

Preregistration

*The influence of fragrance and the ability to signal self-esteem*



## Background

Social communication research has almost exclusively focused on visual, verbal and auditory channels, largely ignoring the role of the chemical sense of olfaction. However, like most other animals, humans are capable of pheromone communication (Wyatt, 2015) also referred to as *chemosignalling* (Doty, 2010). Chemosignalling refers to social communication via odour secreted by humans that is processed by the sense of smell (and not by the vomeronasal organ). In our research programme on social signalling it refers to the ability of a so-called “receiver” to detect or react to another person’s (also referred to as “sender”) emotional state via the body odour they emit from the underarm.

The chemosignalling of emotions seems to be specific. In a recent study, the smell of disgust sweat could be reliably differentiated from sweat produced in fearful or happy participants (Kamiloğlu, Smeets, de Groot, & Semin, 2018). In the research on emotional states, it is assumed that there occurs a temporary change in the composition of the sweat expressed on skin, a chemical profile that is more or less typical of the emotional state experienced by the individual, and that can be discriminated from other states (de Groot, Semin, & Smeets, 2017). The question may be raised whether non-temporal, stable characteristics of individuals, so-called “traits” can be subject to chemosignalling as well.

Evidence from the literature suggest more stable traits can be transmitted in sweat. Gender and sexual orientation signals seem to be transmitted in body odours (Martins et al., 2005). Similarly, Sorokowska and colleagues (2012) suggest personality traits, including dominance, neuroticism and extraversion, can also be identified from someone’s body odour (Sorokowska, 2013; Sorokowska et al., 2012). These findings suggest that in addition to (emotional) states altering the composition or chemical profile of sweat temporarily, there may be an underlying, more stable chemical profile that uniquely expresses individual characteristics that are more stable and less subject to change. In relation to our previous work on chemosignalling of happy state, we now intend to explore more stable positive personality traits, and whether they can be communicated via chemosignalling.

Self-confidence has been regarded to be an independent emotional trait, that is relatively stable across situations, yet can also be changed through situational factors (Orth & Robins, 2014). So while we refer to self-confidence as a trait, we realize that self-confidence is dynamic. Furthermore, self-confidence is a multidimensional construct (Kleitman & Stankov, 2007; Scherer, Shuman, Fontaine, & Soriano, 2013), and closely related to self-efficacy (i.e., feeling being able to complete a task), self-image (i.e., the image one has of themselves, how attractive one finds themselves), and self-esteem (i.e., one’s subjective emotional evaluation of his or her worth). In this project, we will focus on self-esteem.

In the proposed study we investigate whether self-esteem can be signalled via chemicals between individuals. Self-esteem is an important construct for consumer marketing (Durgee, 1986; Truong & McColl, 2011). Additionally, self-esteem has long been the focus of studies in social psychology, and found predictive of the outcome on various measures, such as school performance (Stankov, Lee, Luo, & Hogan, 2012), happiness (Baumeister, Campbell, Krueger, & Vohs, 2003), and satisfaction in relationship and marriage (Orth & Robins, 2014). Low self-esteem is linked to many adverse outcomes, ranging from poor school performance (Stankov et al., 2012) to anxiety, depression and criminal behaviour (Leary, Tambor, Terdal, & Downs, 1995; Orth & Robins, 2014). In addition, self-esteem is theorized as being evolved as a protective mechanism to prevent the disastrous effects of being ostracized in early human communities (Leary, 1999). This merits focusing in on chemosignalling of self-esteem.

As a second topic we are interested in the question whether chemosignalling of self-confidence can be enhanced by pleasant odour. More specifically, can applying perfume boost perceived self-confidence of the wearer in the eyes (and *noses*) of others? In “real life” outside the laboratory, most people, especially in the western world, use deodorants to cover and enhance their body odour with fragrance (Lenochová et al., 2012). We are hardly exposed to natural sweat, as personal hygiene dictates that we cover up unpleasant body odour. Deodorants tend to reduce malodour produced by sweat (or rather than de-odorize, re-odorize it) and it may be assumed that in doing so, they also change the transmission of states and traits.

