

Manipulation of body odour alters men's self-confidence and judgements of their visual attractiveness by women

S. Craig Roberts*, A. C. Little†, A. Lyndon‡, J. Roberts*, J. Havlicek§ and R. L. Wright‡

*School of Biological Sciences, University of Liverpool, Liverpool L69 7BX, UK, †School of Psychology, University of Stirling, Stirling FK9 4LA, UK, ‡Unilever Research and Development, Port Sunlight Laboratory, Quarry Road East, Bebington, Wirral, Merseyside, CH63 3JW, UK and §Department of Anthropology, Charles University, Husnikova 2075, Prague, Czech Republic

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Synopsis

Human body odour is important in modulating self-perception and interactions between individuals. Artificial fragrances have been used for thousands of years to manipulate personal odour, but the nature and extent of influences on person perception are relatively unexplored. Here we test the effects of a double-blind manipulation of personal odour on self-confidence and behaviour. We gave to male participants either an aerosol spray containing a formulation of fragrance and antimicrobial agents or an otherwise identical spray that lacked these active ingredients. Over several days, we found effects between treatment groups on psychometric self-confidence and self-perceived attractiveness. Furthermore, although there was no difference between groups in mean attractiveness ratings of men's photographs by a female panel, the same women judged men using the active spray as more attractive in video-clips, suggesting a behavioural difference between the groups. Attractiveness of an individual male's non-verbal behaviour, independent of structural facial features, was predicted by the men's self-reported proclivity towards the provided deodorant. Our results

demonstrate the pervasive influence of personal odour on self-perception, and how this can extend to impressions on others even when these impressions are formed in the absence of odour cues.

Résumé

L'odeur corporelle humaine a un rôle important dans la modulation de la perception de soi et des interactions entre individus. Les fragrances artificielles sont utilisées pour manipuler l'odeur personnelle depuis des millénaires, mais la nature et l'étendue de leur influence sur la perception des personnes restent relativement peu étudiées. Nous testons ici les effets d'une manipulation en double aveugle de l'odeur personnelle sur la confiance en soi et le comportement. Nous avons donné à des participants masculins soit un spray aérosol contenant une formulation de parfum et des agents antimicrobiens, soit un spray identique mais exempt de ces ingrédients actifs. Sur plusieurs jours, nous avons relevé des différences entre les deux groupes expérimentaux sur le plan des mesures psychométriques de confiance en soi et de caractère séduisant auto-évalué. En outre, bien que le caractère séduisant des hommes évalué d'après leur photo par un panel féminin ne révèle aucune différence entre les deux groupes, ces même femmes ont jugé les hommes utilisant le

Correspondence: S. Craig Roberts, School of Biological Sciences, University of Liverpool, Liverpool L69 7BX, UK. Tel.: +44 151 795 4514; fax: +44 151 795 4408; e-mail: craig.roberts@liverpool.ac.uk

spray actif comme étant plus séduisants dans un clip vidéo, ce qui suggère une différence de comportement entre les deux groupes. Le caractère séduisant lié au comportement, indépendant de traits faciaux structuraux, est prédit par la propension des hommes pour le désodorisant fournie. Nos résultats démontrent l'influence majeure de l'odeur personnelle sur la perception de soi, et comment elle peut s'étendre à l'impression faite aux autres même lorsque ces impressions se forment en l'absence d'indices odorants.

Introduction

The importance of the sense of smell in social interactions and behaviour of animals is well known [e.g. 1, 2]. In contrast, olfaction has often been thought to be of minor relevance to primates in general and humans in particular. Herrick [3] classified both as microsmatic, on the basis that olfaction played a minor role in their behaviour. This perception has been dramatically changing over the past two decades. Schaal and Porter [4] directly challenged this classification, showing that odour coordinates behaviour as wide-ranging as maternal recognition by infants, peer-group relationships in pre-pubertal children and reproductive behaviour (see also [5]). Human body odour also provides cues of ovulatory status [6], psychometric dominance [7] and genetic relatedness [8–10].

