ARTICLE IN PRESS

biology letters

Biol. Lett. doi:10.1098/rsbl.2005.0332

Women's preference for dominant male odour: effects of menstrual cycle and relationship status

Jan Havlicek^{1,*}, S. Craig Roberts² and Jaroslav Flegr³

¹Department of Anthropology, Faculty of Humanities, Charles University, Husnikova 2075, 155 00 Prague, Czech Republic ²Evolutionary Psychology and Behavioural Ecology Research Group, School of Biological Sciences, University of Liverpool, Liverpool L69 3BX, UK

³Department of Parasitology, Faculty of Science, Charles University, Vinicna 7, 127 44 Prague, Czech Republic

*Author for correspondence (jan.havlicek@fhs.cuni.cz)

Body odour may provide significant cues about a potential sexual partner's genetic quality, reproductive status and health. In animals, a key trait in a female's choice of sexual partner is male dominance but, to date, this has not been examined in humans. Here, we show that women in the fertile phase of their cycle prefer body odour of males who score high on a questionnaire-based dominance scale (international personality items pool). In accordance with the theory of mixed mating strategies, this preference varies with relationship status, being much stronger in fertile women in stable relationships than in fertile single women.

Keywords: odour; attractiveness; scent; smell; good genes; mate choice; sexual selection

1. INTRODUCTION

Received 14 March 2005

Accepted 4 April 2005

In many systems, dominance-associated traits have been suggested as honest signals of male genetic quality. Several studies on rodent species have reported preferences for the odour of dominant males (e.g. Mossman & Drickamer 1996; Kruczek 1997; Gosling & Roberts 2001). Odour cues may also play a substantial role in human mate choice. For instance, women prefer the smell of men with low fluctuating asymmetry (Thornhill & Gangestad 1999), which is considered to be a marker of genetic and developmental stability and is an important factor influencing visual attractiveness (Gangestad & Simpson 2000). In addition, humans prefer the scent of opposite-sex individuals with major histocompatibility complex (MHC) genes that are dissimilar (Wedekind et al. 1995; Wedekind & Füri 1997) or intermediately dissimilar (Jacob et al. 2002) to their own (see also Thornhill et al. 2003). Such preferences might result in more viable offspring (Penn 2002).

It has also been observed that preference for men's scent depends on the menstrual cycle phase of women. In controlled experiments, only the women near peak fertility within their cycle preferred scent of men with low fluctuating asymmetry (Gangestad &Thornhill 1998; Rikowski & Grammer 1999; Thornhill & Gangestad 1999; Thornhill *et al.* 2003). Similarly, research on facial attractiveness indicates that female preference for visual masculinity (a trait putatively correlated with dominance) varies across the cycle (Penton-Voak *et al.* 1999) and with partnership status (Little *et al.* 2002). In this study, we investigated whether women's preference for odour of dominant males also varies cyclically and between single women and those in stable relationships.

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

101

102

103

104

2. METHODS

(a) Odour stimuli

Forty-eight male students aged between 19 and 27 were asked to complete an 11-item questionnaire on dominance from the international personality items pool (http://ipip.ori.org/ipip/; Goldberg 1999) and to wear cotton pads in their armpits for 24 h. Pads (Premium cosmetic pads, Boots, www.boots.co.uk) were 100% cotton, elliptical in shape, approximately 9×7 cm at their longest axis and held in place using MicroporeTM surgical tape (Boots). The questionnaire was used intact and corresponds to the scale 'Narcissism' in the widely used California psychological inventory (CPI). Subjects were instructed to avoid spicy and smelly food, alcohol, smoking or using any scented cosmetics on both the evening before and during the day when they were wearing the pads.

$(b) \ \ Subjects \ and \ experimental \ procedure$

Freshly collected pads were presented to 30 female students (mean age 20.6 years) in their follicular phase (days 9 to 15) and to 35 female students (mean age 20.2 years) in other phases of the cycle. The range of days included as falling into the follicular phase (i.e. fertile period) was based on results showing that probability of conception is highest within this 'fertile window' (Wilcox et al. 2000). None of the women were using hormonal contraception. Each of them rated the odour of 10 pads for their intensity, sexiness and masculinity using a 7-point scale. The ratings from each woman were converted to z-scores to compute the correlation between male odour and male dominance as measured by the questionnaire. The obtained correlation coefficients showed a normal distribution and, therefore, were compared with random expectation (r=0) using one-sample *t*-tests. Although our design is between-subjects in nature, this should tend to make our results conservative compared with a within-subjects design.

