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BRIEF REPORT

Sensitivity to the cognitive and affective qualities of odours

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This study examined cognitive and emotional responses to odours in the laboratory in relation to everyday attitudes toward odours. A total of 136 subjects completed a questionnaire about the role of Odours in Everyday Life (OELQ) and their responses were summed to develop an index of overall responsiveness to odours: 36 subjects, who were in the top and bottom quartiles on this index, rated pleasant (e.g., rose) and unpleasant (e.g., synthetic sweat) odours in the laboratory on 7-point scales. Separate factor analyses were done for the OELQ items and the laboratory ratings, and these factors were intercorrelated. The factor analysis on the OELQ data yielded three primary factors, encompassing the Sexual Role of Bodily Odours, Ecological Odour Sensitivity, and Odour-evoked Memories, as well as three secondary factors. Two factors were derived from the laboratory ratings contrasting Cognitive (sensations, images, memories) and Affective (pleasant, soothing, energising) Responses. Correlations among the factors showed that Ecological Odour Sensitivity in everyday life was correlated with strong Cognitive but weak Affective Responsiveness to the laboratory odours. In contrast, the Sexual Role of Bodily Odours (OELQ) was positively correlated with Affective Responses to the odours in the laboratory. These data underscore the dual role of odours in stimulating cognitive and affective reactions both in everyday life and in the laboratory.

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It is typically assumed that the sense of smell in humans is vestigial but data from a variety of sources suggest that odour impressions retain strong influences on cognition and emotion. The primary influence on cognitive processes is ecological and involves the discerning of survival-threatening substances: ''Olfaction is foremost a sensor used to detect potential hazards in food and in the environment'' (Engen, 1991, p. 10). While the ability to verbally label odours is notably poor (Richardson & Zucco, 1989), there appear to be wired-in approach-avoidance tendencies related to odours, as evidenced by a universal aversion toward rotting food and decomposed protein (Schleidt, 1988). Apart from such extreme situations, the hedonic quality attached to odours is malleable and can be shaped through association with emotionally loaded events (Ehrlichman & Bastone, 1992; Herz & Cupchik, 1995). These associations form automatically and incidentally as ''an inherent part of a unitary, holistic perceptual event'' (Engen, 1991, p. 7) and are notably resistant to change. The stronger the emotional experience during encoding in the presence of an ambient odour, the more potent the odour as a cue for subsequently eliciting associations (Herz, 1997). This process lies at the heart of the Proustian phenomenon whereby an ambient odour cue elicits a potent autobiographical memory (Chu & Downes, 2000; Herz & Engen 1996). In addition, individuals may also be differentially sensitive to odours and particular odours may be more meaningful to some than to others as seen by preferences and odour-evoked memories (Wrzesniewski, McCauley, & Rozin, 1999).

The interplay between cognitive and emotional processes can also be observed in the domains of sexuality and social attachment. In relation to sexuality, Freud (1909/1961) proposed that the adoption of an upright posture resulted in an ''organic repression'' (a form of hypocognising odours) whereby previously attractive bodily odours became repellant resulting in an abandonment of the pleasure-smell (*Riechlust*). Bipedalism shifted the centres of olfactory attractiveness upwards and frontwards from the genitals to the axillary organs (Morris, 1967; Stoddart, 1990), providing an underarm zone that could both attract and repulse depending on interpersonal ''chemistry'' and social conventions (Ellis, 1910). A universal distaste for bodily odours emerges in middle childhood, implying the influence of social norms (Peto, 1973; Stein, Ottenberg, & Roulet, 1958). The perfume industry helps to mask these natural human odours with animal and organic scents which subtly bypass the contravening norms and induce unconscious mental associations (Jellinek, 1954). Odour also plays a prominent role in early attachment formation, facilitating kin identification for mammals and people (Macfarlane, 1975; Phillips, 1987).

