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I'm No Longer Torn After Choice: How Explicit Choices Implicitly Shape Preferences of Odors

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Abstract

Several studies have shown that preferences can be strongly modulated by cognitive processes such as decision making and choices. However, it is still unclear whether choices can influence preferences of sensory stimuli implicitly. This question was addressed here by asking participants to evaluate odors, to choose their preferred odors within pairs, to reevaluate the odors, and to perform an unexpected memory test. Results revealed, for the first time in the study of olfaction, the existence of postchoice preference changes, in the sense of an overvaluation of chosen odors and a devaluation of rejected ones, even when choices were forgotten. These results suggest that chemosensory preferences can be modulated by explicit choices and that such modulation might rely on implicit mechanisms. This finding rules out any explanation of postchoice preference changes in terms of experimental demand and strongly challenges the classical cognitive-dissonance-reduction account of such preference changes.

Keywords

preferences, decision making, implicit processing, olfaction

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What determines sensory preferences? Although this research question has been intensively addressed by various disciplines, which mechanisms underlie the shaping of preferences, and in particular how sensory preferences are modulated by various cognitive processes, is still a critically debated research question (e.g., Lazarus, 1984; Lichtenstein & Slovic, 2006; Zajonc, 1984). Remarkably, it has been demonstrated that explicit choices, traditionally considered a reflection of preferences, can in fact shape preferences. Brehm (1956) showed that after having made an explicit (i.e., overt) choice between two objects evaluated as similarly desirable, participants rated the chosen option as more desirable and the nonchosen option (i.e., rejected) as less desirable than during the first evaluation. Since this pioneering experiment, numerous studies have replicated this choice-induced preference modulation (see Harmon-Jones & Mills, 1999).

This effect has classically been interpreted on the basis of the *cognitive-dissonance-reduction assumption* (Festinger, 1957). In this framework, awareness that the choice conflicts with the desirable aspects of the rejected option and with the undesirable aspects of the chosen one elicits discomfort (i.e., cognitive dissonance). Such discomfort could be reduced by devaluing the rejected option and overvaluing the chosen one (see Festinger, 1957; Sharot, De Martino, & Dolan, 2009). However, this classical interpretation is still a matter of debate (see Gawronski, Bodenhausen, & Becker, 2007; Harmon-Jones, Amodio, & Harmon-Jones, 2009; Lieberman, Ochsner, Gilbert, & Schacter, 2001). In particular, the level of processing at which such choice-induced preference modulation could take place is controversial. On the one hand, cognitive dissonance reduction is considered to be based on conscious strategies and mediated by accessibility of dissonant cognitions to awareness (see Allen, 1965; McGregor, Newby-Clark, & Zanna, 1999; Rosenberg & Hovland, 1960; Wicklund & Brehm, 1976). Such interpretation would require participants to explicitly remember the choices they made (see Gawronski et al., 2007; Lieberman et al., 2001). On the other hand, this preference modulation could rely on implicit processes, as previous choices can modulate preferences without requiring conscious or intentional recollection of them. Indeed,

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postchoice evaluation changes have been demonstrated not only in young children and capuchin monkeys (Egan, Santos, & Bloom, 2007) but also in patients with anterograde amnesia (Lieberman et al., 2001).

The aim of the present experiment was thus to test directly, in a normal population, the hypothesis that sensory preferences can be implicitly shaped by explicit choices. Thus, we adapted the free-choice paradigm (Brehm, 1956) and also had our participants perform an unexpected memory test concerning their choices. We hypothesized that explicit memory of a choice is not necessary to observe a postchoice preference change, and we therefore predicted that choice-induced preference modulation would be observed for both remembered and forgotten choices.

We used olfactory stimuli, which have not, to our knowledge, previously been used to study postchoice preference changes. We therefore took advantage of the fact that olfaction is particularly well suited to study implicit memory (e.g., Issanchou, Valentin, Sulmont, Degel, & Köster, 2002). Moreover, we considered that assessing the desirability or the predicted pleasantness of options, as has typically been done, may not be the optimal way to investigate sensory preferences. Indeed, discrepancies have been reported between *experienced* utility—the subjective pleasantness experienced—and *predicted* utility—beliefs about the subjective pleasantness experience of outcomes (see Kahneman, Wakker, & Sarin, 1997). Therefore, we asked participants to perform their choices based on the experienced pleasantness (i.e., experienced utility) elicited by the actually presented odors rather than on the predicted pleasantness (i.e., predicted utility) of the stimuli.

