EC EFFECTS BASED ON CS-ER LEARNING

I Like It Because I Said That I Like It. Evaluative Conditioning Effects Can Be Based on Stimulus-Response Learning

Anne Gast[1,2] and Klaus Rothermund[2]

[1]Ghent University

[2]Friedrich-Schiller-University Jena

In press, *Journal of Experimental Psychology: Animal Behavior Processes*

Corresponding address:

Anne Gast

Department of Experimental Clinical and Health Psychology

Ghent University

Henri Dunantlaan 2

B-9000 Ghent

Belgium

Electronic mail: Anne.Gast@UGent.be

Phone: 0032-(0)9-264-6444

Field Code Changed

Author Note

Anne Gast, Department of Experimental-Clinical and Health Psychology, Ghent University; Klaus Rothermund, Institute of Psychology, Friedrich-Schiller-University Jena.

A similar version of this paper is part of the doctoral dissertation of the first author. We thank Anna Baumert and Joris Lammers for valuable comments on an earlier version of the manuscript.

Correspondence concerning this article should be addressed to Anne Gast, Department of Experimental Clinical and Health Psychology, Ghent University, Henri Dunantlaan 2, B-9000 Ghent, Belgium. Electronic mail should be sent to Anne.Gast@UGent.be.

Field Code Changed

Abstract

Evaluative conditioning (EC) effects are often assumed to be based on a learned mental link between the CS (conditioned stimulus) and the US (unconditioned stimulus). We demonstrate that this link is not the only one that can underlie EC effects, but that if evaluative responses are actually given during the learning phase also a direct link between the CS and an evaluative response – a CS-ER link – can be learned and lead to EC effects. In Experiment 1, CSs were paired with USs and participants were asked to evaluate the pairs during the conditioning phase. Resulting EC effects were unaffected by a later revaluation of the USs, suggesting that these EC effects can be attributed to CS-ER learning rather than to CS-US learning. Experiment 2 replicated Experiment 1 with the difference that no evaluative responses were given during the learning phase. EC effects in this study were influenced by US revaluation, suggesting that these EC effects are mainly based on CS-US learning. In Experiment 3, it was shown that EC effects can be found even if the USs are entirely removed from the procedure and the CSs are only paired with enforced evaluative responses. Together the experiments show that the valence of a stimulus can change due to a contingency with an evaluative response.

Keywords: Evaluative Conditioning; S-R learning; S-S learning; US revaluation; evaluative response

I Like It Because I Said That I Like It. Evaluative Conditioning Effects Can Be Based on Stimulus-Response Learning.

People sometimes develop strong likings for neutral things after encountering them in combination with likeable things or in enjoyable situations. Some people, for example, love the scent of a sun-oil they used on a beach holiday. Such an acquired liking is an example for evaluative conditioning (EC). EC can be defined as the valence change of a stimulus (CS) due to the previous pairing with a likeable or dislikeable stimulus (US); see De Houwer, 2007; De Houwer, Thomas, & Baeyens, 2001; Lovibond & Shanks, 2002 for reviews, or Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010, for a meta-analysis.

The dominant view on conditioning in general, and more specifically also on EC, is that it is based on the mental linking of the relevant events or stimuli that were encountered in the learning episode (Hall, 2002). Whether these mental links that presumably underlie EC effects are automatic or propositional is a major topic in EC research (e.g. Corneille, Yzerbyt, Pleyers, & Mussweiler, 2009; Gast & De Houwer, 2010; Gawronski & Bodenhausen, 2006; Hofmann et al., 2010; Mitchell, De Houwer, & Lovibond, 2009). Less attention is paid to the question of what is actually linked to what. This is surprising as understanding what is linked to what, or understanding the *link structure*, is central for understanding a learning process (Rescorla & Holland, 1982).

In EC research it is often assumed that the mental link between the neutral stimulus and the valent stimulus is responsible for the EC effect. This assumption is also called the CS-US (or S-S) model (Baeyens, Eelen, Van den Bergh, & Crombez, 1992; Hammerl & Grabitz, 1996; Walther, 2002; Walther, Gawronski, Blank, & Langer, 2009). This model states that the CS becomes associated to the US due to CS-US pairing. If the CS is later presented alone, the mental representation of the US is activated via the CS-US association. Consequently, the valence of the activated US influences the evaluation of the CS. In the example, the sun-oil becomes associated to the beach. If the sun-oil is later encountered again it activates the representation of the beach. Because the beach is positive, this improves the evaluation of the sun-oil.

