Research Article

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Evaluative Influences of CS-US Pairings Are Non-Reciprocal

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Supplementary Materials: Data, Materials [see Index of Supplementary Materials]

Abstract

Three experiments examined the reciprocity of evaluative effects following CS-US pairing. In all three experiments, CS evaluations were assimilated to the valence of the US they were paired with (i.e., an evaluative conditioning effect), whereas US evaluations became less extreme (i.e., a US devaluation effect). Of importance, however, US devaluation proved to be independent of CS-US pairing. Experiment 1 replicated previous evidence for US devaluation: USs were less intensely evaluated after a conditioning procedure as compared to their normative ratings. Experiment 2 controlled for the effect of CS-US pairing: A US devaluation effect of similar magnitude was observed for USs paired with the CSs or presented alone during the conditioning procedure. Experiment 3 indicated that US habituation drives US devaluation: USs presented and evaluated only once were less devalued than USs paired with CSs or USs presented alone during the conditioning procedure, with the latter two US types not differing from each other. Together, these findings suggest that US devaluation is driven by US habituation rather than by a CS-to-US influence in an associative learning procedure. The theoretical implications of these findings for associative and propositional accounts of evaluative learning are discussed.

Keywords

evaluative conditioning, associative learning, operating principle

In general, people approach what they like and avoid what they dislike, and this is true in many aspects of their life, including social interactions (Greenwald, McGhee, & Schwartz, 1998), voting behavior (Bassili, 1993, 1995), or food consumption (Hütter & Sweldens, 2018). Because evaluations are mainly acquired rather than inherited (Rozin, 1982; Rozin & Millman, 1987), it is crucial to understand how evaluations are formed and can be changed. One of the simplest ways to influence evaluations about a target stimulus is to pair it with another one. Specifically, an initially neutral stimulus generally acquires the valence of a valent stimulus after being paired with it. This effect is referred to as evaluative conditioning (or EC, De Houwer, Thomas, & Baeyens, 2001). The initially neutral stimulus is called a "conditioned stimulus" (or CS) because its acquisition of valence is conditional on its pairing with the affectively-loaded stimulus. The latter, affectively-loaded, stimulus is called an "unconditioned stimulus" (or US) because it elicits an evaluative response prior to its pairing with the CS. Hence, CSs are conditioned following their pairing with USs. But are US evaluations also influenced by their pairings with CSs? The current research examined this reciprocity question. We first provide a short state-of-the-art discussion and then report three experimental studies that addressed this question.

Is There Evidence That the CS Influences the US Evaluation and Why Does This Question Matter?

That the US elicits an evaluation prior to its pairing with the CS does not imply that its evaluation is not to be altered following that pairing. The US, too, may be conditioned (i.e., it may also be a conditioned stimulus). Consistent with this view, De Houwer, Baeyens, Vansteenwegen, and Eelen (2000) observed that USs elicit milder evaluations after they have been paired with CSs. In their experiment, participants rated 70 face stimuli. Then the authors selected for each participant, the eight most neutral and the four most positive and four most negative stimuli to design the CS-US pairs. They observed the typical evaluative conditioning effect on the CSs: CS ratings were assimilated to the valence of the US they were paired with. More critical to the present research, they also found a "US devaluation" effect: the USs were evaluated less extremely (i.e., they were devalued) after being paired with the CSs. Hence, it seems that the two components in the CS-US pair influenced each other in opposite directions, resulting in more polarized evaluations of the CSs (i.e., an evaluative conditioning effect) and milder evaluations of the USs (what we will refer to here as a "US devaluation" effect).

The US devaluation effect has important practical and theoretical implications. One practical implication is clinical in nature: if people acquire a strong dislike for certain categories of stimuli (e.g., spiders), is there any advantage in actively pairing these with neutral stimuli, rather than presenting them in isolation?

