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Changing likes and dislikes through the back door: The US-revaluation effect

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US-revaluation refers to the observation that subsequent changes in the valence of an unconditioned stimulus (US) after pairing it with a neutral, conditioned stimulus (CS) also changes the valence of the associated CS. Experiment 1 found evidence for the US-revaluation effect using an unobtrusive measure of evaluation. However, US-revaluation effects were more pronounced for positive-to-negative compared to negative-to-positive revaluations. Experiment 2 replicated this finding for self-reported evaluations, further showing that US-revaluation effects are stable over time and independent of explicit memory for the revaluating information. Using a modified paradigm, Experiment 3 ruled out method-related explanations for these findings and showed that changes in CS evaluations are correlated with parallel changes in US evaluations. These findings encourage the view of evaluative conditioning as an instance of stimulus–stimulus (S–S) rather than stimulus-response (S–R) learning. Implications for basic and applied research are discussed.

Keywords: Associative processes; Attitude change; Evaluative conditioning.

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Hardly any topic in basic and applied psychology has attracted more attention than the formation and activation of attitudes. Because attitudes are seen as providing guidance in a complex world, behaviour without attitudes is difficult to imagine. Beyond the question of how attitudes guide behaviour (e.g., Ajzen, 1991; Fazio, 1990), two major topics have been of primary interest in attitude research: (a) the question of how attitudes are formed and (b) the question of how attitudes can be changed. Traditionally, the question of attitude formation has been addressed by accounts that emphasise the significance of affective processes, whereas research on attitude change has tended to focus on cognitive processes (Eagly & Chaiken, 1993).

Research on attitude formation has paid special attention to the occurrence of so-called evaluative conditioning (EC) effects (see De Houwer, Thomas, & Baeyens, 2001; Walther, Nagengast, & Trasselli, 2005, for reviews). EC effects refer to changes in liking that are due to the pairing of stimuli (De Houwer, 2007). In a prototypical EC study, a subjectively neutral picture (conditioned stimulus; CS) is repeatedly presented with a subjectively liked or disliked picture (unconditioned stimulus; US). The common result is a shift in the valence of the formerly neutral CS, such that it acquires the evaluative quality of the US. This means that, different from signal or Pavlovian learning, in which the CS acquires a *predictive value*, the CS in an EC paradigm merely attains the *affective quality* of the US. EC is usually explained by the formation of an association between the cognitive representation of the CS and the US (De Houwer et al., 2001).

There are various manifestations of EC in social psychology. For instance, the famous "kill-the-messenger effect" can be considered as an instance of EC. This effect describes the phenomenon whereby transmitters are inevitably associated with the valence of the message they are conveying (Manis, Cornell, & Moore, 1974). That is, the messenger (CS) seems to acquire a negative valence by being associated with the bad news (US). Similar association-based effects were obtained in a series of intriguing studies by Skowronski, Carlston, Mae, and Crawford (1998), who demonstrated that communicators (CSs) become involuntarily associated with their verbal description (USs) of others (see also Gawronski & Walther, in press). Although descriptions of other people are logically independent of the communicator, the procedure of pairing the descriptions with the communicators can lead to EC effects.

Although EC may be involved in many psychological phenomena, the processes underlying EC are still not sufficiently well understood. Most importantly, at a representational level, there are two possible effects of the repeated co-occurrence of CS and US. The first is the development of a connection between the CS and the US at the response level. According to this account, the CS acquires its own response that mimics the unconditioned response (UR) elicited by the US (S–R learning). The second possibility is that EC reflects a mental connection between the cognitive representations of the CS and the US. Thus, exposure to the CS after repeated pairings with a US will activate the representation of the US, which in turn activates its corresponding response (S–S learning).

The US-revaluation paradigm (Rescorla, 1974) provides a straightforward test of these two possibilities. US-revaluation means that post-conditional changes in the valence of a US lead to corresponding changes in the valence of pre-associated conditioned stimuli (CS). For instance, Baeyens, Eelen, Van den Bergh, and Crombez (1992b) post-conditionally presented positive USs (faces) with negative adjectives and negative USs (faces) with positive adjectives. This revaluation procedure not only led to a reversal in the valence of the US. Rather, the affective quality of the CS also changed in the direction of the revaluated US. In other words, changing the attitude towards a given individual led to corresponding changes in attitudes toward other persons that were merely associated with that individual. Most important, this effect occurred even though the CS had never been paired with the adjectives. Interestingly, Baeyens, Vanhouche, Crombez, and Eelen (1998) failed to obtain US-revaluation effects in evaluative flavour–flavour conditioning. They attributed the absence of the effect in this latter paradigm to the specific nature of the US, such that USs in the face–face paradigm consist of more sensory-descriptive features than a flavour-US. Thus, whereas in the face–face paradigm the CS seems to be associated with a nominal stimulus (i.e., an individual US), only the affective characteristics of the US seem to be associated with the CS in flavour–flavour conditioning. Thus, if only valence is associated with the CS, the revaluation of an individual US cannot have an impact on associated CSs.

The implications of US-revaluation for EC theory are straightforward: Whereas S–R learning implies that responses to the CS should be unaffected by US revaluation, S–S learning implies that responses to the CS should reflect the new valence of the revaluated US. Although the US-revaluation effect has already been demonstrated by Baeyens et al. (1992b), these studies are often considered as inconclusive, because CS–US pairs were not randomised but arranged by the experimenter. Thus, it could not be ruled out that CS–US similarity played a role in the assignment. The present studies aimed at providing more compelling evidence for the US-revaluation effect by controlling for biased self-reports (Experiment 1) and potential memory effects (Experiment 2). Finally, we tested whether changes in CS liking were directly related to changes in US liking, and ruled out that CS–US similarity contributed to the effect (Experiment 3).

EXPERIMENT 1

The main goal of Experiment 1 was to test the impact of US-revaluation on attitudes toward pre-associated CSs using an unobtrusive attitude measure (i.e., affective priming). For this purpose, participants first formed positive or negative attitudes toward several individuals (USs). In a subsequent phase, these USs were repeatedly paired with pictures of affectively neutral individuals (CSs). Afterwards, participants' attitudes towards the USs were changed by presenting information about the USs that was opposite to the initial valence. More specifically, originally positive USs were presented with negative information and originally negative USs were presented with positive information. In a control condition, both positive and negative USs were presented with evaluatively neutral information. Finally, participants' attitudes were assessed with an affective priming task (Fazio, Jackson, Dunton, & Williams, 1995).

Method

Participants and design

A total of 45 psychology students (32 female, 13 male) from the Technical University of Chemnitz (Germany) took part in a study on impression formation. Participants received partial credit towards a course requirement. The experiment consisted of a 2 (Original Valence of US: positive vs. negative) $\times$ 2 (US-revaluation: opposite vs. control) within-subjects design.

Procedure and measures

The first experiment is described in more detail than the subsequent ones, which followed the same general procedure. Participants were greeted by a female or male experimenter and seated in front of a computer screen. The experiment consisted of three sequential phases, which were guided entirely by a computer program: an attitude formation phase, a CS–US pairing phase, and a revaluation phase.

Attitude formation. In the attitude formation phase, participants were asked to imagine that they had just started a new job in a company, and hence were interested in getting acquainted with their new colleagues. Participants were then presented with pictures of eight male individuals. The material was adopted from Gawronski, Walther, and Blank (2005) and comprised four generally liked and four generally disliked individuals, who had been selected on the basis of pre-tests. Participants were presented with the individuals and a number of either positive or negative statements about these individuals, depending on their a priori valence (see Appendix). Three statements were presented one-by-one for each individual, with statements being either consistently positive or consistently negative (see Gawronski et al., 2005, for more details). Thus, there were three trials for each individual. Participants' task was to form an impression of these individuals based on the statements. The individuals were presented via black-and-white portrait photographs on the left side of the screen, with one statement simultaneously appearing on the right. Picture–statement pairs were presented one by one, with each pair being displayed for 7000 ms. The inter-trial interval was 1000 ms. The picture–statement pairs were intermixed in a fixed randomised order.

