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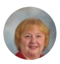

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Original Article

An Environmental Approach to Positive Emotion: Flowers

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Abstract: For more than 5000 years, people have cultivated flowers although there is no known reward for this costly behavior. In three different studies we show that flowers are a powerful positive emotion "inducer". In Study 1, flowers, upon presentation to women, always elicited the Duchenne or true smile. Women who received flowers reported more positive moods 3 days later. In Study 2, a flower given to men or women in an elevator elicited more positive social behavior than other stimuli. In Study 3, flowers presented to elderly participants (55+ age) elicited positive mood reports and improved episodic memory. Flowers have immediate and long-term effects on emotional reactions, mood, social behaviors and even memory for both males and females. There is little existing theory in any discipline that explains these findings. We suggest that cultivated flowers are rewarding because they have evolved to rapidly induce positive emotion in humans, just as other plants have evolved to induce varying behavioral responses in a wide variety of species leading to the dispersal or propagation of the plants.

Keywords: positive psychology; emotion; happiness; flowers; memory; social distance; Duchenne smile.

Introduction

> "…[I]t was the flower that first ushered the idea of beauty into the world the moment, long ago, when floral attraction emerged as a evolutionary strategy" (p.xviii)…[one of]…"a handful of plants that manage to manufacture chemicals with the precise molecular key

> needed to unlock the mechanism in our brain governing pleasure, memory, and maybe even transcendence." (p.xviii) I would be the last person to make light of the power of the fragrant rose to raise one's spirits, summon memories, even in some not merely metaphorical sense, to intoxicate"…(p. 177) (Pollan, 2002).

The proposition that "floral attraction emerged as a evolutionary strategy" for "pleasure, memory and maybe even transcendence" (Pollan, 2002) is basically the hypothesis that there is an evolutionary niche for emotional rewards, a niche to which species far removed from mammals, even flowering plants, may adapt. Few scientists have taken this hypothesis seriously and few studies question the effect that flowering plants or other non-humans, (except dogs; Allen, 2003) have on human emotions. Do flowering plants, in fact, increase positive emotional reaction by influencing emotional displays such as smiling or, over a longer time period, do they change moods and also influence socio-emotional functions such as social greeting patterns or memories of social events? The following studies of social-emotional responses to flowers begin to examine this proposition and to question the human emotional environment outside that of human relationships.

Although we know that depriving humans or other social species of species-specific social contact and emotional support is detrimental to health (Cacioppo et al., 2000; Spitz, 1946), very little research has been directed to the effects of depriving humans of other-species sources for emotional support. Humans are embedded in a larger sensory and social environment than that occupied by their own species. Depriving humans of non-species emotional support may be as detrimental to human survival and fitness as depriving humans of any other resource.

A Brief History

In cultures around the world as far back in history as we have any records, flowers provided emotional information among peoples. Pollen was found in the graves of Neanderthals suggesting that the flowers had a place in the burial (Solecki, 1971), although the significance of the pollen is still in dispute (Sommer, 1999). Flowers are expected to convey sympathy, contrition (guilt), romance (sexual intent) or celebration (pride and joy) (Heilmeyer, 2001). Flowers are also used to express religious feelings and in some religions are considered the direct route for spiritual communication. (Stenta, 1930). Of course, some flowers are used for personal adornment, both the blossoms themselves and their essences in the form of perfumes. The vast majority of personal commercial fragrances have a floral top- and/or mid-note. In spite of some basic survival uses, such as edible or medicinal flowers, most flowering plants grown in the flower industry in modern times are not used for any purpose other than emotional. Floriculture crops in the United States accounted for at least 4.9 billion dollars in sales in 2001 (USDA, 2003). This amount seriously underestimates the floral economy because it does not include imports.

Naive psychology argues that flowers are desired because of learned associations with social events. However, the ubiquity of flower use across culture and history and the lack of easy substitutes for the many uses of flowers suggest that there may be something other than this simple association. Flowers may influence social-emotional behavior more directly or may prime such behavior. That is, flowering plants may have adapted to an emotional niche.

The Emotional Niche – Both the Positive and the Negative

Can one really argue that positive emotion usually has survival benefits or conveys reproductive fitness? Despite early definitions of happiness or joy as a basic emotion, the continuing science of the evolution of emotion has emphasized the negative -- hostile and fearful emotions in animals and depression and hostility in humans (McGuire, 1993). A larger research literature reports on the stimuli that govern negative emotions as well as the patterns of response, secondary effects, and individual differences that emerge in their expression (for reviews, see Lewis and Haviland-Jones, 2000). It is clear that both plants and animals use defenses that elicit emotional fear or disgust reactions through the sensory modes of taste and smell, vision and audition. Snakes and spiders are not necessarily poisonous and the stinking, slimy mushroom may even be edible. It is not necessary that defense mechanisms be physically damaging, only that they produce an emotional reaction leading to avoidance or withdrawal. A plant or animal that can frighten or disgust a predator has gained fitness by exploiting an emotional niche. Withdrawal without physical contact is better than an active physical defense, which might lead to damage or death of the defending species. The ability to produce negative avoidant emotion in a predator has long been considered a possible defense and could be seen as the exploitation of an emotional niche.

That positive emotion could operate in a similar emotional niche has emerged recently but the evidence remains exploratory (Grinde, 2002; Seligman, 2002). Attraction mechanisms for plants have some socio-emotional features. For example, Hawk moths (*Manduca species*.) repeatedly visit Datura flowers (jimsonweed) for a hallucinogenic reward (Grant and Grant, 1983). Some species of orchids produce very little nectar and attract pollinators with perfumes. Orchid bees (*Eulaema, Euplusia and Euglossa genera*) collect perfumes/pheromones from these orchids into specialized pouches; they then use the perfumes as sex attractants. Other species of orchids mimic female sex pheromones and attract males who mate with the flower (Scheistl, et al., 1999). Interestingly, after "mating" the flowers then produce an anti-aphrodisiac pheromone (Schiestl and Ayasse, 2001). The well-known bower bird decorates its nest with flowers (Uy and Borgia, 2000). A number of bat-pollinated flowers emit a sulfur-like odor that mimics odors used in bat mating and social recognition (von Helversen, Winkler, and Bestmann, 2000). Many other plants provide non-nutritional chemical compounds, which insects can use for defense or sexual attraction (Weller, Jacobson, and Conner, 2000). There does not appear to be a demonstration of plants providing socio-emotional benefits using similar chemical or visual mechanisms to humans.