The CS-ER (or S-R) model, on the other hand, states a direct link between the CS and an evaluative response (CS-ER link). As, according to this model, the US can trigger evaluative responses (ERs) during the conditioning trial, the CS can become directly associated to these evaluative responses. If the CS is later presented, the direct link to the evaluative responses influences the evaluation of the CS. In the example, the sun-oil could have become directly associated to evaluative responses that were elicited by the beach. Evaluative responses can have various forms. They could be verbal expressions, laughter, smiling, and also inner responses to the enjoyable experience. If such evaluative responses were triggered by the beach while the sun-oil was present, they could become directly associated to the sun-oil. Consequently, if the sun-oil is encountered again, evaluative response tendencies are activated and influence the evaluation of the sun-oil. To our knowledge, there is only little direct evidence for it (Baeyens, Vanhouche, Crombez, & Eelen, 1998; see also Fulcher & Cocks, 1997). The CS-ER model can also be described as an *intrinsic* learning model, and the CS-US model as a *referential* learning model (Baeyens et al., 1992, 1998; Fulcher, 2001; Levey & Martin, 1987).

CS-US and CS-ER models have been tested with experimental paradigms adapted from research on classical conditioning. These paradigms are *sensory preconditioning* (e.g., Brogden, 1939; Konorski, 1948) and *US revaluation* (e.g., Rescorla, 1973). In sensory preconditioning studies of EC, first two neutral stimuli are combined with each other. In the next step, one of them (CS1) is combined with a valent stimulus. It is then tested whether *the other* neutral stimulus (CS2) changes its valence. With demonstrating this possibility, it has been shown that CS-US associations can be the basis for evaluative conditioning effects (Hammerl & Grabitz, 1996; Walther, 2002).

More relevant for the question whether a given EC effect is based on a CS-ER or a CS-US link, however, are US revaluation studies, in which these two models are tested against each other. In this paradigm, CSs in all conditions are first paired with valent USs. Next, in the *revaluation condition*, the valence of the USs is experimentally changed without further presentation of the CSs. If a US was for example positive during the conditioning phase, it should now for example become negative or neutral. In the control condition, US valence is kept constant. Then, CS valence is measured. The CS-ER model predicts an EC effect that is independent of later US revaluation. According to this model, only the valence of the USs during the conditioning phase is relevant because, in this phase, the ER towards the US can become directly associated to the CS. A CS-ER association should thus remain unaffected by later changes in US valence. CS-US models, on the other hand, do not predict an EC effect in the revaluation condition (or even a reversed EC effect) because the US does not have its former valence anymore after revaluation. Hence, the CS-US association cannot confer this valence to the CS. According to the CS-US model, EC effects should thus differ depending on whether the valence of the US was changed subsequent to conditioning or not. The empirical evidence in US revaluation studies is mixed. Two studies favour the CS-US model by showing that CS valence depends on whether the US is revalued or not (Baeyens et al., 1992; Walther et al., 2009). Baeyens and colleagues (1998), however, conducted a US revaluation study, in which flavours as CSs and a negative taste (Tween) as US were presented together in drinkable solutions. After the CS-US presentation and a first CS rating phase, the US was *inflated* by presenting a solution with a 10 times higher concentration of Tween. There was no evidence for a change of the EC effect due to this manipulation, which would have been predicted by the CS-US model (Baeyens et al., 1998). Therefore, this study supports the CS-ER model. Taken together, the evidence on whether CS-ER associations can be the basis for EC effects, is mixed.

For CS-ER links to be learned, it should be important that the US actually triggers an evaluative response during the learning trials. It is unclear whether this is always the case. Some researchers assume that valent stimuli automatically trigger at least an internal evaluation or evaluative response (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996; Martin & Levey, 1978; Murphy & Zajonc, 1993; Zajonc, 1980). Recent evidence, however, showed that even implicit evaluative responses are not unconditional but depend on an evaluation goal (Spruyt, De Houwer, Hermans, & Eelen, 2007; Spruyt, De Houwer, & Hermans, 2009). Whether and to what degree the US in an evaluative conditioning procedure elicits evaluative responses could therefore depend (1) on whether there is a goal to evaluate, but (2) also on the type of stimulus. Possibly, the stimuli used by Baeyens et al. (1998) – good and bad tastes – are stimuli that are likely to trigger evaluative responses (Berridge, 2000); more likely perhaps than pictures – as used by Baeyens et al. (1992) and Walther et al. (2009).The use of stimuli that are more likely to trigger evaluative responses might explain why EC effects are found to be based on CS-ER links in this study, but not in the other studies. The more general conclusion of this would be that CS-ER based EC effects can be found if USs trigger evaluative responses during the learning phase.

