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Positive Implicit Attitudes toward Odor Words

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Abstract

Associations between certain odors and for instance health effects may lead to positive or negative attitudes toward these odors. However, in experiments we conducted using the Implicit Association Test (IAT), we encountered attitudes even to odor "words." The IAT is based on the principle that reaction times measuring the association between words from a target dimension (in this case, odor vs. a neutral reference category) and an attribute dimension (i.e., positive or negative words) reflect the attitude to the target, where attitude-congruent associations between target and attribute are reflected by shorter reaction times. In a first experiment, we found distinctly positive attitudes to the concept odor in a student sample, which was replicated in a second experiment. In the main experiment, subjects in the aromatherapy group, who prefer using scented consumer products for relaxation purposes, showed a significantly more positive attitude toward odor words in the IAT than a control group, who did not have such a preference. The fact that results from the implicit test were not always associated with explicitly stated attitudes toward the odor words attests to the fact that the IAT measures the attitude of interest in a different way. As such, the IAT has added value in circumstances where explicit tests can be biased.

Key words: Implicit Association Test, implicit attitude, implicit measure, indirect measure, odor perception

Introduction

Perceptions of, and reactions to, odors are significantly affected by beliefs about the possible health consequences of environmental exposure to odorous compounds. In an experimental setting, Dalton (1999) demonstrated that the induction of beliefs about the harmful consequences of exposure to a certain odorant led to an increase in perceived intensity and irritancy of that particular odorant. In addition, the frequency and intensity of symptom perceptions were also increased. Dalton concluded that people's reactions to ambient odors are mediated by cognitive processes.

These findings correspond to real-world situations. For instance, people who are more worried about exposure effects because they believe that environmental odors have a negative effect on health report significantly more health effects compared with others who do not adhere to that belief (Schiffman 1998). One of the supposed mechanisms to account for this is that the belief that certain odors are hazardous for one's health may trigger feelings of anxiety or stress, which results in closer monitoring of internal signals that may indicate potentially harmful effects (Williams and Lees-Haley 1993; Shusterman 2001).

Likewise, beliefs about alleged healthful effects of odors on health can influence people's perceptions in a positive fashion. Many people buy scented products for relaxation or healing purposes, causing a boost in the sales of aromatherapeutic products. Consumers apparently subscribe to the premise of natural essences having holistic, medicinal effects that contribute, if not just to psychological well-being, to enhanced physical health. This is in line with another part of Dalton's (1999) study in which it was demonstrated that beliefs about the "healing" consequences of exposure to a certain odorant resulted in lower levels of symptom reports. Thus, expectations about the effects of odors on health can bias perceptions of odors in either a negative or a positive direction.

There is benefit in a quick categorization of odors as either healthful or harmful. Without this top–down influence on information processing (processing that is initiated by knowledge, expectation, or belief; Kosslyn and Rosenberg 2001), every odor would be evaluated as a novel stimulus. Rapid categorization of odors probably reflects previously learned associations. In newborns, the olfactory system seems to be a "tabula rasa"; they show equal responses to, according to adults, pleasant and unpleasant stimuli (Engen 1988). Hedonic categorization starts to develop once the child learns that certain odors are associated with pleasant or safe contexts and other odors with unpleasant or dangerous contexts. For instance, certain odors that are perceived during pleasant moments (e.g., the body odor of the mother while feeding the child) will consequently acquire a safe connotation.

Epple and Herz (1999) and Herz et al. (2004) demonstrated in an experimental setting that previously learned odor associations can affect subsequent behavior. They exposed subjects to an odor while inducing a frustrating mood. The same odor negatively influenced performance (less task persistence) on a cognitive task during another part of the experiment, indicating that subjects had associated the odor with the prior experience.

In sum, beliefs about health effects of odors can be either negative (odors might be harmful or dangerous) or positive (odors can be healthful or safe), based on previously learned associations between certain odors and either negative or positive contexts. In turn, these odor beliefs can influence behavior later on. This positive versus negative categorization of, in this case, odors is akin to the definition of "attitudes," which are described as "evaluations of virtually any aspect of the social world" (Eagle and Chaiken 1993) or "the association between a concept and an evaluation" (Fazio et al. 1982). It can be argued that as people evaluate odors that are part of their social world as either positive or negative, they develop positive or negative "odor attitudes."

Odor attitudes can be assessed using self-report questionnaires (e.g., the Illness Perception Questionnaire, Moss-Morris et al. 2002, or the Chemical Sensitivity Scale for Sensory Hyperreactivity, Nordin et al. 2004). However, self-report questionnaires carry some limitations. One is their susceptibility to effects of social desirability. In terms of odor perception, subjects may feel embarrassed to report using aromatherapy products or they may feel uncomfortable revealing their concerns about environmental odor exposures. Furthermore, people may have never thought about the topic under investigation or are simply not consciously aware of their attitudes (Fazio and Towles-Schwen 1999). In general, people do not have a clear notion about how their attitudes influence their behavior. For instance, if someone is not aware of associating certain odors with health risks, a questionnaire will not be able to uncover this negative attitude and will consequently not be predictive of behavior.