Research is needed to determine how odours directly affect cognitive processes and emotional reactions (Moncrieff, 1966; Warrenburg, 2002). The present study examined the interrelationships between two kinds of data. First, a questionnaire was developed inquiring about the ecological, sexual, social/personal, emotional, and memory-related role of odours in everyday life. Second, respondents who were most and least responsive to odours in everyday life, based on responses to the questionnaire, participated in a laboratory study examining their reactions to pleasant and unpleasant odours on cognitive (e.g., sensations, images, memories) and affective (e.g., pleasing, soothing, energising) dimensions. It was generally hypothesised that individual differences in everyday sensibilities regarding odours would be reflected in responsiveness to the cognitive and affective qualities of odours in the laboratory.

METHOD

Participants

A total of 136 students attending the University of Toronto and Ryerson University in Toronto participated in Part One (Odours in Everyday Life Questionnaire) of the study. There were 37 males and 99 females, who chose pseudonyms to identify themselves on the questionnaire, and their mean age was 23.2 years. Two groups were then selected for participation in the laboratory phase of the study based on summed responses to the 43 items of the Odours in Everyday Life Questionnaire (OELQ) indicating an *overall responsiveness to odours* in everyday life. In Part Two of the study, 35 subjects, representing the top quartiles of summed OELQ responses (high responsivity—6 males and 10 females) and bottom (low responsivity—7 males and 12 females), participated. The pseudonyms chosen by the students were read out in class and they were paid CAN$10.00 to participate in a one hour laboratory experiment. In accordance with guidelines established by IFF (International Flavors and Fragrances Corporation), subjects could not participate in the study if they had asthma, known respiratory or dermal allergies especially to fragrances, knew or believed themselves to be pregnant, or were taking nasally administered medications.

Materials

Part One: Odours in Everyday Life Questionnaire (OELQ). A 43-item questionnaire was developed to survey the role of odours in assessment of the environment, everyday life practices, sexuality, social relations, and memories (see Table 1). The first question included a 5-point scale (1= a lot less, 5 = a lot more) while the other 42 items involved 4-point scales. The scale for question 2 ranged from (1= not at all important to 4 = very important) and the scales for the remaining 41 questions was 1 = never, 2 = rarely, 3 = sometimes, and 4 = often. The responses of each subject to the 43 items were summed to determine an *overall responsiveness to odours* in everyday life.

Part Two: Laboratory Response to Odours. Two judges rated 18 odours independently and assigned them to pleasant or unpleasant groups. Six pleasant and 6 unpleasant odours were selected for use in the study based on 100% agreement between them. These odours were more or less familiar and represented a contrast comparable to freshness (clementine, rose, fresh cut grass, agarbatti incense, coconut, and relaxing pine) versus decay (rotting leaves, mildew, synthetic sweat, smoke) or medicinal/preventative (mothballs, clean fresh pine, or Vick Vapour Rub) odours. Eleven of the odours were provided by IFF, while synthetic sweat came from the Monell Chemical Senses Center. The odours were diluted in diethyl phthalate polyethylene and absorbed into pellets, and were preserved in small opaque amber-coloured jars. They were transferred individually by tweezers into white squeeze bottles with flip nozzles and replaced after losing their potency (generally after six subjects). Letter-number codes were glued to the bottoms of the bottles so that the experimenter could present the odour stimulus in accordance with the established order.

Three randomised orders were prepared with the constraint that three pleasant and three unpleasant odours appeared in the first and second blocks of 6 trials. Half the

TABLE 1
Odours in Everyday Life Questionnaire (OELQ)

Instructions

We are interested in knowing whether people pay attention to odours and the meaning of odours in everyday life. After each question, please circle the answer that applies. Your responses will be kept confidential. Thank you for your participation.