At the theoretical level, the US devaluation question is relevant to associative versus propositional attitude learning views. As compared to propositions, associations are "unqualified" in nature. As such, they are assumed to contain no structural content qualify-

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ing the CS-US relation (De Houwer, 2009; Shanks, 2007). As a result, associations may be expected to produce reciprocal influences: the CS and the US should either co-activate each other through excitatory links or interfere with each other through inhibitory links. Of course, this analysis does not imply that US-to-CS and CS-to-US influences should be of the same magnitude. Yet, finding a US-to-CS influence but no CS-to-US influence would invite us to question associative learning views (see also the general discussion).

In order to address these questions, it is important to proceed first to a closer examination of the processes that may underlie the US devaluation effects. In particular, two processes may account for US devaluation that are independent of any effect of CS-US pairing. First, US devaluation may reflect a regression to the mean effect. If a variable is extreme upon its first measurement, it will tend to regress to the average on a subsequent measurement (Healy & Goldstein, 1978). When USs are selected for each participant based on their most extreme evaluations prior to CS-US pairing, not only the 'true' US values but also their measurement errors are likely to be extreme. Because of the redistribution of random measurement errors on the second (i.e., post CS-US pairing) measurement, US evaluations should become less extreme even though their true value remains unchanged. Second, US devaluation may be driven by affective habituation. Because CS-US pairing is confounded with exposure to the US, US devaluation may reflect "reductions in stimulus-evoked affective reactions as a result of previous exposure" (Leventhal, Martin, Seals, Tapia, & Rehm, 2007). Neither of these processes would have anything to do with CS-US pairing *per se*.

The present experiments aimed to (1) test the robustness of the US devaluation effect reported by De Houwer et al. (2000), but this time in procedures devoid of a possible regression to the mean effect, (2) test whether there is a CS-US pairing contribution to this devaluation effect and, (3) if there is no such contribution, test for the contribution of a habituation effect in the US devaluation effect.

Overview of the Experiments

Experiment 1 conceptually replicated De Houwer et al. (2000) by measuring evaluative changes in both CSs and USs after CS-US pairing. Experiment 2 examined the contribution of CS-US pairings in US devaluation by introducing non-associative control USs that were presented but not paired during the conditioning phase. Experiment 3 further addressed the role of habituation by comparing the evaluation of USs that were never presented, USs that were paired with CSs, and USs that were presented alone in the learning procedure. All three experiments relied on normative ratings for the selection of the USs. Because different USs were not selected for each participant based on their idiosyncratic ratings (but were instead preselected based on normative ratings provided by other participants), measurement errors were randomly distributed such that regression to the mean effects could not contribute to a systematic devaluation effect in the present experiments.

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Statistical Power and Sample Size

De Houwer and colleagues (2000) reported a – very large – US devaluation effect of Cohen's d = 2.5. We decided to draw on the average EC effect of Cohen's d = .52 (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010) to determine the size of our samples. If the US devaluation effect is as strong as the EC effect (if CSs and USs change to the same degree), we need 31 pairs of observations to achieve a high statistical power $(1 - \beta) = .8$ with a two-tailed Type I error $\alpha = .05$. With a minimum of 82 pairs of observation (Experiment 3), we secured enough sensitivity to observe a devaluation effect as small as d = .32 with a high statistical power $(1 - \beta) = .8$.

Experiment 1

Experiment 1 allowed testing of the presence of the US devaluation effect reported by De Houwer et al. (2000) in a procedure devoid of any regression to the mean effect. This experiment was originally aimed at exploring unrelated hypotheses. Therefore, we collected additional measures (i.e., inter-individual difference measures) that are not reported here. The data from the experiment as well as the R script created to manage, analyze, and represent the data visually are available on Open Science Framework (OSF link: https://osf.io/82mcs/).

Method

Participants

136 participants (M_{age} = 24.32, SD_{age} = 5.99, 99 women) from a large European University participated without compensation. They were contacted by email and invited to take part in an online study. The experiment was programmed using the 'Testable.org' platform.

