being allocated to the other (counterbalancing) CS = Flavor contingency, and the sixth grade class to the other (counterbalancing) CS = Color contingency. Test duration was about 45 minutes. All children were uninformed as to the real purpose of the experiment.

Stimuli and Apparatus

Experimental drinks

Two colorless artificial concentrate flavors, Orange and Raspberry, were used as CS+ and CS− in the CS = Flavor conditions or as a distracter flavor context in the CS = Color conditions. These flavors were obtained from Universal Flavors (Belgium). In a flavor evaluation pilot study (\(N=20\), 11 males and 9 females, aged 10–11), the mean liking ratings for Orange and Raspberry were +4.0 and −1.5, resp., on a −100/+100 dislike/like visual analog scale. Two commercial flavorless food colorings (Vahiné, yellow (E 102) and red (E 122), were used as CS+ and CS− in the CS = Color groups or as a distracter color context in the CS = Flavor groups. Both CS+ and CS− were presented in 5 ml tap water at room temperature. Orange flavor was presented at a concentration of 0.75 ml l−1 water, Raspberry flavor at a concentration of 1 ml l−1 water. A concentration of 1 ml l−1 water was used for the yellow food colorant, and 1.5 ml l−1 water was used for red. All flavorants and colorants were used identically both for the videotaped model and for the observers.

Acquisition video-tapes

Four videotapes were prepared for the acquisition phase, differing with respect to which stimuli functioned as CS+ and CS− (orange = CS+/raspberry = CS−; raspberry = CS+/orange = CS−; red = CS+/yellow = CS−, and yellow = CS+/red = CS−). A boy of about the same age (age 10), the same race and socio-economic class as the children functioned as a model; none of the children was familiar with this model. Each videotape lasted 10 min 40 s and contained a total of 16 40 s scenes. Each scene was structured according to the following fixed sequence: (a) the actor sitting behind a table containing 16 cups placed in a row takes the leftmost cup containing a drink and looks at it (5 s); (b) moves the cup back and forth under his nose and smells the drink (5 s); (c) takes the fluid into his mouth, swirls it around in his mouth, tastes it, and swallows it (5 s); (d) facially (and on some but not all
trials also vocally) expresses his evaluation of the drink (strong dislike or neutral) (5 s); (e) and finally takes a piece of bread from a plate to his right, eats it, and waits for the next trial (20 s). A (female) off-screen voice guided the model's behavior through this sequence by saying "next cup and looking", "smelling", "in mouth and tasting", "swallow", and finally "piece of bread". These off-screen verbal instructions were also recorded on the tape. The model's facial expression of dislike was characterized by several elements of what has been described as disgust faces (Rozin, Lowery & Ebert, 1994), including raising of the upper lip, nose wrinkling, occasionally gaping, frowning, and tightening of the eyes. The neutral expression was characterized by the absence of any specific facial action. The (occasional) vocal expressions of dislike were variations on a clear 'bah!'; no vocalizations were given in case of neutral trials. The 16 trials consisted of both the CS+ and the CS− drinks, each presented four times in combination with each of the two distracter stimuli (e.g. raspberry flavor = CS+, presented four times in yellow and four times in red, and orange flavor = CS− presented likewise four times in red and four times in yellow). The order of presentation of these 16 trials was determined randomly for each of the four acquisition tapes, with the restriction that no more than two consecutive trials were allowed to contain a CS+ (or CS−) scene. Consequently, all children in one of the four subgroups were exposed to this same semi-randomized series of acquisition trials.

Test materials

Ss were tested in their own classrooms and were seated at tables facing a video screen. Sixteen transparent plastic 30-ml cups containing the acquisition solutions were placed in a row in front of each child, in exactly the same order as appeared in the videotape for a particular subgroup. The 12 cups containing the post-conditioning test stimuli (CS+ and CS− liquids, each presented twice with the two acquisition context stimuli and twice without this context stimulus; for example, in CS=Flavor groups, CS+ and CS− flavors were both presented twice with yellow, twice with red, and twice colorless) were also arranged on a row on the table. Additionally, these test cups were numbered 1 to 12, the numbers being written in black on top of each cup. A final series of four cups containing the labels "yellow", "red", "orange", and "raspberry" were used for the awareness measurement. These cups were handed to the child at the moment of the awareness test. Finally, within easy reach of the child, the tables contained dishes filled with small pieces of white bread, to be eaten between each conditioning or test trial. The eating of the piece of bread was introduced to avoid after-tastes and the mixing up of flavors of consecutive trials as much as possible.