To test attitudes in an implicit way, tests like the Implicit Association Test (IAT; Greenwald et al. 1998) have been developed. The term "implicit test" in this context refers to the fact that subjects 1) are not necessarily aware of the fact that the attitude is being measured, 2) do not need conscious access to the attitude, and 3) have no control over the measurement outcome (De Houwer 2005).

During administration of the IAT, words appear one by one on a computer screen. Subjects are requested to categorize these words as quickly as possible into categories of interest, by pressing the corresponding keys on a computer keyboard. An example of a typical IAT is presented in Table 1. During a first block, subjects learn to differentiate as quickly as possible between 2 categories of a "target" dimension (e.g., male vs. female names; when a name belonging to the female category appears on the computer screen, subjects have to press key A; when a male name appears, they have to press key B). During the next block, subjects are trained to differentiate between 2 other word categories of an "attribute" dimension (e.g., positive and negative words; when a word belonging to the positive category is presented, they have to press key A; when a negative word appears, they have to press key B). Then, during a next block, words from both the target and the attribute dimension are randomly presented. One category of the target dimension and one category of the attribute dimension share the same response key during this stage (e.g., response key A for positive words and female names and key B for negative words and male names). During the final block, response keys for the target dimension are switched, whereas the response keys for the attribute dimension remain the same (e.g., response key A for positive words and male names and key B for negative words and female names). Intrinsic association strengths between the target concepts and the attributions will influence performance speed and accuracy during the 2 combined blocks. Switching the required response type from attitude incongruent to attitude congruent will have less of an interfering effect than switching from congruent to incongruent. In the above-mentioned example, reaction times and error rates will decrease during the final block if someone has a (implicit) negative attitude toward females (first positive words and female names share the same key; then negative words and female names share the same key). In case of a negative attitude toward males, the principle works the other way around; reaction times and error rates will increase during the final block because the required response changes from attitude incongruent to attitude congruent.

Table 1 An example of a typical IAT design

Block	Key A	Key B
1	Female name	Male name
2	Positive word	Negative word
3	Female name or positive word	Male name or negative word
4	Male name	Female name
5	Male name or positive word	Female name or positive word

The IAT is a promising method to indirectly measure strengths of associations in a variety of research fields. De Jong et al. (2001), for example, measured implicit dysfunctional beliefs related to social anxiety. Associations were measured between neutral and social situation words ("sitting room" vs. "presentation") and positive and negative outcomes ("succeed" vs. "rejection"). Compared with low-anxious subjects, high-anxious subjects showed the expected decrease in task performance when required responses to the stimuli switched from belief congruent to belief incongruent, that is, when the switch was made from social situation words and negative outcome words sharing the same key to social situation words and positive outcome words sharing the same key. Others have used the IAT to measure implicit attitudes toward nature (Schultz et al. 2004), alcohol (Wiers et al. 2002), smoking (Huijding et al. 2005), and high-fat foods (Roefs and Janssen 2002).

In conclusion, because the influences of odor attitudes on perception and on behavior may be implicit and because of methodological limitations of explicit questionnaires, it is important that implicit methods be developed in this area. Here, an odor version of the IAT is introduced.

The present study is part of a larger project that aims to uncover attitudes toward odors and health in an implicit manner and how these attitudes influence perception of, and reactions to, environmental odors. We started out with an IAT that, simply, measured positive and negative associations with the concept odor, to explore whether people display distinct attitudes (either positive or negative) toward that concept by itself, not yet taking into account the relation with the concept of health. We tested this odor-IAT within a subsample suspected to exhibit distinctly positive odor attitudes: subjects who preferred using scented consumer products as a means of relaxation. This group was compared with subjects who did not have such a preference. It was hypothesized that subjects who use scented products have less difficulty with associating the concept odor with positive words, compared with the non–product users, indicating a (implicit) positive attitude toward the concept odor in the product users group.

However, the results of the construction phase of the odor-IAT turned out to be noteworthy as well. When the test was conducted in a general sample of subjects in which no distinct attitudes were necessarily expected, the results unexpectedly demonstrated definite positive attitudes toward the concept odor. This effect was replicated in a second experiment. Because these results were unexpected and robust, it was decided to also briefly report these 2 first experiments. The main experiment is subsequently reported as Experiment 3.

Experiments 1 and 2

Methods

Subjects

For Experiment 1, 60 Psychology students from Utrecht University (52 females and 8 males) were tested. Mean age was 21.9 years (standard deviation [SD] = 2.4). Sixty-seven students (57 females and 10 males) were tested for Experiment 2. Mean age in this group was 21.2 years (SD = 2.5). The sample size for the second experiment was determined by a power analysis based on a medium effect size found in Experiment 1. For an analysis of variance (ANOVA) with reaction time as dependent variable, a sample of 66 subjects would suffice to achieve 80% power with 2-tailed testing at an alpha level of 0.05 (Cohen 1992). Subjects received either course credit or financial remuneration for their participation.