Procedure and Materials

The procedure involved three phases. In the first - conditioning - phase, eight CS-US pairs were displayed on the screen. Four CSs were presented with positive USs and four CSs were presented with negative USs. The specific CS-US valence pairings were created randomly for each participant. Each pair was presented eight times, in a random order, for 1000ms. The Inter-Trial-Interval (ITI) lasted 500ms. CSs and USs were borrowed from Pleyers, Corneille, Luminet, and Yzerbyt (2007). CSs depicted consumer goods and USs were affective pictures from the International Affective Picture System (IAPS, Lang, Bradley, & Cuthbert, 1997) representing people in happy or sad situations (see Appendix). A CS-US pairing trial involved the presentation of a CS (283 × 283 pixels) and a US (512 × 384 pixels) presented simultaneously on the screen along the horizontal dimension. The position (left vs. right) of the CSs and the USs was set randomly. Participants were instructed that their task was to carefully watch the pictures. In the second – CS evaluation – phase, participants were instructed to report their global feelings towards each CS by using a scale from 1 (very negative) to 9 (very positive). In the third – US evaluation – phase, participants rated each US on a scale from 1 (very unpleasant) to 9 (very pleasant).

Results

Analytical Strategy

For each participant, we computed both for the CSs and for the USs the average difference in ratings between post-conditioning ratings and normative ratings. Normative ratings for the CSs were collected in a pre-test (see Pleyers et al., 2007) and normative ratings for the USs consisted in IAPS ratings. The mean differences in evaluations were averaged, separately for each US valence (positive and negative). The data were analyzed using the 'aov' and 'anovaBF' functions in R (R Development Core Team, 2017; from the R package 'BayesFactor', Morey, Rouder, & Jamil, 2015) for the frequentist and Bayesian analyses respectively. We report the Bayes factors associated with the model comparison made in the frequentist analyses. An augmented model containing the tested factor was compared to a constrained model that did not contain the tested factor. The Bayes factors in favor of the alternative hypothesis (or BF10) are presented when the conventional p-value of .05 is encountered. The Bayes factors in favor of the null hypothesis (or BF01) are reported when the p-value is above this threshold.

CSs

Changes in CS evaluation were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) as a within-participant factor. The main effect of US valence was significant, $F(1, 135) = 104.3$, $p < .001$, $\eta_p^2 = .43$, BF10 > 1000: CSs paired with positive USs (i.e., CSs+) became more positive ($M = 1.09$, $SD = 1.43$, $t(135) = 8.88$, $p < .001$, $\eta_p^2 = .36$) whereas CSs paired with negative USs (i.e., CSs-) became more negative ($M = -.76$, $SD = 1.50$, $t(135) = -5.88$, $p < .001$, $\eta_p^2 = .20$). Hence, the data revealed the typical evaluative conditioning effect (see Figure 1).

USs

Changes in US evaluation were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) as a within-participant factor. The main effect of US valence was significant, indicating that US evaluations became more neutral after the pairing (i.e., a US devaluation effect), $F(1, 135) = 22.15$, $p < .001$, $\eta_p^2 = .13$, BF10 > 1000. Looking at each valence separately, positive USs became more negative, $M = -.61$, $SD = 1.26$, $t(135) = -5.70$, $p < .001$, $\eta_p^2 = .19$, whereas negative USs tended to become more positive, $M = .16$, $SD = 1.15$, $t(135) = 1.59$, $p = .11$, $\eta_p^2 = .01$ (see Figure 1).