CS–US pairings. After this task, participants were asked to imagine that they were now acquainted with some of their new colleagues but still unfamiliar with others. Participants were then presented with pairs of already familiar individuals from the initial attitude-formation task (USs) and yet unfamiliar, neutral target individuals (CSs). USs of positive or negative valence were presented on the right side, while the neutral CSs were presented on the left side of the screen. A total of 8 neutral individuals taken from Gawronski et al. (2005) were used as CSs, which were randomly matched with the USs. These randomised pairs were kept constant for all participants. Half of the CSs were paired with a positive US and the other half were paired with a negative US. CS–US pairs were presented five times simultaneously for 4000 ms, with an inter-trial interval of 2000 ms. Order of CS–US pairs was randomised. Participants' task was to form impressions of the targets presented on the screen.

US-revaluation. Participants were then asked to imagine that they had already been working in the company for several weeks. They were told that they would now receive additional information about their colleagues. The procedure was identical to the attitude-formation phase, except that US pictures were now paired with information of either neutral or opposite valence (see Appendix). More specifically, positive USs were paired with either negative information (revaluation condition) or neutral information (control condition); negative USs were paired with either positive information (revaluation condition) or neutral information (control condition). Special care was taken that the presented information in the experimental groups was opposite in valence but not in direct contradiction to the information presented in the first phase of the study. A total of 3 statements was presented for each individual.

Affective priming task

The procedure of the affective priming task was identical to the one employed by Gawronski et al. (2005). Participants were presented with picture primes showing a US or a CS for 200 ms. This presentation was immediately followed by either a positive or negative target word (negative words: *enemy*, *violence*, *hate*, *war*, *misery*, *terror*, *brutality*, *murder*; positive words: *love*, *laughter*, *fun*, *joy*, *happiness*, *kiss*, *freedom*, *friend*). The SOA was 200 ms; the inter-trial interval was 1000 ms. Participants' task was to indicate as fast as possible whether the target word presented on the screen was positive or negative by pressing one of two response keys on the keyboard in front of them. Each of the 16 pictures of the previous conditioning phase (i.e., the 8 CSs and the 8 USs) was presented three times with a positive word and three times with a negative word in random order, resulting in a total of 96 trials.

Results

Preliminary analyses

Attitude indices were calculated by first eliminating error trials (4.1%) and truncating response latencies higher than 1000 ms and lower than 300 ms (2.9%). The impact of potential outliers was further reduced by removing response latencies that deviated more than 3 standard deviations from an individual participant's mean latency (0.5%). To create an evaluation score, we then subtracted the mean latency for positive words from the mean latency for negative words given a particular prime category (Gawronski et al., 2005). Thus, higher scores indicate more positive attitudes. Mean milliseconds were used a basis for analysis.

Post-revaluation attitudes

US-attitudes. We first analysed effects of revaluating information on US evaluations. A 2 (Original Valence of US: positive vs. negative) $\times$ 2 (US-revaluation: opposite vs. control) ANOVA for repeated measures revealed a significant two-way interaction, $F(1, 44) = 11.98$, $p < .001$, $\eta^2 = .21$. Consistent with the intended manipulation, originally positive USs were less positive under revaluation conditions than under control conditions (Ms = 0.08 vs. 25.46, respectively), $t(44) = 2.54$, $p = .01$, $d = 0.76$. Conversely, originally negative USs were less negative under revaluation conditions than under control conditions (Ms = 23.22 vs. -11.16, respectively), $t(44) = 2.78$, $p = .008$, $d = 0.83$. These results indicate that the employed revaluation manipulation indeed affected the valence of the US, which is a basic requirement for the proposed US-revaluation effect on CS valence.

CS-attitudes. The same ANOVA on CS valence revealed a significant two-way interaction of Revaluation and Original US valence, $F(1, 44) = 3.93$, $p = .05$, $\eta^2 = .08$, indicating that revaluation of the US systematically changed attitudes towards the CS (see Figure 1). Specifically, CSs that were paired with (formerly) positive USs were evaluated less positively after revaluation as compared to control conditions. In contrast, CSs that were paired with (formerly) negative USs were evaluated less negatively after revaluation as compared to control conditions. However, there was also an asymmetry indicating that revaluation effects were statistically significant only for originally positive USs, $t(44) = 2.22$, $p = .03$, $d = 0.41$, but not for originally negative USs, $t(44) = 0.47$, $p = .64$, $d = 0.11$.

Discussion

Results from Experiment 1 shed some light on the content of what is learned in an EC paradigm. The present findings support the idea that evaluative changes in the CS should be understood as being based on an associative link between the CS and the US rather than on intrinsic changes in the CS itself. In the present study, effects of revaluation were not restricted to USs that were directly paired with revaluating information. Instead, revaluation effects also occurred for CSs that were merely pre-associated with USs. In the present study, US-revaluation influenced CS attitudes assessed with an unobtrusive measure, namely Fazio et al.'s (1995) affective priming task

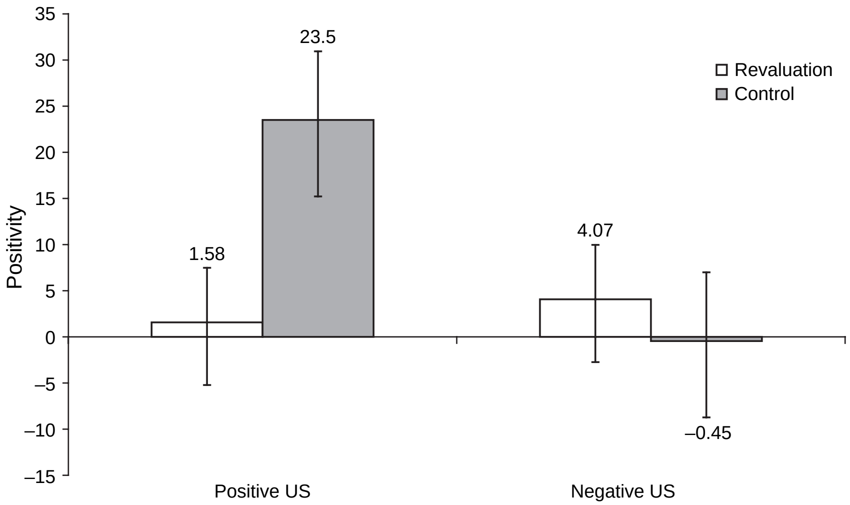

Figure 1. Unobtrusively assessed evaluations of conditioned stimuli (CS) as a function of US valence (positive vs. negative) and US-revaluation conditions (revaluation vs. control). Higher values indicate more positive evaluations; Experiment 1.

(see also Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002). Because affective priming should be less prone to the type of response biases often obtained in self-report measures (Fazio & Olson, 2003), these findings indicate that the US-revaluation effect is not due to simple demand characteristics.