3. RESULTS

105 We found a positive correlation between male psycho-106 logical dominance and odour sexiness when rated by 107 women in their fertile phase $(t_{29}=3.1, p=0.004,$ 108 mean r=0.20) but not in other phases of their cycle. 109 Subsequently, we tested separately the women who 110 reported to be single and those who were in a 111 heterosexual romantic relationship. A strong associ-112 ation between male odour sexiness and psychological 113 dominance was only found for non-single women in 114 the fertile phase of their menstrual cycle ($t_{12}=4.4$, 115 p=0.0008, r=0.29; figure 1). There was no signifi-116 cant correlation between male psychological domi-117 nance and perceived masculinity of their body odour 118 when rated by single women regardless of phase of 119 their cycle. In contrast, we found a negative corre-120 lation between male dominance and intensity of 121 body odour for both female subsamples (fertile phase 122 of the cycle, $t_{29}=2.3$, p=0.03, r=-0.13; rest of 123 cycle, t_{34} = 3.0, p = 0.005, r = -0.18; figure 2). As this 124 effect was observed irrespective of menstrual cycle 125 phase, the shifts in attractiveness of dominant males 126 cannot be explained by variation in odour sensitivity 127 across the cycle (Doty et al. 1981). 128

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18 19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

ARTICLE IN PRESS



Figure 1. Mean (+s.e.m.) correlation coefficient between the male dominance score and their odour attractiveness rated by single (shaded bars) or partnered women (grey bars) in the fertile and non-fertile phases of their cycle.

4. DISCUSSION

129

130

131

132

133

134

135

136

137

138

139

140

141

142

143

144

145

146

147

148

149

150

151

152

153

154

155

156

157

158

159

160

161

162

163

164

165

166

167

168

169

170

171

172

173

174

Our results indicate that psychological dominance is associated with odour attractiveness. The preference for the odour of dominant men varies with menstrual cycle phase and partnership status of women. The published evidence that men who are visually perceived as dominant are also rated attractive is, however, ambiguous. A positive correlation between attractiveness and perceived dominance was found in one study (Neave et al. 2003), but others have found negative correlations (Perrett et al. 1998; Swaddle & Reierson 2002). None of the studies on facial attractiveness investigated actual dominance in local hierarchies or psychological dominance (i.e. tendency to dominate) of the target subjects. Therefore, it is not clear whether dominant-looking men have a genuine tendency to dominate or whether the attribution of dominance based on facial appearance is misplaced. Evidence for the former suggestion comes from Mueller & Mazur's (1997) study, which found that dominant-looking men reach higher military rank compared with those who look rather submissive. However, even in this case, it remains possible that achieved rank is influenced by dominant appearance without necessarily implying a direct link with psychological dominance.

Although we find that psychological dominance 175 predicts odour attractiveness, we find no significant 176 correlation between dominance and perceived odour 177 masculinity. It has been shown that women rate the 178 smell of androstenone more positively around the 179 time of ovulation (Hummel et al. 1991; Grammer 180 1993). This substance is a significant constituent of 181 axillary odour and is found in much higher concen-182 trations in men than in women (Gower et al. 1985). 183 More objective measurement of odour masculinity 184 185 (e.g. levels of 16 androstenes in the axilla) was 186 unfortunately not available in our study. Dominance 187 is stereotypically attributed to more masculine faces 188 (Perrett et al. 1998). However, it is possible that the 189 relationship between dominance and both perceived 190 and measured odour masculinity differs qualitatively 191 from the relationship between dominance and facial 192 masculinity.

Biol. Lett.



Figure 2. Correlation between standardized ratings of odour intensity and males' dominance score. (a) Ratings by women in the fertile phase of their cycle, (b) Ratings by women in other phase of their cycle. The two correlations are significant (p < 0.05).

217

218

219

220

221

There is no common agreement on the interpret-222 ation of the association between dominance and 223 attractiveness. Some researchers have suggested that 224 the high mating value of dominant men is a result of 225 their tendency to reaching higher socio-economical 226 status and, therefore, gaining the resources that they 227 may invest in their mate and offspring (Mueller & 228 Mazur 1997). Alternatively, dominance has been 229 suggested to honestly reflect male genetic quality. 230 Tendency to dominate is a risky strategy in competi-231 tive encounters and is associated with higher levels of 232 testosterone, which may reduce immunocompetence 233 in various species (Folstad & Karter 1992); domi-234 nance could, therefore, reliably indicate male con-235 dition. There is also evidence that males of high 236 genetic quality have a tendency for lower parental 237 investment (Waynforth 1998). In response, a mixed 238 mating strategy may have evolved in females: they 239 prefer genetically superior males as short-term or 240 extra-pair sexual partners while, at the same time, 241 they seek males who are more willing to invest in their 242 offspring as long-term or social partners (Reynolds 243 1996; Penton-Voak et al. 1999; Blomqvist et al. 2002; 244 Foerster et al. 2003). This interpretation is consistent 245 with our findings that women in stable relationships 246 have a strong tendency to prefer the smell of 247 dominant men when in the fertile phase of their cycle, 248 while single women and all women in non-fertile 249 phases lack this preference. 250