1. How would you rate the amount of attention you pay to odours relative to other people?
2. How would you rate the importance of odours in your day-to-day life?
3. Do you find yourself in situations where you smell something but most other people do not?
4. Do you tend to notice ''off'' odours in the refrigerator before others do?
5. When you have a cold/flu and can't smell, does it bother you?
6. Are you someone who is sensitive to odours in your environment?
7. Have you ever thought you could smell sickness in yourself or other people?
8. Are your food preferences and aversions determined, in part, by the way foods smell?
9. Do you like some smells because they remind you of places?
10. When you like a new place, is it partly because you like the odours there?
11. Do you avoid using public washrooms whenever possible partly because of the way they smell?
12. Do you use deodorants or antiperspirants?
13. Do you wear perfume or cologne?
14. Do you use scented soaps, body lotions or shampoos?
15. Do you use scented laundry detergents?
16. Do you use mouthwash?
17. Do you wear the same clothes two days in a row?
18. Do you scent your shoes using powder or commercial sprays/scents?
19. Do you use air fresheners or deodorisers at home or in your car?
20. Do you think about how you smell to other people?
21. Do you smell your clothes before wearing them?
22. Do you shave your armpits?
23. Do you sniff under your armpits?
24. Do you bathe or shower more than once a day?
25. In general, do you prefer cosmetics/ health products which are scented to those which are unscented?
26. Do you like the way you smell without any deodorants/ scents?
27. Do you think about how you smell to members of the opposite sex?
28. Can you recognise people by the way they smell?
29. Do you eat garlic or onions before social interactions?
30. Do you prefer that other people hide their natural body odour?
31. Are you strongly affected when you are near someone who smells badly?
32. Have you ever been attracted to someone partly because of the way they smell?
33. Do you find it offensive when women do not shave their armpits?
34. Have you ever found someone's perfume or the scent of a product they use repulsive?
35. Are odours important to your romantic life?
36. Do you prefer your sexual partner to hide his/her natural body scent?
37. Have you ever been attracted to your sexual partner's natural body scent?
38. Do you like the way your partner's armpits smell?
39. Have you ever been sexually aroused by someone's natural body scent?
40. Have you ever been soothed by someone's natural body scent?
41. Have odours ever brought back memories of places you haven't been for some time?
42. Can you remember how certain people smell in your mind?
43. Have odours ever brought back memories of people you haven't seen for some time?

subjects received the odours in the order 1 through 12, while the other half of the subjects were presented the odours from 12 through 1. Six subjects were randomly assigned to 5 of the 6 stimulus presentation orders formed by the combination of three Randomised Orders and two Directions (1 through 12, 12 through 1) and five subjects were assigned to the remaining presentation order.

Procedure

Subjects were run individually in a 3 m × 3.3 m windowless room with the door kept ajar. Air was circulated through vents in the ceiling and constant room temperature was maintained. Subjects were told that ''the purpose of the following study is to investigate people's impressions of odours''. They were presented with the odours according to the assigned randomised sequence and were permitted to squeeze the bottle as many times as needed in order to give their ratings.

Subjects first indicated whether or not they could identify the odour. Then they rated the odour on twelve 7-point scales; how familiar (e.g., 1 = extremely unfamiliar, 7 = extremely familiar), pleasant, intense, soothing, energising, and orient toward or away from. They also assessed the degree (1=none at all, 7=a great many) to which the odour evoked sensations, images, feelings, memories, and clarity of those memories (1=extremely vague, 7=extremely clear). Subjects were informed of the odour name at the end of the trial and asked ''If I tell you the name of the odour, does it help 'lock it in' and make it more familiar?'' (1=not at all, 7=very much so).

RESULTS

Part One: Odours in Everyday Life Questionnaire

Factor analysis. The 43-item Odours in Everyday Life Questionnaire (OELQ) was completed by 136 respondents and these data were submitted to a factor analysis, with varimax rotation, yielding 6 factors with eigenvalues greater than 1.00. The results in Table 2 include all factor loadings for each of the factors with absolute values of .50 or greater (see Berlyne & Ogilvie, 1974; Cupchik, 1974). The first factor highlighted the Sexual Role of Bodily Odours with natural body scents *attracting*, *arousing*, and *soothing* the respondents who also *liked* the smell of their partner's armpits. The second factor reflected Ecological Odour Sensitivity to informative qualities of odours, with respondents indicating that they were *sensitive to*, *aware of*, and *attentive to* odours in everyday life. The third factor explicitly linked Odours and Memory for respondents *remembering* and *recognising* both people and places. The next three factors pertained to everyday practices and the social aspects of odours encompassing the *Use of Artificial Scents* (Factor 4), *Odour Self-awareness* (Factor 5), and *Odour Other-awareness* (Factor 6).