Stimulus words

The target dimension of the odor-IAT consisted of 2 word categories: the house category (porch, basement, room, hallway, attic) and the odor category (whiff, aroma, smell, nose, scent). The attribution dimension also consisted of 2 word categories: the good category, consisting of positive words (pleasure, love, success, peace, talent), and the bad category, consisting of negative words (fail, waste, naughty, war, abuse). Following De Jong et al. (2001), the house category was chosen because it may be assumed that this category is a neutral one and thus that neither the concept house nor the exemplars of this concept are intrinsically associated with the concepts good or bad. We checked all words for their frequency and length (in Dutch) in order to have 2 comparable word categories on both dimensions. In addition, an independent student sample (N = 44) was asked to rate the valence of the 5 house exemplar words and the 5 odor exemplar words as positive, neutral, or negative. The same was done for the good and bad exemplar words. Negative ratings were recoded to −1, neutral ratings to 0, and positive ratings to 1. Sum scores of the scored valence of the 5 exemplars per concept (with possible scores between −5 and 5) were compared. The house exemplar words and the odor exemplar words were rated as equally neutral, $t(43) = 1.31$, $P = 0.20$ ($M_{odor} = 0.98$, SD = 1.65, and $M_{house} = 0.66$, SD = 1.18). The good exemplar words were rated as positive ($M_{good} = 4.77$, SD = 0.60) and the bad exemplar words were rated as negative ($M_{bad} = -4.25$, SD = 1.10).

Procedure

Following Greenwald et al. (1998), the odor-IAT consisted of 5 blocks and 2 practice blocks. Figure 1 demonstrates the counterbalanced design of the test. During Block 1, subjects were trained on how to differentiate between the odor words and the house words of the target dimension. There were 5 house words and 5 odor words that were presented twice, resulting in 20 trials. Subsequently, subjects had to use the same response keys for classification of the 5 good words and the 5 bad words, which were presented twice, resulting in 20 trials. During Practice Block 3a, the 2 former tasks were combined. Half of the subjects started the combined task with pressing the same key for odor words and good words (Order 1). The other half started this block with pressing the same key for odor words and bad words (Order 2; see also Figure 1). Because Block 3a was a practice block, words from all concepts were presented once (20 trials), and reaction times and error rates were not registered. Block 3b was the same as Block 3a (and depicted as one block in Figure 1), except that now registration took place and words from all concepts were presented twice (40 trials). During Block 4, the target

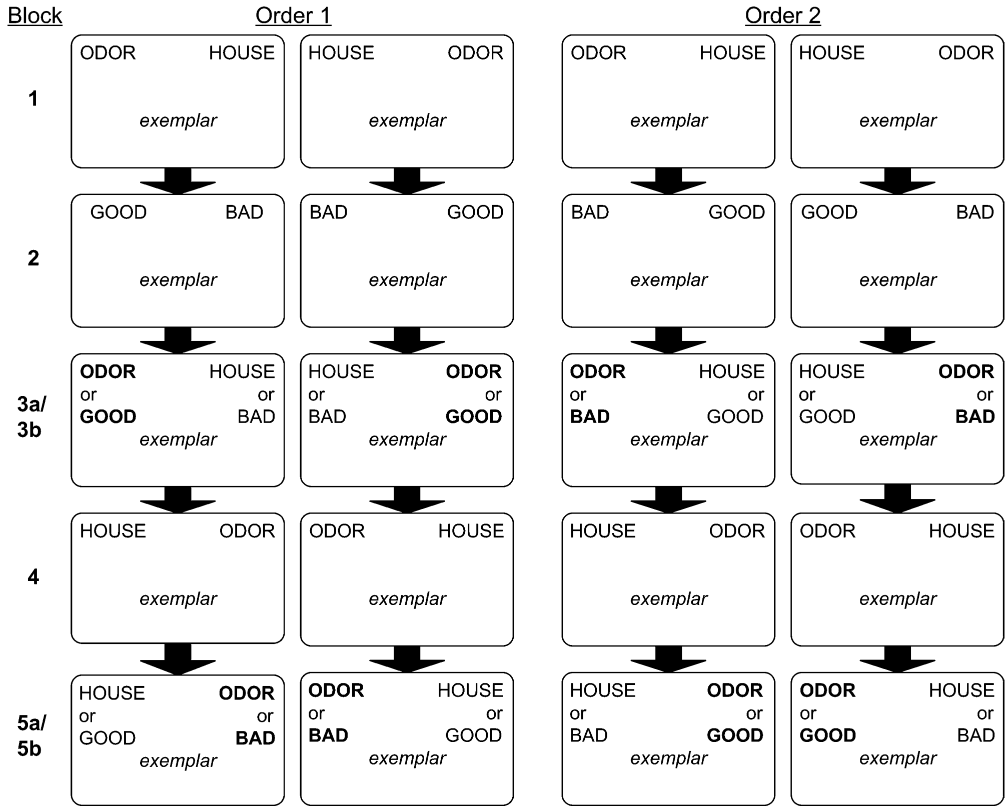

Figure 1 Counterbalanced design of the odor-IAT. Subjects in Order 1 start the combined task with the odor and good block (in either the left or the right upper corner of the computer screen) and then complete the odor and bad block (again in either the left or the right upper corner of the screen). Subjects in Order 2 start the combined task with the odor and bad block and then complete the odor and good block. Word exemplars appear in the center of the screen. If a word belongs to a concept at the left side, subjects have to press a left key; if a word belongs to a concept at the right side, subjects have to press a right key.

