Research Report

Smells Like Clean Spirit

Nonconscious Effects of Scent on Cognition and Behavior

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ABSTRACT—*Three studies explored whether odor can influence people's cognition and behavior without their being consciously aware of the influence. In two studies, we tested and confirmed that when participants were unobtrusively exposed to citrus-scented all-purpose cleaner, the mental accessibility of the behavior concept of cleaning was enhanced, as was indicated by faster identification of cleaning-related words in a lexical decision task and higher frequency of listing cleaning-related activities when describing expected behavior during the day. Finally, a third study established that the mere exposure to the scent of all-purpose cleaner caused participants to keep their direct environment more clean during an eating task. Awareness checks showed that participants were unaware of this influence. The present studies reveal the nonconscious influence that olfactory cues can have on thinking and doing.*

Scents influence people's thinking and doing. We all may have the experience of sniffing at a shirt before deciding to wash it, taking in the odor of food to determine whether it is still edible, and perhaps suddenly walking faster through a street when a garbage truck passes by. Scents are also expected to modify consumer behavior. For example, aroma diffusers are installed in hotels, shopping malls, and airports. Also, some neutral products are pleasantly scented before they are placed in the stores. Given the potential impact of scents on thinking and doing, it is surprising that the relation between olfaction and action has hitherto received only limited theoretical analysis and empirical attention. Whereas a great deal of research has focused on the physiological features of odor perception (see, e.g., Goldstein, 1999), the influence of scents on cognition and behavior has been largely neglected.

Some studies have reported effects of scent on approach-avoidance tendencies. For example, research on consumer behavior suggests that scents increase gambling in casinos (Hirsch, 1995), the time spent on a decision task (Bone & Ellen, 1999; Mitchell, Kahn, & Knasko, 1995), and intentions to visit a store (Spangenberg, Crowley, & Henderson, 1996). Moreover, some authors claim to have obtained effects of pheromones on menstrual cycles (Russell, Switz, & Thompson, 1980; Weller & Weller, 1993) and even human sexual behavior (Cutler, McCoy, & Friedmann, 1998; McCoy & Pitino, 2002). Such basic responses are likely to emerge because of the direct link between the olfactory processing modules and parts of the limbic system, which is known to be important for the regulation of affect and sexual activity.

However, the processing of odors does not stop at the limbic system. Associations may be formed between odors and other sensory information (e.g., taste; see Stevenson, Boakes, & Prescott, 1998), as well as semantic and episodic knowledge (Degel, Piper, & Köster, 2001; Stevenson & Boakes, 2003). For example, by means of co-occurrences, the smell of pine trees may be associated with Christmas, and the scent of citrus may be associated with cleaning. When the odor is perceived, such a semantic association may become activated. For instance, it has been shown that odors can cue memories of early childhood (e.g., Chu & Downes, 2000). Yet semantic associations of scents may have consequences that go beyond the sheer activation of associated memories. In the present research, we aimed to explore whether semantic associations that are activated upon odor perception may shape overt behavior, even outside conscious awareness.

Our ideas are based on recent research concerning the direct link between social perception and behavior (for overviews, see Dijksterhuis & Bargh, 2001; Ferguson & Bargh, 2004). This research shows that the mere perception of social categories (e.g., persons, social stereotypes) semantically activates associated traits or behavior representations that, in turn, can guide further thinking and doing automatically in the situation at

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hand. For example, in a study of the effects of stereotype priming on action, Bargh, Chen, and Burrows (1996) primed participants with words that are stereotypical for the social category "elderly" (e.g., *Florida*, *grey*, *bingo*) to enhance the accessibility of "being slow" and then asked participants to walk down the hallway near the lab. Primed participants walked more slowly than control participants. Participants had no clue whatsoever that their behavior was influenced by the priming procedure. These results illustrate the ideo-motor principle—that the mere ideation about or perception of behavior (e.g., being slow) is sufficient to increase the tendency to adjust ongoing behaviors pertaining to the behavior concept (see also Carpenter, 1874; James, 1890).

To extend knowledge with regard to the processes underlying the influence of scent on behavior, we tested the possibility that scents influence behavior, by the same mechanisms as those that purportedly guide ideo-motor action. We used the scent of citrus that is typical for all-purpose cleaners. Obviously, this scent is very often present when cleaning is taking place. Therefore, a strong semantic association between typical cleaner scent and cleaning behavior will be established. The first two studies tested the initial hypothesis that exposure to cleaner scent enhances the accessibility of the cleaning concept automatically, so that such exposure would speed up participants' responses to cleaning-related words in a lexical decision task (Study 1) and guide their expectations of future home activities (Study 2). Finally, in Study 3, we examined the effect of cleaner scent on actual cleaning-related behavior. We tried to demonstrate that the influence of scent on cognition and behavior can occur without a person's conscious awareness of this influence. Following previous research on nonconscious influences on human functioning (Bargh & Chartrand, 2000; Dijksterhuis, Aarts, & Smith, 2005; Shanks & St. John, 1994), we checked whether participants did become aware of the presence of the scent and, if they did, whether they were aware of the influence of the scent on their thinking and doing.