Despite the consistency of our findings with the S–S-learning account, a potential alternative explanation is that the obtained differences in CS evaluations are not due to the influence of learning and revaluation, but merely reflect a priori differences in the evaluations of the CSs. As outline in the method section, CSs were not counterbalanced across conditions but were paired with USs in a fixed randomised order. Although we can not completely rule out the possibility of a priori differences in CS evaluations, the fact that the CSs were pre-tested as neutral and turned out to be of neutral valence in previous studies (Gawronski et al., 2005) makes this explanation rather unlikely. Moreover, the extreme positive value in the positive US control condition, suggests that appetitive learning rather than baseline differences contributed to this effect. Nevertheless, we tried to rule out this alternative explanation in Experiment 3 by using fully counterbalanced pairings of CSs and USs.

Somewhat to our surprise, US revaluation effects turned out to be more powerful in changing positive into negative attitudes rather than vice versa. Similar asymmetries have been obtained in the area of flavour conditioning, showing that aversive learning is stronger than appetitive conditioning (Baeyens, Eelen, Van den Bergh, & Crombez, 1990). This finding is consistent with previous research on negativity bias, indicating that the impact of negative information is generally stronger than the impact of positive information (e.g., Baumeister, Bratlavsky, Finkenauer, & Vohs, 2001; Cacioppo & Berntson, 1994; Fazio, Eiser, & Shook, 2004; Gidron, Koehler, & Tversky, 1993; Ito, Larsen, Smith, & Cacioppo, 1998; Reeder & Brewer, 1979; Rozin & Royzman, 2001; Skowronski & Carlston, 1989). One explanation is that negative information is regarded as higher in diagnosticity than positive information (Fiedler, Walther, & Nickel, 1999). Thus, when it comes to small effects like in the US-revaluation paradigm, in which the impact on CSs is only indirect and mediated by changes in the USs, the higher power of negativity may come into play. In any case, it is an interesting question whether this asymmetry in US-revaluation is a robust phenomenon that can be replicated in the following studies.

EXPERIMENT 2

On the basis of Experiment 1 we concluded that US-revaluation effects can arise independent of demand-like characteristics. Accordingly, changes in attitudes were assessed with standard likeability ratings in the following studies. However, the important question remains whether these changes are influenced by explicit memory for the statements of the revaluation information. After all, it is not implausible to assume that participants recalled at least some of the statements along with the USs that were paired with them. In other words, participants' responses to the USs may have been driven by explicit knowledge of the revaluation information at the time responses were assessed. This explicit revaluation of the USs may have in turn led to inferences regarding the valence of the CSs. In order to address the possibility that explicit knowledge of the statements contributed to our results, we assessed recognition memory for the statements. Moreover, we investigated recognition memory and the stability of the revaluation effect over a period of one week. If explicit knowledge of the revaluation information contributed to the pattern obtained in Study 1, revaluation effects on CS should become weaker with decreasing memory over time. If, however, the effects obtained in Experiment 1 were driven by simple associations between CSs and USs, revaluation effects should remain stable over time, even when explicit memory decreases.

Method

Participants and design

A total of 33 Psychology students (24 female, 9 male) drawn from a subject pool from the Technical University of Chemnitz (Germany) took part in a study on impression formation. Participants were compensated with partial credit towards a course requirement. The experiment consisted of a 2 (Original Valence of US: positive vs. negative) $\times$ 2 (US-revaluation: opposite vs. control) $\times$ 2 (Time: immediately after study vs. after one week) within-subjects design. Three participants failed to take the recognition test in the second session; data from these participants were excluded from analyses.

Procedure

The procedure of Experiment 2 was largely identical to Experiment 1, the main exceptions being that participants were asked to judge the stimuli on explicit likeability ratings and that they were asked to evaluate the stimuli again after one week. In addition, we assessed participants' memory for the revaluating information.

Post-revaluation attitudes. After the revaluation procedure, participants were asked to evaluate all individuals on a 20 cm long graphic rating scale (labelled "*dislike*" on the left and "*like*" on the right) by positioning the cursor on any point of the scale and then pressing the left mouse key. To avoid response tendencies, the graphic scale consisted of no additional numbers or other numerical labels. The computer program recorded negative judgements on the left side from -1 to -100, and positive judgements on the right side from $+1$ to $+100$. The neutral midpoint of the scale (0) served as the starting position for each judgement. The same measure was used in the second session after one week.

Recognition test. In addition, we included a recognition test to assess participants' memory for the face–statement combinations. Specifically, participants were handed booklets with a recognition test immediately after the post-revaluation measure. This recognition test consisted of the 8 USs presented in the study, each picture on one page. Below the picture, the three statements of the attitude formation phase and the three statements of the revaluation phase (i.e., targets) intermixed with 18 distracters (statements not presented in the study) were presented on the sheet. To test whether participants could clearly identify the presented statements or simply recall the valence of the statements, the distracter statements were fully matched with the valence of the target statements previously presented in the study. That is, for each statement of the original attitude formation and revaluation phases, two distracter statements of the same valence were presented, along with six neutral distracters that were not used in the analyses. Participants were instructed to indicate which of the statements were actually presented with the pictures by marking a "present" or "not present" field for all 24 statements. As with the attitude measure, the same recognition task was administered again in the second session after one week.

Results

Post-revaluation attitudes

US-attitudes. We first analysed effects of revaluating information on USs. A 2 (Original Valence of US: positive vs. negative) × 2 (US-revaluation: opposite vs. control) × 2 (Time: immediately after study vs. after one week) ANOVA with repeated measurement on all factors revealed a significant main effect of Time, $F(1, 29) = 13.55$, $p < .001$, $\eta^2 = .31$, indicating that evaluations became somewhat more positive over time ($M = 9.55$ vs. $M = -1.82$), and a main effect for Revaluation, $F(1, 29) = 52.25$, $p < .001$, $\eta^2 = .64$, supporting the idea that faces were rated more positively ($M = 26.58$) in the revaluation than the control condition ($M = -18.85$). Moreover, there was a Time by Valence interaction, $F(1, 29) = 37.76$, $p < .001$, $\eta^2 = .56$, showing that the differences between positively and negatively valenced pictures were smaller after a week ($M = -37.19$ vs. $M = -59.8$). In addition, a significant Time by Revaluation interaction indicated that differences between revaluation and control were smaller after one week. That is, they were more enhanced in the immediate test independent of the particular valence, $F(1, 29) = 78.11$, $p < .001$, $\eta^2 = .72$. More importantly, a highly significant three-way interaction between Valence, Time and Revaluation, $F(1, 29) = 27.09$, $p < .001$, $\eta^2 = .48$, emerged. This result indicated that the employed revaluation manipulation indeed affected the valence of the USs, which is a basic requirement for the proposed US-revaluation effect on CS valence. However, this effect was influenced by time. Even though the intended effect on USs remained significant in a two-way interaction between valence and revaluation after a one-week interval ($M = -26.20$ revaluated positive US vs. $M = 76.18$ control; $M = -1.21$ revaluated negative US vs. $M = -34.00$ control), $F(1, 29) = 31.25$, $p < .001$, $\eta^2 = .51$, this effect was somewhat weaker than immediately after the study ($M = 19.56$ revaluated positive US vs. $M = 36.80$ control; $M = 0.56$ revaluated negative US vs. $M = -40.78$ control), $F(1, 29) = 76.54$, $p < .001$, $\eta^2 = .72$.

CS-attitudes. The same 2 (Original Valence of US: positive vs. negative) × 2 (US-revaluation: opposite vs. control) × 2 (Time: immediately after study vs. after one week) ANOVA on CS attitudes revealed a very similar pattern of results (see Figure 2). There was a significant main effect of Revaluation, $F(1, 29) = 23.64$, $p < .01$, $\eta^2 = .44$, showing that CS attitudes were more positive in the control than in the revaluation condition.