Part Two: Laboratory responses to odours

Factor analysis. A factor analysis was performed on the 12 verbal rating scales used to judge the 12 odours, averaging across the 6 pleasant and 6 unpleasant odours. Despite of the restricted sample of 35 participants in the laboratory phase of the study, the mean for each participant on each scale reflected a reaction to a diverse array of stimuli. This

TABLE 2
Factor analysis of the Odours in Everyday Life Questionnaire (OELQ)

Factor	*Item*	*Loading*	*Eigenvalue*
1. *Sexual Role of Bodily Odours*			6.74
Attracted to natural body scent	37	.81	
Aroused by natural body scent	39	.78	
Soothed by natural body scent	40	.64	
Like smell of partner's armpits	38	.62	
2. *Ecological Odour Sensitivity*			3.10
Sensitive to odours in environment	6	.69	
Notice ''off'' odours in fridge	4	.57	
Pay attention to odours	1	.56	
Smell better than others	3	.53	
Importance of odours in life	2	.50	
3. *Odours and Memory*			2.37
Odours evoke memories of place	41	.75	
Odours evoke memories of people	43	.70	
Like smells that remind you of places	9	.62	
Can recognise people by their smell	28	.52	
Can remember smell of people	42	.51	
4. *Use of Artificial Scents*			1.58
Use scented laundry detergent	15	.67	
Use scented soaps or shampoos	14	.63	
Use air fresheners or deodorisers	19	.52	
5. *Odour Self-awareness*			1.34
Think about your smell (opposite sex)	27	.73	
Use deodorants	12	.53	
Think about your smell (other people)	20	.49	
6. *Odour Other-awareness*			1.18
Affected by others' bad smell	31	.54	

contributed to the stability of each scale entry and yielded a clear cut solution with two factors contrasting cognitive and affective responses (see Table 3). Factor 1, Cognitive Responses, represented mental experiences having to do with *clear memories*, *images*, *feelings*, and *sensations* that were *familiar*. Note that a broad array of mental activities were associated with *generalised* feelings. Factor 2 involved Affective Responses that were *pleasantly soothing*, yet *energising*, and participants *oriented-toward* these odours. Two points should be emphasised regarding the Affective Responses factor. First, the three affective dimensions, *pleasant*, *soothing*, and *energising* parallel Wundt's (1903) three classic dimensions of feelings; *pleasantness*, *relaxation*, and *excitement* (see Izard,

TABLE 3
Factor analysis of responses to odours in the laboratory

Factor	*Scales*	*Weights*	*Eigenvalue*
1.	*Cognitive Responses*		6.09
	Evoke memories	.91	
	Clear memories	.91	
	Evoke images	.86	
	Evoke feelings	.78	
	Sensations	.74	
	Familiar	.67	
	Intense	.59	
2.	*Affective Responses*		1.50
	Soothing	.92	
	Orient away-Orient toward	.88	
	Pleasant	.83	
	Energising	.66	

1971). Second, approach behaviour was governed by the affective rather than the cognitive qualities of the odours.

Interrelations between the OELQ and laboratory factors

The intercorrelations among the OELQ and laboratory factors are presented in Table 4. Factor 2 of the OELQ, Ecological Odour Sensitivity, was significantly correlated with Factor 6 of the OELQ, Odour Other-awareness (+.48), and Factor 3 of the OELQ, Odour and Memory (+.36). Thus, a general sensitivity to odours in the environment was associated with both a *spontaneous* aversion to the bad odours of others in daily life and to odour-based *memories* for people and places. At the same time, Ecological Odour Sensitivity was marginally negatively correlated with Affective Responses to odours in the laboratory (−.29). Individuals who were interested in the informational qualities of odours appear to have a tendency to actively disregard the expressive qualities of odours.