If EC effects are found that are due to the mental linking of the evaluative response with the CS, it should be possible to observe also effects that are based on pairing the CS with only the evaluative response and no other stimulus. If a person is for example confronted with a piece of music, a person, or a present that seems genuinely neutral or even negative to him or her, he or she might nevertheless express liking. This pretended expression might influence the actual liking of the person or the object. Although such an effect would not be due to pairing a stimulus with another stimulus and is therefore beyond what is typically considered as an EC effect (De Houwer, 2007), it seems to be relevant for understanding the processes that can underlie EC on the one hand, and the development of likes and dislikes in everyday life on the other.

In the following experiments we tested whether CS-ER contingencies can lead to an evaluative change in the CS. We tested this both in an EC paradigm in which participants see the pairings of neutral and valent stimuli and are explicitly asked to give evaluative responses during the learning phase and in an experiment in which the CS is paired only with evaluative responses. Thus two different strategies were applied to exclude the possibility that resulting EC effects are based on CS-US associations. In Experiment 1, CSs were paired with valent USs and participants were asked to evaluate the stimulus pairs during the conditioning trials. We tested whether EC effects in this experiment were based on CS-ER or on CS-US associations with a US revaluation procedure, as described above. In Experiment 2, a further US revaluation study, we tested whether evidence for CS-ER associations is found if the conditioning procedure does not involve open evaluative responses. In Experiment 3 we tested whether the valence of a stimulus can be changed by pairing it with an evaluative response only. CSs in this study were therefore not paired with USs, but with enforced evaluative responses only.

Across experiments, we used implicit measures only or in addition to explicit ratings to reduce the possibility of demand effects. We used two different implicit measures (affective priming, affective misattribution procedure) to reduce the risk of interpretations based on possible artifacts of a particular procedure and to increase the generalizability of the results. Both measures are suitable for the valence measurement of single stimuli that underwent an EC procedure and have been used in EC studies before (affective priming: Fazio et al. (1986); for an application to EC research see, e.g. Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen (2002); affective misattribution procedure: Payne, Cheng, Govorun, & Stewart (2005); for an application to EC research see, e.g. Prestwich, Perugini, Hurling, & Richetin (2010). The popular implicit association test (IAT; Greenwald, McGhee, & Schwartz, 1998) is not ideal for this purpose as its construction requires stimulus categories and captures the valence of these categories instead of only the valence of individual stimuli (Gast & Rothermund, 2010).

Experiment 1

In Experiment 1, we tested whether a valence change that is due to a CS-ER link can be found in an EC procedure that assures that evaluative responses are given during the conditioning phase by explicitly asking participants to give evaluative responses. To be able to test CS-US vs. CS-ER links, Experiment 1 comprised a US revaluation procedure. Except for the evaluative task in the conditioning phase, the experiment was modelled closely after Walther and colleagues (2009). In their study, the authors had found evidence for CS-US learning.

In the conditioning trials of Experiment 1, neutral CSs were paired with valent USs. Participants were asked to indicate on each trial whether their impression of the CS-US pair is rather positive or rather negative. Such a procedure leads to strong EC effects (Gast & Rothermund, in press). After the conditioning phase, half of the USs underwent a revaluation procedure. The CS-ER model predicts no influence of US revaluation on CS valence (and EC effects also for CSs paired with USs that are revalued after the conditioning phase); the CS-US model on the other hand predicts an influence of US revaluation on CS valence (and an EC effect only for CSs paired with USs that were not revalued). Valence was assessed explicitly (rating) and implicitly with an affective priming procedure (Fazio et al., 1986). In the trials of an affective priming procedure, a valent prime is presented shortly before a valent target that is categorized by the participant according to its valence. Responses are faster if the target is preceded by an evaluatively congruent prime (positive prime - positive target or negative prime - negative target) than if it is preceded by an evaluatively incongruent prime (positive prime - negative target or negative prime - positive target). Therefore the affective priming procedure can be used as an implicit measure of CS valence if the CSs are used as primes in combination with evaluatively polarized targets. Evaluative conditioning can be inferred if positive CSs speed up responses to positive targets compared to responses to negative targets – relative to the pattern found for negative CSs and positive and negative targets.