Method

Participants

Thirty-seven University of Geneva students (25 females, 12 males; mean age: 23.6 ± 0.62 years) took part in this experiment. Before starting, they completed a consent form. All participants reported a normal sense of smell. They were individually tested and were paid 10 Swiss francs for their participation. During the day of testing, they were asked not to wear any fragrance.

Stimuli

Eighteen odorants (provided by Firmenich, Geneva, Switzerland) were selected on the basis of their ratings of pleasantness, familiarity, and intensity obtained from a previous study (Delplanque et al., 2008). To hinder odor recognition, we excluded very familiar odors (Rabin & Cain, 1984). We also excluded odors that were extreme in valence or intensity. The mean ratings of the selected odors are provided in Table 1. Odorants were diluted in odorless dipropylene glycol to obtain a roughly similar average intensity and were injected into cylindrical felt-tip pens (provided by Burghart, Wedel, Germany; see Delplanque et al., 2008, for further details). Each odorant was coded by a random three-digit code.

Table 1. The 18 Odors Used and Their Mean Ratings

	Rating		
Odor	Mean prechoice pleasantness	Mean postchoice pleasantness	Mean postchoice intensity
Odors included in all phases of the experiment			
Aladinate (floral note)	5.09 (2.13)	5.13 (2.21)	6.84 (1.88)
Detergent	5.43 (2.06)	5.81 (2.06)	4.81 (1.99)
Shampoo fragrance	8.40 (1.83)	8.40 (1.83)	6.58 (1.61)
Fig flower	6.18 (2.89)	5.39 (2.26)	6.33 (2.08)
Raspberry flower	6.67 (2.33)	6.74 (1.24)	3.81 (2.55)
Lavender flower	7.10 (3.00)	7.47 (2.66)	7.67 (1.79)
Lilac flower	7.58 (2.49)	7.16 (2.18)	6.51 (1.65)
Freesia flower	6.49 (2.50)	6.51 (2.13)	5.17 (2.24)
Melon	5.18 (2.32)	4.31 (2.41)	6.77 (1.87)
Tutti–frutti	7.89 (2.71)	7.88 (2.74)	8.23 (1.32)
Violet flower	5.85 (2.54)	5.60 (2.12)	5.72 (1.98)
Yogurt	3.62 (1.90)	3.82 (2.71)	7.02 (2.13)
Odors added during the fourth part of the experiment			
Basil	—	—	4.70 (2.05)
Mushroom	—	—	6.70 (1.97)
Honey	—	—	3.52 (2.53)
Lime	—	—	7.56 (1.03)
Paracresol (animal note)	—	—	5.74 (2.75)
Vetyver (woody note)	—	—	6.66 (2.09)

Note: Pleasantness was rated on a scale ranging from 1, *very unpleasant*, to 10, *very pleasant*; intensity was rated on a scale ranging from 1, *not perceived*, to 10, *very strong*. Standard deviations are given in parentheses.

Procedure

First, we assessed individual ratings of pleasantness for 12 of the 18 odors. On the basis of these first ratings, pairs were created for the choice phase. During this second phase, each participant was presented with six odor pairs, four of them corresponding to the conditions of interest: (a) two pairs of odors that he or she had rated as similarly pleasant (i.e., difficult-choice condition; mean rating differences = 0.3, *SD* = 0.08, on the 10-point subjective scale described in the next section) and (b) two pairs of odors that he or she had rated differently for pleasantness (i.e., easy-choice condition; mean rating differences = 4.34, *SD* = 0.94, on the 10-point subjective scale described in the next section). Participants were required to choose the odor they preferred within each pair. In the third phase, about 10 min later, participants again assessed the pleasantness of the 12 odors. Finally, participants rated the intensity of these 12 odors, together with 6 new odors (see Table 1). Critically, participants also indicated whether they had already smelled each odor. If they answered "yes," they were asked whether they had chosen or rejected this odor during the choice phase. Before this time, participants were not aware that they would have to complete a memory task. During the entire experiment, the order in which odors or pairs of odors were presented was controlled. Participants were instructed to smell each odor for no more than two inhalations.

Subjective ratings

After each odor was presented during the prechoice and the postchoice phases, participants rated its pleasantness on a computer screen. Participants used a mouse to move a vertical marker across a horizontal line and click to indicate their rating. Participants rated the odor on a scale ranging from *very unpleasant*, 1, to *very pleasant*, 10. During the last phase, participants rated the subjective intensity of the odor on a scale ranging from *not perceived*, 1, to *very strong*, 10.