categories changed positions on the computer screen, resulting in a required switched response for the target words. Again the 5 odor words and the 5 house words were presented twice (20 trials). No exemplar words from the good and bad categories were presented during this block. Practice Block 5a was a new combined task due to the target dimension switch. Words from all concepts were presented once (20 trials). Block 5b was the same as Block 5a (again depicted as one block in Figure 1), except that registration took place and all words were presented twice (40 trials).

Subjects were instructed to categorize as quickly and accurately as possible the words into the 4 categories (odor, house, good, bad) by pressing the corresponding response keys on a computer keyboard. The words that had to be classified appeared one by one in the center of the screen. During each IAT block, the category concepts remained visible in the left and right upper corners of the screen (see Figure 1). Order 1 and Order 2 had both 2 versions where the target–attribute pairs were allocated to different sides of the screen. Subjects had to respond by pressing the "q" (index finger left hand) for words that belonged to a category in the left corner and the "p" (index finger right hand) for words that belonged to a category in the right corner. In case of a wrong answer, a red cross appeared. Subjects had to correct the mistake by quickly pressing the alternate key. As soon as the correct key was pressed, the next word appeared.

Subjects in Experiment 2 were asked to score the explicit valence of the odor, house, good, and bad exemplars after completing the test, such that the implicit test outcome could be compared with explicit evaluation.

Results

Data reduction

Following Greenwald et al. (1998), reaction times below 300 ms were recoded to 300 ms (3, 0.02% [Experiment 2]) and reaction times above 3000 ms were recoded to 3000 ms (45, 0.42% [Experiment 1]; 35, 0.29% [Experiment 2]). Reaction times for trials answered incorrectly were excluded for further reaction time analyses (677, 6.27% [Experiment 1]; 751, 6.23% [Experiment 2]). An alpha level of 0.05 was used for all statistical tests.

Reaction times

For the 2 critical combined blocks (3b and 5b) of the odor-IAT, mean reaction times are shown separately for Order 1 and Order 2 in Table 2 and Figure 2 (solid lines [Experiment 1]

Table 2 Mean reaction times in milliseconds and error rates (SDs in parentheses) for Order 1 and Order 2 during phases of the test where the concept odor had to be associated with the concepts good and bad, shown separately for Experiment 1 and Experiment 2

Order	Blocks	Reaction times	Error rates
Experiment 1 (*N* = 60)			
Order 1[a] (*n* = 30)	Odor and good	730.59 (105.47)	0.05 (0.05)
	Odor and bad	875.81 (178.52)	0.07 (0.06)
Order 2[b] (*n* = 30)	Odor and bad	783.73 (171.77)	0.09 (0.06)
	Odor and good	809.03 (160.98)	0.07 (0.04)
Experiment 2 (*N* = 67)			
Order 1[a] (*n* = 33)	Odor and good	723.74 (104.48)	0.05 (0.05)
	Odor and bad	811.36 (146.49)	0.08 (0.07)
Order 2[b] (*n* = 34)	Odor and bad	756.46 (138.60)	0.09 (0.07)
	Odor and good	813.54 (171.26)	0.07 (0.05)

[a]Subjects in Order 1 first had to complete the odor and good block and then the odor and bad block.
[b]Subjects in Order 2 first had to complete the odor and bad block and then the odor and good block.

and dashed lines [Experiment 2]). A 2 (Association: odor and good vs. odor and bad) × 2 (Order: order 1 vs. order 2) ANOVA with reaction time as dependent variable was conducted for both experiments. This revealed a main effect of association, $F(1, 58) = 7.36$, $P < 0.01$ in Experiment 1, indicating that reaction times were shorter during odor and good blocks. Additionally, a significant association × Order interaction effect was found in both experiments, ($F(1, 58) = 14.89$, $P < 0.01$ [Experiment 1], and $F(1, 65) = 12.42$, $P < 0.01$ [Experiment 2]). Post hoc testing showed that subjects had significantly more difficulty with the odor and bad block when they had first completed the odor and good block, ($t(29) = -5.08$, $P < 0.01$ [Order 1; Experiment 1], and $t(32) = -3.68$, $P < 0.01$ [Order 1; Experiment 2]). Subjects who had first completed the odor and bad block and then the odor and good block did not show significantly more difficulty with the new combined task ($t(29) = -0.75$, $P = 0.46$ [Order 2; Experiment 1], and $t(33) = 1.72$, $P = 0.10$ [Order 2; Experiment 2]). This implies that it was easier to "unlearn" the odor and bad association than to unlearn the odor and good association (see Figure 2).