Changes in preference for mate-related traits 251 during the menstrual cycle have been demonstrated 252 repeatedly. Researchers have focused particularly on 253 body odour, symmetry and facial masculinity. The 254 results of four different studies show that the body 255 odour of symmetrical men is rated as more attractive 256

by women in the fertile phase but not other phases of 257 258 the cycle (Gangestad & Thornhill 1998; Rikowski & Grammer 1999; Thornhill & Gangestad 1999; 259 260 Thornhill et al. 2003). Several studies also report that 261 women in the fertile phase of their cycle prefer 262 relatively more masculine faces (Penton-Voak et al. 263 1999; Penton-Voak & Perrett 2000; Johnston et al. 264 2001). The relative preference for more masculine 265 faces was found also when rated by single women or 266 in a short-term partnership context (Little et al. 267 2002). All of the above-mentioned studies are con-268 gruent with our findings and support the hypothesis 269 about female mixed mating strategies dependent on 270 their cyclical and partnership states. 271

The proximate mechanism responsible for the correlation between psychological dominance and odour sexiness is unknown. Nevertheless, previous studies have shown that emotional state (e.g. fear or happiness) may influence perception of body odour quality (Chen & Haviland-Jones 2000; Ackerl *et al.* 2002). The higher self-confidence of dominant males may also have an impact on the perceived sexiness of their body odour.

We thank all volunteers for their participation in the study, two anonymous referees for their comments on the manuscript and Jindra Jileckova for language corrections. This study was supported in part by the NATO Science Fellowship and the Owen F. Aldis Fund (J.H.) and grant no. 0021620828 awarded to J.F. by the Czech Ministry of Education.

REFERENCES

272

273

274

275

276

277

278

279

280

281

282

283

284

285

286

287

288

289

290

291

292

293

294

295

296

297

298

299

300

301

302

303

304

305

306

307

308

309

310

311

312

313

314

315

- Ackerl, K., Atzmueller, M. & Grammer, K. 2002 The scent of fear. *Neuro Endocrinol. Lett.* 23, 79–84.
- Blomqvist, D., Andersson, M., Küpper, C., Cuthill, I. C., Kis, J., Lanctot, R. B., Sandercock, B. K., Székely, T., Wallander, K. & Kempenaers, B. 2002 Genetic similarity between mates and extra-pair parentage in three species of shorebirds. *Nature* **419**, 613–615.
- Chen, D. & Haviland-Jones, J. 2000 Human olfactory communication of emotion. *Percept. Mot. Skills* **91**, 771–781.
- Doty, R. L., Snyder, P. J., Huggins, G. R. & Lowry, L. D. 1981 Endocrine, cardiovascular, and psychological correlates of olfactory sensitivity changes during menstrualcycle. *J. Comp. Physiol. Psychol.* **98**, 45–60.
- Foerster, K., Delhey, K., Johnsen, A., Lifjeld, J. T. & Kempenaers, B. 2003 Females increase offspring heterozygosity and fitness through extra-pair matings. *Nature* 425, 714–717.
- Folstad, I. & Karter, A. J. 1992 Parasites, bright males, and the immunocompetence handicap. *Am. Nat.* **139**, 603–622.
- Gangestad, S. W. & Simpson, J. A. 2000 The evolution of human mating: trade-off and strategic pluralism. *Behav. Brain Sci.* 23, 573–644.
- Gangestad, S. W. & Thornhill, R. 1998 Menstrual cycle variation in women's preferences for the scent of symmetrical men. *Proc. R. Soc. B Biol. Sci.* 265, 927–933.
- Goldberg, L. R. 1999 A broad-bandwidth, public domain,
 personality inventory measuring the lower-level facets of
 several five-factor models. In *Personality psychology in Europe* (ed. I. Mervielde, I. Deary, F. De Fruyt &
 F. Ostendorf), pp. 7–28. Tilburg: Tilburg University Press.
 - Biol. Lett.
 - RSBL 20050332-23/5/2005-12:10-AMALI-150583-XML pp. 1-4