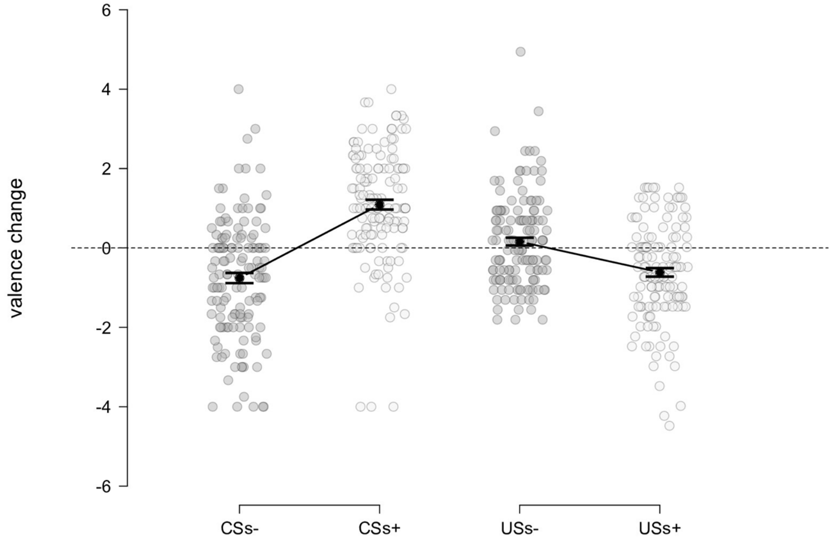

Figure 1. Change in evaluation for positive and negative CSs and USs. Dots represent individual responses. Filled squares represent observed means. Error bars represent standard errors of means. CSs- = negatively conditioned stimuli; CSs+ = positively conditioned stimuli; USs- = negative unconditioned stimuli; USs+ = positive unconditioned stimuli.

Discussion

In Experiment 1, the valence of the CSs was more extreme after than before the EC procedure (i.e., an evaluative conditioning effect emerged). Conversely, USs elicited less extreme evaluations after than before CS-US pairing (i.e., the US devaluation effect was replicated). Because of the use of normative ratings as a baseline, no regression to the mean effect could contribute to US devaluation. Instead, US devaluation may be due to the CS-US pairing or to the mere presentation of the USs. Of note, US devaluation was significant only for the positive USs. One should therefore remain cautious about the interpretation of this result as it may be due to the reliance on different samples for normative and experimental ratings. Collecting evaluations before and after CS-US pairings within the same sample of participants allows this interpretational issue to be overcome. This is the procedure used in Experiment 2.

Experiment 2

The role of the CS-US pairing was examined in Experiment 2 by including control US-alone stimuli in the conditioning procedure. As a further asset, Experiment 2 relied on idiosyncratic rather than normative US evaluations. In this case, participants served as their own control, although USs were still selected on the basis of prior normative ratings (therefore precluding regression to the mean effects). We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the experiment. The raw data from the experiment as well as the R script created to manage, analyze, and visually represent the data are available on Open Science Framework (OSF link: https://osf.io/82mcs/).

Method

Participants

We collected data on 163 participants (M_{age} = 33.74, SD_{age} = 10.39, 78 women) on the online platform ‘Prolific academic’. Participants received compensation of £0.6 for their participation.

Procedure and Materials

Participants first rated eight CSs (Pleyers et al., 2007) and 16 USs (see Appendix) using a scale from 1 (very negative) to 9 (very positive). Eight randomly selected USs always appeared alone (US-alone trials) and the remaining eight USs were systematically paired with CSs (US-paired trials) during the conditioning procedure. For the US-alone trials, the US appeared alone for 1000ms. For the US-paired trials, the US was simultaneously paired with a CS for 1000ms. All trials were randomly ordered and separated by an ITI of 500ms. After the conditioning procedure, participants rated the CSs and USs anew.

Results

Analytical Strategy

We computed the difference between post- and pre-ratings for the CSs and USs at the stimulus level for each participant. A positive value reflects more positive evaluations at post-test. We then averaged evaluative change scores by participants as a function of US valence and pairing type. As in Experiment 1, we used frequentist and Bayesian repeated-measures ANOVA to analyze the data.