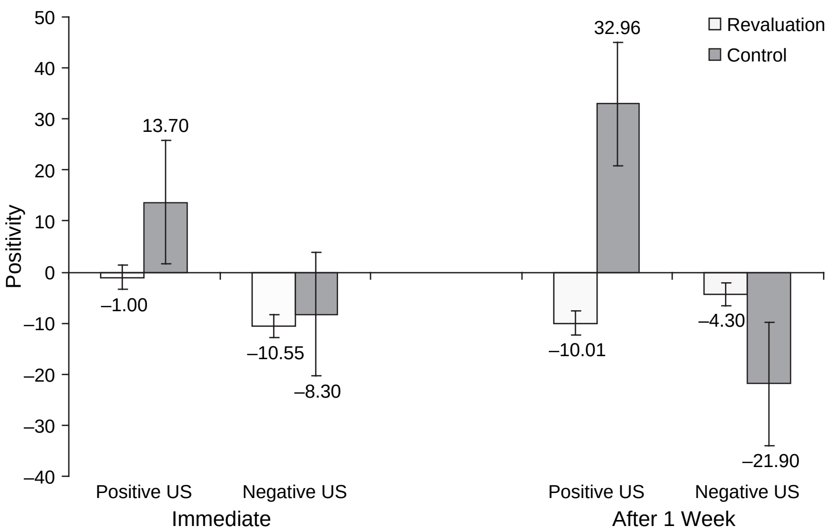

Figure 2. Evaluations of conditioned stimuli (CS) as a function of US valence (positive vs. negative), US-revaluation conditions (revaluation vs. control), and time of measurement (immediately after study vs. after one week). Higher values indicate more positive evaluations; Experiment 2.

Moreover, a significant main effect of Time, $F(1, 29) = 6.17$, $p < .01$, $\eta^2 = .17$, revealed that attitudes became more positive over time. More important, there was also a significant three-way interaction, indicating that revaluation effects on CSs differed over time, $F(1, 29) = 7.91$, $p = .008$, $\eta^2 = .21$ (see Figure 2). To specify this interaction in terms of the present hypotheses, we conducted separate 2 (Original Valence of US: positive vs. negative) × 2 (US-revaluation: opposite vs. control) ANOVAs for each of the two time conditions. When attitudes were assessed immediately after the study, the interaction between valence and revaluation was not significant, $F(1, 29) = 1.17$, $p = .28$, $\eta^2 = .03$, but the US-revaluation pattern was in the expected direction. Interestingly, the effect of US-revaluation on CS attitudes was enhanced after the delay of one week, $F(1, 29) = 25.06$, $p < .001$, $\eta^2 = .46$. Thus, in contrast to the assumption that US-revaluation effects on CS attitudes may dissipate over time, US-revaluation effects became stronger rather than weaker.

Recognition memory

Following data analytic procedures of previous studies (Walther et al., 2002), responses were transformed to percentages of "yes" answers for further analysis. Thus, higher scores indicated a higher percentage of hits or false alarms, depending on the item category (i.e., target vs. distracter). In a second step, we computed d' scores according to Signal Detection Theory (Green & Swets, 1966) over each valence condition in targets and distracters. Submitted to a 2 (Valence of Original US: positive vs. negative) × 2 (formation vs. revaluation) × 2 (Time: immediately after study vs. after one week) ANOVA with repeated measurement on all factors, d' scores revealed a highly significant main effect of time, $F(1, 29) = 75.53$, $p < .001$, $\eta^2 = .72$. Not surprisingly, memory performance decreased from the first to the second test. In addition, there was a significant two-way interaction between Time and Revaluation, $F(1, 29) = 18.08$, $p < .001$, $\eta^2 = .38$, indicating that, immediately after the study, information of the revaluation phase was better recognised than information of the attitude formation phase (Ms = 1.70 vs. 1.48, respectively), whereas memory for attitude formation information was slightly better than memory for revaluation information after the delay of one week (Ms = 1.33 vs. 1.22, respectively). Apparently, the revaluation information benefited more from a recency effect than the attitude formation information from primacy. However, this effect was qualified by a significant three-way interaction of Original Valence, Revaluation, and Time, $F(1, 29) = 14.78$, $p < .001$, $\eta^2 = .33$, revealing that memory for negative statements was better in the short run and that this effect was stronger for formation than for revaluation information.

In subsequent analyses we tested effects separately for the statements presented in the attitude formation and in the revaluation phase. For statements presented in the attitude formation phase, a 2 (Original Valence of US: positive vs. negative) × 2 (Time: immediately after study vs. after one week) ANOVA with repeated measurement on both factors revealed a main effect of Time, $F(1, 29) = 11.89$, $p = .002$, $\eta^2 = .29$, and a significant two-way interaction of Original Valence and Time, $F(1, 29) = 11.60$, $p = .002$, $\eta^2 = .28$. When memory for both time conditions was compared, it turned out that memory for positive statements remained relatively stable (*M*s = 1.42 vs. 1.49, respectively), $t(29) = 0.70$, $p = .48$, $d = 0.25$, but memory for negative statements decreased substantially over time (*M*s = 1.53 vs. 1.17, respectively), $t(29) = 4.31$, $p < .001$, $d = 1.60$.

For the revaluation information, a 3 (US-revaluation: positive vs. control vs. negative) × 2 (Time: immediately after study vs. after one week) ANOVA with repeated measurement on all factors revealed a significant main effect of Time $F(2, 28) = 20.69$, $p < .001$, $\eta^2 = .42$, indicating that memory generally decreased over time. However, this effect was qualified by a significant two-way interaction of Revaluation and Time, $F(2, 28) = 30.26$, $p = .001$, $\eta^2 = .51$, showing that relative to the neutral control statements the decrease in memory for negative information over time was stronger (*M*s = 1.85 vs.1.00, respectively), $t(29) = 6.01$, $p < .001$, $d = 2.23$, than the decrease in memory for positive revaluation information (*M*s = 1.60 vs. 1.26, respectively), $t(29) = 3.96$, $p < .001$, $d = 1.47$ (see Figure 3). This is remarkable because the impact of negative information on attitudes (i.e., revaluation effect) was much stronger than the influence of positive information. In the memory tests, however, the reverse pattern emerged. If anything, memory for positive information was better than memory for negative information.

In order to test whether participants remembered the nominal stimulus or just kept the valence of the picture in mind, the same analysis was computed for simple means of valence similar targets and distracters. A 2 (Valence of Original US: positive vs. negative) × 2 (formation vs. revaluation) × 2 (Time: immediately after study vs. after one week) ANOVA with repeated measurement on all factors only revealed a main effect of Time, $F(1, 29) = 8.11$, $p = .008$, $\eta^2 = .25$, and a two-way interaction between Time and Revaluation, $F(1, 29) = 7.34$, $p = .01$, $\eta^2 = .20$, indicating that the difference between formation and revaluation information was larger in the second than in the first test phase. Interestingly, no influence of valence was obtained in this analysis. Thus, there was no difference between negative, positive, or neutral items when data were collapsed over targets and distracters of the same valence.