Method

Participants

Fifty students of different faculties of the University of Jena participated and were paid 2 Euro. Data from two participants had to be excluded from the analyses, one due to an extremely high error rate (> 50%) in the affective priming task; the other due to an erroneous labelling of the response keys. Of the remaining participants, 28 were female. Ages ranged from 18 to 36 years (M = 22.1, SD = 3.8).

Material

CSs and USs were portraits taken from the data base of Minear and Park (2004), cut to depict the face and neck of a person. Following Walther et al. (2009), stimuli were not selected individually, but based on their likeability ratings on 19-point scales in previous studies. Eight pictures that were rated neutral in valence were selected as CSs (range: M = -0.9 to M = 0.8). Half of these pictures depicted women, the other half men. Four pictures that were rated positively (range: M = 1.8 to M = 4.3) and four pictures rated negatively (range: M = -3.7 to -2.6) were chosen as USs. All of these depicted men. Statements in the attitude formation and in the revaluation phases (see Procedure) were identical or similar to those used by Walther et al. (2009). The targets in the affective priming procedure were positive and negative nouns taken from Gawronski, Walther, and Blank (2005; positive words: love, laughter, fun, joy, happiness, kiss, freedom, friend, humour, present; negative words: enemy, violence, hate, war, misery, terror, brutality, murder, anxiety, poison).

Procedure

All experiments reported were conducted in laboratories at the campus-site of the University of Jena. The experimental program for all experiments was run under E-Prime. For this and the following experiment, up to eight participants were tested simultaneously at individual work spaces. They were seated in front of a computer screen which displayed all instructions. The experiment consisted of the following phases: an attitude formation phase, a conditioning phase, a US revaluation phase, and a phase in which the resulting valence of the CSs were measured, first with an affective priming procedure as an implicit measure, and then with explicit ratings.

Attitude formation. To make sure that the portraits used as USs had the correct valence for each participant, the experiment started with an attitude formation phase in which participants were asked to imagine that they had just started to work in a new company and were interested in getting to know the new colleagues. They were asked to form impressions of the colleagues depicted on the presented pictures. Each of the eight US pictures was then shown three times in combination with one of three different statements each of which corresponded in valence with the portrait (e.g. “Is always willing to listen to other people’s problems”). The 24 impression formation trials were presented in random order. Each US-statement pair was shown for 7000 ms. Following an inter-trial interval of 1000 ms, the next trial started.

Conditioning. At the beginning of the conditioning phase, participants were told that they now were acquainted with some of the colleagues, while still not knowing others. It was announced that in the following part, pairs of pictures of two colleagues would be presented. The participants’ task was to form an impression of the two colleagues together and indicate whether they had a more positive or more negative impression of them. In each trial, one US and one CS were presented. Each CS-US pair was presented eight times. Thus, the conditioning phase consisted of 64 trials, which appeared in random order. Each trial started with the simultaneous presentation of the CS and the US next to each other. Participants had time to press one of two marked keys (“X” or “M”) during the first 2700 ms of the presentation. For half of the participants “X” indicated positive; for the other half it indicated negative. After 2700 ms either the word “positiv” (“positive”)or the word “negativ” (“negative”) appeared below the pictures, depending on the decision of the participant, or “keine Reaktion” (“no reaction”) if the participant had failed to respond. The pictures and the word remained on the screen for 1000 ms. Following an inter-trial interval of 4000 ms, the next trial started. Participants responded according to the valence of the US picture in 85.1 % of all conditioning trials.

US revaluation. Participants were instructed to imagine that after a few weeks of working in the company they had already had time to get acquainted with the colleagues. Some of the information they received earlier turned out to be true, while other information turned out not to be reliable. It was announced that they would receive additional information about some of the colleagues. They were asked to form impressions about them, and to indicate for each colleague whether the impression was positive, negative, or neutral at the given moment of presentation. The US-revaluation phase consisted of 24 trials in which each of the eight USs was presented with three new positive or negative statements. Half of the USs were always combined with statements that corresponded in valence with the statements from the impression formation phase (congruent revaluation) and half of the USs were always combined with statements of opposite valence (incongruent revaluation). Each trial started with the presentation of the US and the statement for 6000 ms during which participants could indicate their impression by pressing one of the keys “X”, “G”, or “M” (“G” indicated neutral, “X” and “M” indicated positive and negative, respectively, or vice versa for the same halves of participants as in the conditioning task). Then, “positive”, “negative”, “neutral”, or “no response”, depending on the participant’s response was written below the US and the statement for 1000 ms. After an inter-trial interval of 1000 ms, the next trial started.