The attraction to flowering plants reflected above may be related to positive emotion. Panskepp's (2000b) research suggests that non-human species use positive emotion similarly to humans. "Tickling" rodents elicits high pitched "laughter." This laughter is related to the appropriate neurological patterns for positive emotion, and is attractive to other members of the same species. Rats will prefer to approach a human caretaker who is a "tickler" over one who provides food and water. In other words, the immediate elicitation and expression of emotion even coming from another species is related to secondary social attraction effects. The secondary effects of positive emotion are demonstrated in a large number of behavioral domains for people as well as for rodents (Panksepp, 2000a). Positive emotion makes people appear to be more attractive, even sexually attractive and arguably, more likely to be approached socially. (Cunningham, Barbee, and Philhower, 2002; Otta, Abrosio, and Hoshino, 1996).

Both short and long-term expressions of positive emotion are related to secondary effects of positive mood. For example, cognitive processing that is inclusive and exploratory (Isen, 1987) often accompanies or follows positive expressions. Positive mood also improves memory processes (Isen, 1999; Levine and Burgess, 1997) and serves as a buffer against stress. Those who are induced to be positive will recover more rapidly from stressors (Folkman and Moskowitz, 2000; Fredrickson, 2000). Also, the long-term expression of positive moods leads to a prolonged involvement in an ongoing activity, and several researchers have argued that happiness is related to feelings of safety and would therefore be associated with social gathering and caring for infants (for reviews see Ekman and Davidson, 1994). Finally, happy people are more likely to get married, thereby establishing families (Mastekaasa, 1992).

Thus, happiness in humans facilitates both immediate and long-term social and cognate functions (Fredrickson, 2002; Izard and Ackerman, 2000; Panksepp, 2000a) and may lead to long-term survival benefits. Health benefits are often documented in laboratory studies of animals other than humans. For example, Poole (1997) suggests that unhappy animals are often physiologically and immunologically abnormal, and Hockly et al. (2002) found that the environmental enrichment of lab mice slowed the progression of Huntington's chorea in genetically engineered mice. Environmental enrichment also is known to upregulate genes involved with neuronal growth (Rampon et al., 2000). There is a growing body of evidence supporting the need for a positive emotional environment for optimal health, social and cognitive processes. If positive emotion has these effects, then human emotional needs are a niche to which other species can adapt.

If flowering plants are exploiting a human emotional niche, it must be shown that they directly influence emotional states and thereby, also beneficially influence secondary cognitive and social behaviors. It is the goal of our research studies to demonstrate that some plants, notably domesticated flowers, have a strong effect on emotional state and influence secondary cognitive and social behaviors.

Measurement of Positive Emotion

The measurement of emotion, particularly positive emotion, is reliably done in several ways. Positive expressive movements among humans are reliably measured with facial movement, particularly smiles. The smile is the easiest facial movement to recognize. This is especially important when the movement is brief and embedded in ongoing activity. Self-reports of moods are also reliable when longer mood states are measured.

The Duchenne smile is consistently related to positive emotion in humans and is a reliable indicator of happiness, whether or not the happiness can be self-reported (Dimberg, Thunberg, and Elmehed, 2000). For example, Messinger, Fogel and Dickson (2001) showed that the Duchenne smile is associated with reciprocal positive emotion because it is displayed by infants when their mothers are also smiling. Williams et al (2001) argue that the Duchenne smile elicits a hardwired reciprocal response in observers. The Duchenne smile functions both as a shared communication as well as an individual response to positive stimuli. It is a reliable indicator of the ability of a stimulus to elicit immediate positive emotion.

In the course of research on fear stimuli Dimberg and Thell (1988) used pictures of snakes for fear stimuli, and pictures of flowers for neutral stimuli. They found that flowers were not neutral but had effects on rapid changes in facial musculature. They reported that the facial EMG reaction to the flower stimuli is zygomatic muscle activity (smile), which they refer to as a positive response. Dimberg and Thell did not conclude that the study participants exposed to the flower picture were happy because a genuine, or "true" smile (the Duchenne smile) also requires orbicularis oris movement (movement around the eye), which they did not measure. It is possible that they inadvertently discovered a positive emotional stimulus in flowers. This immediate response needs to be tested with further study of the facial response to determine whether the response is indeed the Duchenne smile. This will be one of the first tests we use in Study 1.

If people respond to cultivated flowers with a Duchenne smile, it would be a strong indicator that flowers are an immediate stimulus for positive emotions. Then if interviews and self-reports corroborate the positive effects, this is evidence for long term or secondary effects on mood.

Goals of the Studies

In the following studies we first (Study 1) compare the emotional influence of cultivated flowers with that resulting from comparable objects which supply more basic needs such as food or warmth. We predict that the influence of cultivated flowers on human mood should be powerful both immediately and long term. To measure immediate emotional change we observe smiling behaviors; to measure longer-term mood change we measure mood before receiving a floral bouquet and 3 days afterwards.

In Study 1 we use only female participants; however, if the flowering plants fill a human emotional niche, the effect should, at least partly, overcome local social convention such as gender. Though women are the usual recipients of flowers in 21st Century North America and thought to be more responsive to flowers, this may be related to the perception (or bias) that women are more emotionally responsive generally (Brody and Hall, 2000). Such a bias only reinforces the hypothesis that flowers influence emotion, but does not eliminate the possibility that men can be influenced similarly. In Study 2 we hypothesize that the positive emotional effects of flowers should generalize to men. Finally, if the effect on emotional state is powerful, we predict that the moods produced by cultivated flowers would have positive effects on social behaviors. In Study 2 we measure emotional and social behavior in a naturalistic observation.

The goal of Study 3 is to expand our information about secondary effects to the cognitive area. It also examines the long-term impact of repeated exposure to flowers (i.e. the dose effect). In the third study we provide people living in senior living residences with flowers. We predict that the flowers will have both a long-term effect and a short-term effect on mood. Further we predict that the secondary or spiraling mood changes will influence social behavior and episodic memory.

Study 1 – Immediate Smiles and Long Term Mood Change

To test the effects of flowers, we compared the immediate and long-term emotional behavior of participants who received floral bouquets to the behavior of participants who were presented with flower-irrelevant control stimuli.

Method

Participants

The participants were 147 adult women evenly distributed across three age groups (20-39; 40-59, 60+). Nearly all participants were white (n = 137); 2 were "African Americans", 5 were "Asian Americans", and 3 were "other". Women were chosen for several reasons: (1) they are more facially expressive, making the coding of their immediate emotional response more reliable; (2) they are more likely to report shifts in moods, especially negative moods (Brody and Hall, 2000) and (3) women are the more common recipients of flowers in the local culture. The participants were recruited through alumnae newsletters, newspaper advertisements and postings in grocery stores and churches in the New York-New Jersey Metropolitan Area.