Overall, memory was far from being perfect. The recognition test revealed an overall d' score of 1.33, and an identification rate for targets of

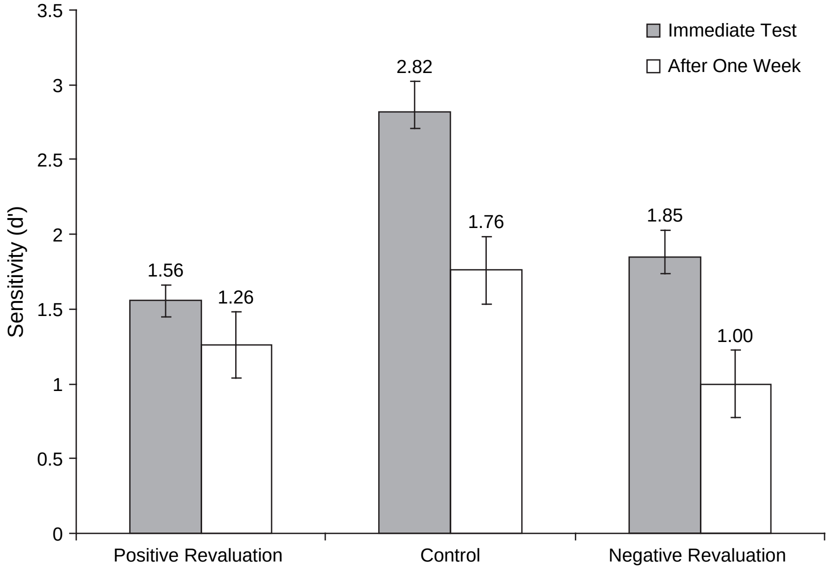

Figure 3. Sensitivity scores (*d′*) of recognition memory for revaluation information as a function of information type (positive vs. negative vs. control), and time of measurement (immediately after study vs. after one week). Higher values indicate better memory; Experiment 2.

approximately 56%. In other words, only half of all statements were correctly identified by the participants as being presented. Notwithstanding this rather poor recognition performance, memory data were by no means due to superficial guessing, as indicated by the low false alarm rate in the first test (11.5%) and the somewhat higher false alarm rate after delay (15%). The highly significant difference in recognition memory for targets and distracters suggests that it is quite unlikely that participants stored only the valence of the stimuli in memory. Otherwise a higher confusion rate between the targets and the distracters, which were of the same valence, would have been obtained.

As expected, memory was strongly influenced by time. While effects of revaluation on attitudes increased over time, results of the memory test clearly pointed in the opposite direction. Memory decreased from the first to the second test and this effect was most pronounced for the negative statements that were most effective in the revaluation process. In further analyses, we directly addressed the question of whether revaluation effects were influenced by memory for the statements. There was no significant correlation between the *d′* scores and any of US or CS attitudes (mean aggregated $r = .08$), providing further evidence for our assumption that US-revaluation effects are independent of explicit memory for the revaluation and the formation information.

Discussion

Experiment 2 not only replicated the US-revaluation effect, it also shed further light on the mechanism underlying this phenomenon. Even though recognition memory for the revaluating information decreased over time, the US-revaluation effect on CS-attitudes increased after a one-week time delay. This result suggests that US-revaluation was not dependent on explicit memory for the revaluation information. Instead, the increase in US-revaluation effects over time resembles a common finding in research on the sleeper effect (Pratkanis, Greenwald, Leippe, & Baumgardner, 1988), in which attitude change is inversely proportional to memory for its source. One possible explanation refers to the response ambiguity towards CSs. During the first test, participants' responses may be influenced by the associated valence of the USs from the formation as well as from the revaluation phase, both of which may still be accessible in memory to some degree. Over time, decay leads to a decrease in ambiguity, and thereby to more pronounced revaluation effects. Similar results have been obtained in recent anxiety studies, indicating that negative response towards stress increases with time (Matuszewich, Karney, & Carter, 2007). A further factor that presumably contributes to the finding that CS effects increase while US effects decrease over time may be differential regression for extreme and less-extreme values. Due to their extremity, US scores are generally more regressive than CS scores, which tend to be distributed around the neutral midpoint of the scale. As a matter of principle, regression effects increase with information loss, and therefore over time (Fiedler, 2000). Thus, it is not surprising that CS changes are not a perfect mirror image of US changes because both are differentially susceptible to regression tendencies.

EXPERIMENT 3

Although Experiments 1 and 2 generally supported the notion of S–S rather than S–R learning involved in EC, critical readers might suggest that an S–S account would also predict a strong positive correlation between CS and US evaluations after US-revaluation. According to this argument, the association between the CS and the US in memory would imply that evaluations of the revaluated US directly correspond to evaluations of the CS. Even though this prediction is a straightforward implication of the S–S account, our first two studies employed a design that is rather dysfunctional for testing correlations between CS and US evaluations. In these studies, the face stimuli employed for a particular condition were determined randomly on an a priori basis, and these a priori stimulus-condition assignments were kept constant for all participants. Keeping stimulus-condition assignments constant is functional to reduce error variance resulting from individual features of the employed stimuli. However, it is dysfunctional for testing correlations between CS and US evaluations, as it limits such analyses to within-cell correlations. Such within-cell correlations are often attenuated because of restricted variance. For these reasons, we conducted a third experiment in order to address the relation between CS and US evaluations in a more straightforward manner. This study employed a counterbalanced assignment of the CS faces to the experimental conditions to overcome the problem of restricted variance in Experiments 1 and 2. Moreover, to overcome the problem of reduced statistical power due to increased error variance in a counterbalanced setup, we also used a larger sample size and data were aggregated over sets of six instead of two target stimuli per condition.

By virtue of these modifications, Experiment 3 also addressed another methodological issue involved in the previous studies. As outlined above, participants in Experiments 1 and 2 were provided with a priori randomised CS–US pairs, and these randomised pairs were kept constant for all participants. Thus, we cannot rule out that these pairs accidentally share some a priori features that might have contributed to the obtained results (see also Baeyens et al., 1992b). This concern can be ruled out with the revised setup employed in Experiment 3, in which CS–US pairings were counterbalanced across conditions. Specifically, each of the employed CSs was paired with each of the employed USs in a Latin square design to minimise potential effects of accidental similarities between a given CS and its associated US.

Method

Participants and design

A total of 96 students (56 female, 39 male) from the University of Trier (Germany) took part in a study on impression formation. Students received €5 (approximately US$7 at the time) for their participation. The experiment consisted of a 2 (Original Valence of US: positive vs. negative) $\times$ 2 (US-revaluation: opposite vs. control) between-subjects design.

Materials, procedure and measures

Experiment 3 used a procedure similar to the one employed in Experiments 1 and 2, the primary difference being that our critical factors were manipulated between subjects rather than within subjects. Specifically, the core design of Experiment 3 consisted of presenting half of the participants with six positive USs in the attitude formation and US–CS pairing phases (Original Valence of US: positive); the remaining half were presented with six negative USs (Original Valence of US: negative). In the revaluation phase, the two groups were further divided into participants who received additional information about the USs that was of opposite valence to the original valence (US-revaluation: opposite) and participants who received neutral information about these USs (US-revaluation: control).

As the core design would have been, on its own, rather artificial and potentially prone to demand characteristics, it was supplemented by the presentation of additional distracter stimuli and information that served to disguise the critical manipulations at various stages of the procedure, specifically to counteract any impressions of uniformity of stimulus valence and associated information that might have resulted from the core design. More precisely, the supplementary materials contained four distracter stimuli in the attitude formation phase for which participants were presented with evaluative information that was opposite to the information presented for the US stimuli. In addition, we included six additional distracter stimuli, for which participants were shown evaluative information of the same valence as the USs in the attitude formation phase. Thus, in total, the attitude formation phase included six USs and ten distracter stimuli, with six distracters being of the same valence as the original USs and four distracters being of the opposite valence. In the US–CS pairing phase, the six USs were each paired with one of the six CSs and the six distracters were paired with one of six supplementary neutral distracters. In the revaluation phase, the six USs were presented with either neutral information (control condition) or with evaluative information that was directly opposite to the one presented in the attitude formation phase (revaluation condition). The six same-valence distracter stimuli were presented with neutral information in the revaluation condition and with either positive or negative information in the control condition. The four opposite-valence distracters were not included in the revaluation phase.

