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Contents:		
	437	The International Society for the Study of Individual Differences (ISSID)
	439	Call for 10th Annual Award Applications to The H.J. Eysenck Memorial Fund
<i>General Articles</i>	440	Correlational and factor analytic support for Rushton's differential K life history theory
D.J. Temperley	445	Alexithymia – Imagination – Creativity
K. Czerwicka and B. Szymura	451	Self-rated attractiveness predicts individual differences in women's preferences for masculine men's voices
J. Vukovic, D.R. Feinberg, B.C. Jones, L.M. DeBruine, L.L.M. Welling, A.C. Little and F.G. Smith	457	Beliefs about the relationships between personality and intelligence
R. Mõttus, J. Allik, K. Konstabel, E.-M. Kangro and H. Pullmann	463	The interplay of perceiving and regulating emotions in becoming infected with positive and negative moods
I. Papousek, H. H. Freudenthaler and G. Schuster	468	Psychopathic traits in adult ADHD patients
H. Eisenbarth, G.W. Alpers, A. Conzelmann, C.P. Jacoby, P. Weyers and P. Pauli	473	Protestant ethic ideology: Its multifaceted relationships with just world beliefs, social dominance orientation, and right-wing authoritarianism
A.N. Christopher, K.L. Zabel, J.R. Jones and P. Marck	478	Preferences for variation in masculinity in real male faces change across the menstrual cycle: Women prefer more masculine faces when they are more fertile
A.C. Little, B.C. Jones and L.M. DeBruine		
<i>[Continued on outside back cover]</i>		
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He sees, she smells? Male and female reports of sensory reliance in mate choice and non-mate choice contexts

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ABSTRACT

Men and women differ in the importance that they ascribe to the characters of a potential mate. Previous work has shown that women rate olfactory cues as more important than men in mate choice. We investigated whether this sex difference (a) is specific to the mate choice context; (b) is reliant upon sexual experience; and (c) exhibits cross-cultural differences between the US (previous study) and the Czech Republic (current study). A questionnaire on the importance of particular senses in different situations was administered to 717 Czech high school students. We replicated existing findings of greater reliance on olfactory cues by women, and of visual cues by men, both for partner choice and during sexual arousal. We also found that women valued olfactory cues significantly more than men in non-sexual contexts. Principal components analysis showed that responses could be grouped by both context and sensory modality. There was no apparent influence of sexual experience on sensory reliance. Cultural differences were also evident: the Czech high school students of our sample rated body odors more positively, and were less visually oriented, than the US university students of previous work.

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1. Introduction

In partner choice, it is commonly held that women value high social status and resources, while men place more value on physical cues (e.g. Buss, 1998). Support for this position has been both theoretical, with reference to male–female differences in reproductive investment (Trivers, 1971), and empirical, although research is based mostly on university student populations and lonely heart advertisements (e.g. Waynforth & Dunbar, 1995; for an alternative view see Mulder, 2004). However, in species such as humans with biparental investment, the theoretical approach also suggests that we might expect sexual dimorphism in partner preference to be less pronounced (e.g. Mealey, 2000). In line with this, it has been suggested that within specific contexts, females might value physical appearance as much as men (e.g. Kenrick, Groth, Trost, & Sadalla, 1993). For instance, women use appearance to judge male socio-economic status in mate choice (Townsend & Wasserman, 1998). The commonly reported male reliance on physical cues could be an artifact of studies that focus almost exclusively on vi-

sual cues such as facial or bodily attractiveness (for reviews, see Gangestad & Scheyd, 2005; Roberts & Little, 2008). Yet physical cues can be perceived through sensory channels other than vision, and these may be of relatively higher importance to women.