Stimuli

The mixed-flower bouquet (including roses, lilies and stocks) was chosen after consultation with the Society of American Florists about the most popular bouquets. A mixed-flower bouquet has a variety of colors and odors and should maximize the effect across a diverse group of participants. An initial focus group of 15 women, ages similar to those of the experimental participants, listed stimuli that could substitute for flowers. This initial group was joined by an additional 15 women and these 30 women rated all the stimuli on similarity to flowers. The focus groups selected (1) a fruit and sweets basket (food) and (2) a large, multi-wicked candle (light, heat) on a stand. The selected stimuli had some of the traditional traits of domesticated plants -- food and fuel. Chocolate sweets were not selected because ratings were split, either very high (desirable) or very low (undesirable due to allergies or weight consciousness). The selected stimuli were uniformly rated high. The stimuli all had the same economic value, had some pleasant odor, had variation in color, and were wrapped similarly for presentation in clear plastic with colorful bows.

Measures

Mood Measures. The 24-item Differential Emotion Scale (DES)-long form (Izard, 1971) is divided into 8 subscales representing 8 primary emotions. Each item expresses a feeling, such as "felt like what you're doing or watching is interesting." The DES was developed to measure changes in normal moods rather than dysfunctional ones. A participant was asked to indicate how often she had felt "each of these feelings" in the past 2-4 days, ranging from "0" (Never) to "4" (very often). The Life Satisfaction Scale (LSS; Diener and Larson, 1984) is a 5-item scale including statements such as "So far, I have gotten the important things I want in life." The participant was asked to indicate the extent of her agreement with each statement on a 5-point bipolar scale ranging from "Strongly disagree" to "Strongly agree."

Assessment of Secondary Behaviors. A series of open-ended questions assessed the possible influence of the floral bouquets on secondary behaviors. During the last interview, participants rated the extent and type of social support they had experienced within the last 2-3 days. These included questions about intimate contacts (i.e., people with whom participants had close relationships such as family or friends), relaxation activities, creative activities, and amusements. This interview also included questions about the placement of the stimulus in the home and the use of the stimulus.

Coding the Immediate Positive Emotion. In the first 5 sec after presentation of the stimulus, the coder recorded the presence of (a) the Duchenne smile (zygomatic and orbicularis oris movement), or (b) the zygomatic smile alone (no movement of the muscle orbiting the eye) or (c) no smile. The duration of the movements within the 5 sec was not coded, only their occurrence. These facial muscles are easily discerned and coded even by untrained people. With training, the coding is highly reliable (Ekman, Friesen, and Davidson, 1990; Frank, Ekman, and Friesen, 1993).

Procedure

Participants were recruited for a study about normal daily moods. At initial contact, participants answered demographic questions and scheduled the delivery of the stimulus to their homes. They were told they would receive a gift for their participation, one of 10 possibilities, but were not told which one. All participants agreed to be interviewed by phone three times, including the initial contact. Both interviewers and participants were blind to the stimuli.

Initial Interview Prior to Stimulus. About 10 days before the presentation of the stimulus, the participant was interviewed by an experimenter who had no knowledge of which stimulus would be given to that participant. The experimenter asked the participant to respond to items on both the DES and the LSS.

Stimulus Delivery. Two experimenters delivered the stimuli to the homes of the participants on a prearranged schedule. One presented the stimulus and the other coded the type of smile. The presentation was double blind -- blind to the participant until the moment of presentation and to the coder before and during the presentation. The person holding the box with the stimulus had her entire upper body and face blocked by the box so she was unlikely to give any cue as to the contents. The stimulus was in a large box with one open side. This side was turned away from the participant and from the coder. When the participant had her attention on the box, the open side was turned towards her but the contents were still not visible to the coder. This method of presentation allowed us to focus on the response activated by the stimulus rather than the response to the delivery people. The coder noted the type of smile in the initial 4-5 seconds after the stimulus was uncovered.

Follow-up Interviews. The second interview occurred 2-4 days after the delivery of the stimulus. The interviewer was neither a coder nor a presenter of the stimuli and remained blind to which stimulus the participant had received. The participant again responded to the DES and the LSS. This interview also included open-ended questions to assess social support as a possible secondary effect and to determine use of the stimulus.

Results

Immediate emotional reaction

In the 5 sec following the presentation of the stimulus, 100% of the participants in the flower group responded with the Duchenne smile indicating happiness. The Duchenne smile was common in response to all the stimuli but there was some variation in response to the other stimuli; 10% of participants receiving fruit and 23% of participants receiving the candle did not respond with a Duchenne smile. The differences between the groups is very significant (χ^2 (2, N = 147) = 14.21, *p* = .007). There were age-related preferences to the control items. Older participants were more likely to display the Duchenne smile when presented with fruit baskets than the younger (χ^2 (4, N = 98) = 9.74, *p* = .045). For the candle, age differences were marginally significant. Younger participants were more likely to smile than the older ones (χ^2 (4, N = 98) = 8.99, *p* = .061). In a few cases, we became aware during interviews that some participants preferred another stimulus. However, stated preferences apparently had no effect on the universal Duchenne response to the flowers.

Mood Interviews

All groups of participants showed an expected decline in the intensity of emotions from the first interview to the second. All *t*s on negative emotion were greater than 2.02; all *p*s were less than .05; there were only marginal effects for positive emotions (see Diener and Larson, 1984, on retesting moods). Only the Participants who received the flowers reported an increase in positive emotion on the DES inventory (i.e., enjoyment, M = 0.22, -0.44, and -0.54 for flowers, fruit, and candle respectively; *F*(2, 139) = 3.95, *p* = .02).

All three groups had higher scores on the LSS at the second interview than at baseline (*t*(146) = -4.32, *p* = .001). This is an overall study effect and there was no significant interaction by stimuli.

During the second interview we also asked questions about the use of the stimuli. The flowers were at least twice as likely to be placed in communal space, that is, places such as the foyer, the living room or dining room. Flowers were not very likely to be placed in the most private spaces such as baths, bedrooms or inside cupboards, whereas the other stimuli were more likely to be in private space than in communal space (χ^2 (2, N = 147) = 20.35, $p < 0.001$). Participants who received flowers were more likely than those receiving the other stimuli to answer positively to social support questions (e.g. contacting people, talking intimately) after they received the flowers than before (χ^2 (2, N = 147) = 7.35, *p* = .05). On the other hand, there were no changes in responses to questions about engaging in amusements or relaxation. These results from the interviews suggest that the flowers influence secondary socio-emotional behaviors as well as having a strong effect on immediate emotional behavioral expression. However, these were post-hoc analyses requiring further study.

Discussion

The Duchenne smile is common on the presentation of all the stimuli as expected; however, the highest (100%) response rate occurred to flowers. The only longer term increase in positive moods reported was for those who received flowers. There were additional indications that flowers were different from other stimuli. Follow-up interviews indicated that people who received flowers placed them in communal spaces more often and slightly changed their social behavior.