The attitude formation phase of the core design served to establish USs of a strong valence. For this purpose, half of the participants saw three positive statements about each of six pre-tested positive US faces (all picture stimuli were adapted from Gawronski et al., 2005). The remaining half saw three negative statements about each of six pre-tested negative USs. In the US–CS pairing phase, each of the six CS faces was presented five times with one of the six US faces. The specific pairings of individual CS and US stimuli were counterbalanced across participants using a Latin square design. In the revaluation phase, half of the participants were presented with three neutral statements about each of the six US faces of the attitude formation phase (control condition); the remaining half were presented with three evaluative statements that were opposite to the information they had seen during the attitude formation phase (revaluation condition). The same numbers of presentations were used for the distracter statements and distracter pairings.

Finally, all participants rated the likeability of all CS, US, and distracter faces using the same graphic rating scale employed in Experiments 1 and 2.[1]

Results

US evaluations

Aggregate scores of USs evaluations were calculated by averaging the scores of the six USs. Submitted to a 2 (Original Valence of US: positive vs. negative) $\times$ 2 (Revaluation: opposite vs. control) ANOVA, US evaluations revealed a significant main effect of revaluation, $F(1, 92) = 48.46$, $p < .001$, $\eta^2 = .345$, which was qualified by the expected two-way interaction of Revaluation and Original US Valence, $F(1, 92) = 67.38$, $p < .001$, $\eta^2 = .423$. In line with the intended revaluation manipulation, originally positive USs were evaluated more favourably than originally negative USs in the control condition (Ms $= 34.42$ vs. -8.15, respectively), $F(1, 45) = 16.55$, $p < .001$, $\eta^2 = .269$, whereas the opposite was true in the revaluation condition (Ms $= -68.52$ vs. 0.31, respectively), $F(1, 47) = 62.36$, $p < .001$, $\eta^2 = .57$. Moreover, evaluations of originally positive USs were less favourable in the revaluation compared to the control condition, $F(1, 46) = 183.95$, $p < .001$, $\eta^2 = .80$. However, in line with our previously obtained negativity bias, evaluations of originally negative USs did not significantly differ between revaluation and control conditions, $F(1, 46) = 0.56$, $p = .46$, $\eta^2 = .012$.

CS evaluations

Aggregate scores of CS evaluations were calculated by averaging the scores of the six CSs. Submitted to the same 2 (Original Valence of US: positive vs. negative) $\times$ 2 (Revaluation: opposite vs. control) ANOVA, CS evaluations revealed a significant main effect of revaluation, $F(1, 92) = 5.71$, $p = .02$, $\eta^2 = .056$, which was again qualified by the expected two-way interaction of Revaluation and Original US Valence, $F(1, 92) = 4.28$, $p = .04$, $\eta^2 = .044$ (see Figure 4). Corroborating the results of Experiments 1 and 2, CSs in the control condition tended to be more positive when they were

[1] Experiment 3 also included an attitude measure immediately after the CS–US pairing phase, which was identical to the one after the revaluation phase. For the sake of simplicity and to keep analyses consistent across the three studies, the main analyses in the results section are limited to the post-revaluation measure. Using the same 2 (Original Valence of US: positive vs. negative) $\times$ 2 (Revaluation: opposite vs. control) ANOVA that was used for our main analyses, the pre-revaluation measure showed the expected main effect of original US valence for US evaluations (Ms $= 25.61$ vs. -27.73, respectively), $F(1, 92) = 67.98$, $p < .001$, $\eta^2 = .425$, and CS evaluations (Ms $= 15.33$ vs. -3.38, respectively), $F(1, 92) = 15.49$, $p < .001$, $\eta^2 = .144$, supporting the effectiveness of our attitude formation and CS–US pairing manipulations. No other main or interaction effects reached statistical significance (all Fs < 1.19).

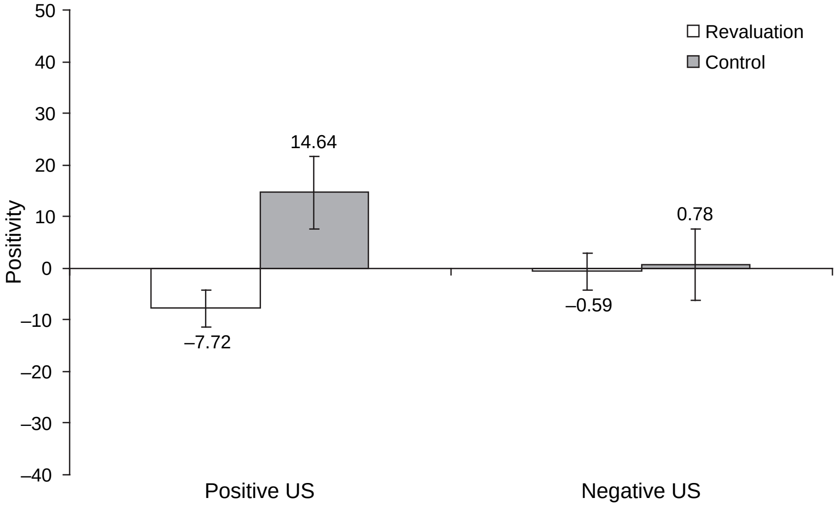

Figure 4. Evaluations of conditioned stimuli (CS) as a function of US valence (positive vs. negative) and US-revaluation conditions (revaluation vs. control). Higher values indicate more positive evaluations; Experiment 3.

paired with originally positive USs than when they were paired with originally negative USs, $F(1, 45) = 3.60$, $p = .06$, $\eta^2 = .074$, whereas a non-significant tendency in the opposite direction emerged for CSs in the revaluation condition, $F(1, 47) = 1.02$, $p = .32$, $\eta^2 = .021$. Moreover, CSs that were paired with originally positive USs were evaluated less favourably in the revaluation compared to the control condition, $F(1, 46) = 12.12$, $p = .001$, $\eta^2 = .208$. However, evaluations of CSs that were paired with originally negative USs did not significantly differ between revaluation and control conditions, $F(1, 46) = 0.30$, $p = .86$, $\eta^2 = .001$, again replicating the asymmetry obtained in Experiments 1 and 2.

Distracter evaluations

Even though these findings are consistent with our prediction that changes in CSs evaluations are driven by a mental association between CSs and USs in memory, the between-subjects design employed in the present study implies the possibility of mood effects, which may produce the expected pattern even in the absence of S–S learning. Specifically, it is possible that a predominant presentation of positive or negative information within a particular between-subjects condition induces positive or negative mood states, which may in turn influence evaluative judgements by means of the "How-do-I-feel-about-it?" heuristic (Schwarz, 1990). To rule out mood effects as an alternative explanation for the present findings, we averaged participants' evaluations of the six distracter stimuli that were originally presented with statements of the same valence as our USs but with neutral information in the revaluation condition and valenced information in the control condition. The resulting scores were then submitted to the same 2 (Original Valence of US: positive vs. negative) × 2 (US-revaluation: opposite vs. control) ANOVA. If mood was indeed responsible for the obtained changes in CS and US evaluations, evaluations of the distracter stimuli should show the same two-way interaction pattern obtained for US and CS evaluations. In contrast to this prediction, the ANOVA revealed a significant two-way interaction in the opposite direction, $F(1, 92) = 53.20$, $p < .001$, $\eta^2 = .366$. Specifically, distracters in the control condition were evaluated more favourably when the original USs were negative than when they were positive (Ms = 11.47 vs. −27.41, respectively), $F(1, 45) = 30.78$, $p < .001$, $\eta^2 = .406$. Conversely, distracters in the revaluation condition were evaluated more favourably when the original USs were positive than when they were negative (Ms = 31.51 vs. −2.39, respectively), $F(1, 47) = 22.83$, $p < .001$, $\eta^2 = .327$. In other words, distracter evaluations reflected the valence that was associated with them during the attitude formation and the revaluation phases, and that valence was exactly opposite to the one associated with the USs and the CSs. If the obtained effects on US and CS evaluations were driven by mood effects, distracter evaluations should be identical to CS and US evaluations, which was clearly not the case. Instead, the pattern for distracters is directly opposite to the one that would be expected if our findings were driven by mood effects, thereby ruling out mood as an alternative explanation for the present results.