Factor 2 of the OELQ (+.55), Ecological Odour Sensitivity, and Factor 6 of the OELQ (+.39), Other-awareness of Odours, were significantly correlated with Factor 1 of the laboratory study, Cognitive Responses. Thus, a self-described general sensitivity in everyday life to meaningful odours in the environment, including the aversive odours of others, was related to judgements of odours in the laboratory emphasising sensations, images, and memories.

Factor 1 of the OELQ, the Sexual Role of Bodily Odours, was significantly correlated with Affective Responses to odours in the laboratory (+.33). Not surprisingly, respondents who described themselves as attracted, aroused, and soothed by the bodily scents of their partners in everyday life reacted in an approaching manner toward the soothing, energising, and pleasing qualities of the odours in the laboratory.

These findings establish a clear cut relationship between self-described attitudes and practices in everyday life involving odours and responses in the laboratory to the two

TABLE 4
Intercorrelations among the OELQ and laboratory factors

	OELQ factors					
Factor	*1 Sexual*	*2 Ecological*	*3 Memories*	*4 Use scents*	*5 Self-aware*	*6 Other-aware*
OELQ						
2. Ecological	−.06					
3. Memories	.19	.36*				
4. Use scents	−.07	.19	−.26			
5. Self-aware	−.01	.20	−.26	−.04		
6. Other-aware	.28	.48**	.20	.06	.18	
Laboratory						
1. Cognitive	.17	.55***	.28	.12	.22	.39*
2. Affective	.33	−.29†	−.05	−.16	−.08	−.18

* $p < .05$; ** $p < .01$; *** $p < .001$; † $p < .10$.

complementary facets of odours, cognitive and affective. Sensitivity to the physical and social ecological odours in everyday life is associated with actively discerning the informational qualities of decontextualised odours in the laboratory. On the other hand, sensitivity to the sexually stimulating and soothing properties of bodily odours in everyday life is expressed in the laboratory as an appreciation of the pleasant, energising, and soothing qualities of bottled odours.

Individual differences

A series of ANOVAs were performed for each of the 12 rating scales, treating Gender and High versus Low Odour Responsiveness in Everyday Life as between-subjects variables, and Odour (pleasant vs. unpleasant) as a within-subjects variable. A replication factor was also included as a within-subjects variable to account for the 6 pleasant and 6 unpleasant odour trials.

The High and Low Responsiveness groups differed significantly from each other on 5 scales related to cognitive responses: *sensations*, $F(1, 30) = 7.56$, $p < .01$, *images*, $F(1, 30) = 10.32$, $p < .003$, *memories*, $F(1, 30) = 7.11$, $p < .01$, *clarity of memories*, $F(1, 30) = 8.61$, $p < .01$, and could *lock-in the name of the odour*, $F(1, 30) = 14.60$, $p < .001$. The High Responsive group experienced more *sensations* ($M = 4.60$), *images* ($M = 4.57$), *memories*, ($M = 4.01$), *clarity of memories*, ($M = 3.79$), and could *lock-in the name of the odour* ($M = 5.30$) compared with the Low Responsive group ($M = 3.94$, $M = 3.69$, $M = 3.25$, $M = 2.94$, and $M = 4.35$, respectively). They were clearly more successful than the Low Responsive group at having perceptual/cognitive experiences involving the odours, but affective responses were *not* implicated. These data suggest that overall responsiveness to odours is predicated on perceptual/cognitive tuning and echo the relationship between Ecological Odour Sensitivity of the OELQ and the Cognitive Responses laboratory factor.

DISCUSSION

The data from the laboratory phase of the project were obtained with a restricted sample of 35 subjects who represented extremes of the overall responsiveness index and repeated measurements using a diverse array of pleasant and unpleasant odours lent stability to the dataset. The results of a factor analysis revealed that odours have complementary cognitive, and affective facets. The cognitive effects encompassed sensations, images, and memories, as well as generalised feelings. The association of generalized feelings with cognitive processes was previously observed in a study where judgements of originality, success, and memorability of sculptures loaded on the same factor with feelings about them (Cupchik & Shereck, 1998). This pairing of cognitive assessment with generalised feelings figured prominently in cognitive balance studies from the 1960s (see McGuire, 1969) suggesting that cognition is always accompanied by some form of affect.