Study 2 – Social Behavior and Flowers: The Elevator Study

In Study 1, we only included female participants and we only observed one behavior, the smile. It appeared from post-hoc analyses that a broader range of social behaviors might be affected. To expand and confirm the results, in Study 2 we included men as well as women as recipients of flowers. We collected data on the Duchenne smile and other social indicators such as proximity and initiation of conversation. We believed it would be difficult to obtain self-reports of any positive effect of flowers on men in this society when flowers are viewed as very feminine and are seldom presented to men. In the second study we observed Participants being handed single flowers or an alternate stimulus in a constrained social situation - an elevator. The norms for social distance are well established (see Hall, 1966; Sussman and Rosenfeld, 1982), and this is certainly true of public spaces (Burgess, 1983) including elevators. Popular knowledge suggests that the most typical behavior for elevators that are sparsely occupied is for strangers to retreat to opposite corners. We predicted that the smile would occur more for the flower while social distance would decrease, and that the behavior of men and women would be comparable.

Method

Participants

Participants were 122 individuals (60 males, 62 females) who entered a university library elevator alone. Because of the study's focus on naturalistic observation, participants were not made aware that they were being observed. Thus, no age or ethnicity data were obtained; however, the ages of people in a university library will tend to be towards the early 20s, but not exclusively. In this large East Coast University, there are representatives of many ethnic groups.

Stimuli

By random assignment, participants were observed in one of four conditions. (1) In the flower condition, participants received one Gerber Daisy. Gerber or Transvaal daisies are characterized by bold colors and blooms 4-5" across, although there is little odor. (2) In the exposure condition, participants were exposed to a basket of Gerber Daisies, but did not receive anything. (3) In the alternate stimulus condition, participants were not exposed to flowers, but received a pen with a university inscription. (4) In the no-exposure condition, participants were not exposed to flowers, nor did they receive anything; neither a basket nor a sign were present. Flowers and pens were always held in a flat basket. A sign was attached to the basket, “Free Flowers/Gift! The Society of American Florists Supports a Random Act of Kindness Day! People will be receiving flowers/gifts at random, on the elevator. You can pass on the kindness!” In the pen condition, the sign did not include a reference to the Society of American Florists.

Measures

Facial Reaction. At any time after the participant entered the elevator, the female experimenter could note a smile. As in Study 1, three types were recorded: (a) no smile, assigned a value of 0; (b) a polite smile, involving zygomatic muscle movement but no movement of the muscle orbiting the eye, assigned a value of 1; and (c) a Duchenne smile, involving both zygomatic and orbicularis oris movement, assigned a value of 2. Experimenters returned smiles but did not initiate them. The smile with the highest rating was the only one recorded.

Proxemic Behavior. After the elevator began moving, the participant’s proximity to the experimenter was recorded. This was the farthest position taken by the participant after the conversation was initiated and the participant stopped moving into the elevator. The elevator floor was divided into five semi-circular sections with very small grid marks using clear tape, radiating out from the experimenter’s location by the elevator button. The grid marks were easily visible to the experimenters who had placed them but were not likely to be noticed by others. Grid 5 was designated as the area where participants may have touched the experimenter; grid 1 was when the participant leaned on the farthest wall in the corner of the elevator. The grids were arranged 24 inches apart. Proximity was coded on a scale from 1 (farthest away) to 5 (closest or touched experimenter) according to the participant’s location in the elevator.

Initiation of Conversation. After the initial comments made by the experimenter, any conversation initiated by the participant was coded. Superficial remarks such as "Thank you" or "A flower?" were not coded as initiated speech but treated as a response to the experimenter. If the participant initiated conversation beyond the experimenter’s first greeting, a value of 1 was assigned for conversation initiation; if not, a 0 was assigned. Experimenters responded politely but briefly.

Eye gaze/head_orientation. Experimenters noted whether participants were directing their gaze toward them by noting head orientation, recording this as toward the experimenter or away/up/down. Again this was noted in the same time frame as the proximity rating – after the elevator moved and after the first response to the experimenter. If the experimenter observed gaze at or in the direction of the experimenter’s face from the participant, a value of 1 was assigned for the presence of an eye gaze, otherwise, a value of 0 was assigned.

Total Social Score (TSS). Individual scores for (a) type of smile, (b) conversation initiation, (c) proximity to the experimenter, and (d) gaze/head orientation to experimenter were summed to obtain a Total Social Score (TSS) which served as the main dependent variable for the experiment (Cronbach's α = .70, indicating adequate reliability). The possible range for TSS was from 1 to 9.

Procedure

Only one stimulus condition was run per day. On those days when flowers/stimulus were presented, flower/stimulus presentation and flower/stimulus exposure/no presentation were alternated. An individual who entered the elevator became a participant if s/he entered the elevator alone.

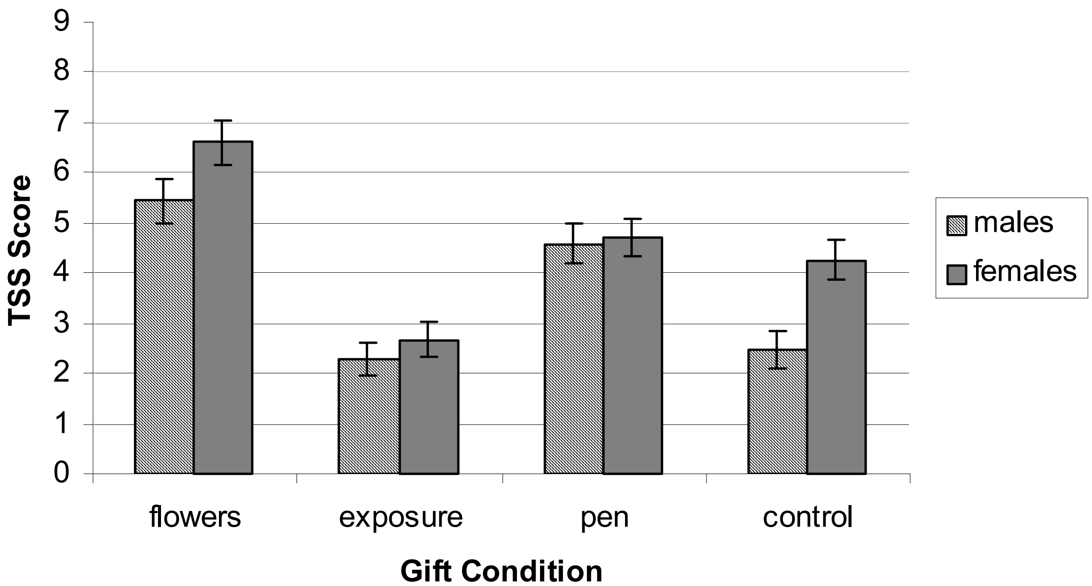
Two experimenters were present. A male experimenter held the basket and positioned himself next to the elevator control panel. A female experimenter stood next to him holding a clipboard for recording data. The experimenters' placement in the elevator did not vary. In the flower/stimulus presentation conditions, the male experimenter initiated conversation according to a pre-constructed script. He also handed the flower or pen to the participant. In the exposure/no presentation and control conditions, he said: "Hi, which floor would you like?" After this brief question or stimulus presentation, the experimenters did not speak except in response to the participant. The female experimenter recorded proximity, conversation, facial movement, and eye contact on a standardized coding sheet. If a participant asked the female experimenter what she was writing, she responded that she was keeping a record of gift recipients for the Society of American Florists. This gave participants the opportunity to request that nothing be recorded about them.