CSs

Changes in CS evaluation were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) as a within-participant factor. This analysis revealed a main effect of US valence, $F(1, 162) = 25.37$, $p = < .001$, $\eta_p^2 = .13$, BF10 > 1000. As expected, CSs+ became more positive, $M = .39$, $SD = .98$, $t(162) = 5.03$, $p < .001$, $\eta_p^2 = .13$, whereas CSs- became more negative, $M = -.27$, $SD = 1.17$, $t(162) = -2.96$, $p = .004$, $\eta_p^2 = .05$. Hence, an EC effect was found.

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USs

Changes in US evaluative ratings were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) and pairing type (alone vs. paired) as within-participant factors. We observed a main effect of US valence, $F(1, 162) = 5.61$, $p = .019$, $\eta_p^2 = .03$, BF10 = 8.20. As in Experiment 1, positive USs, $M = -.24$, $SD = .87$, $t(162) = -3.99$, $p < .001$, $\eta_p^2 = .08$, changed in valence whereas negative USs did not, $M = -.02$, $SD = 1.12$, $t(162) = -.318$, $p = .75$, $\eta_p^2 = .00$. We did not observe a US valence × pairing type interaction, $F(1, 162) = .55$, $p = .459$, $\eta_p^2 = .00$, BF01 = 5.81. As depicted in Figure 2, the US devaluation effect did not differ between the US-alone trials and the US-paired trials. No main effect of pairing type was observed either ($F < 1$).

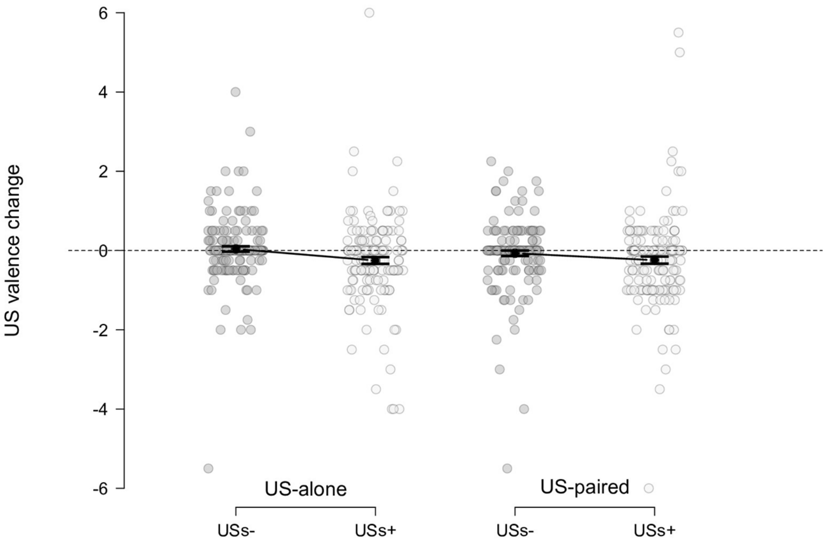

Figure 2. Change in evaluations of the USs as a function of US valence and pairing type. Dots represent individual responses. Filled squares represent observed means. Error bars represent standard errors of means. USs- = negative unconditioned stimuli; USs+ = positive unconditioned stimuli.

Discussion

Experiment 2 replicated both an EC effect and a US devaluation effect. We found no evidence, however, that CS-US pairing effect contributed to US devaluation: US presented alone and US paired with CSs decreased in valence to a similar extent. The Bayesian analysis suggests that the null effect of pairing is over five times more likely than an effect of pairing in the devaluation effect. Once again, the US devaluation was observed only for the positive USs. This time, this cannot be due to a difference in the samples investigated (i.e., normative versus experimental). Instead, this imbalance points to an asymmetric affective habituation effect, with larger habituation to positively than negatively charged stimuli.