Procedure

Observational conditioning phase

The learning phase consisted of a systematic consumption of the 16 acquisition drinks, each component of a trial and the presentation order of the liquids being perfectly synchronized with the model's behavior on the videotape. Consequently, whenever one of the eight CS+ drinks was consumed by the children, this was immediately followed by the actor's expression of dislike, whereas each of the eight CS− drinks was followed by the actor's neutral facial display. The children were tested in four groups (N=15–22), each group representing one of the four possible
CS–US’ acquisition contingencies. Upon entering their classroom, it was explained that we were interested in some variables which might play a role in the perception of flavors. The experimenter said that “they should first attentively look at and consume a series of drinks, without having to give any explicit responses”. The video display was introduced as a mere instructional device, and no reference was made to the fact that the model would facially express his evaluation of the drinks: “A videotaped model drinking exactly the same series of drinks as they would receive, would show them what to do at every moment of the experiment, while a voice on the tape would likewise tell them when and how to consume each of the drinks”. Hence, even though this was not emphasized, the children were led to believe that the model consumed an identical series of drinks as they did. It was stressed “that they should follow the model’s actions as closely as possible, and that they should not pay attention to their classmate’s behavior. After this, they would be presented with a second series of drinks, about which some questions should be answered”. Next the children consumed the 16 CS+/CS− acquisition drinks while watching the videotape.

**Evaluative response measurement**

The children received a response booklet containing rating scales for each of the 12 test stimuli (CS+ and CS− liquids, each presented twice with the two acquisition context stimuli and twice without this context stimulus). They were instructed to consume each of the drinks in the same way as the first series of drinks, the only two differences being that they should now follow the experimenter’s verbal instructions rather than a video-taped model, and that they should also indicate how much they liked or disliked each drink. The rating scale was a line 152 mm long, labelled very bad at the left extreme, bad left from the middle, not good, not bad in the middle, good right from the middle, and very good at the right extreme. The line was also subdivided into 21 categories, half of which were labelled by numbers under the scale (−100/−80/−60/…/0/+60/+80/+100). The child was asked to mark the category indicating her/his global, spontaneous evaluation of the drinks. The children rated a solution every 40 s on the experimenter’s signal. Hence during the first 5 s of each trial, participants took a cup and looked at it; during the next 5 s they smelled it; during the next 5 s they took the solution into their mouths and tasted it; after 5 s of waiting, they rated the solution and next ate a piece of bread; the remainder of the last 20 s were waiting time. The order of presentation of the 12 test stimuli was semi-randomized, in that no more than two consecutive trials were allowed to be a CS+ (or CS−). A different semi-random sequence was used for each child.

**Contingency awareness measurement**

The children were handed the four cups containing Raspberry and Orange flavor, and yellow or red food colorant. In order to assess participants’ explicit beliefs about the critical CS–US’ contingency they had been exposed to, they were asked to write down “which particular type of drinks they believed the boy (the model) on the videotape disliked”. Before answering, the children were allowed to freely look at, smell, and/or consume the cups containing the different response possibilities.
RESULTS

Ratings of CS+ and CS− Liquids

For the CS=Flavor groups, first the average was calculated of each child's two ratings of the liquids containing the CS+ flavor or the CS− flavor presented in the color yellow, the color red, or colorless. Next, yellow and red flavor ratings were averaged in order to obtain a single index of the evaluation of CS+ and CS− flavors in the presence of the acquisition context (colors); evidently, the colorless flavor rating represented the index of the CS+/CS− flavor evaluations in the absence of the acquisition context. Hence, the 12 data points were reduced to four per participant. Similarly, for the CS=Color groups, each child's average rating was determined for the liquids containing the CS+ or the CS− color presented without (Flavorless) or with the acquisition context flavors (Raspberry/Orange). These means are displayed in Fig. 1, the top figure presenting the data of the CS=Flavor groups, the bottom figure showing the data of the CS=Color groups. In the CS=Flavor condition, the CS+ ratings were substantially lower than the CS− ratings, but apparently only so when the CS flavors were presented in the context of the acquisition colors. In the CS=Color condition, the evaluative CS+/CS− differentiation appeared to be much less pronounced, and even implied slightly less negative CS+ then CS− ratings when the CS colors were presented together with the acquisition flavors.