Results

TSS Scores

A 4 (condition) x 2 (gender) analysis of variance (ANOVA) revealed a highly significant difference on TSS by condition, $F(3, 114) = 31.41$, $p = .0001$. Examination of the means by group indicates that the highest levels of social behaviors were displayed in the flower-receiving condition, followed by the pen-receiving condition, the no stimulus condition, and finally the flower-exposure condition. There was also a significant main effect for gender, $F(1, 114) = 9.79$, $p = 0.002$, such that across all conditions, women had, on average, higher TSS than men (for women: M = 4.55, SD = 2.06; for men: M = 3.70, SD = 2.06). However, there was not a significant condition by gender interaction, $F(3, 114) = 1.86$, $p = 0.14$, indicating that both men and women were as likely to respond with more social behaviors when receiving flowers versus receiving pens or receiving nothing.

Figure 1: Differences in Total Social Score (TSS) received by Participants in the four gift conditions. Those receiving flowers received the highest TSS (p = .0001).



Individual Analysis of Social Behaviors

Type of Smile. When all social behaviors were analyzed separately, this pattern of results was strongly maintained. For type of smile, there was a significant difference in the distribution by condition (χ^2(6, N = 122) = 42.73, p = 0.001). Those who received flowers were more likely to respond with the Duchenne smile than those in the other conditions, including those who received pens (simple effects, χ^2(2, N = 122) = 8.72, p = .01). There were no significant gender differences in smile types (p = 0.10).

Proximity and Initiation of Conversation. In terms of proximity and initiation of conversation, those who received flowers stood closer to the experimenter and were more likely to initiate conversation than those in all other conditions (χ^2(12, N = 122) = 43.64 and χ^2(3, N = 122) = 33.38, respectively, both p's = 0.001). Simple comparison of the stimuli-receiving conditions showed proximity was significantly closer for those who received flowers versus those who received pens (simple effects, χ^2(4, N = 61) = 14.05, p = 0.002), while differences in the likelihood of conversation initiation were marginally significant (simple effects, χ^2(1, N = 61) = 2.98, p = 0.08).

Direction of Head. Finally, for gaze/head direction, there were significant differences by condition (χ^2(3, N = 122) = 14.41, p = 0.01), but simple effects comparisons indicated that the presence of gaze direction did not differ between those receiving flowers versus pens ($\chi^2(1, N = 61) = 1.01$, *n.s.*). Thus, while receiving an object from a stranger elicits eye contact regardless of the type of stimulus, it was flowers alone that elicited a higher level of social behaviors including type of smile, proximity, and initiation of conversation.

Discussion

Contrary to cultural expectation, both men and women presented with flowers (as opposed to a pen or with nothing) were more likely to smile, to stand at a social distance rather than at an impersonal distance and to initiate conversation. Men are not expected to prefer flowers, yet they show the same pattern of smiling and approach in Study 2 as women. The prediction that the mere presence of flowers would be positive was not supported. The field notes suggest that participants were disappointed not to have received a flower. We had two cases of individuals in this condition returning to the elevator and asking for a flower. A better test of the presence of flowers that is not contaminated with such expectations is needed.

While the presentation of flowers seems to have more effect on behavior than comparable stimuli, it is possible that this is a very short-term effect. In Study 3, we test the effects of repeated exposure to flowers. We also expand the potential influence of the positive affect induced to include cognitive consequences.

Study 3 – Secondary Effects of Flowers on Senior Retirees: Social and Cognitive Consequences

While the presentation of flowers seems to have important socio-emotional effects on behavior, it is possible that this is largely due to the unusual experimental presentation. People in Study 3 receive two, one or no flower bouquets over a 2-week period. To follow up the social effects seen in the previous studies, in this third study we asked participants to keep daily diaries of social interactions. We also predicted secondary effects of the flowers on cognitive function. If there are generalizing effects of the flowers on moods, then they might affect episodic memory as well as sociability. Depression is known to have negative effects both on social interaction (Reifler, 1994) and on memory (Backman et al., 2000; Gotlib, Roberts, and Gilboa , 1996; Watts, 1995). If negative mood or depression is responsive to flowers, then we predict that there are both social and cognitive secondary effects related to the positive mood increases.

To further demonstrate the predicted secondary effects of flowers on moods, we used a participant population of senior retirees. In this population generally, the rate of depression is underreported (Friedhoff, 1994), withdrawal from social events occurs as a result of such depression (Reifler, 1994) and there is a general decline in episodic memory production (La Voie and Light, 1994; Spencer and Raz, 1995; Zacks, Hasher, and Li, 2000).

Method

Participants

We recruited 113 participants (93 women and 10 men). Their average age was about 73 years (14 Ss aged 55 - 65; 30 Ss aged 65 - 75 and 69 Ss over 75 years). The oldest person giving her exact age was 93 (many declined to give exact ages). Among these, 104 completed the interview part of the study and 91 also completed and mailed the daily logs. Dropping out usually occurred because of a death in the family or illness (no participants died during the study). We removed one participant whose materials had been completed by a relative. Most of the sample was European-American (90), but there were also 7 Asian-Americans, 4 African-Americans, one Native American and 3 “other”. Participants were recruited from retirement communities, from community centers offering programs for seniors, through community video announcements and through postings in stores, churches, and alumni newsletters.

Stimuli

All participants received at least one bouquet, which was identical to the most popular bouquet in Study 1. One group received a second bouquet. The second bouquet was composed of mixed flowers but was monochromatic yellow. Participants were assigned to one of four stimulus conditions. (1) In the primary stimulus condition, the early group, participants received bouquets only the first week, 2-3 days after the baseline interview (to assess the long-term deterioration of the flower effect). (2) In the delayed stimulus condition, the late group, participants received bouquets only the second week, 2-3 days after the second interview (to assess stability of moods and the addition of flowers to the environment). Together, these two groups were the "one flower" group. (3) In the repeated stimulus condition, the “all flowers” group, participants received bouquets after the first and second interviews (to assess "dose" effects of flowers). (4) In the no-stimulus condition, the no-flowers group, participants received bouquets only after the experiment was over (to determine baseline measures of normal mood changes without flowers). A florist delivered the bouquets.