Experiment 3

Experiment 3 was designed to further investigate the role of CS-US pairing in US devaluation. In addition, this experiment provides a formal test for the contribution of US habituation. This was achieved by comparing evaluations for USs that were presented and rated only once versus USs that were either paired with CSs or presented alone in the conditioning procedure. If US habituation plays a role, ratings should be less extreme for US-alone and US-paired stimuli than for USs presented and rated only once. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the experiment. The raw data from the experiment as well as the R script created to manage, analyze and visually represent the data, are available on Open Science Framework (OSF link: https://osf.io/82mcs/).

Method

Participants

We collected data on 82 participants (M_{age} = 22.90, SD_{age} = 5.11, 56 women) on the online platform ‘Prolific academic’. Participants received compensation of £0.6 for their participation.

Procedure and Materials

A total of 24 USs were used (see Appendix), 12 positive and 12 negative. During the conditioning procedure, eight were never presented, eight were presented alone, and eight were paired with CSs. Which US fell into each of these three categories was determined randomly for each participant. The US-alone and the US-paired trials were presented in random order for 1000ms each, with an ITI of 500ms. Participants then rated the CSs and the USs using an evaluative scale from 1 (very negative) to 9 (very positive).

Results

Analytical Strategy

We averaged CS and US evaluative ratings within each US valence and pairing type for each participant. Similar to Experiment 1, we then computed the average difference in ratings between post-conditioning ratings and normative ratings as a function of US valence and the presentation condition. As for the previous experiments, we used frequentist and Bayesian repeated-measures ANOVA to analyze the data.

CSs

Changes in CS evaluation were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) as a within-participant factor. This analysis revealed a main effect of US valence, $F(1, 81) = 38.06$, $p < .001$, $\eta_p^2 = .31$, BF10 > 1000: CSs+ were evaluated more positively ($M = 1.01$, $SD = 1.29$) than CSs- ($M = -.18$, $SD = 1.38$), therefore confirming an EC effect.

USs

Changes in US evaluation were submitted to a repeated-measures ANOVA with US valence (positive vs. negative) and pairing type (US-never vs. US-alone vs. US-paired) as within-participant factors. This analysis revealed no main effect of US valence, $F(1, 81) = 1.90$, $p = .172$, $\eta_p^2 = .01$, BF01 = .42: the change in evaluation of positive USs ($M = -.46$, $SD = 1.16$) was not different on average from the change in evaluation of the negative USs ($M = -.24$, $SD = .91$).

This analysis further revealed a US valence × pairing type interaction, $F(2, 162) = 10.77$, $p < .001$, $\eta_p^2 = .11$, BF10 = 4.04 (see Figure 3).

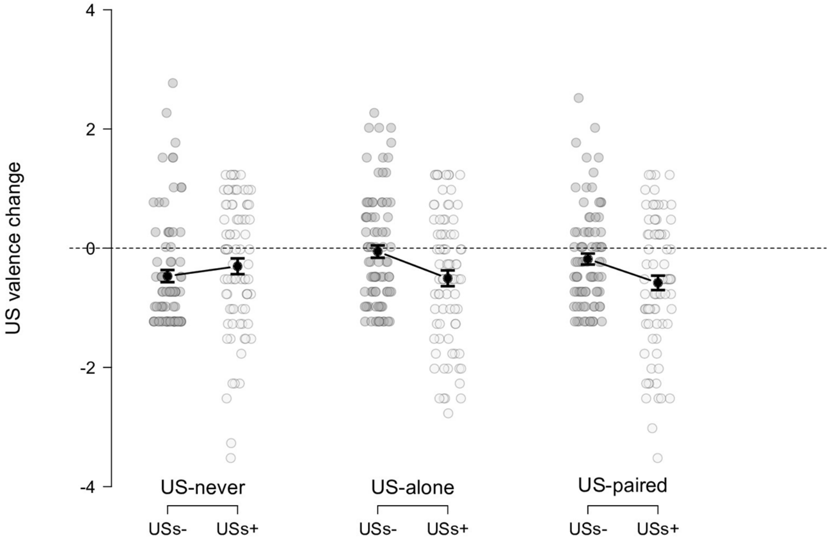

Figure 3. Change in evaluations of the USs as a function of US valence and pairing type. Dots represent individual responses. Filled squares represent observed means. Error bars represent standard errors of means. USs- = negative unconditioned stimuli; USs+ = positive unconditioned stimuli.