Data analyses

First, the difference between prechoice and postchoice ratings for each of the 12 odors was converted to standardized individual *z* scores. Second, for each participant, we assessed odor-recognition-memory performance by using parameters based on signal detection theory (Corwin, 1989). If the odor was presented during the experiment and declared so by a participant, a hit was scored. If the odor was not presented during the experiment but declared so, a false alarm was recorded. From hit and false alarm scores, we then calculated four parameters: hit rate (*HR*), false alarm rate (*FR*), discrimination measurement (*d'L*), and response bias (*CL*). We also assessed memory performance as a function of choice by using the same procedure, with a hit being recorded if the odor was chosen or rejected and the participant declared so accurately and a false alarm being recorded if the odor was chosen or rejected but the participant declared the opposite choice. For the analyses performed on the subjective ratings (pleasantness and intensity), we defined a trial as remembered if the participant correctly recalled the choice he or she made. Otherwise, the trial was considered forgotten.

Results

Memory performance

We first assessed odor-recognition-memory performance. As indicated by the participants' mean hit rate, discrimination index, and response bias (*HR* = 0.87, *d'L* = 3.33, *CL* = –0.47), participants remembered the presented odors well and discriminated them well from the distracting odors. In contrast, memory performance for choice was globally poor (*HR* = 0.41). In addition, we investigated whether recall of choice depended on the type of choice made (chosen vs. rejected) and its difficulty. Thus, we performed a 2 × 2 repeated measures multivariate analysis of variance (MANOVA), with choice (chosen, rejected) and difficulty (difficult, easy) as the independent variables and hit rate, discrimination, and response bias as the dependent variables. Critically, neither main effect (choice or difficulty) nor the Choice × Difficulty interaction was statistically significant, all Fs(1, 36) < 1, ps > .29.

Choice-induced change of preferences for odors

Choice-induced changes are typically reported when the choice is difficult. In our case, this was when the pleasantness of the two paired odors had been rated similarly before. A repeated measures analysis of variance (ANOVA), with choice (chosen, rejected) as the independent variable and the difference between prechoice and postchoice ratings in the difficult condition as the dependent variable, was significant, $F(1, 36) = 15.15$, $p < .001$, $\eta_p^2 = .29$. To specify whether this effect was due to the overvaluation of the chosen odors or the devaluation of the rejected odors, we analyzed pleasantness scores in the difficult-choice condition using a 2 × 2 repeated measures MANOVA with phase (prechoice, postchoice) and choice (chosen, rejected) as the independent variables. As displayed in Figure 1, the interaction between these factors was statistically significant, $F(1, 36) = 17.10$, $p < .001$, $\eta_p^2 = .32$. For difficult choices, pleasantness ratings were significantly decreased for rejected odors, planned contrast, $F(1, 36) = 8.75$, $p < .01$, $\eta_p^2 = .20$; the increase in pleasantness ratings for chosen odors was marginally significant, planned contrast, $F(1, 36) = 2.88$, $p = .098$, $\eta_p^2 = .07$. The identical analysis performed on the pleasantness scores in the easy-choice condition revealed only a significant main effect of choice, $F(1, 36) = 90.3$, $p < .001$, $\eta_p^2 = .71$, which simply reflected significantly higher pleasantness ratings for chosen odors than for rejected ones.

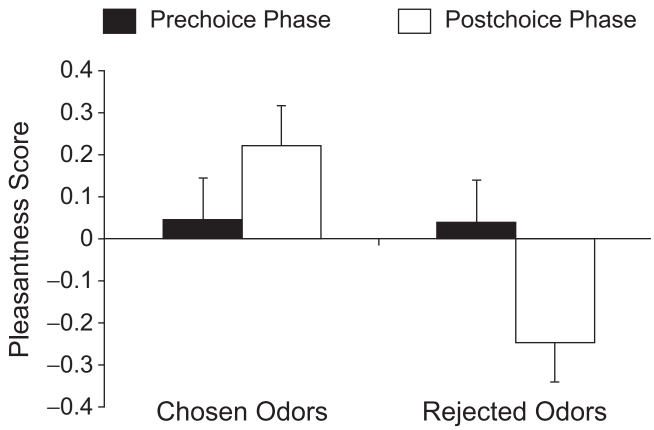

Fig. 1. Mean pleasantness ratings of odors that were presented in the difficult-choice condition, as a function of phase of the experiment (prechoice or postchoice) and whether the odor was chosen or rejected during the choice phase. Pleasantness ratings were converted to mean z scores. Error bars represent standard errors of the mean.