Two previous, questionnaire-based studies address this point by asking participants to rate the relative importance of the different senses used within mate choice. The first found that women rate olfactory cues as more important than all other sensory cues when choosing a potential lover (Herz & Cahill, 1997). The second study (Herz & Inzlicht, 2002) allowed respondents to select characteristics related to social and personality factors of a potential partner as well as physical factors. Both men and women rated the pleasantness of the potential lover as most important, but in terms of physical cues, women placed significantly more importance on body odor, and men on visual appearance. Consistent with this, women of all ages are more sensitive than men to different odors (Brand & Millot, 2001), especially to compounds such as androstene steroids contained within body odor (Dorries, Schmidt, Beauchamp, & Wysocki, 1989). Body odor cues may provide useful information related to various desirable qualities of a potential partner (e.g. Havlicek, Roberts, & Flegr, 2005; Thornhill & Gangestad, 1999), or to the genetic basis of a potential partner's immune

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system (their MHC type) and hence their compatibility as a reproductive partner (see Havlicek & Roberts, submitted for publication, for a review). Findings such as these suggest that greater female olfactory sensitivity may have arisen partly under selective pressure for adaptive mate choice.

Yet a functional explanation for the greater female olfactory ability cannot be restricted to mate choice. In many hunter-gatherer societies, women are responsible for much food collection and preparation (e.g. Eibl-Eibesfeldt, 1989), a task that may rely on greater olfactory acuity for the avoidance of toxic or spoiled food. Odor cues may be particularly important during pregnancy, when the developing fetus could be vulnerable to certain foods (Pepper & Roberts, 2006) and when female odor intolerance increases (Nordin, Broman, & Wulff, 2005). Women may make use of olfactory sensitivity in offspring identification and early attachment (see Porter, 1998, for a review). Female olfactory advantage is also apparent in childhood before mate choice is relevant, and may be used in forming familial bonds (Ferdenzi, Coureaud, Camos, & Schaal, 2008).

The main aim of our study was thus to investigate whether differences in self-reports of the importance of olfaction between men and women are restricted to mate choice contexts. To allow for comparison with existing research, we used the questionnaire tool of previous studies (Herz & Cahill, 1997; Herz & Inzlicht, 2002) and also included a newly-designed set of questions relating to the importance of the different senses outside of the mate choice context, namely in environmental contexts. We set out to compare men and women across different contexts, and to analyse whether context or sensory modality was the primary predictor of male/female differences. Our survey took place in the Czech Republic, which allowed for a cross-cultural comparison with previous US-based samples (Herz & Cahill, 1997; Herz & Inzlicht, 2002). Furthermore we also collected information on relationship status and sexual experience to determine their relative impact on the rated importance of sensory cues.

2. Method

2.1. Subjects

Seven hundred and seventeen students (aged 17–19, $M = 17.7$; 318 males) from mixed-sex Prague high schools participated as unpaid volunteers. Questionnaires were administered in three rounds of data collection: June 2000 (JH, 69 male, 53 female participants); September 2000 (JH, 114 male, 148 female participants); autumn 2003 (EJ & JV, 135 male, 198 female participants). These three sessions were included as a factor in the analysis to control for seasonal or researcher effects. Participants were assured that answers would be confidential, and were asked to omit rather than falsify answers.

2.2. Questionnaire

The importance of sensory cues in partner choice was assessed by a Czech translation of the Sensory Stimuli and Sexuality Survey (Herz & Cahill, 1997), which investigates the importance of different sensory modalities in (1) choice of a (potential) lover; and sexual arousal both (2) during and (3) outside of sexual activity. To assess the importance of sensory cues in situations unrelated to mate choice or sexual activity, we developed an analogous questionnaire, the Environmental Sensory Stimuli Inventory (see [Supplementary Material](#)), which investigates the importance of different sensory modalities in: (4) meal choice; the things which (5) attract attention and (6) stimulate memory formation in an unfamiliar landscape; (7) flower choice and (8) pet choice. Participants used a 7-point scale anchored by verbal descriptions