Affective Priming. In the affective priming phase, CSs and USs were used as primes and positive and negative words as targets. Participants were told that they would see words, preceded by rapidly appearing and disappearing pictures. They were instructed to decide as fast and correctly as possible whether the word was positive or negative, and press the right key (“M”) for positive and the left key (“X”) for negative words. The primes (CSs and USs) were not further mentioned in the instructions. Please note that for half of the participants the allocation of evaluative responses to keys in the affective priming phase was identical to the (counterbalanced) allocation of evaluative responses to keys in the previous learning phases, while it was reversed for the other half. This is important as a consistent relation between a stimulus and a keypress might cause facilitation in the affective priming phase independent from the evaluative learning. Likewise a reversed relation might cause interference. Counterbalancing key allocation in the learning phases allows us to estimate evaluative learning across conditions of response key consistency.

Each trial started with the presentation of a prime for 200 ms. Immediately after the offset of the prime, the target appeared on the screen (SOA 200 ms) and remained there until the participant responded. After an inter-trial interval of 1000 ms, the next trial started.

In the main block of the affective priming procedure, the eight CS pictures and the eight US pictures were used as primes, in addition to four neutrally evaluated portraits that had not been shown before, and which were used in baseline trials. Each of these pictures was randomly combined with three positive and three negative targets, summing up to 120 trials, which were presented in random order. These were preceded by 12 practice trials and four warm-up trials in which the same targets but different prime pictures were used. Only during the practice trials, feedback on erroneous responses was given.

Ratings. Participants were asked to rate the likeability of the persons depicted on the CS and US pictures. They were instructed to give a subjective impression, but nevertheless to use the whole scale and to try to be as exact as possible. The pictures appeared one by one, with a response scale consisting of 19 green squares below them. The endpoints were labelled “positive” and “negative”; the middle square was labelled “neutral”. Participants could rate the likeability of a portrait by clicking on one of the squares. Thus, ratings could vary between -9 and +9 (the numbers were not indicated on the scale). Participants rated first the CSs and then the USs. Within these categories the order was randomized.

Design

The experiment consisted of a 2 (*original US valence: positive, negative*) × 2 (*congruency of US revaluation: congruent, incongruent*) within-subjects design. Other factors (the assignment of CS pictures to the conditions US valence and revaluation, the assignment of US pictures to the revaluation condition, and the assignment of keys to labels in the conditioning and the US revaluation task) were counterbalanced across participants.

Results

All analyses are based on 2 (original US valence: positive, negative) by 2 (congruency of US revaluation: congruent, incongruent) repeated-measurement ANOVAs. These analyses were performed for both the affective priming task and for the explicit ratings. For both measures, results on the USs and the CSs are reported.

Affective Priming

Incorrect responses (6.3 %) as well as outliers (5.8 %) were removed before RT analyses of the affective priming data. Reaction times were treated as outliers if they were below 250 ms, more than 1.5 interquartile ranges above the third quartile of individual response time distributions (“outliers”; Tukey, 1977), or more than 3 interquartile ranges above the third quartile of overall response time distribution (1119 ms , “far outs”, Tukey, 1977). Baseline trials were used to test whether RTs in trials with negative targets differed from RTs in trials with positive targets, and if necessary to correct for it. As this was not the case, $t(47) = 0.75$, *ns*, $d = 0.11$, and because baseline correction would only change descriptive values but not the statistics of the relevant comparisons, baseline trials were not further analysed. Both CSs and USs fall into four conditions: (1) originally positive, congruent revaluation, (2) originally positive, incongruent revaluation, (3) originally negative, congruent revaluation, (4) originally negative, incongruent revaluation. For each of these eight stimulus conditions (four CS conditions, four US conditions), RTs on positive and RTs on negative targets are available. These are used to calculate evaluative scores by subtracting RTs on positive targets from RTs on negative targets (Gawronski et al., 2005). Thus, higher scores indicate more positive evaluations. Please note that only the difference of these scores between conditions and not their absolute value should be interpreted. The latter is confounded with a main effect of target valence and hand (as the positive response in the affective priming task is always given with the right hand and vice versa).