Measures

Focus Groups. We pre-tested the measures on older participants since most of them were designed originally for use with college students. Eight women over age 60 who had participated in Study 1 collaborated with us. None of them would be included in Study 3. We went over the goals and methods of Study 3 with them and asked them to do two things. First, we asked them to pair up so that one person would act as the interviewer and the other as the interviewee. They then performed the whole interview making note of any problems, including length, and then suggested ways to correct them. Any interview questions that were difficult to understand or objectionable were reworded or eliminated. Second, we asked them for a general critique of the research and for advice on recruitment. From this, we developed the social logs and the episodic memory tasks.

Mood Measures. Both the DES and the LSS administered in Study 1 were again administered in Study 3 (see Study 1 for descriptions).

Social Contact Logs. We prepared booklets to help participants keep records of daily social encounters. The information in the booklets also would comprise test items to be recalled for the episodic memory tasks (see below). Participants noted each social contact, making separate entries for 8 categories: family, friends, medical personnel, household services, neighbors, shopkeepers, religious contacts, delivery people, and other. The booklets were entitled "Social Contact Log" with a yellow cover page that included clearly written directions. The contents included 4 pages with 3 or 4 rows of boxes along side each category. Instructions were to begin filling out the log for Week 1 on the day of the interview and to start the log for Week 2 on the day of the second interview. The pages for Weeks 1 and 2 were distinguished by differently colored decorative borders. We mailed each participant the booklets and required a record at least 4 days out of every 7. We included a stamped envelope for their return and reminded participants during phone contacts to complete the logs and return them.

Episodic memory measure. The memory assessment included three sets of memory questions: (a) memory of the flowers (did not include the group who had not received flowers, of course); (b) memory of the booklets used for the daily social contact logs; and (c) memory of a social event that had been indicated on the logs. The set of flower questions asked the participant when they had been received and then asked for comments on "special things" about the flowers. For those participants who had received flowers, one point was given for recall of types of flowers, one for colors, one for the round glass vase and one for the ribbon on the vase. This score was kept separate and used to compare to the other memory score. The set of questions about the booklets included the number of entries per week, the week the booklets were received in the mail, as well "special things" about the booklets. Points were given for naming a category, for describing an icon, for giving the paper color, and for describing the border design. The set of questions about social contacts scored points for describing specific parts of the object or event. Points were given on the memory-for-social contact set of questions if the participant responded with a particular person, time, event and place. One prompt, if necessary, was used to elicit more complete information. The participant received a composite score for the event and the booklet recollections.

Procedure

The interviews were double blind. The participant did not know to which group s/he had been assigned (although this became evident over time). Interviewers never knew to which group the participant was assigned. We asked the participants not to tell the interviewer whether or not they had flowers until the memory task, which included questions about the flowers; this was the last task. The person who scheduled flower delivery was separate from the rest of the lab.

Interviews. The initial contact with the participant simply scheduled interviews and obtained an address so that we could mail the participant a copy of the interview materials, the social contact logs, as well as notify the florist for flower delivery. At the first baseline interview, we obtained baseline data on moods, health, social support, life satisfaction and some demographic description. The interviewer would also make certain that all the materials had arrived and were understood. The interviewers let the participants set the pace for the interviews. There were two more interviews, about a week apart. The second interview was the same as the baseline interview, excluding demographic information. In the third and final interview, we also included the memory task.

Results

Mood Interview

We predicted that the mood effects seen in Study 1 would be replicated. In the first study we compared the group receiving flowers with groups receiving other stimuli. Here we collapsed the groups who received flowers (early or late or both early and late), comparing them with the group who had not received flowers. As expected, the participants who had received flowers had significantly more positive moods (DES scores for happy and interest questions minus depression -- sad, shame, guilt, self-hostility) than participants who had not yet received flowers ($t(102) = 2.07$, $p<.041$). Comparing the groups separately with the no-flowers group reveals trends; examination of means illustrates that these trends are in the expected direction. Participants who had received flowers early reported more interest and happiness (M = 5.24, SD = 3.5) than participants who had not (M = 3.72, SD = 3.3). At the end of the second week all participants who had received flowers again report more interest and happiness (M = 5.39, SD = 3.3) than those without flowers (M = 3.9, SD = 3.9).

There is some evidence that increasing the number of bouquets is additive. On the DES depression score (sad, shame, guilt, and self-hostility) score, 81% of participants who received both bouquets, as well as 64% of participants who received one bouquet, had lower depression scores than they did at the pretest. Only 57% of participants who had not received flowers (i.e., about half the “no flowers group” increased and half decreased their scores, as expected by chance). These slight differences in the direction of shift between the groups are significant ($\chi^2(2, N = 104) = 6.14$, $p = 0.05$). There are no other significant effects on mood or life satisfaction. The other negative affect factors of the DES are not significantly different; the Life

Satisfaction Scale showed no differences.

Social Contact

There were no significant differences by group on the number of social contacts. We hypothesized that the potential for change in social contacts might be very limited for most of the Participants who resided in retirement homes.

Episodic memory—secondary mood effects

Since the mood shifts were found to be most significant between participants who received flowers at all and those who had not, the sample was collapsed into 2 groups, those who had received flowers by the last interview and those who had not. The difference in memory score between these two groups is highly significant. ($t(3) = 3.75$, $p = 0.001$; M = 0.77, SD = 0.88, no flowers condition; M = 1.06, SD = 0.88, flower condition). The secondary effect is as strong or stronger than the reported mood shift.

Discussion

The third study replicates Study 1 in that people receiving flower bouquets are happier and perhaps less depressed than people who do not receive bouquets. People who received two may be happier than people who received one. This suggests that the effects found in Studies 1 and 2 are not due simply to surprise, nor do effects dissipate rapidly when more flowers are provided.

Study 3 provides additional evidence that the increase in positive emotion related to the flowers will have secondary benefits. Participants who received the flowers had higher scores on the episodic memory task than those who had not yet received any bouquets.

Even though we collected daily diaries to report on social interaction and even though an examination of the diaries suggested that a subgroup of socially active senior residents increased their social contacts, there was no effect overall. The social interactions of the people in the retirement community are very regular due to scheduled visits and planned activities. It is possible that the effect would be seen in other contexts with less regimented social interaction. This remains a question for further research.

General discussion

There is very little extant theory that lends itself to an easy explanation for the effects of flowers on positive socio-emotional change as found in our three studies. Any explanation of our findings must consider the puzzling strength of the effect of receiving flowers. In the double-blind design of Study 1, female participants received one of three possible stimuli. Every participant who received flowers responded with the Duchenne smile in the first 5 sec after the visual presentation. Although it is true that the Duchenne smile is the most common response in all stimulus conditions, it occurs significantly more often for the flower presentation, having occurred in every instance. This response was replicated in Study 2 when male and female participants received a single flower. Again the Duchenne smile occurred significantly more often, although it did not reach the 100% response rate found in Study 1. These findings are particularly intriguing because the Duchenne smile is referred to as the "true" smile and is related to changes in brain chemistry and various psychophysiological indices (Dimberg, Thunberg, and Elmehed, 2000). Our results indicate that the simple presentation of flowers, even a single flower, will release a strong and immediate behavior reflecting positive affect. Given the presence of the Duchenne smile, it is possible that the flowers—either through their visual or odorous qualities—have effects on brain chemistry.