Role of explicit memory of the choice

To assess the role of memory for the choice in postchoice preference changes, we performed a 2 × 2 repeated measures MANOVA with choice (chosen, rejected) and memory (remembered, forgotten) as the independent variables and difference score in the difficult-choice condition as the dependent variable. This analysis revealed a main effect only of choice, $F(1, 9) = 6.95$, $p < .03$, $\eta_p^2 = .44$, showing that the difference between the overvaluation of the chosen odors and the devaluation of the rejected ones was significant for forgotten and remembered choices combined (see Fig. 2). Two repeated measures ANOVAs conducted on the difference scores for the forgotten and remembered difficult choices separately confirmed significant postchoice preference changes for both, $F(1, 28) = 7.91$ and $F(1, 14) = 7.06$, ps < .05, η_p^2s = .22 and .33.

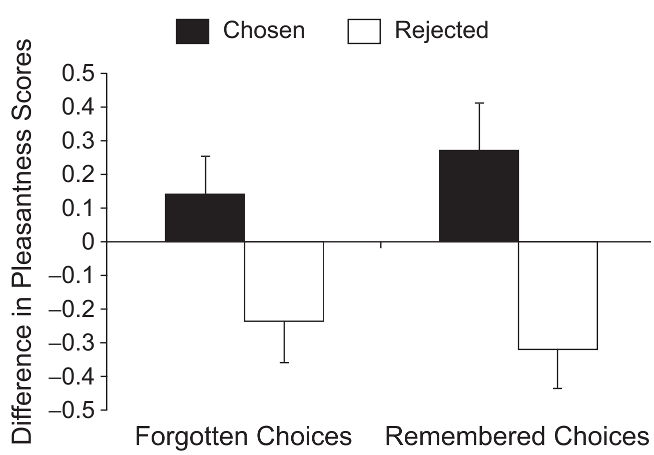

Fig. 2. Mean difference in pleasantness scores in the difficult-choice condition as a function of whether the odor was chosen or rejected and whether this choice was forgotten or remembered correctly. Scores were converted to z scores, and difference was calculated as the postchoice score minus the prechoice score. Error bars represent standard errors of the mean.

Influence of pleasantness on choices

We further investigated whether the pleasantness of the odor before the choice varied as a function of the participants' choice. A repeated measures ANOVA with pleasantness score before the choice as the dependent variable and choice (chosen, rejected) as the independent variable did not reach significance, $F(1, 36) = 0.23$, $p > .6$.

Intensity ratings

The mean intensity ratings for all the odors are reported in Table 1. There was no difference between the intensity ratings of the chosen and the rejected odors, $F(1, 36) = 2.17$, $p > .1$.

Discussion

Results showed, for the first time in the study of olfaction, the existence of postchoice preference changes, as exhibited by an overvaluation of chosen odors and a devaluation of rejected ones. This finding indicates that preference shaping by decision-making processes also applies to smell, suggesting that the underlying mechanisms may not be modality specific. In this respect, further studies might investigate the extent to which postchoice preference changes could be transferred from one modality to another.

Moreover, we demonstrated the existence of postchoice preference changes not only when choices were remembered, but also, critically, when choices were forgotten. This last point rules out any explanation of the choice-induced preference changes in terms of experimental demand and, most important, suggests that the mechanisms underlying this choice-induced preference change may function at an implicit level (see also Lieberman et al., 2001). Therefore, the classical cognitive-dissonance model cannot accurately account for these findings unless one assumes that dissonance elicitation and reduction may be implicit.

The recent action-based model of cognitive dissonance (Harmon-Jones et al., 2009) postulates that making a choice between two similarly pleasant stimuli leads to conflicted action tendencies, as they both elicit approach tendencies automatically (Chen & Bargh, 1999; Custers & Aarts, 2005). These conflicted action tendencies lead to an unpleasant emotional reaction of dissonance that is reduced by postchoice preference changes. In particular, a decrease in pleasantness of a rejected stimulus will decrease the approach tendency toward it (Veling, Holland, & van Knippenberg, 2008) and consequently reduce the unpleasant emotional reaction elicited by the initial conflicting action tendencies.

Testing alternative models of postchoice preference changes could benefit from a better understanding of the brain mechanisms underlying these psychological processes. For instance, in the first functional magnetic resonance imaging experiment on this topic, Sharot et al. (2009) have shown that postchoice changes in stimulus evaluation can be predicted on the basis of the activation in the caudate nucleus, a region modulated by the perceived value of a stimulus, as well as by choices associated with rewards (Delgado, 2007).

To conclude, our results suggest not only that preference acquisition can be determined by antecedent explicit choice, but also that such changes might rely on implicit processes. An important research question concerns the consolidation of implicitly shaped preferences in long-term memory. In particular, future experiments could investigate how postchoice preference changes evolve over time when choices are remembered or forgotten.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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