(“strongly agree” and “strongly disagree”) to report their evaluation of the importance of sensory cues in specific contexts (e.g. the importance of visual cues in the selection of a lover or potential lover was assessed by the questionnaire item, “How someone looks can make a big difference to me”; the importance of odor during sexual activity by the item, “Body smells can arouse me”). There were between three and seven questionnaire items, each relating to different sensory channels (e.g. visual, auditory, olfactory, gustatory, tactile cues), for each of the eight sections. Participants also reported sex, age, current partnership status: 169 (43.8%) females and 89 (26.7%) males in a relationship (13 females and 18 males did not respond and total number of sexual partners: 228 (71.1%, median = 1, mean = 2.0) females and 161 (78.5%, median = 1, mean = 2.6) males reported at least one sexual partner; 78 females and 83 males did not respond).

2.3. Statistical analysis

We aimed to compare scores from males and females. If one sex used more of the scale, this would confound our results. To overcome this, we transformed the scores from each individual subject into z-scores, using the formula $z = (X - M)/SD$, where X = single rating, and M and SD = mean and standard deviation of all of the items in each inventory (i.e., Sensory Stimuli and Sexuality Survey or Environmental Sensory Stimuli Inventory). Session 1 participants did not complete the Environmental Sensory Stimuli Inventory; and if a participant omitted to answer any question, we omitted the entire section (e.g. meal choice context) within which the question was contained. Degrees of freedom are adjusted accordingly. Results are qualitatively similar with raw data rather than z-scores, with a few minor differences in the significance level in post-hoc tests. Initial analyses showed that sexual experience had no significant main effect or interaction with sex of participant (all $p > .05$) and did not change the results in any qualitative way; hence sexual experience was not included in the analysis reported. Analysis further revealed two higher-order interactions (lover choice: interaction between questionnaire item, session, relationship status ($F_{6,1929} = 2.3$, $p = .04$); arousal during sexual activity: interaction between questionnaire item, relationship status, participant sex, session ($F_{12,2322} = 1.8$, $p = .04$)) which are not analysed further to avoid over-interpretation of the data on questions that are peripheral to the hypotheses. All other significant effects are reported below.

3. Results

Mixed model ANOVA (unit of analysis: participant; within-subject factors: z-score ratings for each questionnaire item; between-subject factors: gender, session, relationship status) was performed separately for each of the eight sections of the questionnaires, and the Tukey HSD was used for post-hoc comparisons (Statistica 7.1).

3.1. Questionnaire items

Questionnaire items were rated as significantly different in their importance for all contexts (main effect of questionnaire item for the context lover/potential lover ($F_{3,1929} = 71.5$, $p < .001$), sexual arousal during sexual activity ($F_{6,2322} = 123.5$, $p < .001$), sexual arousal during non-sexual activity ($F_{6,3486} = 91.7$, $p < .001$), meal choice ($F_{3,1632} = 424.7$, $p < .001$), attraction of attention ($F_{2,1084} = 194.0$, $p < .001$) and memory formation ($F_{2,1090} = 301.7$, $p < .001$) in an unfamiliar landscape, flower choice ($F_{1,545} = 62.4$, $p < .001$), pet choice ($F_{3,1587} = 146.1$, $p < .001$)); but these main effects were all modified by significant interactions with other variables, set out below.

3.2. Sex differences

Males and females differed significantly in the importance they ascribed to the different sensory cues in every context except for meal choice (i.e., significant interactions between questionnaire item and participant sex for lover/potential lover ($F_{3,1929} = 16.5, p < .001$), sexual arousal during non-sexual activity ($F_{6,3486} = 31.3, p < .001$), attraction of attention in an unfamiliar landscape ($F_{2,1084} = 16.1, p < .001$), memory formation in an unfamiliar landscape ($F_{2,1090} = 3.8, p = .02$), flower choice ($F_{1,545} = 10.9, p = .001$), and pet choice ($F_{3,1587} = 6.6, p < .001$)). The significant interaction between questionnaire item and participant sex for the context arousal during sexual activity ($F_{6,2322} = 26.9, p < .001$) was modified by a significant interaction between questionnaire item, relationship status, participant sex and session ($F_{12,2322} = 1.8, p = .04$, see below.) Table 1 summarises post-hoc comparisons of males and females and ranking of importance for each questionnaire item.