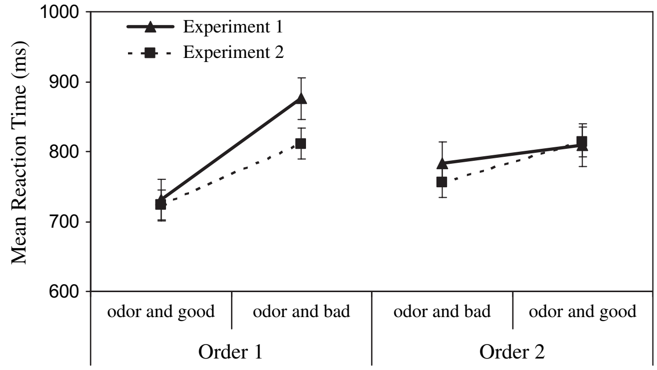

Figure 2 Mean reaction times in milliseconds for Order 1 and Order 2 during the phases of Experiment 1 and Experiment 2 where the concept odor had to be associated with the concepts good or bad.

Error rates

A 2 (Association: odor and good vs. odor and bad) × 2 (Order: order 1 vs. order 2) ANOVA with error rate as dependent variable was conducted for both experiments. This revealed a main effect of association ($F(1, 58) = 9.08$, $P < 0.01$ [Experiment 1], and $F(1, 65) = 5.16$, $P = 0.03$ [Experiment 2]), showing that fewer errors were made during odor and good blocks, compared with odor and bad blocks (see Table 2).

Explicit ratings Experiment 2

Scores of explicit ratings differed for the house and odor exemplar words, $t(66) = 3.44$, $P < 0.01$; odor exemplar words were rated significantly more positive compared with house exemplar words ($M_{odor} = 1.67$, SD = 1.84, and $M_{house} = 0.90$, SD = 1.20), indicating an explicit positive attitude toward the odor words. As expected, the good exemplar words were rated as positive compared with the neutral words ($M_{good} = 4.99$, SD = 0.12); bad exemplar words were rated as negative compared with the neutral words ($M_{bad} = -4.66$, SD = 0.62).

Discussion

Subjects showed faster reaction times during blocks where the concept odor had to be associated with the concept good compared with blocks where the concepts odor and bad had to be associated. Additionally, fewer errors were made during odor and good blocks. Unexpectedly, the odor-IAT demonstrated a distinctly positive attitude toward the concept odor in 2 independent subject samples, reflecting a robust effect. Interestingly, these first results suggest that people have affective attitudinal tendencies to a wider range of concepts commonly regarded as neutral.

Prior to conducting Experiment 1, and as stated earlier, an independent sample had rated the target exemplar words from the odor and house categories as equally neutral. However, when assessed in the same sample (Experiment 2), both explicit and implicit attitudes to odor words were now found to be positive. Explicit evaluation of odor words might have been influenced by implicit odor attitudes activated during the odor-IAT.

In the main experiment, Experiment 3, we investigated whether the odor-IAT is capable of distinguishing between individuals, whose odor attitudes may be expected to be different. We tested this cross-sectionally by comparing IAT results of 2 samples of subjects selected on self-reported preference of use of scented consumer products.

Experiment 3

To test whether the odor-IAT was able to distinguish individuals who prefer using scented consumer products as a means of relaxation from individuals who do not have such a preference, subjects were selected based on their score on a questionnaire developed for the purpose of this experiment. Subjects were told that the questionnaire aimed to examine students' relaxation habits, in order to minimize the chance that they were aware of our specific interest in utilization of scented consumer products. The short questionnaire consisted of 2 parts. The first part contained 6 irrelevant items (e.g., "Do you go to the cinema from time to time to clear your mind?" or "Do you sometimes drink alcohol to become more relaxed?"). Two odor items were interspersed with these 6 items to measure whether subjects used fragranced products or odorized candles for relaxation purposes: "Do you sometimes use odorized products like scented shower gel to relax yourself?" and "Do you light odorized candles now and then to relax yourself or to feel healthier?" Subjects had to answer these questions with "yes" or "no." A yes answer to the odor items was recoded to 2; a no answer to 0. The second part of the questionnaire is demonstrated in Table 3. Subjects were instructed to rank the alternatives according to preferences from 1 to 4. Numbers in front of the odor-related answers (see Table 3) were recoded (the first choice was recoded to 4, the second choice to 3, the third choice to 2, and the fourth choice to 1). In this manner, subjects could have scores varying from 1 to 20 (0–4 from the first part of the questionnaire; 1–16 from the second part). A total of 285 Psychology students from Utrecht University were asked to complete the questionnaire. Mean score was 9.73 (SD = 3.71). Individuals with extreme scores (approximately 1.5 SD above the mean and 1.5 SD below the mean) were approached to participate. Subjects with high scores (≥14), reflecting frequent use of or preference for scented products, were invited and included in the what we will refer to as the aromatherapy group (N = 32, mean = 15.28, SD = 1.30). Subjects with low scores (≤5) served as controls (N = 31, mean = 4.03, SD = 1.45).