Implicit US evaluative scores. For the US analysis, only data of 47 participants were available because one participant had only incorrect responses in one cell. Mean evaluative scores and SDs for the USs in the conditions of original valence and revaluation condition can be found in Table 1. A 2 (original US valence) by 2 (revaluation: congruent, incongruent) ANOVA for repeated measures showed a main effect of original US valence, $F(1,46) = 4.94$, $MSE = 6915.48$, $p < .05$, $\eta^2_{partial} = .10$. Originally positive USs yielded higher evaluative scores than originally negative USs. There was no main effect of congruency of US revaluation, $F < 1$. Importantly, congruency of US revaluation interacted with US valence, $F(1,46) = 15.63$, $MSE = 5357.54$, $p < .001$, $\eta^2_{partial} = .25$. The evaluative scores of US_{pos} and

US_{neg} differed only in the congruent revaluation condition, $t(46) = 4.15$, $p < .001$, $d = 0.61$, and not in the incongruent revaluation condition, $t(46) = -0.97$, *ns*, $d = 0.14$. Thus, US revaluation, as measured with the affective priming procedure, was successful.

Implicit CS evaluative scores. The 2 by 2 ANOVA for repeated measures on evaluative scores for CSs showed a main effect of the factor original US valence (EC effect), $F(1,47) = 4.42$, $MSE = 5282.28$, $p < .05$, $\eta^2_{partial} = 0.09$. CSs that were combined with positive USs were evaluated more positively than those that were combined with negative USs. No main effect of revaluation was found, and, most importantly and in line with the CS-ER learning hypothesis, no interaction between original US valence and revaluation condition, all $F < 1$. To answer the critical question whether an EC effect was also obtained for CSs that were paired with later incongruently revalued USs, we tested the simple main effect of original US valence in both revaluation conditions separately. A significant EC effect was found in the incongruent revaluation condition: CS_{pos} had a more positive evaluative score than CS_{neg}, $t(47) = 1.81$, $p < .05$, one-tailed, $d = 0.26$. In the congruent revaluation condition, the difference between CS_{pos} and CS_{neg} failed to reach significance, $t(47) = 1.22$, $p = .23$, $d = 0.18$. The result pattern thus indicates that implicitly measured CS valence depends on US valence during conditioning and not on US valence after conditioning. This is in line with the CS-ER hypothesis. EC effects based on the difference between the evaluative scores of CS_{pos} and CS_{neg} for both revaluation conditions can be seen in Figure 1.

Ratings

For each participant, we calculated mean ratings of the two USs and two CSs in the four conditions: (1) originally positive, congruent revaluation, (2) originally positive, incongruent revaluation, (3) originally negative, congruent revaluation, (4) originally negative, incongruent revaluation. Mean ratings and SDs for these conditions can be found in Table 2. Based on these rating scores, 2 (original US valence: positive, negative) x 2 (congruency of US revaluation: congruent, incongruent) ANOVA with repeated measures were calculated.

US ratings. The 2 by 2 ANOVA on US ratings showed a main effect of original US valence. US_{pos} were rated more positively than US_{neg}, $F(1,47) = 334.68$, $MSE = 11.62$, p < .001, $\eta^2_{partial} = .88$. Importantly, US valence interacted with revaluation condition, $F(1,47) = 55.13$, $MSE = 9.67$, $p < .001$, $\eta^2_{partial} = .54$, indicating that the difference between US_{pos} and US_{neg} was larger in the congruent revaluation condition, $t(47) = 23.20$, $p < .001$, $d = 3.35$, than in the incongruent revaluation condition, $t(47) = 7.29$, $p < .001$, $d = 1.05$.

CS ratings. The 2 by 2 ANOVA on CS ratings showed a main effect of original US valence in pairing (EC effect). CS_{pos} were rated more positively than CS_{neg}, $F(1,47) = 34.23$, $MSE = 7.47$, $p < .001$, $\eta^2_{partial} = .42$. There was no main effect of US revaluation, $F < 1.3$. Most importantly, the EC effect did not interact with US revaluation, $F < 1$. An analysis of the simple main effects, revealed significant EC effects both in the congruent, $t(47) = 4.97$, $p < .001$, $d = 0.72$, and in the incongruent revaluation condition, $t(47) = 4.22$, $p < .001$, $d = 0.61$. In line with a CS-ER learning hypothesis, this indicates that in this experiment also CS valence measured with ratings depended on the US valence during the conditioning phase and not on US valence after revaluation. EC effects based on ratings (rating CS_{pos} minus rating CS_{neg}) for the conditions congruent and incongruent US revaluation can be seen in Figure 2, left side.