Correlations between CS and US evaluations

To further explore the proposed link between CSs and USs, we investigated the correlations between the aggregate scores of CS evaluations and US evaluations. An S–S learning account would predict a positive correlation between CS and US evaluations in both revaluation and control conditions, as CS evaluations should directly depend on the evaluation of the associated US. In contrast, an S–R learning account predicts a positive correlation only in the control condition, in which the final evaluation of the US is still in line with the one acquired by the CS during CS–US pairings. However, the S–R account predicts a negative correlation in our revaluation condition, due to the fact that this condition encompassed two subgroups with originally negative and positive USs, respectively. According to the S–R account, the new evaluation of the US should be directly opposite to the one previously acquired by the CS. Hence, originally negative USs that have become positive during revaluation would be linked to CSs that acquired a negative valence and originally positive USs that have become negative during revaluation would be linked to CSs that acquired a positive valence. An initial analysis across all experimental conditions established that the overall correlation between CS and US evaluations was strongly positive, $r = .50$, $p < .001$. Moreover, consistent with the S–S account, our analyses revealed a significant positive correlation in the control condition ($r = .56$, $p < .001$) as well as in the revaluation condition ($r = .37$, $p = .01$). Correlations did not significantly differ across conditions, $z = 1.17$, $p = .24$.

Discussion

The findings of Experiment 3 provide further support for the assumption that evaluative changes in the CS should be understood as being based on an associative link between the CS and the US rather than on intrinsic changes in the CS itself. In line with this assumption, the present study found a positive correlation between CS and US evaluations in both revaluation and control conditions. Moreover, alternative explanations of the previous findings in terms of accidental features of fixed CS–US pairings could be ruled out in the present study by using a counterbalanced assignment of CS and US pictures.

GENERAL DISCUSSION

The present studies not only present an interesting empirical phenomenon; they also provide deeper insights into the underlying mechanisms of EC effects. Although EC has been investigated for almost thirty years and has become more and more important in many areas of psychology (De Houwer et al., 2001), the processes underlying EC are still not sufficiently understood and subject to debate (e.g., Gawronski & Bodenhausen, 2006; Kruglanski & Dechesne, 2006). Specifically, it is not clear whether EC represents an instance of S–S or S–R type of learning (Baeyens, Crombez, Van den Bergh, & Eelen, 1988). An S–S account implies that a CS acquires evaluative meaning by virtue of its association to the US (Rescorla, 1974). The presentation of the CS activates the associative link to the US, which in turn makes the evaluative meaning of the CS accessible. This assumption is consistent with an explanation put forward by Baeyens, Crombez, and Eelen (1995), who characterised evaluative conditioning as an associatively based form of learning dependent on a referential relationship between two stimuli. This process is different from S–R learning in which the CS changes intrinsically during the conditioning procedure.

The US-revaluation paradigm provides a straightforward means to disentangle these two possibilities. Whereas S–R learning implies that responses to the CS should be unaffected by US revaluation, S–S learning implies that responses to the CS should reflect the new valence of the revaluated US. The present data support the idea of S–S learning in the EC paradigm. In all of our studies, responses to the CSs changed in line with evaluations of the USs after US revaluation. Moreover, confirming a corollary of the S–S idea, the post-revaluation attitudes of initially paired USs and CSs were positively correlated in Experiment 3. These findings not only support the notion of S–S learning; they also challenge the notion that EC effects are driven by S–R learning. If the CS acquires its own valence during the initial pairing with the US, the resulting evaluation should remain intact even if the original evaluation of the US is changed. A related issue is the question of whether the CS is associated with the representation of positive or negative valence as such, or whether the CS is associated with a nominal stimulus consisting of additional features other than valence. Based on the former idea, identifying the correct US in a post-conditional awareness test is often not distinguished from selecting a stimulus of the same valence (e.g., Baeyens, Eelen, Crombez, & Van den Bergh, 1992a; Baeyens, Hermans, & Eelen, 1993; Field, 2000; Fulcher & Hammerl, 2001). Consistent with previous work (Walther & Nagengast, 2006), the present studies support the notion that nominal stimuli are indeed connected to the CS. If CSs were not connected to a particular US, revaluation of the US should leave CS evaluations unaffected. Support for this idea came also from our recognition data. When *d′* scores derived from signal detection theory (Green & Swets, 1966) were taken into account we found a strong influence of valence on recognition memory. Remarkably, this influence vanished completely if only valence of the items (i.e., collapsed means of targets and distracters) but not their status (presented vs. not presented) was taken into account.

Limitations and avenues for future research

Notwithstanding this conclusion, we also obtained some unexpected results. In the present studies, US-revaluation effects were generally stronger for positive-to-negative than for negative-to-positive revaluations. This asymmetry was already present in US change scores, which were generally larger in the positive as compared to the negative domain, and emerged for both self-reported and unobtrusively assessed evaluations. Thus, the asymmetric revaluation effects in CSs can be interpreted as a direct consequence of the asymmetric effects in USs. Although similar effects have been obtained in the area of flavour conditioning (Baeyens et al., 1990), there is no systematic research investigating such asymmetries. Thus, one direction for future research might be an examination of the boundary conditions and the reliability of negativity effects in EC.

Another limitation inherent to our studies is that US valence was not initially given but was formed during a pre-conditioning stage. Although the US pictures were already positive or negative when introduced in the attitude formation stage (see Gawronski et al., 2005, for details), their evaluation was strengthened and bolstered by pairing them with valenced statements (see Appendix). On a technical level, then, the present studies may be considered as instances of second-order conditioning, in which a CS first acquires the qualities of a US before it is paired with another CS in a learning paradigm (Walther, 2002). This US formation technique was successfully used in previous research (Gawronski et al., 2005) in order to prevent strong inter-individual differences in the evaluation of the USs. However, different results may be obtained in studies in which biologically significant USs are used (e.g., electric shocks). This latter concern refers to most studies using the face–face paradigm in which socially acquired valence rather than biologically predisposed valence is given. The fact that the USs in the present studies were not initially neutral but already possessed valence to some degree at the beginning of the experiment distinguishes these studies from the standard second-order learning paradigm. Nevertheless, it could be argued that US-revaluation may be restricted to studies in which USs are formed via second-order learning. This hypothesis, however, would be at odds with previous classical-conditioning findings showing US-revaluation effects with biologically significant USs only in first-order but not in second-order conditioning (Rescorla, 1974). In any case, it is an important question for future research to investigate the impact of biologically significant USs in the US-revaluation paradigm.

Although the present findings strongly support the notion of S–S rather than S–R learning as the basis mechanism underlying EC, it seems that S–R learning cannot be completely ruled out in the present studies. For instance, it could be argued that S–R learning occurs during the US-revaluation phase, which counteracts prior S–R learning that occurred during the attitude formation phase. More generally, a main problem with the S–S approach is that it is silent with respect to how associations between stimuli cause the organism to make a response. Put differently, if all evaluative learning was the result of S–S learning, one would end up in an infinite regress, as a given US would acquire its valence via its association to another US, which in turn would acquire its valence by virtue of its association to a third US, ad infinitum. Future theoretical as well as empirical work is necessary to solve this issue and to further disentangle S–S and S–R approaches.