STUDY 1

Method

Participants and Design

Fifty Dutch undergraduates (10 males[1]) participated, receiving €1 in return. Participants were randomly assigned to either a cleaner-scent or a control condition.

Procedure

Participants conducted a lexical decision task in a cubicle. In the scent condition, the citrus scent of all-purpose cleaner was diffused in the cubicle by putting 45 ml of all-purpose cleaner in a bucket with 1.5 L of lukewarm water. The bucket was hidden in the cubicle behind a cupboard and was not visible to participants. In the control condition, no scent was diffused.

In the lexical decision task, participants were asked to indicate as quickly and accurately as possible whether a letter string appearing on a computer screen was an existing word. Responses were made by pressing a "yes" or "no" key on the keyboard. Across the 40 trials, 20 nonwords and 20 real words were presented. Six of the real words were cleaning-related words (e.g., *poetsen*, "cleaning"; *opruimen*, "tidying up"; *hygiëne*, "hygiene"). The other 14 real words were not related to cleaning (e.g., *fietsen*, "bicycling"; *tafel*, "table"; *computer*, "computer") and served as control words. Experimental and control words were matched on valence, as determined in a pilot study.

Immediately after the task, participants filled out a two-page questionnaire examining their awareness of the scent and of the influence of the scent on their performance (cf. Bargh & Chartrand, 2000). Specifically, the first page included items assessing participants' thoughts regarding the possible purposes and hypothesis of the study. On the second page, we explicitly asked whether they had noticed a specific scent in the cubicle, and, if so, what kind of scent they had noticed. Finally, participants were asked whether they thought that this scent might have affected their performance on the lexical decision task, and, if so, how this occurred. This funneled debriefing procedure indicated that none of the participants were able to guess the hypothesis under investigation. Six participants were aware of the presence of the scent; however, none of them thought that the scent had influenced their performance.

Results and Discussion

Incorrect ("no") responses to words were excluded from the analyses (3%), as were responses more than 3 standard deviations from the mean (3%). These errors and slow responses were evenly distributed across the two types of words and conditions. One participant was dropped from analyses because of extremely slow response latencies in general (more than 3 standard deviations from the mean for the sample). The response times on the six target trials were averaged, as were those on the control trials.

These mean response latencies were subjected to a 2 (scent: cleaner vs. none; between participants) × 2 (word type: cleaning vs. control; within participants) analysis of variance. This analysis revealed a main effect of word type, $F(1, 47) = 5.97$, $p = .02$, $\eta^2 = .11$. Participants responded faster to cleaning-related words than to control words. The Scent × Word Type interaction was also significant, $F(1, 47) = 4.33$, $p = .04$, $\eta^2 = .08$. Excluding participants who were aware of the scent did not change the pattern of results. The nature of the results is illustrated in Figure 1, which depicts the means for participants who were not aware of the scent. In line with our prediction, participants in the scent condition responded faster to cleaning-related words than

[1]Across the three studies, no gender effects were found.

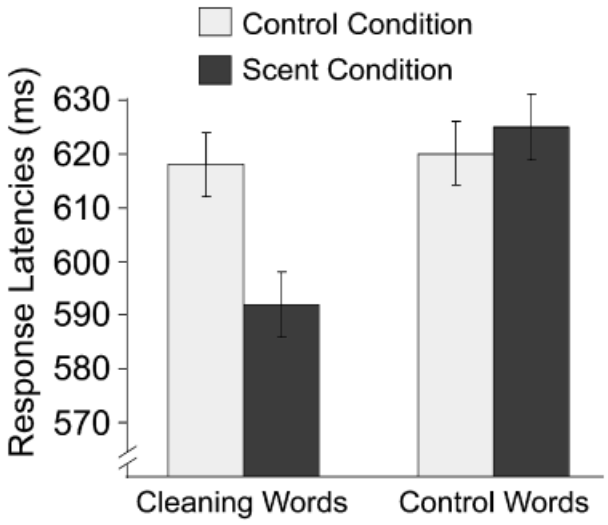

Fig. 1. Mean response latencies and standard deviations for cleaning-related words and control words in the scent and control conditions, Study 1.

did participants in the control condition. The means for the control words were similar across experimental conditions. Furthermore, in the scent condition, responses to cleaning words were faster than responses to control words, whereas such a difference between word types was not manifested in the control condition.

This first study provides initial support for the idea that a scent can facilitate access to behavior concepts that are semantically associated with the scent without participants' conscious awareness of this effect. Study 2 tested the prediction that scents may also guide action plans nonconsciously. Specifically, assuming that the scent of all-purpose cleaner enhances the accessibility of the cleaning concept, we explored whether this scent increases the likelihood that participants will use the behavior concept of cleaning in describing their future home activities.

STUDY 2

Method

Participants and Design

Fifty-six Dutch undergraduates (19 males) participated in this study, receiving €1 in return. Participants were randomly assigned to the scent or control condition.

Procedure

The scent manipulation was identical to that in Study 1. The study was presented as being aimed at learning more about students' daily activities, and participants were asked to write down five activities that they were planning to do during the rest of the day. As in the previous study, the funneled debriefing indicated that none of the participants was aware of the scent or the hypothesis.