Despite the potential communicatory significance of human body odour, many cultures have a remarkably uneasy relationship with it. As Stodart [11] puts it: 'human beings behave as if they are afraid of smelling like human beings, for human beings smell bad'. Negative impressions of body odour are widespread [12] and commonly associated with outgroup prejudices such as racist sentiment [13] or attribution of lower social class [14]. Eli *et al.* [15] reported that oral malodour (halitosis) can lead to low self-image and behavioural changes.

At least since the ancient Greek and Egyptian civilizations [11], individuals have employed exogenous fragrances to manipulate their body odour. Although effects of odours on mood and behaviour are well-known [16], relatively little research has examined psychological effects of wearing fragrances specifically applied to the body to enhance or mask personal odour. However, one recent study familiarized women to a pleasant fragrance within their skin care product and showed that

this odour later induced psychological and physiological changes associated with a state of increased relaxation [17]. Beyond effects on the wearer, wearing fragrances can modulate personality attribution and affect towards the wearer in other people, particularly in terms of romantic relationships and sexual attraction [18, 19] but also in other contexts such as job interviews [20, 21].

Here we describe an experiment in which we set out to test the effects of self-perceived personal odour quality on the self-confidence of young men and on the attributions made by others. We used a repeated-measures, within-subject experimental design in which, after having collected baseline information, we asked participants to apply an underarm spray each day. Measures of self-confidence were recorded before application, 15 min after application and 48 h later. This design allowed for body odour development and associated behavioural changes to become manifest. We divided men into two treatment groups: both groups of men received visually-identical deodorants specifically prepared for this experiment, but one group's spray contained a full commercial deodorant formulation whereas the other lacked vital ingredients responsible for fragrance and bactericidal action. We predicted that use of the two formulations would lead to differences between groups in self-confidence and self-rated attractiveness. We also aimed to test whether any induced behavioural effects might alter attributions made by others. To do this, we filmed men while they recorded an introductory video and showed these videos to a female panel in the absence of any odour cues.

Methods

Participants

Participants were 35 heterosexual and non-smoking male students or staff at Liverpool University. Advertisements were distributed throughout the campus and on the University's intranet. An incentive of £15 payment was offered for participation. Participants were aged 19–35 (mean \pm SD: 23.49 \pm 3.43) years. Permission for the study was granted by the University's Biological Sciences Human Ethics Review Board, and all participants gave informed consent. Participants were informed that the research aimed to examine the effects of deodorant use on behaviour, but were provided

with no further details and were unaware of the experimental hypotheses or design; as the same information was given to all participants, this could not have accounted for the observed difference between D+ and D- groups.

Experimental design

A mixed longitudinal design was used. In session 1, participants completed the questionnaires (described below) to record baseline measurements. At the beginning of session 2, approximately 24 h later, participants were allocated test deodorant sprays (see *Deodorant formulations*) and asked to apply them immediately. Participants completed the questionnaires again 15 min after deodorant application (we chose 15 min because it balanced the two requirements of ensuring sufficient exposure had occurred for any potential immediate fragrance-induced effect to occur (cognitive responses to androgen steroids are known to occur within 6 min, for example, [22, 23]) and minimizing inconvenience to participants). They were then instructed to substitute the test deodorant for their usual deodorant for the next 48 h, allowing sufficient time for body odour to develop even after thorough cleansing [24], but not too long so as to inconvenience participants.

Two days later (session 3), they completed the questionnaires for the final time, and were video-recorded. Video clips were collected only once, after 2 days of deodorant use, to avoid practice effects. Deodorants were collected from participants during session 3. At the end of the study, we asked men to rate the pleasantness of the deodorant spray that had been allocated to them, using a Likert scale (1 = unpleasant, 7 = pleasant). All men confirmed they had used the allocated sprays each day.

The independent variable was the type of deodorant given, with assignment alternating in order of recruitment. Eighteen participants were provided with a full deodorant (see below) to use (the D+ group) and 17 were allocated the placebo (D- group). The experimenter was unaware of the group to which participants had been allocated.

In an initial background questionnaire, 32 of the men indicated they used a deodorant spray either every day or on most days; of the three who rarely or never normally used deodorants, one was allocated to the D+ group and two to the D- group. None of the men used the formulation used in this experiment.