Table 3 The second part of the selection questionnaire for Experiment 3

What do you consider as a "special treatment"?	__A breakfast in bed
	__A massage with essential oils*
	__Someone who takes care of my shopping
	__An invitation to my favourite restaurant
What will boost your energy after an exhausting day?	__My favourite music
	__A nice fragrance*
	__Cold wind
	__A refreshing walk
You have the entire Saturday for yourself. What are your plans?	__To invite friends to come to my place
	__To read an exciting book
	__To go shopping
	__To take a warm and scented bath*
What store do you prefer to go to?	__A cloth store
	__A big department store
	__A music store
	__A perfume store*

Subjects were asked to rank the alternatives according to preference from 1 to 4, by placing corresponding numbers in front of the answers (odor-related items are here indicated by an asterisk).

Methods

Stimulus materials and procedures were the same as in Experiments 1 and 2. Explicit attitudes were again collected after the experiment. Halfway during the experiment, we realized that attitudes toward the concept as a whole (so toward the words "odor" and "house") would be equally relevant as attitudes toward the individual exemplar words belonging to those categories (De Houwer 2002). Thus, 52% of the subjects scored both exemplars as well as concepts.

Subjects

There were 29 subjects in the aromatherapy group (27 females and 2 males) and 26 (18 females and 8 males) in the control group. Mean age of the aromatherapy group was 21.3 years (SD = 5.0) and of the control subjects 20.4 years (SD = 2.8). Subjects received either course credits or financial remuneration for their participation. Subjects were not informed about the purpose of the test prior to participation.

Results

Data reduction

Reaction times above 3000 ms (25; 0.25%) were recoded to 3000 ms. Reaction times for trials answered incorrectly (588; 5.94%) were excluded for further reaction time analyses.

Reaction times

For the 2 critical combined blocks (3b and 5b) of the odor-IAT, mean reaction times are shown separately for Order 1 and Order 2 and for the aromatherapy and control groups in Table 4 and Figure 3. A 2 (association: odor and good vs. odor and bad) × 2 (Order: order 1 vs. order 2) × 2 (group: aromatherapy vs. control) ANOVA with reaction time as dependent variable revealed a main effect of association, $F(1, 51) = 17.99$, $P < 0.01$, indicating that reaction times were shorter during odor and good blocks, compared with odor and bad blocks. In addition, a significant group × association interaction was found, $F(1, 51) = 8.30$, $P < 0.01$. Post hoc testing showed that the control subjects did not have more or less difficulty with either the odor and good block or the odor and bad block, $t(25) = -1.15$, $P = 0.26$. The aromatherapy group, however, showed significantly shorter reaction times during odor and good blocks, compared with odor and bad blocks, $t(28) = -4.53$, $P < 0.01$.

Error rates

A 2 (Association: odor and good vs. odor and bad) × 2 (Order: order 1 vs. order 2) × 2 (group: aromatherapy vs. control) ANOVA with error rate as dependent variable revealed a main effect of association, $F(1, 51) = 13.66$, $P < 0.01$, showing that fewer errors were made during odor and good blocks, compared with odor and bad blocks (see Table 4).

Table 4 Mean reaction times in milliseconds and error rates (SDs in parentheses) for Order 1 and Order 2 during phases of Experiment 3 where the concept odor had to be associated with the concepts good and bad, shown separately for the aromatherapy and the control groups

Order	Blocks	Reaction times	Error rates
Aromatherapy group (N = 29)			
Order 1[a] (n = 16)	Odor and good	794.70 (136.21)	0.07 (0.07)
	Odor and bad	976.33 (160.26)	0.09 (0.07)
Order 2[b] (n = 13)	Odor and bad	998.73 (392.67)	0.11 (0.11)
	Odor and good	752.63 (103.16)	0.05 (0.04)
Control group (N = 26)			
Order 1[a] (n = 13)	Odor and good	728.86 (153.95)	0.04 (0.03)
	Odor and bad	811.82 (129.05)	0.07 (0.07)
Order 2[b] (n = 13)	Odor and bad	928.71 (241.47)	0.09 (0.11)
	Odor and good	929.95 (261.37)	0.06 (0.06)

[a]Subjects in Order 1 first had to complete the odor and good block and then the odor and bad block.
[b]Subjects in Order 2 first had to complete the odor and bad block and then the odor and good block.