Specifically, the difference in the mean change of US evaluation between positive and negative pairings was observed for both US-alone trials, $M = -.45$, $SD = 1.75$; $F(1, 81) =$

5.40, p = .023, η_p^2 = .05, BF10 = 5.74, and US-paired trials, M = -.40, SD = 1.51; F(1, 81) = 5.76, p = .019, η_p^2 = .05, BF10 = 5.28, but not for US-never trials, M = .16, SD = 1.78; F(1, 81) = .70, p = .405, η_p^2 = .00, BF01 = 3.50. There was no difference between the former two conditions, F(1, 81) = .125, p = .724, η_p^2 = .00, BF01 = 5.36.

Looking at habituation effects within each US valence, ratings between learning conditions differed for both positive USs, F(2, 162) = 3.51, p = .03, η_p^2 = .03, BF10 = 1.92, and negative USs, F(2, 162) = 12.39, p < .001, η_p^2 = .12, BF10 > 1000. Yet, in the US-alone and in the US-paired trials, we observed a habituation effect for positive USs, t(163) = 6.10, p < .001, η_p^2 = .12, BF10 > 1000, but not for negative USs, t(163) = 1.71, p = .09, BF01 = 2.76.

Discussion

In Experiment 3, USs presented alone or with a CS during the conditioning procedure were evaluated less intensely (and equally so) than USs never presented before. Hence, the present study again finds no evidence for the contribution of CS-US pairing in the US devaluation effect. In addition, it provides evidence for the contribution of the mere US presentation to this effect. Finally, consistent with Experiment 1 and 2, a US devaluation effect was found for positive USs only.

General Discussion

In this research, we examined the reciprocity of evaluative changes following CS-US pairings. An evaluative conditioning effect emerged systematically, which confirms the influence of the US in the evaluation of the CS after pairing these together. Consistent with De Houwer et al. (2000), we found evidence for a US devaluation effect, with reduced evaluations of the USs following their pairings with the CS. Of importance, however, various control conditions suggest that this devaluation effect is immune to any CS-US pairing influence. Specifically, in Experiment 2 and 3, the US devaluation effect was the same for USs paired with CSs and for USs presented alone during the conditioning procedure. Hence, CS pairing did not contribute to US devaluation. Rather, the devaluation effect is likely driven by an affective habituation effect: USs presented (alone or with a CS) during the conditioning procedure were evaluated less intensely (and to the same extent so) than USs never presented before.

Across studies, habituation was systematically observed for positive USs only. As for the negative USs, there was a trend for habituation in Experiments 1 and 3, but it was absent in Experiment 2. The asymmetry in valence of affective habituation echoes the asymmetry observed in the processing of positive versus negative information. Overall, two types of such affective asymmetries have been documented, both of which may account for the present findings. First, a “good is weaker than bad” account would suggest that negative information has a stronger psychological impact than positive information.

Typically, negative information draws more attention (Pratto & John, 1991) and is related to stronger psycho-physiological reactions than positive information (Ito, Larsen, Smith, & Cacioppo, 1998). Therefore, negative affective reactions might be more difficult to habituate than positive ones. Second, a "good is more alike than bad" account would suggest that positive stimuli are conceptually more redundant with each other than negative stimuli are (Koch, Alves, Krüger, & Unkelbach, 2016). This higher conceptual redundancy of the positive USs may facilitate habituation because affective habituation (1) occurs at a conceptual rather than perceptual level, and (2) is negatively affected by the novelty of the stimuli (Leventhal et al., 2007).