- Gosling, L. M. & Roberts, S. C. 2001 Scent-marking by male mammals: cheat-proof signals to competitors and mates. *Adv. Stud. Behav.* **30**, 169–217. 323
- Gower, D. B., Bird, S., Sharma, P. & House, F. R. 1985 Axillary 5 alpha-androst-16-en-3-one in men and women: relationships with olfactory acuity to odorous 16-androstenes. *Experientia* **41**, 1134–1136.
- Grammer, K. 1993 5- α -androst-16en-3 α -on: a male pheromone? A brief report. *Ethol. Sociobiol.* 14, 201–208.
- Hummel, T., Gollisch, R., Wildt, G. & Kobal, G. 1991 Changes in olfactory perception during the menstrual cycle. *Experientia* 47, 712–715.
- Jacob, S., McClintock, M. K., Zelano, B. & Ober, C. 2002 Paternally inherited HLA alleles are associated with women's choice of male odor. *Nat. Genet.* **30**, 175–179.
- Johnston, V. S., Hagel, R., Franklin, M., Fink, B. & 335
 Grammer, K. 2001 Male facial attractiveness—evidence 336
 for hormone-mediated adaptive design. *Evol. Hum.* 337 *Behav.* 22, 251–267. 338
- Kruczek, M. 1997 Male rank and female choice in the bank vole, *Clethrionomys glareolus*. *Behav. Processes* 40, 171–176.
- 171–176.
 Little, A. C., Jones, B. C., Penton-Voak, I. S., Burt, D. M. &
 Perrett, D. I. 2002 Partnership status and the temporal context of relationships influence human female preferences for sexual dimorphism in male face shape. *Proc. R.*Soc. B Biol. Sci. 269, 1095–1100.
 346
- Mossman, C. A. & Drickamer, L. C. 1996 Odor preferences of female house mice (*Mus domesticus*) in seminatural enclosures. *J. Comp. Psychol.* **110**, 131–138.
- Mueller, U. & Mazur, A. 1997 Facial dominance in *Homo* sapiens as honest signaling of male quality. *Behav. Ecol.* 8, 569–579.
- Neave, N., Laing, S., Fink, B. & Manning, J. T. 2003 Second to fourth digit ratio, testosterone and perceived male dominance. *Proc. R. Soc. B Biol. Sci.* 270, 2167–2172.
- Penn, D. J. 2002 The scent of genetic compatibility: sexual selection and the major histocompatibility complex. *Ethology* **108**, 1–21.
- Penton-Voak, I. S. & Perrett, D. I. 2000 Female preference for male faces changes cyclically: further evidence. *Evol. Hum. Behav.* 21, 39–48.
- Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K. & Minamisawa, R. 1999 Menstrual cycle alters face preference. *Nature* 399, 741–742.
- Perrett, D. I., Lee, K. J., Penton-Voak, I. S., Rowland, D., Yoshikawa, S., Burt, D. M., Henzi, S. P., Castles, D. L. & Akamatsu, S. 1998 Effects of sexual dimorphism on facial attractiveness. *Nature* 394, 884–887.
- Reynolds, J. D. 1996 Animal breeding systems. *Trends Ecol. Evol.* **11**, 68–72.
- Rikowski, A. & Grammer, K. 1999 Human body odour, symmetry and attractiveness. Proc. R. Soc. B Biol. Sci. 266, 869–874.
- Swaddle, J. P. & Reierson, G. W. 2002 Testosterone increases perceived dominance but not attractiveness in human males. *Proc. R. Soc. B Biol. Sci.* 269, 2285–2289.
- Thornhill, R. & Gangestad, S. W. 1999 The scent of symmetry: a human sex pheromone that signals fitness? *Evol. Hum. Behav.* 20, 175–201.
- Thornhill, R., Gangestad, S. W., Miller, R., Scheyd, G.,
 McCollough, J. K. & Franklin, M. 2003 Major histocompatibility complex genes, symmetry, and body scent attractiveness in men and women. *Behav. Ecol.* 14, 668–678.
 380 381 382 382 383

364

365

366

367

368

369

370

371

372

373

374

375

376

324

325

326

327

330

331

339

340

ARTICLE IN PRESS

4 J. Havlicek and others Male dominance and odour attractiveness

- Waynforth, D. 1998 Fluctuating asymmetry and human male life-history traits in rural Belize. *Proc. R. Soc. B Biol. Sci.* 265, 1497–1501.
- Wedekind, C. & Füri, S. 1997 Body odour preferences in men and women: do they aim for specific MHC combinations or simply heterozygosity? *Proc. R. Soc. B Biol. Sci.* 264, 1471–1479.
- Wedekind, C., Seebeck, T., Bettens, F. & Paepke, A. J. 449 1995 MHC-dependent mate preference in humans. *Proc. R. Soc. B Biol. Sci.* 260, 245–249. 451
- Wilcox, A. J., Dunson, D. & Baird, D. D. 2000 The timing of the 'fertile window' in the menstrual cycle: day specific estimates from a prospective study. *Br. Med. J.* 321, 1259–1262.

Biol. Lett.