Discussion

Experiment 1 was designed to test whether EC effects found after a conditioning procedure with CS-US pairings that the participants had to evaluate, are based on a CS-ER link rather than a CS-US link. In line with our hypothesis, the EC effect found in this experiment did not interact with US revaluation condition. Only US valence during the pairing but not US valence after US revaluation was relevant. EC effects were also significant when the incongruent US revaluation condition was analysed separately. These results were found both on an implicit and on an explicit measure. We thus can conclude that if evaluative responses on CS-US pairs are given during the conditioning phase, resulting EC effects are based on CS-ER associations and not on CS-US associations.

To exclude alternative interpretations, it is important to control whether US valence was successfully changed. This was the case as shown by the implicit and the explicit assessment of US valence. Incongruently revalued US valence, however, looked somewhat different on the implicit and on the explicit measure. On the implicit measure, the original US valence was completely removed. If anything, formerly positive USs were evaluated more negatively than formerly negative USs. For the implicit data, we can therefore safely conclude that an EC effect in the incongruent condition was found although the USs did not have the original valence anymore. On the explicit measure, however, positive USs were still rated more positively than negative USs after incongruent revaluation, although far less so than after congruent revaluation.

To rule out the possibility that the EC effect in the incongruent revaluation condition was due to a less than perfect revaluation of the USs that leaves USs with residual valence, we performed an additional analysis that was based on only those 25 % of the participants who showed the most negative difference regarding the incongruently revalued USs. For this subsample, any difference in explicit US evaluation was completely eliminated after revaluation (US_{pos}-US_{neg}: $M = -1.6$, $SD = 2.0$). In line with the predictions of the CS-ER association model, we also found an EC effect on the CS ratings in the incongruent revaluation condition in this subsample of participants, $t(11) = 2.69$, $p < .05$, $d = 0.78$. This shows that also for the explicit data, an EC effect is found in the incongruent revaluation condition that cannot be explained by an association of CSs with USs of residual valence.

Taken together, Experiment 1 shows that EC effects obtained after CS-US pairings with an evaluation task can be immune to US-revaluation. This suggests that these effects are based on a CS-ER link.

Experiment 2

Experiment 2 was a replication of Experiment 1 without the evaluative responses during the conditioning phase and thus a replication of earlier US revaluation experiments (Baeyens et al., 1992; Walther et al., 2009). With this experiment, we wanted to investigate whether eliminating overt evaluative responses produces CS-US- rather than CS-ER-based EC effects. If this is the case, the CS-ER links for which we found evidence in Experiment 1 can be more clearly attributed to the responses that had to be given during the conditioning phase of Experiment 1.

Participants

Fifty-three students of different faculties of the University of Jena participated and were paid 2 Euro. Data from one participant had to be excluded from the analyses due to an extremely high error rate (> 50%) in the affective priming task. Twenty-five of the remaining participants were female. Ages ranged from 20 to 43 years (*M* = 25.1, *SD* = 4.4).

Material and Procedure

Material and Procedure were identical to Experiment 1, with the difference that the participants did not have the task to evaluate the CS-US pairs during the conditioning phase. Even for this phase, instructions were kept as similar to those of Experiment 1 as possible. In particular, participants were asked to form an impression about the presented colleagues but they were not asked to indicate whether their impression was positive or negative.

Results

All analyses were based on 2 (original US valence: positive, negative) by 2 (congruency of US revaluation: congruent, incongruent) repeated-measurement ANOVAs.

These analyses were performed for both the affective priming task and for the explicit ratings. For both measures, results on USs and CSs are reported.

Affective Priming

Incorrect responses (3.6 %) as well as outliers (5.7 %) were removed before RT analyses of the affective priming data. The same outlier criteria were used as in Experiment 1. The overall cut-off value was 1111 ms. Evaluative scores were calculated as in Experiment 1, separately for USs and CSs in all four conditions. The means and SDs of these scores can be found in Table 1.

Implicit US evaluation scores. A 2 (original US valence) by 2 (revaluation: congruent, incongruent) ANOVA for repeated measures showed a main effect of original US valence, $F(1,51) = 15.24$, $MSE = 3150.86$, $p < .001$, $\eta^2_{partial} = .23$. Originally positive USs yielded higher evaluative scores than originally negative USs. There was no main effect of congruency of US revaluation, $F < 1$. Crucially, congruency of US revaluation did also not interact with US valence, $F < 1$. The evaluative scores of US_{pos} and US_{neg} differed both in the congruent revaluation condition, $t(51) = 3.21$, $p < .01$, $d = 0.45$, and in the incongruent revaluation condition, $t(51) = 2.75$, $p < .01$, $d = 0.38$. Thus, the US revaluation as measured with the affective priming procedure was not successful.