Affective reactions to the odours mapped on to pleasing, soothing, and energising dimensions, the same ones distinguished by Wundt (1903), and these related positively to approach tendencies.

While it may appear paradoxical that the soothing and energising dimensions should load on to the same factor, Pribram and McGuinness (1975) have offered an account of relations between relaxation and excitement. They contrasted a system-modulating *arousal*, which is a phasic physiological response to stimulus input centred in the amygdala, with *activation*, a tonic phase of readiness to respond centred in the basal ganglia of the forebrain. Accordingly, *excitement* (*arousal* in their terms) is modulated by *stimulus properties*, whereas *relaxation* (activation in their terms) has more to do with the state of a *muscular response mode*. Thus, odours can both stimulate sexual excitement while fostering the experience of soothing attachment.

The data obtained from the Odours in Everyday Life Questionnaire highlighted two distinct domains in which odours may play a role in daily life, sexuality, and general ecological sensitivity. The primary factor to emerge from the OELQ concerned the sexual role of odours. Conjectural theories postulating a ''nasal-genital'' link have been addressed in both anecdotal and experimental bodies of literature and a dominant theme in these writings is that sexual allurement by odours occurs mainly at an unconscious level (Book, 1971; Brody, 1975). This is typically attributed to the fact that there are anatomical connections between sexual and olfactory centres in the evolutionary old brain. The present data suggest that humans are, at least to some extent, aware of the psychological (i.e., hedonic, affective) effects afforded by odours in the domain of sexuality.

In contrast, the secondary factor reflected a sensitivity to the informational value of odours *vis-à-vis* matters pertaining to survival. Information about potentially harmful stimuli in the proximate and distal environments is also contained in the odour atmosphere. The ability to discriminate between edible versus poisonous foods, healthy versus diseased conspecifics, and environments with safe versus dangerous air, was of critical importance to survival in evolution, and the olfactory sense retains this early warning function. Thus, the main two factors underlying odour awareness in everyday life correspond to two separate adaptive functions of olfactory processing related to reproduction and survival, respectively.

The results of this study clearly demonstrated that everyday attitudes and practices related to odours map on to behavioural responses in the laboratory. Subjects who were

vigilant regarding the informational value of odours in everyday life were responsive to the cognitive qualities stimulated by odours in the laboratory and suppressed or hypocognised their affective qualities. Generally speaking, respondents who expressed a higher overall responsiveness to odours in everyday life on the OELQ were more sensitive in the laboratory to the cognitively oriented scales related to sensations, images, and memories. This implies that individual differences in cognitive processing of odours may underlie the Proustian phenomenon. Respondents who expressed a sexual responsiveness to odours in everyday life, finding their partner's scent attractive, arousing, and soothing, oriented toward the pleasing, energising, and soothing qualities of the laboratory odours. These latter results suggest that odour plays a fundamental role in attachment, beginning with childhood when soothing physical contact with a caregiver provides pleasure and continuing in adulthood where the scents of sexually significant others can be both energising and soothing.

Researchers in the odor literature have traditionally discriminated on the *stimulu*s side between pleasant and unpleasant odours. The findings of this study established a potentially valuable distinction between cognitive and affective *responses* to odours. Future research might take into consideration the interaction of odour hedonics and odour response in particular stimulus contexts. For example, Cupchik and Phillips (2005 this issue) examined the effects on literary experience of relative hedonic congruence between the theme of short story excerpts (positive, negative) and an odour (pleasant, unpleasant) inhaled while reading the passage. Results showed that positive subject matter combined with pleasant odour to evoke the most images, feelings, and bring the story to life. In a study on the recall of details from literary passages (Phillips & Cupchik, 2004), the combination of positive subject matter and pleasant odour was reflected in more accurate recall of character details, while pairing negative subject matter and unpleasant odour resulted in more accurate recall of setting details. Clearly, odour interacts in a coherent manner with cognitive and affective processes impacting a diverse array of episodes and experiences in everyday life.

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