Fragrance may boost self-confidence in wearers, and this may be picked up in perceivers, too. In one study, male participants rated their self-confidence and were asked to apply either a fragranced deodorant or a placebo (Craig Roberts et al., 2009). After applying, they rated their self-confidence again and were videotaped. The participants rated their self-confidence as higher in the fragrance condition compared to the control condition. More tellingly, a group of women rated the videos of participants that applied fragrance as more attractive and more self-confident than participants who applied the placebo (Roberts et al., 2009). In a different study, participants who at baseline overestimated their body size more accurately judged their body image after applying deodorant (van Paasschen, Walker, Phillips, Downing, & Tipper, 2015), suggesting deodorant effects self-image, which is closely related to self-confidence (Stankov et al., 2012).

So in summary, on the one hand, people may unwittingly signal self-confidence through their body odour, whereas on the other hand, manipulation of one’s body odour can boost self-confidence. In the current study we explore these possibilities.

#### Research questions and hypotheses

*Research question 1:* Is high and low self-esteem signalled in body odor?

*Research question 2:* Can own rated and other perceived low self-esteem be improved by fragrance manipulations of body odor?

*Hypothesis 1.* If self-confidence is signalled via body odour, exposure to sweat from males varying in self-confidence will modulate social judgments related to self-esteem of face stimuli in females: exposure to sweat from low self-confident males will cause lower perceived self-esteem compared to exposure to sweat from highly self-confident males.

*Hypothesis 2.* If fragrance masks low self-confidence, sweat obtained from men with low self-confidence treated with fragrance will lead to higher perceived self-confidence of face stimuli in females.

*Exploratory hypothesis.* In addition to these hypotheses, we will explore whether applying a fragranced deodorant will affect self-reported self-esteem in low confident male donors.

### **Method**

The project consists of two phases, comparable to previous studies investigating social signals in sweat (de Groot, Semin, & Smeets, 2014; De Groot et al., 2015; Kamiloğlu et al., 2018), i.e., a donor phase and a receiver phase.

#### **Phase 1 methods and procedure**

In the donor phase, participants will be selected based on a number of criteria, and pre-screened their trait self-esteem using existing Dutch translated versions of three questionnaires related to self-confidence: the Rosenberg Self-Esteem Questionnaire (RSEQ; Rosenberg, 1979), the Extraversion questionnaire from the NEO-FFI (Costa & McCrae, 1992) and the self-confidence questionnaire from the Hogan Personality Inventory (Hogan & Hogan, 2007). Based on this pre-screening, two groups of participants will be recruited: 20 men scoring in the first quartile of the RSEQ (i.e., men who rate themselves low on self-esteem), and 20 men scoring in the upper

quartile of this questionnaire (i.e., participants who rate themselves high on self-esteem). Sweat will be collected in a mixed between-within design in which each participant from both groups participates in two conditions (between factor: high vs. low self-esteem; within factor: no fragrance vs. fragrance) in counterbalanced order. Participants will be asked to join two consecutive sessions separated by a week for the collection of non-fragranced sweat and fragranced sweat. During each visit, participants will perform a filler task, composed of 5 minutes of word-search puzzles, two clips of the television show 'how it's made', and 5 minutes of playing the arcade game Tetris. After these filler tasks, participants' current self-esteem is measured using two implicit tasks: the signature task (Rudman, Dohn, & Fairchild, 2007; Zweigenhaft, 1977) and the name-initial preference task (Nuttin, 1985; Stieger, Voracek, & Formann, 2012), as well as the State Self-Esteem Survey (SSES; Heatherton & Polivy, 1991). Finally, participants complete a current emotional state questionnaire (as was used in De Groot et al., 2015).

After this, the sweat pads are removed, weighed and cut into 8 parts and frozen in vacuum sealed bags.

**Participants.** For the Donor study (Phase 1), a group of 100 potential participants will initially be invited to complete the pre-screening questionnaire. From this, two groups of 20 participants will donate their sweat during two sessions. All male participants will be matched on age, and only non-smokers or recreational not-current smokers will be selected. Medication use that may interact with the research agenda is evaluated on a case-by-case level.

**Sweat collection procedure.** In the donor phase, sweat collected from individuals onto pads held in the underarm serves as the odour stimulus. Sweat will be collected from both the left and right underarm. Each sweat pad will be cut into 8 equal pad parts and sealed, vacuumed and frozen immediately after donation. The sample size is based on practical considerations, and will enable us to create enough odour stimuli for the receiver study. These stimuli tend to be very variable, and to reduce individual differences across donors, partial sweat pads from 4 donors (using two left arm pads and two right arm pads) are pooled into one stimulus. Thus, a sample size of 32 in total will enable us to create enough odour stimuli for the receiver study (i.e., 32 participants x 8 pad pieces x 2 armpits x 2 fragrance conditions = 256 stimuli, divided over 2 x 2 different conditions = 64 potential receiver participants), but a total of 40 participants is recruited to factor potential drop-outs. In addition, this sample size will allow us to explore the effect of fragrance on self-reported self-esteem (i.e., the exploratory hypothesis), but is not statistically powered to demonstrate a small effect.