3.3. Relationship status

The analyses revealed several significant effects of, or interactions with, relationship status. In rating of cues important in sexual arousal during sexual activity, participant sex interacted significantly with relationship status ($F_{1,387} = 4.4, p = .04$); coupled women gave higher ratings than single women, although this difference was not statistically significant ($p = .1$). In the context of non-sexual activity, questionnaire item interacted significantly with relationship status ($F_{6,3486} = 2.3, p = .03$): people with a partner were slightly less aroused by products of the imagination ($p = .08$) and visual cues ($p = .1$). Partnered respondents also gave higher ratings overall in their meal choice ratings ($F_{1,544} = 5.7, p = .02$), and single respondents placed a higher value on auditory cues in memory formation in an unfamiliar landscape ($F_{2,1090} = 5.9, p = .003$).

Table 1
Importance of the different questionnaire items for men and women (z-score ratings), by context

	Males			Females			p
	Mean	SD	Rank	Mean	SD	Rank	
<i>Lover choice</i>							
Visual	.472	.055	1–3	.154	.050	3–4	<.001
Auditory	-.049	.058	4	.033	.053	3–4	n.s.
Tactile	.398	.050	1–3	.481	.046	2	n.s.
Olfactory	.454	.044	1–3	.752	.040	1	<.001
<i>Arousal during sexual activity</i>							
Visual	.659	.057	2–3	-.042	.063	5–6	<.001
Imaginary	.232	.064	4–5	.098	.072	2–4	n.s.
Olfactory (bodily origin)	.047	.056	4–5	.231	.063	2–4	n.s.
Olfactory (non-bodily origin)	-.512	.069	6–7	-.127	.077	5–6	<.001
Sexual sounds	.468	.063	2–3	.078	.071	2–4	<.001
Music	-.777	.072	6–7	-.318	.080	7	<.001
Tactile	1.019	.041	1	1.182	.046	1	n.s.
<i>Nonsexual activity</i>							
Visual	.343	.053	1–2	-.163	.051	2–4	.001
Imaginary	.350	.050	1–2	.112	.048	1	.05
Olfactory (bodily origin)	-.304	.055	3–5	-.124	.052	2–4	n.s.
Olfactory (non-bodily origin)	-.753	.057	6	-.405	.054	5	.001
Sexual sounds	-.154	.062	3–5	-.756	.059	6–7	.001
Music	-1.122	.056	7	-.665	.054	6–7	.001
Tactile	-.359	.069	3–5	-.312	.065	2–4	n.s.
<i>Meal choice</i>							
Visual	-.209	.067	3	-.183	.052	3	n.s.
Olfactory	.263	.047	2	.325	.036	2	n.s.
Gustatory	.884	.034	1	.811	.027	1	n.s.
Tactile	-.847	.075	4	-.913	.058	4	n.s.
<i>Landscape: attention</i>							
Visual	.673	.037	1	.603	.029	1	n.s.
Auditory	-.113	.060	2–3	-.197	.047	3	n.s.
Olfactory	-.119	.053	2–3	.190	.041	2	<.001
<i>Landscape: memory</i>							
Visual	.608	.046	1	.533	.036	1	n.s.
Auditory	-.590	.068	2–3	-.737	.053	2–3	n.s.
Olfactory	-.788	.078	2–3	-.602	.060	2–3	n.s.
<i>Flower choice</i>							
Visual	.634	.044	1	.558	.034	1	n.s.
Olfactory	.183	.056	2	.348	.043	2	.03
<i>Pet choice</i>							
Visual	.393	.058	1	.189	.044	1–2	n.s.
Auditory	-.756	.078	4	-.925	.060	4	n.s.
Tactile	-.153	.061	2–3	.122	.047	1–2	.02
Olfactory	-.089	.070	2–3	-.137	.054	3	n.s.