The data were analysed by means of a 2×(4)×2×2 [CStype (CS=Flavor/CS=Color)×CSplus (CS+ = orange/raspberry or yellow/red)×Conditioning (CS+/CS−)]×Context (Acquisition context present/absent) ANOVA with repeated measurement on the last two variables and the CSplus variable nested within the CStype variable. An unweighted-means analysis was used to handle the unequal N's in the four between-groups of the design, and Greenhouse–Geisser correction of the df was applied when necessary. An alpha level of 0.01 was used for all statistical tests. The three-term interaction between Conditioning × CStype × Context proved to be significant, $F(1,70)=8.09$, $p=0.006$; MSE=536.5. None of the main effects or other interactions reached significance. The conditioning × CStype × Context interaction was further analysed by means of a series of contrasts, testing for the effect of conditioning at each level of the CStype × Context variables. In CS=Flavor

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2 As a result of our strategy of allocating existing class groups (differing in grade) to CS=Flavor or to CS=Color conditions (see Participants section), the average child in CS=Flavor conditions was about one year (one grade) younger than the average child in CS=Color conditions. Even though not very likely, some might argue that the interaction with CStype might also be interpreted as reflecting an interaction with Age (the younger CS=Flavor participants are more readily influenced by the experimental contingencies than the older CS=Color participants). To reduce the likelihood of this interpretation, we performed an additional ANOVA including only the third grade children (i.e. one of the two CS=Color groups and one of the two CS=Flavor groups). Evidently, in this analysis the countering of which flavor (or color) functioned as CS+ or CS− is no longer guaranteed, and consequently the results of this analysis should be interpreted cautiously. Nevertheless, this CStype (CS=Color/CS=Flavor)×conditioning (CS+/CS−)×Context (Acquisition context present/absent) ANOVA basically confirmed the results of the ANOVA including all participants. Again, the only significant effect (alpha level=0.05) was the three-term interaction between conditioning × CStype × Context, $F(1,29)=4.89$, $p=0.04$; MSE=567.7. Also, in the CS=Flavor group the effect of the conditioning was confined to the CS+/CS− flavors being presented in the context of the acquisition colors, $F(1,29)=8.93$, $p=0.006$; MSE=498.7, and disappeared without the acquisition colors, $F(1,29)=0.28$, $p=0.61$; MSE=1248.4. In the CS=Color group, no reliable CS+/CS− differentiation was obtained, whether these colors were presented in the context of the acquisition flavors, $F(1,29)=0.57$, $p=0.46$; MSE=498.7, or without flavors, $F(1,29=1.29)$, $p=0.27$; MSE=1248.4.
groups the effect of conditioning was confined to the CS+/CS− flavors being presented in the context of the acquisition colors (mean CS+ = −2.89, mean CS− = 13.88), F(1,70) = 10.35, p = 0.002; MSE = 561.1, and disappeared when the CS+/CS− flavors were presented without the acquisition colors (mean CS+ = 11.32, mean CS− = 13.16), F(1,70) = 0.14, p = 0.72; MSE = 834.9. In CS=Color groups, no reliable evaluative differentiation between drinks containing the CS+ or CS− colors was obtained, whether these CS+/CS− colors were presented in the context of the acquisition colors (mean CS+ = −1.11, mean CS− = −9.03), F(1,70) = 1.83, p = 0.19; MSE = 561.1, or were presented without the acquisition colors (mean CS+ = −7.08, mean CS− = −0.00), F(1,70) = 1.40, p = 0.25; MSE = 834.9. Thus, a clear observational evaluative learning effect was obtained when the flavor of the drinks functioned as the CS, but not with the color of the drinks functioning as the CS.
Moreover, this flavor conditioning effect was completely dependent on the presence of the local context provided by the acquisition color of the drinks.

**Awareness of Experimental Contingencies**

The children’s answers on the question which was the correlate of the model’s expression of disgust were categorized into eight different mutually exclusive response classes, according to whether they contained: (1) the CS +, exclusively (e.g. CS + color in CS = Color groups); (2) the CS +, plus “distracter” stimuli (e.g. Orange and yellow, in CS = Flavor group); (3) both the CS + and the CS −; (4) both the CS + and the CS −, plus “distracter” stimuli; (5) the CS − (exclusively); (6) the CS −, plus “distracter” stimuli; (7) the “distracter” stimuli, exclusively; (8) no response. Table 1 shows the number of children whose response was categorized into each of the eight response categories, separately for the CS = Flavor and for the CS = Color groups (between brackets: percent of CS = Flavor or CS = Color participants categorized into each category).