Deodorant formulations

Formulations were either available as a commercially available product (the D+ formulation) or form part of one (the D- formulation). Both were an ethanol solution pressurized with a butane/propane gas mix. D+ further contained a proprietary fragrance oil and an antimicrobial ingredient aimed at reducing malodour. Both deodorants were prepared in white 150-mL spray cans marked only with instructions for use and two contact numbers of experimenters for use in the event that any adverse reaction occurred; however, no such reactions were reported.

Questionnaires

In each session, participants completed a questionnaire measuring several variables related to self-confidence and self-perceived attractiveness. This included the physical attractiveness, dominance, assertiveness, self-efficacy, competence and extraversion scales [25] and Rosenberg's Self-Esteem Scale [26]. All scales were taken from the International Personality Items Pool: <http://ipip.ori.org/ipip>. We used Spearman rank correlations (as raw data are measured on an ordinal scale, despite all variables being normally distributed Kolmogorov-Smirnov tests, all $P > 0.2$) to describe correlations between scores (all from Session 1) on these seven primary self-confidence constructs, and with a composite construct, Total Self-Confidence (the sum of the seven primary constructs). Total Self-Confidence is strongly correlated with each of the primary constructs (Table I). In view of this, and to avoid statistical issues involving multiple testing if we used each construct separately, analyses investigating the effects of personal odour manipulation on self-confidence used this composite score.

Raters also completed three independent 5-point Likert scale questions asking participants to rate their facial attractiveness, physical attractiveness and overall appearance [27], and the mean of these was used as a score of self-rated attractiveness.

Images

During the third test session, participants were asked to film a short video of themselves in a scenario in which they were instructed to imagine introducing themselves to an attractive woman. Participants were shown how to use the digital

Table 1 Matrix of correlations between constructs relating to psychological self-confidence. Data are Spearman rank correlation coefficients (r_s) (above) and exact two-tailed P values (below). Significant correlations are highlighted in bold

	SEs	Ass	Com	Dom	Ext	SEf	TSC
PA	.24	.41	.14	.25	.53	-.15	.56
	.158	.015	.436	.142	.001	.395	.000
SEs		.21	.16	.16	.42	.25	.57
		.232	.368	.354	.012	.144	.000
Ass			.36	.63	.55	.43	.74
			.036	.000	.001	.010	.000
Com				.25	.39	.48	.61
				.156	.021	.003	.000
Dom					.38	.21	.64
					.026	.220	.000
Ext						.20	.79
						.243	.000
SEf							.45
							.006

PA, physical attractiveness; SEs, self-esteem; Ass, assertiveness; Com, competence; Dom, dominance; Ext, extraversion; SEf, self-efficacy; TSC, total self-confidence (composite score).

video camera (Sony Handycam DCR-SR52E), and then the researcher left the room. The camera was positioned at a distance of 2 m from a chair in which participants sat, immediately behind which was a plain white background, in a windowless room with standardized overhead lighting (fluorescent tube). A still face photograph was also taken from a distance of 2 m, asking participants to adopt a neutral expression and to look straight into the camera. Video clips were subsequently processed (Adobe After Effects 7.0, cropped to 400 × 480 pixels) and edited to a duration of 15 s (the first 15 s after the subject was judged to be both seated and talking; videos of 15 s or less provide sufficient time to make accurate social and personality judgements [28–30] and attractiveness judgements in particular are typically made in less than a second [31, 32]) and encoded as 25 fps QuickTime movies using the MPEG-4 codec. Photographs were normalized on interpupillary distance, cropped just above the top of the head and just below the chin, and resampled to 400 × 480 pixels (resolution 72 dpi); videos showed seated men from the waist to just above the head. Seven men wore glasses (four in the D+ group, three in the D– group) and three had facial hair (one D+, two D–); these were constant in both photographs and videos.

A panel of eight independent female raters (aged 19–26) assessed the facial photographs of the participants on a 7-point Likert scale (1 = very unattractive, 7 = very attractive). When watching the video clips, the same raters judged the participants with respect to confidence (1 = not at all confident, 7 = very confident) and attractiveness (1 = very unattractive, 7 = very attractive). Photographs were rated before the videos. Video ratings were made twice (with/without sound), in counter-balanced order. Images of individual males were presented in randomized order for each participant within each of the three types of presentation, using either a java applet (for photographs) or Powerpoint (for videos). Both kinds of image were presented with onscreen dimensions of 27 × 20 cm. Mean scores for each male image (photograph or video) were calculated and used in the analyses (Cronbach's α coefficients were within acceptable limits for psychological constructs [33], ranging between 0.65 and 0.77).