The present findings suggest that evaluative changes elicited by CS-US pairings are non-reciprocal, in the sense that pairing the US with a CS has no demonstrated influence on the US evaluation over and above that elicited by US habituation. The one-sided evaluative effect of the CS-US association seems problematic for dual-learning models of attitudes that rely on associative assumptions. Specifically, it is unclear why unqualified associations between stimuli should show non-reciprocal effects (see also below). One possibility is that CSs, being neutral, elicit no response, the latter of which would be needed for establishing evaluative effects. Whether an absence of affective response should be equated to the presence of a neutral response is an interesting question. To the extent that non-valenced stimuli are identified by neutral evaluative ratings (i.e., responses), the answer to this question is affirmative: neutral stimuli, clearly, do elicit (neutral) evaluative responses. It is therefore important to specify the scope of observable responses elicited by neutral stimuli that would or would not be relevant to associative or dual-learning models of attitude. The latter specification would help to further constrain these models.

Alternatively, CS-to-US effects may have been too small to allow their detection in Experiment 2 and 3. Although it is possible that the present experiments did not reach sufficient power to detect such small effects, we systematically observed substantial evidence in a Bayesian approach for the null-hypothesis that CS-US pairings have no effect on US evaluation over and above the mere US presentation (see, for instance, Wagenmakers, Wetzels, Borsboom, & Van Der Maas, 2011). Furthermore, providing evidence for the inexistence of CS-to-US effects in every possible EC procedure is formally impossible. CS-to-US effects may apply to other pairing or evaluative measurement paradigms that remain to be uncovered (see also below).

If we cautiously assume that effects of CS-US pairings are non-reciprocal, then this would suggest that the evaluative effect of CS-US linkage is sensitive to a directional qualifier, one that goes from the US to the CS only, at least by default. This qualified (in this case, non-reciprocal) CS-US linkage is compatible with propositional accounts of attitude learning (e.g., Fiedler & Unkelbach, 2011; Mitchell, De Houwer, & Lovibond, 2009; Zanon, De Houwer, & Gast, 2012). Of importance, whereas the non-reciprocity of evaluative influences of CS-US pairings is consistent with a propositional approach, it does not necessarily mean that the US devaluation effect itself is driven by propositional processes. US devaluation may reflect an affective habituation effect that relates to a chronic need for novelty seeking (Leventhal et al., 2007).

By comparison, the absence of a reciprocal effect seems less consistent with an associative learning account. This is because associative learning typically refers to a low-level process that automatically registers co-occurrences between stimuli independent of their validity and relational meaning (for a recent discussion, see Corneille & Stahl, 2018). This issue should encourage the further constraining of dual-models of attitude learning with the extra assumptions (1) that weakly valenced and weakly arousing stimuli elicit no evaluative response that is relevant to these models, and that (2) evaluative effects are contingent on the spontaneous production of evaluative responses. Turning to propositional models, they may be further tested in experiments that reverse the assumed US-to-CS relational qualifier, for instance by instructing participants to pay more attention to the meaning of the CS-to-US relation.

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Data Availability: The data from all three experiments as well as the R scripts created to manage, analyze, and represent the data visually are available on Open Science Framework (see the Supplementary Materials section).

Supplementary Materials

The raw data and analysis scripts created to manage, analyze, and represent the data visually are available online via the project hub on the Open Science Framework: https://osf.io/82mcs/

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Appendix

Table A.1

IAPS Numeric Labels of the US Pictures

USs -	**USs +**
6312, 2750, 6360, 6561,	4608, 4700, 8200, 8460,
2141, 2900, 6315, 6510,	2550, 4603, 4641, 8120,
6210, 6312, 6550, 6571	1603, 2501, 8162, 7325

Note. IAPS = International Affective Picture System; USs = unconditioned stimuli. All USs were used in Experiment 3. USs from the first two rows were used in Experiment 2. USs from the first row were used in Experiment 1.

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