In the CS = Flavor groups, none of the children made exclusive reference to the CS + flavor as the correlate of the model’s expression of dislike, i.e., none of them were aware of the critical CS + flavor–US’ contingency. In sharp contrast to this, the majority of the children in the CS = Color groups correctly indicated the CS + color as the critical stimulus which was contingently paired with the US’. From a different point of view, it could be argued that CS = Flavor and CS = Color participants expressed very similar explicit beliefs about the CS–US’ contingency. Namely, since the modal response of the CS = Flavor participants was a “distracter” and hence a color answer, both groups were similar in consciously focusing on the color rather than on the flavor dimension of the drinks.

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<th>Response category</th>
<th>Condition CS = Flavor</th>
<th>Condition CS = Color</th>
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<tbody>
<tr>
<td>(1) CS +</td>
<td>0 (0%)</td>
<td>24 (66.7%)</td>
</tr>
<tr>
<td>(2) CS + and distracter(s)</td>
<td>2 (5.3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>(3) CS + and CS −</td>
<td>0 (0%)</td>
<td>2 (5.6%)</td>
</tr>
<tr>
<td>(4) CS + and CS − and distracter(s)</td>
<td>8 (21.1%)</td>
<td>2 (5.6%)</td>
</tr>
<tr>
<td>(5) CS −</td>
<td>0 (0%)</td>
<td>4 (11.1%)</td>
</tr>
<tr>
<td>(6) CS − and distracter(s)</td>
<td>4 (10.5%)</td>
<td>1 (2.8%)</td>
</tr>
<tr>
<td>(7) Distracter(s)</td>
<td>22 (57.9%)</td>
<td>2 (5.6%)</td>
</tr>
<tr>
<td>(8) No response</td>
<td>2 (5.3%)</td>
<td>1 (2.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>38 (100%)</td>
<td>36 (100%)</td>
</tr>
</tbody>
</table>
DISCUSSION

The main purpose of the present study was to obtain straightforward evidence in favor of the often suggested but seldom tested possibility of observational Pavlovian conditioning of the valence of foods. To this purpose, children were exposed to a contingency between a specific characteristic of an actually consumed neutral drink (c.q. its flavor or color, CS) and the facial expression (neutral/dislike) (US') of a videotaped model who consumed identical drinks. The major findings of this study may be summarized as follows. First, a clear observational evaluative learning effect was obtained when the flavor of the drinks was systematically paired with the model's facial expression of dislike. Second, this acquired evaluative differentiation of drinks containing the CS+ or CS− flavor appeared to be highly dependent on the presence of the local context cues (c.q. the colors of the drinks) which were used during acquisition. Third, the contingent pairing of the color of the drinks with the model's expression of dislike did not result in any systematic effect on participants' subsequent evaluation of drinks containing the CS+ or CS− color. Fourth, none of the children in the CS=Flavor groups evidenced any explicit knowledge about the crucial CS-US' relationships presented during conditioning, whereas the majority of the children in CS=Color groups did so.

The Observational Conditioning Procedure

Several elements of the specific observational learning procedure used in this study may have facilitated the evaluative conditioning effect, and are worthwhile of further experimental investigation. For example, there is some good evidence that similarity between the model and the observer enhances observational Pavlovian conditioning (Bandura, 1977). The fact that the model on the videotape was of the same age group, the same race, and the same socio-economic class as the children, probably made him an easy target for identification. Future studies might investigate the importance of this factor for evaluative flavor learning by means of a systematic manipulation of the similarity between the model and the observers.