As mentioned, Study 2 extends the results of Study 1, showing that even a single flower presented to men or women will elicit a Duchenne smile significantly more often than other stimuli (a pen or nothing). This second study, a naturalistic observation conducted in a public elevator, also investigated other social behaviors. These included the distance participants stood from the experimenter, their initiation of conversation, and their looking towards the experimenter. All these social behaviors increased when a flower was presented. Again, this is intriguing, particularly the findings regarding social distance, since the norms for social distance are well established (see Burgess, 1983; Hall, 1966; Sussman and Rosenfeld, 1982). The most typical behavior for elevators that are sparsely occupied is for strangers to retreat to opposite corners. That flowers in particular closed the distance between strangers is remarkable. That this did not occur when pens were presented indicates that the receipt of a stimulus in itself did not change the relationship between strangers. It was something about the flowers.

Study 3 provided additional evidence that the increase in positive emotion when flowers are presented is substantial. In the third study, most participants were residents in retirement and assisted living settings, though a few still resided in the community while attending senior programs. Demographically, many people in this age group are somewhat depressed and may have decrements in their cognitive skills (e.g., Backman et al., 2000). Nevertheless, presenting flowers continued to have a positive impact on mood. This was sustained or perhaps improved when a second presentation was made. Those participants who received flowers had higher scores on episodic memory tasks.

Anecdotally, the responses are even more fervent than the behavioral observations have indicated. Some participants responded with such unusual (for experimental studies) emotional displays that we were unprepared to measure them and have only field notes to indicate their presence. The delivery experimenters reported that they received hugs and kisses for the flowers. Florists also tell us that this is common. We were invited to return to the participants' homes when they were "off duty" for refreshments. We received attractive "Thank you" cards and letters from several participants who received flowers for allowing them to be in the study, some with photographs of the flowers, one with multiple photographs to show the continuing beauty of the bouquet. In many years of studying emotions, we have never received hugs and kisses, thank you notes or photographs, not even for candy, doughnuts, decorated shirts or hats, gift certificates, or direct monetary payment; the flowers are different.

Theoretical Explanations

Given that there is little theory to guide us, what explanations might we present for these findings? We suggest that the explanations fall into three categories: (1) simple learned associations of flowers with positive social events, (2) associations of flowers with food that could be part of an evolutionary response promoting food search, and (3) flowers as specially evolved human sensory mood enhancers. We will review the evidence and rationale for each possibility.

Learned Associations. We cannot eliminate the strong possibility that the global symbolic meaning of the flowers leads to a positive learned response. Our attempt to use men as a test of differential learning of positive responses to flowers may not be sufficient. It may be necessary to find a society or group of people who do not use flowers in any symbolic way, if possible. Since the mere presence of flowers in study two did not elicit positive social behavior, it remains possible that the learned association between flowers and giving is accounting for much of the effect. The design of study two apparently created an expectation in participants that they would receive a flower. When they did not, the disappointment was palpable. A research design that looks at the effect of flowers in pubic spaces, or perhaps along roadsides, where there is no expectation that they will be given to individuals might answer this question. But even if it is the case that the effect is purely an associative one, it is still somewhat surprising that there are such strong positive mood effects and secondary benefits simply following the receipt of flowers. This associative explanation evades the question about how flowers in comparison to other positive objects, such as food or other highly desirable gifts, have come to have stronger positive emotional associations across cultures and history.

Evolutionary food association. Rather than hypothesize a simple learned association of flowers and positive social habits, one might hypothesize that there has been some evolutionary advantage to the attraction of flowers in their relation to fruits and other food products. For example, Orians and Heerwagen (1992) suggest that aesthetic preferences for landscapes and potentially other growing things are related to early hominid survival when these environmental cues would be related to foraging success. Thus, flowers would be preferred because humans became hardwired to “emotionally” appreciate “beauty” associated with food gathering.

Orians and Heerwagen (1992) postulate that flowers would evoke a positive response (joy), that predicted future food supplies and possibly a better place for rearing progeny.

Pinker (1997) makes a similar suggestion that the attraction to flowers is hardwired into our brain because flowers directly signal the future availability of fruit, nuts, or tubers. Humans remember where and when flowers were observed to obtain food in the future. The strength of this argument is mitigated by the fact that mammals find food with all their senses, most of which are of more immediate use than long term memory for key environmental features (Stiles, 2000). More to the point, the showy flowers that humans seem to find especially attractive generally do not produce edible fruit.

Instead of the association being either learned or innate, we could take a middle position that humans are biologically primed to associate flowers with happiness. Under this condition, recognition of flowers would not be hard-wired, per se, but aspects of flowers would easily become associated with happiness and it would be very difficult to associate flowers with negative emotions (Cook and Mineka, 1987).

Mood Enhancers. Our last explanation takes a different approach but is in some ways an extension of the middle position. The third hypothesis is that various sensory elements of flowers combine, even serendipitously, to directly affect mood. The effect would occur even if a flower were a *de novo* event in a human experience. Using this explanation, flowers prime positive psychological responses because they are “super stimuli,” directly affecting moods through multi-channel sensory interactions (or one of the channels alone might be able to carry the effect). It would be easy to learn positive associations, but the general mood effect would be predicted to occur without learning.

Most of the sensory attractors lead partially or entirely to changes in mood. This process places moods or emotions in a central position for the evolution or even co-evolution of plants and people – a process that is useful for the results of our studies. This theory is congruent with Panksepp’s (2000a) concept of an affective consciousness. According to Panksepp, there are primal neural networks in the posterior thalamic, tectal and periaqueductal regions of the mesencephalon that constantly process emotional information. Organisms seek this information. Sensory stimuli such as visual symmetry, color, odor, and pheromones provide the information sought and affect moods. We will briefly examine some examples of these sensory stimuli as they are not often used to explain socio-emotional results.

With respect to symmetry, Enquist and Arak (1994) argue that we have an evolved preference for patterned symmetries because these can be detected easily as a recognizable signal within in a wide variety of visual arrays. In other words we are attracted to symmetry. The ease of recognition and the familiarity engendered should be associated with improved mood, as well as easy identification (see Zajonc, 1980; for the rationale for an association of familiarity and emotion). There does not need to be an established memory or association to the flower in order for there to be a positive effect. It is the symmetrical pattern alone that is important. One might look at it from the point of view of the flowering plant and describe the effect as one in which the plant uses symmetry to attract a human for seed or tuber dispersal or to protect the plant from predators or dangerous environments. Ultimately, then the plant that only has a preferred symmetry, even if it has no other product, potentially can be protected and dispersed by humans. The result for humans is improved mood.