Rank values indicate the order of the mean answers in men and women in each context. p values indicate male/female differences in post-hoc tests; significant ($p < .05$) differences are indicated in bold.

3.4. Session effects

There was a main effect of session on pet choice ($F_{1,529} = 4.9, p = .03$), due to higher overall ratings in the second compared to third session ($p = .052$). There were also significant interactions with session and relationship status (described above) and between session and questionnaire item in the context of sexual arousal during non-sexual activity ($F_{6,3486} = 2.2, p = .001$), but post-hoc comparison of questionnaire items revealed no significant differences between sessions. Further, we tested the temporal dynamics in attitude change by including the factor 'session' as the only independent factor for each of the eight questionnaire sections; only session * questionnaire item (context: sexual arousal during non-sexual activity) was significant ($F_{12,3678} = 2.1, p = .01$), but post-hoc analysis of this interaction revealed no significant differences.

3.5. Contextual effects

Principal component analysis with varimax rotation (PCA; SPSS 12.0) was used to determine whether raters' judgments are independent of the context, i.e., if factors were based on sensory cues irrespective of context, or whether raters' judgments were context-dependent, in which case factor structure should be loaded according to context and not sensory cue. This method (i.e., PCA) is commonly used to explore the structure underlying a large number of variables. Each factor that is extracted is uncorrelated with the previous factors, and accounts for a successively smaller portion of the variance. Male and female scores were analysed separately because of the significant sex differences demonstrated above, and in previous work. To reduce the number of factors extracted, we restricted factors to those with eigenvalues above 1.3. We used varimax rotation because this method minimizes the number of variables with high loading on each factor, simplifying interpretation. Each questionnaire item was assigned to the factor with the highest loading. To maximise interpretability, only items loaded above .45 are reported. The most consistent model consisted of seven factors for females and eight for males (Table 2). The origin (context-dependence or context-independence) is indicated for each factor.

4. Discussion

We set out to determine whether women's reported greater reliance on olfactory cues (Herz & Cahill, 1997; Herz & Inzlicht, 2002) is restricted to mate choice contexts. We used questions previously asked only of US students (replicating: Herz & Cahill, 1997; Herz & Inzlicht, 2002) to allow for a cross-cultural comparison, and added questions about non-sexual contexts so we could determine whether sexual differences were restricted to mate choice. Finally, we collected data on relationship status and sexual experience, allowing investigation of whether sexual experience moderated evaluation of sensory modality.

Men and women responded differently to olfactory cues. Firstly, women considered olfactory cues to be more important than men in both sexual (lover choice, arousal during sexual activity) and environmental (attraction of attention in an unfamiliar landscape, flower choice) contexts. In contrast, men considered visual cues to be more important in sexual contexts (lover choice, arousal during sexual activity). Women are thus more olfactorily oriented in general, not only in sexual contexts. Secondly, females rated perfumes as more arousing during non-sexual contexts than did men, a difference which may be a consequence of female-oriented perfume advertisements. Thirdly, the principal components analysis for women loaded questionnaire items relating to body odors onto one factor ('Arousal'), while loading non-body odors onto a separate

Table 2
Results of PCA analysis (varimax rotation)