Explicit ratings

Explicit ratings differed for the house and odor exemplars, $t(54) = 6.31$, $P < 0.01$: odor exemplars were rated significantly more positive compared with house exemplars ($M_{odor} = 2.27$, SD = 1.59, and $M_{house} = 0.29$, SD = 1.29), indicating an explicit positive attitude toward the odor words. However, aromatherapy subjects did not differ from the control subjects in explicit rating of the odor exemplars, $F(1, 53) = 0.04$, $P = 0.84$ ($M_{aroma} = 2.32$, SD = 1.63, and $M_{control} = 2.23$, SD = 1.59), and the house exemplars, $F(1, 53) = 0.07$, $P = 0.79$ ($M_{aroma} = 0.24$, SD = 1.48, and $M_{control} = 0.33$, SD = 1.12).

For the concept words "house" and "odor" on the other hand, no significant difference in explicit rating was found, $t(27) = 0.83$, $P = 0.42$, indicating that the concepts odor and house did not differ in explicit valence (respectively $M_{odor} = 0.39$, SD = 0.50, and $M_{house} = 0.29$, SD = 0.46). Again, no group difference was found between aromatherapy subjects and control subjects on the explicit ratings of the concept odor, $F(1, 26) = 1.78$, $P = 0.19$ ($M_{aroma} = 0.25$, SD = 0.45, and $M_{control} = 0.50$, SD = 0.13), and of the concept house, $F(1, 26) = 0.22$, $P = 0.64$ ($M_{aroma} = 0.33$, SD = 0.14, and $M_{control} = 0.25$, SD = 0.45).

As expected, the good words were rated by both groups as positive compared with the neutral words (mean = 4.91, SD = 0.32); bad words were rated as negative compared with the neutral words (mean = –4.36, SD = 0.87).

Discussion

Again, subjects had significantly less difficulty with the odor and good association, compared with the odor and bad association. This result replicated an intrinsic positive attitude toward odors already found in Experiments 1 and 2. In this third experiment, this effect was mainly caused by the aromatherapy subjects: they showed significantly shorter

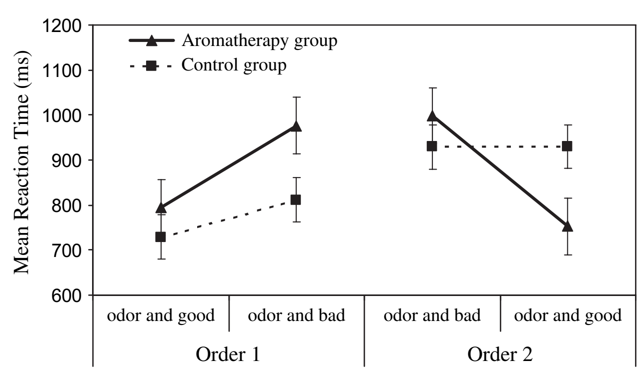

Figure 3 Mean reaction times in milliseconds for Order 1 and Order 2 during phases of Experiment 3 where the concept odor had to be associated either with the concept good or bad, shown separately for the aromatherapy and control groups.

reaction times when they had to associate the concept odor with positive words than when they had to associate odor with negative words. For the controls, performance speed during odor and good blocks and odor and bad blocks was not significantly different. The odor-IAT was able to distinguish between the 2 subject groups, selected on degree of preference for odorized products as a means of relaxation.

As in Experiment 2, explicit attitudes toward odor exemplar words were found to be more positive as compared with house exemplar words. However, the between-group distinction in implicit odor attitude was not reflected by a between-group difference in explicit odor attitude. Likewise, even though the explicit attitude toward odor words was positive on average, this was not the case for the concept word "odor". These results suggest that the odor-IAT measures an implicit attitude that is distinctly different from explicit odor attitudes.

General discussion

Three experiments were conducted to explore attitudes toward the concept odor in an implicit manner, using an odor version of the IAT. The results of main Experiment 3 can be summarized as follows: whereas subjects who preferred using scented consumer products as a means of relaxation showed a definite positive attitude to the concept odor, subjects who did not have such a preference showed neither a positive or a negative attitude toward that concept. Apparently, the distinction between the groups based on self-reported preference for scented products was reflected by a distinction in attitudes to the concept of odor measured implicitly by the odor-IAT. Additionally, from the experiments conducted in a general sample of students of Psychology, in which no definite attitudes toward the concept of odor were expected, overall results revealed positive attitudes to the concept odor, which was reflected by shorter reaction times and lower error rates during the odor and good blocks in Experiment 1 and then replicated in Experiment 2.

The odor-IAT measured odor attitudes in an implicit way: firstly because subjects were not required to think about odors or state any opinions but were instructed to press a key upon seeing an odor word; secondly, during debriefing, most subjects indicated not being aware of the purpose of the test; and thirdly, results obtained with the odor-IAT were not always paralleled by the results obtained with the explicit test. It may thus be concluded that the odor-IAT may serve as a useful tool to predict behaviors to odor exposures when those behaviors are believed to be driven a priori by unconscious motives. However, before being able to fully appreciate the advantages versus limitations of using implicit measures in the odor realm, the following issues need to be addressed.