A further interesting observation was that the revaluation effects on CSs increased with time whereas memory for the revaluation information was markedly reduced after one week. That revaluation effects became stronger over time may be due to the simultaneous accessibility of the conflicting formation and revaluation information at the time of the first test. Thus, although the associated USs were presented with revaluation information, CS attitudes might still have been "loaded" with the original information to some degree, which reduced the net revaluation effect. However, as time went by, and with increasing decay of the attitude formation information, the new dominant reaction may have been enhanced, which resulted in a stronger net revaluation effect. This finding parallels the well-known sleeper effect in persuasion research, describing the increased power of a persuasive message as a function of decreasing memory for its source (e.g., Pratkanis et al., 1988). However, further research is necessary to explain whether the same mechanisms may underlie the two kinds of effects.

The effect that conditioning effects become stronger over time is a well-known phenomenon in fear therapy called incubation (Eysenck, 1968). According to Eysenck's theory of fear incubation, exposure to a fear-provoking conditioned stimulus (CS) can result in a sustained growth of fear under certain conditions. This concept is used to explain extreme avoidance (symptom) maintenance in extinction. One of the aspects that enhances incubation is a strong US, as given in neurosis and also in the present studies. Taking the negativity effect of revaluation into account also, it might be of interest for future research to study inter-individual differences in EC (e.g., Livingston & Drwecki, 2007).

Attitude change through evaluative conditioning

Different from attitude formation, attitude change has typically been addressed by theories that emphasise the significance of cognitive processes (Eagly & Chaiken, 1993). For instance, research in the tradition of cognitive response models (Greenwald, 1968) argues that the effectiveness of a persuasive message in changing attitudes depends on the particular thoughts a recipient generates in response to the message. Even though the two approaches (the affective approach and the cognitive approach) can generally be applied to both attitude formation and attitude change, previous research has been somewhat selective, such that affective processes have been primarily employed to study attitude formation whereas cognitive (i.e., persuasion) models have been primarily employed to study attitude change (Eagly & Chaiken, 1993). The present research adds a subtle and indirect means for changing attitudes: the US-revaluation effect. Specifically, the present findings indicate that changing the valence of a stimulus into the opposite valence also influences the valence of pre-associated other stimuli. This effect emerged even though the associated CSs were never presented with the revaluating information. Moreover, US-revaluation effects also emerged for unobtrusively assessed attitudes, indicating that they are not caused by demand characteristics. The US-revaluation effect proved stable over time and was not contingent on explicit memory for the revaluating information, supporting its low-level associative nature. Finally, CS changes show a straightforward relation to US changes, thus corroborating the S–S learning assumption. Taken together, these results indicate that changing minds does not require direct evaluative information or cognitive elaboration but can work indirectly through simple association chains.

Implications for applied settings

The US-revaluation effect has important implications for attitude change in social and applied settings. An association with positively evaluated individuals, like highly respected experts, or admired celebrities, should have a positive impact on one's own image only as long as a positive evaluation of the associated other persists. If the associated individual loses his or her prestige as a result of negative behaviour, this slip may also affect one's own reputation. Thus, basking in the reflective glory of highly respected individuals (Cialdini & De Nicholas, 1989) may be a risky strategy when the positive evaluation of these individuals is fragile.

Similar consequences pertain to the area of advertising. In order to create positive evaluations of products, a common strategy among advertisers is to present brands and products (e.g., AOL, Nike, H&M) along with well-known individuals, a strategy called *celebrity endorsement*. Many examples—like those of Kate Moss who has been caught with drugs, or Kobe Bryant who was charged with sexually assaulting a hotel worker—suggest that this advertising strategy can be quite risky. Within the logic of the US-revaluation effect, the loss of the celebrity's positive image in the public opinion due to socially undesirable behaviour can have negative consequences for associated brands and products. More precisely, a decrease in the positive reputation of the celebrity inevitably leads to a devaluation of the product. Most important, this can be the case even when celebrities are abandoned immediately after they become embroiled in trouble, or when consumers do not even remember that the celebrity endorsed the product (Walther & Langer, 2007). The US-revaluation effect suggests that such strategies of "damage control" may not be as effective as expected, because the devaluation of the product does not depend on subsequent pairings of the product and the celebrity. Due to the association between CS and US established in previous ads, the mere devaluation of the celebrity is sufficient to affect consumers' attitudes toward the product.

Finally, the US-revaluation effect has important implications for contemporary models of persuasion, such as the elaboration likelihood model (Petty & Cacioppo, 1986), the heuristic-systematic model (HSM; Chaiken, Liberman, & Eagly, 1989), or the unimodel (UM; Kruglanski & Thompson, 1999). Notwithstanding some fundamental differences, all of these models focus primarily on attitude changes resulting from direct links between evaluative information and an attitude object. A common finding in this line of research is that attitudes are more likely to be influenced by the relative strength of complex arguments when recipients of a persuasive message engage in elaborate processing. However, attitudes are more likely to be affected by peripheral or heuristic cues of a persuasive message (e.g., a highly attractive source) when recipients process the available information superficially (see Petty, Cacioppo, Strathman, & Priester, 2005, for a review). The US-revaluation effect expands on these findings, indicating that peripheral cues, like source attractiveness, may influence attitudes even when the original message is not available anymore. If an originally likeable source acquires a negative valence, this change in source valence can affect attitudes toward the object without any additional contact with the original message. From this perspective, it seems interesting to expand contemporary models of persuasion by focusing on the associative representation of evaluative information in memory (Gawronski & Bodenhausen, 2006). Future studies combining the general findings of evaluative conditioning and persuasion research may provide an important step in this direction.

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APPENDIX

Statements used in the attitude formation and revaluation phases, Experiments 1–3

Attitude formation phase	*Revaluation phase*
Positive statements	*Revaluation statements*
Is always willing to listen to other people's problems	Lays a hand on weaker persons
Is doing overtime so that others can take off from work	Gave a boot to a colleague once
Is almost always in a good mood	Often makes jokes at the expense of other colleagues
Stands up for fairness and justice	Regularly strikes the wrong tone when talking to others
Always listens very carefully	Takes drugs
Voluntarily takes on unpleasant tasks	Acts up as if he were the boss
Positive statements	*Neutral statements*
Gives others the feeling of being special	Goes jogging before work
Is always nice and courteous	Visits art exhibitions
Sticks by his colleagues even when they are made responsible for mistakes	Likes to live in a big city
Likes to help new colleagues to incorporate	Moved a few times already
Explains difficult issues really well	Likes to cook Asian food
Is interested in the wellbeing of his colleagues	Often goes to the theatre
Negative statements	*Revaluation statements*
Molested another colleague once	Is always there for colleagues when they need help
Becomes angry fast if he can't enforce his opinion	Pays regard and attention to others
Patronises other colleagues	Completes tasks nobody else wants to do without complaining
Is always very aggressive	Always behaves politely and respectably
Always wants to enforce only his own interests	Knows a lot but is always humble
Thinks he's the best	Sees the positive in each situation
Negative statements	*Neutral statements*
Abuses his little daughter	Likes to go to the cinema
Constantly accuses colleagues when they make a mistake	Likes to listen to music
Cheats on his wife	Likes to talk about literature
Often comes to work drunk	Goes for a walk with his dogs
Is almost always in a bad mood	Regularly goes swimming
Steals the ideas of other colleagues	Likes to read comics