Analysis

Data were analysed using repeated-measures MANOVA, with total self-confidence and self-rated attractiveness scores as dependent variables, Session as the within-subjects measure (with three levels) and Group (D+ or D–) as a fixed factor. If the experiment was successful in influencing self-confidence, we would expect a significant interaction between Group and Session. Analyses of judgements of static and dynamic stimuli used two-tailed independent samples t -tests or Pearson correlations (distribution of the data fulfilled statistical assumptions).

Results

Mean scores of self-confidence and self-rated attractiveness across the three test sessions are shown in Fig. 1. Repeated-measures MANOVA on the two dependent variables (total self-confidence, self-rated overall attractiveness) revealed, as predicted, a significant Session × Group interaction [$F(2,66) = 5.30, P = 0.007$]. There were no main effects of Session or Group, indicating that these variables did not vary systematically across the three sessions or between the D+ and D– groups. The significant interaction was attributed more strongly to changes in self-confidence, [$F(2,66) = 3.83, P = 0.027$] than to changes in attractiveness

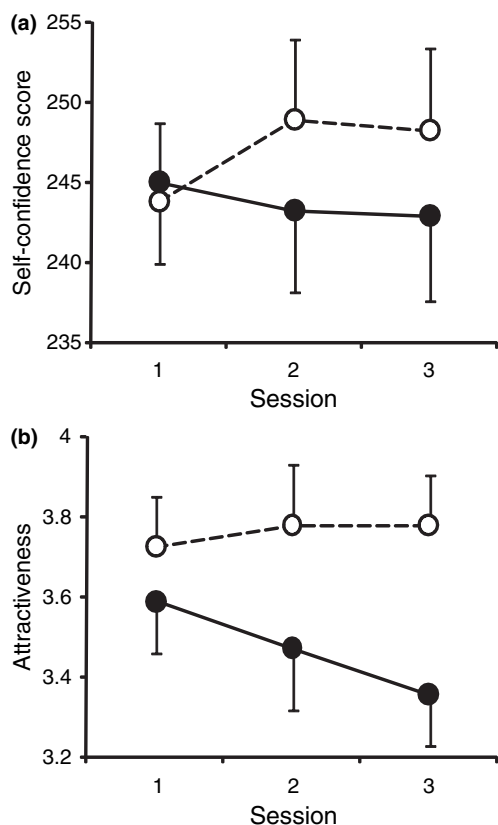


Figure 1 Means and standard errors of scores collected from participants in the D+ (open circles) and D- (closed circles) groups across three sessions spanning 72 h. (a) self-confidence, (b) self-rated attractiveness.

[$F(2,66) = 2.56, P = 0.085$]. Planned contrasts across sessions revealed that self-confidence differed between Sessions 1 and 2 [$F(1,33) = 8.96, P = 0.005$], whereas attractiveness rating did not [$F(1,33) = 1.84, P = 0.18$]. This indicates that self-confidence was sensitive to even a 15-min exposure to the deodorants, whereas there was no comparable short-term effect on self-rated attractiveness. In contrast, differences between Sessions 1 and 3 approached statistical significance for both self-confidence [$F(1,33) = 3.65, P = 0.065$] and attractiveness [$F(1,33) = 4.07, P = 0.052$].

We then examined differences in the perception of individuals in the D+ and D- groups by a panel of independent female judges. We found no difference in the attractiveness ratings of facial photographs of the participants in the two groups [$t(33) = 0.20, P = 0.84$; see Fig. 2a]. There was also no difference in the ratings when video clips were played with sound, [$t(33) = 1.57, P = 0.13$,