For instance, the control subjects in Experiment 3 showed different reactions on the odor-IAT compared with subjects tested in Experiments 1 and 2. The control group was selected based on their limited use of, or preference for, scented consumer products, whereas subjects in Experiment 1 and 2 were not screened on any particular odor-related behavior. It would appear that within the population tested in all the experiments, subpopulations with a more or less positive attitude can be distinguished, leading to a predominantly positive average attitude. The overall positive attitude found in the first 2 experiments is probably best explained by the fact that they were conducted using Psychology students as subjects, most of whom were female (approximately 82%). Because the low number of male subjects in either experiment did not allow a comparison between the sexes, it was decided to conduct an exploratory meta-analysis on a combination of samples (154 females versus 28 males). The analysis indeed provided support for the explanation that the main finding of positive attitudes toward the odor concept was carried by the female subsample rather than the male subsample as the male subsample responded significantly slower during odor and good blocks than the female subsample. The hypothesis of sex differences in odor attitudes should however be tested independently using equal samples of both sexes. For now, we conclude that definite positive attitudes to the concept of odor were assessed using an implicit test in Experiments 1 and 2 and that individual differences in attitudes were associated in a meaningful manner to odor-related preferences using an explicit test in Experiment 3.

Besides investigating the effect of sex on the odor-IAT, the test should be further validated based on scores of other, well-defined groups to investigate whether the odor attitudes assessed with the odor-IAT reveal distinct attitudes that show a meaningful relation to relevant behaviors of these groups. Examples of such populations are individuals with Multiple Chemical Sensitivity or residents who are involuntarily exposed to obnoxious fumes from nearby industry. Logically, the odor-IAT should show distinct negative attitudes in those populations.

Additionally, it should be further investigated how implicit and explicit methods relate to one another and which of the 2 methods is most suitable for behavior prediction. By looking at the explicit ratings made by the independent subject sample (but from the same population) prior to Experiment 1, it could be concluded that both the odor exemplar words and the house exemplar words are equally neutral. The explicit ratings of the subjects in Experiment 2, who had just completed the odor-IAT, revealed a positive evaluation of the odor exemplar words. Here implicit and explicit ratings both showed positive attitudes toward odors. However, subjects had already completed the odor-IAT, which might have influenced explicit attitudes. Subjects in Experiment 3 again evaluated the odor words as more positive than the house words, but no group difference was found between the aromatherapy subjects and the controls, which showed that the odor-IAT was capable of assessing individual differences that could not be assessed on the basis of explicit attitudes. In our experiments, the valence of odor attitudes as measured by the explicit test seemed to depend on whether or not the test was administered together with the odor-IAT. For future testing, it is advised to administer the explicit test independently from, and well in advance of, the odor-IAT in the same population.

In other domains, implicit and explicit methods sometimes do and sometimes do not correlate (Nosek 2005), which raises the question whether, and in what cases, people's conscious and unconscious attitudes are different and which attitude most likely drives behavior. Fazio and Olson (2003) concluded that implicit measures are useful in predicting behavior that is difficult to control or behavior in situations where people do not have the opportunity to control the impact of automatically activated attitudes on behavior. This implicit method seems therefore most suitable for odor behavior prediction. However, before claiming this with certainty, the odor-IAT should again be compared with explicit self-report measurements and in turn with relevant behavior.

Another issue has to do with the role of a neutral reference category (De Houwer 2002). In other IAT studies, 2 complementary concepts are often selected for the target dimension. In the example described in the Introduction for instance, male and female names are used as target concepts, where a negative attitude toward male names could also be interpreted as a positive attitude toward female names. In this example, both interpretations are informative because the conclusion remains the same (e.g., a more positive attitude toward females compared with men is equivalent to a more negative attitude toward males compared with females). In the present study, the observed attitudes toward the concept odor are in fact all relative to attitudes toward the concept house; the latter concept was used in our experiments as the neutral reference category. It was assumed, in advance, that people would not have a negative or positive attitude toward the house concept (see also De Jong et al. 2001). Therefore, the results have been interpreted as positive attitudes toward odors, not as negative attitudes toward the concept house, although, in theory, this interpretation is also possible. Still, we feel that the results of Experiment 3 strengthen the interpretation of the results in terms of positive odor attitudes because there is no reason to assume that subjects in the aromatherapy group had a more negative attitude toward the house concept than controls. In general, implicit attitude tests have been conducted with concepts about which people tend to have outspoken attitudes, such as racial (e.g., Smith-McLallen et al. 2006), gender (e.g., Geer and Robertson 2005), or body weight issues (e.g., Chambliss et al. 2004). In the case of a sensory modality being the concept, such as olfaction in this case, we would not expect outspoken attitudes toward the concept itself, unless it was related to health or tested in special populations. The fact that our results clearly demonstrate distinctly positive attitudes suggests that people have affective attitudinal tendencies to a wider range of concepts commonly regarded as neutral. This is an interesting topic for future research.

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