Factor	Context	Questionnaire item	Loading	
<i>Female model</i>				
Environmental cues	Meal choice	Olfactory	.436	
		Tactile	.555	
		Auditory (sound)	.744	
	Landscape: attention	Olfactory	.687	
		Auditory (sound)	.666	
		Olfactory	.720	
	Landscape: memory	Olfactory	.493	
		Olfactory	.372	
	Intimacy	Sexual arousal	Sexual sounds	.521
			Tactile	.584
Nonsexual activity		Sexual sounds	.652	
		Music	.633	
Nonsexual activity		Tactile	.565	
<u>Lover choice</u>	Lover choice	Visual	.488	
		Auditory (voice)	.610	
	Lover choice	Tactile	.690	
	Lover choice	Olfactory	.731	
	Meal choice	Gustatory	-.355	
Arousal	Sexual arousal	Visual	.404	
		Imagination	.795	
	Sexual arousal	Olfactory (bodily origin)	.498	
		Visual	.603	
	Nonsexual activity	Imagination	.789	
Nonsexual activity	Olfactory (bodily origin)	.467		
Pet choice	Meal choice	Visual	.605	
		Visual	.741	
	Pet choice	Auditory (sound)	.580	
		Tactile	.566	
Perfume	Sexual arousal	Olfactory (non-bodily origin)	.820	
		Auditory (music)	.520	
	Nonsexual activity	Olfactory (non-bodily origin)	.817	
<i>Environmental visual cues</i>	Landscape: memory	Visual	.703	
		Visual	.753	
	Landscape: attention	Visual	.570	
<i>Male model</i>				
Odors	Lover choice	Olfactory	.506	
		Olfactory (bodily origin)	.780	
		Olfactory (non-bodily origin)	.823	
	Sexual arousal	Olfactory (bodily origin)	.775	
		Olfactory (non-bodily origin)	.833	
	Nonsexual activity	Olfactory (non-bodily origin)	.833	
Environmental cues	Landscape: attention	Auditory (sound)	.615	
		Olfactory	.673	
	Landscape: attention	Auditory (sound)	.647	
		Olfactory	.723	
	Landscape: memory	Olfactory	.723	
Arousal	Sexual arousal	Visual	.320	
		Imagination	.661	
	Nonsexual activity	Visual	.764	

(continued on next page)

Table 2 (continued)

Factor	Context	Questionnaire item	Loading
Nonsexual activity	Imagination	.668	
Nonsexual activity	Sexual sounds	.552	
Pet choice	Meal choice	Tactile	.456
	Pet choice	Visual	.559
	Pet choice	Auditory (sound)	.773
	Pet choice	Tactile	.701
	Pet choice	Olfactory	.570
Intimacy	Sexual arousal	Auditory (music)	.694
	Nonsexual activity	Auditory (music)	.833
	Nonsexual activity	Tactile	.609
Lover choice	Lover choice	Visual	.560
	Lover choice	Auditory (voice)	.587
	Lover choice	Tactile	.621
	Flower choice	Olfactory	.525
Environmental visual cues	Sexual arousal	Tactile	.398
	Sexual arousal	Sexual sounds	.378
	Meal choice	Taste	.429
	Landscape: attention	Visual	.595
	Landscape: memory	Visual	.756
	Flower choice	Visual	.441
<u>Meal choice</u>	Meal choice	Visual	.764
	Meal choice	Olfactory	.714

Loadings above .45 are marked in bold. Each questionnaire item was assigned to the factor with the highest loading. Factors that are loaded by identical sensory cues across different contexts are marked in italics (i.e. context-independent judgments); factors that were loaded only by items within a particular questionnaire context are underlined (i.e. context-dependent judgments).

factor ('Perfume'). In contrast, men's responses to all odors loaded together onto one factor ('Human odors'). These results again suggest a more complex response to olfactory cues in women.

We also used the PCA to establish whether sensory cues would be grouped together into their underlying components irrespective of the context in which they were judged, which would suggest that their importance is independent of context; or whether the contexts themselves would predict the groupings, which would suggest that the importance of cues changes between different contexts. In fact, both types of groupings were evident. Questionnaire items relating to female lover choice and male meal choice were grouped together, irrespective of sensory modality, suggesting that sensory modalities may be used in a different way in these compared to other contexts. Similarly, for both men and women, factors relating to 'Intimacy' (situations of close interpersonal contact) and 'Arousal' (more distant contacts) also grouped questionnaire items from two similar questionnaire sections (arousal during non-sexual and sexual contexts) irrespective of sensory modality, suggesting that choice of sensory modality is subordinate to context. Evidence for the primacy of sensory modality over context was provided by the grouping together of multiple questionnaire items relating to a single sensory modality for the factor 'Environmental visual cues' in women, and the factor 'Odors' in men. Additionally, the PCA did not combine sensory cues related to socio-sexual contexts together with those related to environmental contexts, suggesting that sensory cues are prioritised differently in the context of mate choice compared to non-sexual, environmental contexts.