Second, different from auditory or visual stimuli, when food and especially flavor stimuli are used as a CS in an observational learning paradigm, the very nature of these stimuli requires that the observer S has to put into her/his mouth a food stimulus which is not literally the same as the one the model is eating or drinking. Even though this was not emphasized in the instructions, in our procedure the children were led to believe that the model consumed an identical series of drinks as they did. It is not clear at present whether this aspect of the procedure is or is not a requirement for successful modification of the evaluation of the drinks. Intuitively, however, it seems less plausible to obtain a similar shift in the valence of the flavor, when participants would be convinced that the model is exposed to another flavor than they are. An analysis of the role of this type of "belief" may also be relevant with respect to the issue of which processes are involved in this type of observational conditioning. For example, to the extent that the procedure would work equally well when participants believe that they are drinking the same drink, or a different drink as the model, or when they would have no relevant information about this, this might favor the theoretical position arguing that the overt components of the responses of the model act directly as a US' for the observer. On the other hand, when the procedure would have no effect when the observers are not convinced
that they are drinking the same drink, this might argue for a contribution of high-level cognitive inference processes.

Third, it might not be irrelevant that we used a negative facial display, expressing strong disliking of the stimuli, rather than a positive expression of liking. Namely, there is a lot of evidence that negative events often have more affective impact than equally intense positive events (Peeters & Czapinski, 1989). In this case, this might imply that humans (and other omnivores) are predisposed to learn more rapidly or easily about the correlates of negative than of positive events (see Rozin, 1984, 1986; Peeters & Czapinski, 1989; Zahorik, 1979, e.g. for further evidence and discussion of a negative learning bias). Future research may investigate whether observational evaluative learning effects may also be obtained when the model expresses to like the consumed food, and whether this effect is equally strong as the acquired dislike demonstrated here.

Observational Versus Direct Evaluative Learning About Foods

Two characteristics of the data obtained in this observational learning paradigm demonstrate a striking similarity to what has been observed in non-observational evaluative food conditioning paradigms. First, the fact that a clear observational learning effect was obtained when the flavor but not when the color of the drinks was the CS, replicates previous findings obtained using the Tween 20 paradigm (see introduction), and provides additional evidence to support the hypothesis that selective associations may occur in humans' acquisition of food likes and dislikes.

Second, as in Baeyens et al. (1990), a clear dissociation was obtained between explicit beliefs about the relevant CS-US' contingency and the "evaluative knowledge" expressed in the post-conditioning rating of the drinks. Apparently, observational evaluative conditioning does not require the acquisition of a conscious and correct belief about the correlate of the model's evaluative expression, which adds to the position defended by Baeyens et al. (1994) and De Houwer et al. (submitted) that evaluative learning in general may proceed at the level of implicit learning. On the other hand, the results of the CS=Color group also suggest that a conscious and correct belief about the CS-US' contingency does not necessarily result in a modification of evaluative reactions towards the CS.

Notwithstanding these similarities, one aspect of the pattern of results obtained in this study markedly differed from what has been found in the non-observational flavor-Tween paradigm, namely, the fact that the evaluative learning effect was strictly dependent on the acquisition color context cues. This observation raises several questions. First, it is not clear at present to which aspect of the procedure this phenomenon should be attributed. For example, it might be related to the fact that an observational rather than a direct conditioning procedure was used, or, to the fact that the participants were children rather than adults as was the case in our flavor-Tween studies. In this respect, it might be useful to remember that a similar dependency of the acquired evaluative discrimination upon the local acquisition context cues was also observed in the Baeyens et al. (1996) "foot/no foot" observational learning study using adults. This opens the possibility that the context sensitivity of the acquired evaluative discrimination indeed might be related to the fact that an observational evaluative learning procedure was used. A second question raised by this finding pertains to what exactly was the target of evaluative change in CS=Flavor groups. Up to now, we have suggested that the drinks were analysed
sowever as containing two separate components, a flavor and a color, and that it was the flavor which was conditioned, dependent however on the presence of the color context cue. It is also possible, however, that the drinks were treated in a more holistic manner, such that for example red-colored-orange-flavored drinks and yellow-colored orange-flavored-drinks were the functional units which were paired with an expression of dislike. Available evidence does not yet allow however to favor one of these alternatives.

These questions should not distract attention from the main findings of this study, changing the observational evaluative learning hypothesis to explain acquired food likes and dislikes from a “reasonable, but largely unproven model of food socialization” (Rozin, 1988) into an experimentally supported paradigm inviting further experimental research. For example, it would be highly relevant to study the impact of the observational learning procedure on foods for which people do already have a previously established preference, or to investigate the relative salience of observational learning and direct experience (e.g. post-ingestional consequences/flavor–flavor associations) when people are concurrently exposed to both types of—affectively congruent of incongruent—environmental contingencies.

REFERENCES


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