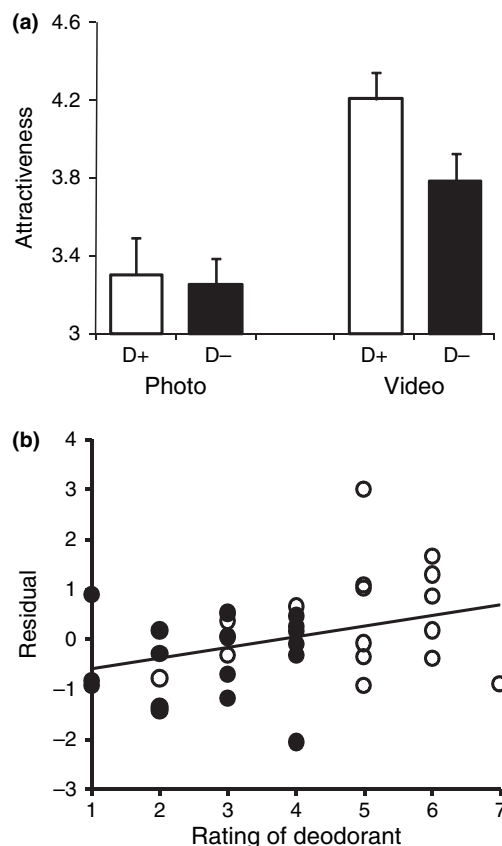


Figure 2 Ratings of male facial attractiveness by female judges. (a) Means (+SE) based on either digital images or video clips. (b) Standardized residuals of video-rated over photograph-rated attractiveness and male-assessed odour pleasantness, for the D+ group (open circles) and D- group (closed circles). Men who expressed liking for the deodorant were more likely judged attractive in video-ratings than expected based on photograph-rated attractiveness.

nor in ratings of participant confidence, either with or without sound, despite attractiveness and confidence judgements being positively correlated [e.g. without sound, $r = 0.703, n = 35, P < 0.001$; Fig.3]. However, video-rated (without sound) attractiveness of the male participants was higher for the D+ group [$t(33) = 2.14, P = 0.040$; Fig. 2a].

Furthermore, we also tested these effects while controlling for facial attractiveness by calculating standardized residuals from regression with video-rated attractiveness as the dependent variable and photograph-rated attractiveness as the independent variable, in order to obtain a measure of the extent to which individual male participants

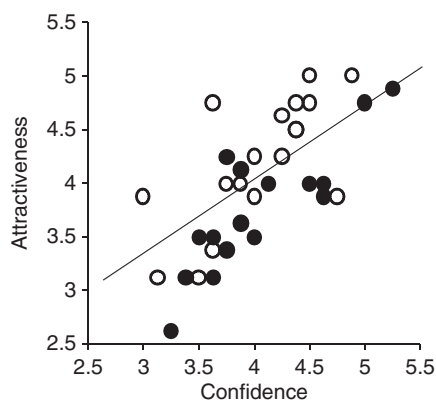


Figure 3 Relationship between ratings of male confidence and attractiveness in video clips. Open circles indicate males in the D+ group, closed circles denote the D- group.

appeared more attractive in the video clips than predicted based on their static image rating. This measure thus parses attractiveness of an individual's movement and non-verbal behaviour from attractiveness of structural facial components. The regression was significant [$F(1,34) = 19.1$, $P < 0.001$, $r^2 = .37$]. Residuals were higher among the D+ group [$t(33) = 2.59$, $P = 0.014$], and were predicted by the self-reported pleasantness of the allocated deodorant [$r = 0.352$, $n = 35$, $P = 0.038$; Fig. 2b].

Discussion

An increasing number of studies demonstrate a pervasive, and hitherto underestimated, influence of olfaction on human behaviour. Our results emphasize the particular importance of combined personal odour and fragrance in modulating both self-perception, especially self-confidence, and consequent perception by others. This is emphasized by the widespread use of exogenous fragrances to mask or augment body odour in many human societies [11] and apparent genetic underpinning of individual fragrance choice [34].

Male participants using active deodorant showed increases in measures of self-confidence compared with those who did not, over a period of only 48 h of body odour manipulation. In fact, a detectable increase was detected in the predicted direction only 15 min post-application, although change in self-rated attractiveness was less rapid. The immediacy of this effect on self-confidence is

perhaps surprising, but consistent with many other studies in psychological responses to fragrances and indeed forms the basis for a growing industry in provision of ambient fragrances, for example in marketing psychology [35]. Figure 2 indicates that the significant interaction we detected between changes in self-rated attractiveness and deodorant use was driven mainly by negative effects in the D- group, with a relatively homeostatic effect being evident in the D+ group. It thus appears that increased intensity of body odour, probably associated with changes in the axillary microbial flora, together with absence of masking fragrance, has a detrimental effect on self-perception of attractiveness.