Two independent judges blind to condition and the hypothesis scored whether or not a cleaning-related activity (e.g., cleaning, tidying up) was listed. The interjudge reliability was high (κ = .95), and disagreements were solved through discussion.

Results and Discussion

Participants in the scent condition more frequently listed a cleaning activity (36%) than participants in the control condition (11%), $\chi^2(55, N = 56) = 4.91$, $p = .04$. These findings further support the idea that citrus scent enhanced the accessibility of the cleaning concept and, as a result, increased the probability of mentioning cleaning activities in plans for future action. Impressed by these findings, in the next study we aimed to test direct effects of citrus scent on overt cleaning-related behavior.

STUDY 3

Method

Participants and Design

Twenty-two Dutch undergraduates (6 males), receiving €1 in return, were randomly assigned to the scent or control condition.

Procedure

Participants first filled out a filler questionnaire in a cubicle with or without the citrus scent. Subsequently, they moved to another nearby room (in which no scent was diffused). There they were seated at a table and instructed to eat a round biscuit that usually produces crumbs when one bites into it. A hidden video camera recorded the participants' hand movements at the table while consuming the biscuit. The dependent measure was the extent to which participants kept their table clean. Accordingly, two independent judges who were blind to conditions and the hypothesis counted the number of times participants removed crumbs from the table during the task. The correlation between the scores of the two judges was 1.0. Previous research (Aarts & Dijksterhuis, 2003) suggests that this behavior measure is well suited to assessing the nonconscious influences of scents on behavior, because participants' attention is directed to eating, and not to cleaning.

Finally, participants followed the funneled debriefing procedure. One participant had noticed the scent. However, none of the participants were aware of the hypothesis. Also, none of the participants had conscious thoughts about cleaning during the eating task.

Results and Discussion

The measure of cleaning behavior was subjected to a t test. Participants removed the crumbs substantially more often in the scent condition ($M = 3.54$) than in the control condition ($M = 1.09$), $t(20) = 2.37$, $p = .02$, $\eta^2 = .23$, thus showing a direct link between scent perception and behavior. Excluding

the participant who was aware of the scent did not change the pattern of results.

GENERAL DISCUSSION

The present research explored the nonconscious influence of scents on thinking and doing. Results of Studies 1 and 2 showed that the mere presence of the scent of a typical all-purpose cleaner enhanced the accessibility of the behavior concept of cleaning. Study 3 established that exposure to the scent influenced actual performance of cleaning behavior. Furthermore, awareness checks showed that only a few participants were aware of the presence of the scent (although we attest to the difficulty of controlling the thresholds of conscious odor perception; Doty, 1991; Laing, 1982). It is important to note that in none of the studies were participants aware of the fact that their cognition and behavior were affected by the scent. Together, then, these observations provide compelling evidence that scent can have a nonconscious influence on thinking and doing.

The results of Study 2 suggest that the scent brought the cleaning concept into consciousness. This "entering of consciousness" effect may not be a direct cause of the exposure to the scent itself, but rather may have emerged because participants relied on accessible information in order to list activities for future action. As the results of Study 1 demonstrated, the cleaning concept showed enhanced accessibility as a result of exposure to the scent. Such nonconscious influence of knowledge activation has been repeatedly observed in the research on social perception and judgment (e.g., Higgins, 1996). However, this should not be taken to mean that participants consciously decided to keep the table clean or were aware of cleaning the table when eating the biscuit in Study 3. More likely, the cleaning concept was applicable to the task at hand, and, hence, the enhanced accessibility of the behavior representation enabled participants to directly guide and adjust their movements while eating the biscuit (see also Aarts & Dijksterhuis, 2003). Thus, nonconsciously activated information (e.g., the activation of the cleaning concept by exposure to citrus scent) can guide a person's behavior without the need for that person to become aware of the source causing the behavior (e.g., Ferguson & Bargh, 2004; Strack & Deutsch, 2004). This is especially true when, as in our third study, the person is not cognizant of the behavior (e.g., see also Dovidio, Kawakami, & Gaertner, 2002).

Hitherto, the rare psychological research on the link between odors and human behavior focused on affective mechanisms and studied mainly approach-avoidance behavior as a function of odor pleasantness. In contrast, we focused on a cognitive route by which scent influences behavior. The present research is the first to show that behavior is brought in line with semantic associations that become activated upon the perception of a scent.

The primary aim of the present research was to advance understanding with regard to the processes underlying effects of scent on behavior. However, this research also contributes to the perception-behavior literature. Although a large number of studies have provided evidence for an automatic link between perception of the environment and behavior, these studies have focused almost exclusively on visual perception. We are the first to show that perception-behavior links also exist within the domain of olfactory perception. Furthermore, the "environment" is often operationalized in research as words that are flashed on a computer screen or used in a scrambled-sentence task. In a way, using scent as an environmental cue can be considered a more ecological test of the perception-behavior link. In our studies, individuals smelled their environment, and it smelled like clean spirit.

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