Similarly, we may have preferences for certain colors based on the primate trichromatic color visual system. Such a preference might have evolved because the various color channels are important in finding ripe fruit against a green background (Osorio and Vorobyev, 1996; Parraga, Troscianko, and Tolhurst 2002) or in distinguishing high protein leaves (Dominy and Lucas, 2001). Again, the preferences for particular colors may be separated from their use in spotting food and become rewarding more generally. Plants with preferred colors that have no other products would be protected and dispersed. Plants with preferred colors and symmetry may become “superstimuli” with the combination.

We might also have a preference for specific floral odors. To our knowledge this has not been extensively studied within the psychological literature for perception and sensing although perfumers have shown that differences in preferences exist (see Jellinick, 1997). Obviously, humans use olfactory information and relate this to other sensory information. The coordination of olfactory and visual cues is known to influence neurological responding. For example, Sarfarazi et al (1999) showed that the amplitude of the P400 visual event related potential was decreased if the odor cue did not match the visual cue. Considered alone, specific odors seem to modulate moods (see Baron, 1997, Schiffman et al., 1995; Shiffman, Suggs and Sattley-Miller, 1995; Freyberg, Wilson, and Haviland-Jones, under review). Schiffman and her colleagues have shown that popular colognes that often have a floral topnote will reduce depression, and Freyberg, Wilson, and Haviland-Jones have shown that certain putative pheromones or fragrances can reduce negative moods, for example.

There is also the possibility that humans might be sensitive to the effects of floral social chemicals. We have long known that a variety of species are responsive to pheromones produced by plants to mimic sex pheromones. The perfume manufacturers have believed for centuries that humans are sensitive to such pheromones and use pheromonal animal products as the base for fine perfumes (e.g., civit, musk). Several researchers have demonstrated mood effects of androstodienone on women (Jacob and McClintock, 2000; Wilson et al., under review; Freyburg, Wilson, and Haviland-Jones, under review). Such social chemicals might function in courtship and increase social behaviors, as well as affecting moods.

Plants are sometimes considered to be biological chemists. Their chemical make-up is rapidly responsive to other species, time of day, and other variables. They could certainly use chemical or visual cues to attract humans. Following the argument that plants have significant, largely unexplored chemical potential, Wilson

(1984) wrote:

> The natural products of plants and animals are a select group in a literal sense. They represent the defense mechanisms and growth regulators produced by evolution during uncounted generations, in which only organisms with the most potent chemicals survived to the present time . .. .Very few pharmaceuticals have been invented from a knowledge of the first principles of chemistry and medicine. Most have their origin in the study of wild species. . .(p. 134).

Is it reasonable to propose that plant-human co-evolution or even domestication is based on socio-emotional rewards? There are many instances of such plant and animal relationships, though they are not usually thought of in this way. Plants may reward animals for defending them. For example, the "swollen thorn" acacia trees of Central America have large thorns which can be used for ant nests. Their leaves have nectaries, which produce nectar consumed by the ants. In return the ants attack any herbivores and even remove vegetation around the trees. If the ants are removed, the plants are soon killed by predators (Janzen, 1966).

Plants attract animals for a variety of reasons and by a variety of methods. Plants utilize animals for pollination, seed dispersal and protection. While the vast literature on the attractiveness of flowers has been focused almost entirely on insect pollinators, some flowers attract vertebrate pollinators. For example, a number of bat-pollinated flowers emit a sulfur-like odor that mimics odors used in bat mating and social recognition (von Helversen, Winkler, and Bestmann, 2000). At least one flower, *Mucana holtonii*, reflects and focuses bat sonar signals to attract pollinators (von Helversen and von Helversen, 1999). Other flowers attract hummingbirds with color; such flowers tend to be red, have symmetrical tubular flowers, and provide a heavy nectar flow.

A wide variety of plants utilize vertebrates as seed dispersing agents (Stiles , 2000). Plants have a variety of powerful mechanisms that could affect mood positively and attract animals for seed dispersal -- including color, odor or even sound. For many plants, including flowering plants, humans are the primary seed-dispersing organism. To our knowledge, humans are the only organism that routinely digs up, divides and replants tubers, bulbs and corms of flowers. Some domesticated flowers may have become dependent upon humans for propagation (Comba et al., 1999). For example, cultivated orchids are a highly selected and preferred flower that is hand pollinated by humans. Orchids have a sensory attractiveness but little or no food or medicinal usefulness for people. These scattered features continue to suggest that plants can attract people even if there is no reward in terms of food, medicine, shelter and so forth. Plants may only enhance or prime positive moods.

The idea that flowering plants with no known food or other survival value have coevolved with humans by using an emotional niche spawns a couple of predictions that can be addressed in future research. First, domesticated flowers should, in general, be better at inducing positive emotions than their progenitors. Second, different flowers will induce their effects through different combinations of modalities. Some might be primarily visual. Others might be visual and olfactory. Some may even mimic human pheromones. Given the wide HLA variation among humans in responses to odor (Jacob, et al., 2002), it is also likely that humans vary in their responses to particular flowers. There may be gender and ethnic effects as well.

An extensive literature search for research on why certain flowering plants are selected for domestication or propagation yields almost nothing. Many books and articles discuss the domestication of plants useful for humans in food, medicine, shelter and so forth; the notable exception is the domestication of flowers. We suspect this is part of the general neglect of emotional processes as major contributors to biological evolution. Flowers cultivated by humans occur in the wild in disturbed ground. Usually they are weeds taking cultivated land away from edible/burnable/constructive produce. If the flowers induced positive emotions they might have been allowed to remain in or near the cultivated fields. The loss in food production due to weeds would have been offset by an increase in positive emotion. The selected offspring of these pleasing plants might have become even more pleasing. We hypothesize that as flowers moved into the new niche created by agriculture there was an increase in variation and the more pleasing and attracting flowers were allowed to remain. At some point humans might have moved from merely tolerating these weedy species to actively saving and sowing the seeds. It has not escaped our attention that the scenario we present for the evolution of flowers is very much like the scenario that Budiansky (1994) presents for the evolution of dogs. Flowers may be the plant equivalent of companion animals.

Our hypothesis is that cultivated flowers fit into an emotional niche - their sensory properties elicit human positive emotions. The flowering plants are thereby rewarding to humans and in return, the cultivated flowers receive propagation that only humans can provide. Demonstration of such a phenomenon fills several gaps in the literature. It supports the basic significance of emotion for survival. As a corollary it supports the adaptive function of positive as well as negative emotion. Finally it opens an area of investigation into the psychological relationships between humans and other species through their sensory properties that have been relatively neglected.

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