Cultural differences in sensory cue evaluation were apparent from a comparison with previous data from US students (Herz & Cahill, 1997; Herz & Inzlicht, 2002). Students within the US sample appeared to be more visually oriented: visual cues were rated as most arousing (by men) or second most arousing (by women). Amongst Czech students, visual cues were second most arousing for men, but were preceded in importance by almost all other senses for Czech women. Female rating of body odor also demonstrated cultural differences. Although women in both samples found odor cues highly important to lover choice, body odor was

rated least arousing by the US women, but second most arousing by the Czech women. If body odor is used in both cultures, it seems to be viewed as a positive asset amongst Czech women and a negative asset amongst US women. This might be a consequence of the prevailing culture in the US which evaluates body odors as negative and suggestive of low hygiene standards (Classen, Howes, & Synnott, 1994). Moreover, body odor might also be associated with individuals of low social-economic status, essential to women's mate decisions (e.g. Townsend & Wasserman, 1998). If such reactions are being established in the Czech public sphere, they have still not fully entered the private domain (i.e., sexual contexts). Advertising was highly restricted under the former communist regime, and future studies might investigate whether the rise in perfume advertising has changed attitudes to body odors in the Czech Republic. However, our data show no difference in ratings between 2000 and 2003, suggesting that any such attitude changes must be taking place over a longer period of time.

Our sample was aged 17–19; and, accordingly, participants had less than fully adult experiences in sexual relationships. Although three quarters of the participants who responded reported at least one previous sexual relationship, one quarter of women and a third of men did not respond to this question. Hence, it is possible that only one half of the participants had any previous sexual experience as this issue is highly sensitive for teenagers (Sprecher & Regan, 1996). This estimate concurs with a 1998 census on sexual behavior, where 47% of women and 42% of men reported that their first experience of sexual intercourse had occurred before the age of 18 (Weiss & Zverina, 2001). Irrespectively, we found no significant effect of sexual experience, and no consistent effect of relationship status. Future research could investigate whether greater levels of sexual experience might eventually lead to a moderation in the evaluation of sensory cues in different contexts.

In sum, our results replicated the findings of greater importance of olfactory cues for women and extended this to non-sexual contexts. Comparison with previous work demonstrated cultural differences between US and Czech respondents, a finding that sounds a cautionary note for the generalisation of research findings from the standard experimental cohorts of westernised university students to the rest of the world. In this context, we also note the intrinsic limitations of questionnaire-based surveys: respondents' own perceptions of their senses may in fact be a mental construct derived from cross-sensory interactions (Castiello, Zucco, Parma, Ansuini, & Tirindelli, 2006; Kemp & Gilbert, 1997) rather than a reflection of actual behavior. Nevertheless, our study adds important evidence to the body of literature on the differences between gender in evaluation of sensory cues. It shows that greater female olfactory sensitivity is employed consciously outside of the context of mate choice, a finding that is consistent with hypotheses relating the emergence of greater female olfactory acuity to non-sexual contexts, such as food choice and familial contexts.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.paid.2008.06.019.