## **Phase 2 methods and procedure**

The receiver study follows a within-subject 4 Sweat Type design with a counterbalanced presentation order of the conditions. Sweat Type will be high self-confidence sweat untreated, high self-confidence sweat treated (with deodorant), low self-confidence sweat untreated and low self-confidence sweat treated. In these four conditions, the participants perform a task where they judge ambiguous faces on several social traits that are known to vary with self-esteem (e.g., self-confidence, dominance, attractiveness and trustworthiness; the exact traits are to be determined). After this, the participants will perform a discrimination task to see whether the different types of sweat can be perceptively distinguished, rate all sweat samples on a number of dimensions (including pleasantness and intensity), and will perform a standardized test to measure olfactory function.

**Participants.** To test Hypothesis 1 and 2, whether self-confidence can be perceived by females in male sweat, and whether this can be modulated by applying fragrance, 60 females will complete a face judgement task four times (once for each sweat type condition). Sample size was determined by a power analysis (G\*Power 3.1; Faul, Erdfelder, Buchner, & Lang, 2009) for ANOVA within subjects ( $d = .28$ , power = .8,  $\alpha = .05$ ). The effect size was obtained from similar research on the effect of sweat on the judgment of perceived stress and confidence, and the application of antiperspirant thereon (Dalton, Mauté, Jaén, & Wilson, 2013). The effects in this study yielded  $d =$

.41 for the difference between untreated stress sweat and stress sweat treated with an antiperspirant on confidence ratings, and  $d = .28$  for the difference in overall social judgements between the two sweat conditions. These effect sizes were pooled ( $d = .35$ ) and converted to  $\eta^2$  ( $\eta^2 = .0297$ ), and yielded  $n = 46$  as group sizes. To cope with potential drop-outs, 60 female participants will be recruited.

### **Proposed analyses**

To test the two primary hypotheses, social face judgments will be compared between different conditions (i.e., exposed to sweat from low and high self-esteem males wearing fragrance or no fragrance). The design to test these hypotheses is a 2 by 2 within subject design with donor self-esteem (high vs. low), and applied fragrance (yes vs. no) as within-participant factors.

The dependent variables are social judgment on the different 9-point likert scale face characteristics to be determined.

The intention is to use separate repeated measures ANOVAs with these dependent variables and factors, if data follows the assumptions for repeated measures ANOVA. Outliers ( $\pm 3SD$ ) will be removed. If necessary, data (logarithmic) transformations will be applied. Otherwise, parametric analyses outcomes will be checked using non-parametric equivalents.

Hypothesis 1 will be confirmed if there is a main effect of donor self-esteem on face judgements in such a direction that high self-esteem sweat will lead to increased social judgements of faces and low self-esteem sweat will lead to decreased ratings.

Hypothesis 2 will be confirmed when there is either a main effect of applied fragrance on face judgement ratings, or an interaction between applied fragrance and donor self-esteem: the (positive) effect of deodorant on face ratings may only be present in case the sweat was taken from low self-esteem donors.

To test the exploratory hypothesis, scores from the implicit and explicit self-esteem measures (i.e., signature size, name-initial preference scores, and SSES total score), will be subjected to 2 by 2 repeated measures ANOVAs with donor self-esteem level (high vs. low) as between participant factor and applied fragrance (yes vs. no) as within participant factor. In case of significant effects on the SSES data, to explore what domain of self-esteem is affected by deodorant use, subscales of the SSES will be analysed separately.

To explicitly explore the effect of applied deodorant on self-esteem in low self-esteem participants (i.e., the exploratory hypothesis), the previous analysis will be followed by three paired t-tests on the data from low self-esteem participants alone, with applied fragrance as factor and the self-esteem measures as dependent measures (i.e. signature size, name-initial preference score, and SSES total score). Bonferroni corrections will be applied. The hypothesis will be confirmed when participants show increased self-esteem after application of deodorant.

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