Our design allowed us to test any self- or other-rated effects resulting from the use of the full deodorant vs. the placebo, but not whether effects are attributable to the fragrance or the antimicrobial agent. This was because we were primarily interested in investigating whether, rather than how, such a manipulation would elicit a measurable behavioural effect. However, the rapidity (within 15 min) of the change in self-confidence is suggestive of an effect of the fragrance in the deodorant treatment, rather than the presence of the antimicrobial agents. In contrast, the absence of these may well have played a role in the declining self-confidence and self-rated attractiveness scores in the D- group over the following 48 h, through a likely increase in body odour intensity associated with growth of axillary bacterial populations. Although this conclusion must remain a preliminary one, the results suggest an interesting further study, which could be conducted to tease apart the effects of the positive, pleasant fragrance contained within the treatment used and the negative effects of increasing body odour associated with absence of antimicrobial action. It would also be of interest to investigate the efficacy of different fragrances on the reported effects.

The reported changes in men's self-assessment could have arisen directly through their own perception of their personal odour and the fragrance, or alternatively, they could have been influenced indirectly through positive or negative reactions of others in interactions during the experimental period. During debriefing, it was found that eight of 10 men among the D+ group reported that comments had been made about their new deodorant, of which seven were positive and one was negative. In contrast, only one (negative) comment

was reported by men in the D- group. These responses could also have contributed to the behavioural differences observed in the videos. However, we think it more likely that the responses were attributable to direct effects on the participants themselves, for two reasons: first, because the increase in self-confidence was higher after 15 min of exposure than after 48 h; second, because (within the D+ group) mean video-rated attractiveness was in fact lower for those men who had received positive feedback compared with those who had received none (mean residual \pm SE, 0.42 ± 0.39 vs. 0.44 ± 0.34).

The analysis of the video ratings of self-confidence, even though only 15 s of exposure was shown to the female panel, demonstrated significantly higher rated attractiveness of D+ males compared with males in the D- group. The absence of a similar effect when raters were asked to specifically focus on and rate confidence is more indicative, perhaps, of the perceptual processing of information in the rater rather than of effects on the males, because attractiveness and confidence ratings were strongly correlated. A similar effect has been found in facial attractiveness research where raters are found to be relatively poor at discriminating symmetry but good at distinguishing attractiveness between images that differ in symmetry [36]. Further, it has also been shown that the ability to detect symmetry is dissociated from preference for it [37], suggesting that the ability to judge a trait like confidence may also not necessarily be related to how attractive it is found. Video-recording was carried out only once because of potential practice effects, and the corresponding analysis is therefore between-subjects whereas the other analyses include a within-subjects design. It is therefore possible that the video-rated attractiveness difference between the two groups was coincidental and unrelated to a change in response to the manipulation. However, we think that this is unlikely on the basis that (i) critically, there was no difference in facial attractiveness between the two groups (the null result for photograph ratings thus acts as a control for the difference in video ratings – the between-group difference seen in videos is not because of the differences in structural facial features visible only in photographs), (ii) even though ratings from static and dynamic images were highly related, the difference between the D+ and D- groups was larger when we controlled for facial attractiveness than when we did

not, and (iii) the extent to which participants appeared more or less attractive than expected based on their static image was predicted by the degree to which they expressed a liking for the deodorant they had been given.

Conclusion

Our results show that changes in self-confidence and self-perceived attractiveness of young men can be induced by the use of a spray containing fragrance and antimicrobial agents compared with a spray lacking these active ingredients. Furthermore, these changes are associated with an effect on the attributions made by others on the basis of visible non-verbal behaviour, even in the absence of any olfactory cues (see also [20]). This effect highlights the flexible nature of self-esteem to respond to rapid changes in one's own physical traits through the use of artificial cosmetic products. An individual's personal odour and the perfume product chosen may thus influence both self-perception and impressions formed by others.

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