References

- Brand, G., & Millot, J. L. (2001). Sex differences in human olfaction: Between evidence and enigma. *Quarterly Journal of Experimental Psychology Section B – Comparative and Physiological Psychology*, *54*, 259–270.
- Buss, D. M. (1998). *Evolutionary psychology – The new science of the mind*. Boston: Allyn and Bacon.
- Castiello, U., Zucco, G. M., Parma, V., Ansuini, C., & Tirindelli, R. (2006). Cross-modal interactions between olfaction and vision when grasping. *Chemical Senses*, *31*, 665–671.
- Classen, C., Howes, D., & Synnott, A. (1994). *Aroma – The cultural history of smell*. London and New York: Routledge.
- Dorries, K. M., Schmidt, H. J., Beauchamp, G. K., & Wysocki, C. J. (1989). Changes in sensitivity to the odor of androstenone during adolescence. *Developmental Psychobiology*, *22*, 423–435.
- Eibl-Eibesfeldt, I. (1989). *Human ethology*. New York: Aldine de Gruyter.
- Ferdenzi, C., Coureaud, G., Camos, V., & Schaal, B. (2008). Human awareness and uses of odor cues in everyday life: Results from a questionnaire study in children. *International Journal of Behavioral Development*, *32*, 417–426.
- Gangestad, S. W., & Scheyd, G. J. (2005). The evolution of human physical attractiveness. *Annual Review of Anthropology*, *34*, 523–548.
- Havlicek, J., & Roberts, S. C. (submitted for publication). MHC related mate choice in humans: A review. *Psychoneuroendocrinology*.
- Havlicek, J., Roberts, S. C., & Flegr, J. (2005). Women's preference for dominant male odour: Effects of menstrual cycle and relationship status. *Biology Letters*, *1*, 256–259.
- Herz, R. S., & Cahill, E. D. (1997). Differential use of sensory information in sexual behavior as a function of gender. *Human Nature – An Interdisciplinary Biosocial Perspective*, *8*, 275–286.
- Herz, R. S., & Inzlicht, M. (2002). Sex differences in response to physical and social factors involved in human mate selection – The importance of smell for women. *Evolution and Human Behavior*, *23*, 359–364.
- Kemp, S. E., & Gilbert, A. N. (1997). Odor intensity and color lightness are correlated sensory dimensions. *American Journal of Psychology*, *110*, 35–46.
- Kenrick, D. T., Groth, G. E., Trost, M. R., & Sadalla, E. K. (1993). Integrating evolutionary and social-exchange perspectives on relationships – Effects of gender, self-appraisal, and involvement level on mate selection criteria. *Journal of Personality and Social Psychology*, *64*, 951–969.
- Mealey, L. (2000). *Sex differences: Developmental and evolutionary strategies*. London: Academic Press.
- Mulder, M. B. (2004). Are men and women really so different? *Trends in Ecology and Evolution*, *19*, 3–6.
- Nordin, S., Broman, D. A., & Wulff, M. (2005). Environmental odor intolerance in pregnant women. *Physiology and Behavior*, *84*, 175–179.
- Pepper, G. V., & Roberts, S. C. (2006). Rates of nausea and vomiting in pregnancy and dietary characteristics across populations. *Proceedings of the Royal Society B – Biological Sciences*, *273*, 2675–2679.
- Porter, R. H. (1998). Olfaction and human kin recognition. *Genetica*, *104*, 259–263.
- Roberts, S. C., & Little, A. C. (2008). Good genes, complementary genes and human mate choice. *Genetica*, *132*, 309–321.
- Sprecher, S., & Regan, P. C. (1996). College virgins: How men and women perceive their sexual status. *Journal of Sex Research*, *33*, 3–15.
- Thornhill, R., & Gangestad, S. W. (1999). The scent of symmetry: A human sex pheromone that signals fitness? *Evolution and Human Behavior*, *20*, 175–201.
- Townsend, J. M., & Wasserman, T. (1998). Sexual attractiveness: Sex differences in assessment and criteria. *Evolution and Human Behavior*, *19*, 171–191.
- Trivers, R. (1971). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man* (pp. 136–179). London: Heinemann.
- Waynforth, D., & Dunbar, R. I. M. (1995). Conditional mate choice strategies in humans – Evidence from lonely hearts advertisements. *Behaviour*, *132*, 755–779.
- Weiss, P., & Zverina, J. (2001). *Sexualni chovani v CR – Situace a trendy (Sexual behavior in Czech Republic – Situation and trends)*. Portal: Prague.