Implicit CS evaluation scores. The 2 by 2 ANOVA for repeated measures on evaluative scores for CSs showed no main effect of the factor original US valence (EC effect), $F < 1$. No main effect of revaluation was found, and no interaction between original US valence and revaluation condition, all $F < 1$. Simple main effects of original US valence were also tested in both revaluation conditions separately. A significant EC effect was found neither in the incongruent revaluation condition, $t(51) = 0.59$, *ns,* nor in the congruent revaluation condition, $t(51) = - 0.33$, *ns.*

Ratings

As in Experiment 1, we calculated mean ratings of the two USs and two CSs for each participant in the four conditions. Based on these rating scores, a 2 (original US valence: positive, negative) x 2 (congruency of US revaluation: congruent, incongruent) ANOVA with repeated measures was calculated. Mean ratings and SDs for these conditions can be found in Table 2.

US ratings. The 2 by 2 ANOVA on US ratings showed a main effect of original US valence. US_{pos} were rated more positively than US_{neg}, $F(1,51) = 244.82$, $MSE = 11.84$, $p < .001$, $\eta^2_{partial} = .83$. There was also a main effect of revaluation, indicating that congruently revalued stimuli were more positive than incongruently revalued stimuli, $F(1,51) = 7.45$, $MSE = 6.65$, $p < .01$, $\eta^2_{partial} = .13$. Importantly, US valence interacted with revaluation condition, $F(1,51) = 24.66$, $MSE = 12.24$, $p < .001$, $\eta^2_{partial} = .33$. The difference between US_{pos} and US_{neg} was larger in the congruent revaluation condition, $t(51) = 18.16$, $p < .001$, $d = 2.52$, than in the incongruent revaluation condition, $t(51) = 6.37$, $p < .001$, $d = 0.88$.

CS ratings. The 2 by 2 ANOVA on CS ratings showed a main effect of original US valence in pairing (EC effect). CS_{pos} were rated more positively than CS_{neg}, $F(1,51) = 5.38$, $MSE = 10.05$, $p < .05$, $\eta^2_{partial} = .10$. There was no significant main effect of US revaluation, $F(1,51) = 3.47$, $MSE = 4.82$, $p = .07$. Most importantly, the EC effect did interact with US revaluation, $F(1,51) = 5.10$, $MSE = 2.85$, $p < .05$, $\eta^2_{partial} = .09$. An analysis of the simple main effects revealed a significant EC effect in the congruent revaluation condition, $t(51) = 3.03$, $p < .01$, $d = 0.42$, but not in the incongruent revaluation condition, $t(51) = 1.01$, $p = .32$, $d = 0.14$. In line with a CS-US learning hypothesis, this indicates that in this experiment explicitly measured CS valence depended on the US valence during measurement and not during conditioning. EC effects based on the ratings (rating CS_{pos} minus rating CS_{neg}) for the conditions congruent and incongruent US revaluation can be seen in Figure 2, right side.

Discussion

Experiment 2 was designed to test whether EC effects found after a conditioning procedure like the one in Experiment 1 – but without evaluative responses – are based on a CS-US link. The results on the ratings clearly suggest that this is the case: Different from Experiment 1, we found a US-revaluation effect on the CSs. This suggests that in this experiment, the valence of the CSs depended on the valence of the associated USs, which is in line with a CS-US explanation. The CS-ER-based EC effect in Experiment 1 seems therefore to be due to the only difference between the experiments, that is, the evaluative responses that were given in the conditioning phase.

The data from the affective priming procedure do not clearly speak to our research question: None of the basic effects, neither the revaluation of the USs, as measured on the USs, nor the EC effect were found. Possibly the manipulations were too weak to affect the implicit measure. More specifically, the failure to find an EC effect in the affective priming data in Experiment 2 might be attributed to the removal of the evaluative task. As was previously shown by Gast and Rothermund (2011), the strength of EC effects depends on whether an evaluative mind-set is established during the conditioning phase. Removing the evaluative task might have weakened the evaluative mindset, so that the resulting EC effects might have become too weak to be detected with an implicit measure. The failure to find a revaluation effect on the USs in the implicit data could be explained by dual process assumptions. It has been shown that the reversal of an affective valence proceeds faster on an explicit than on an implicit measure (e.g. Gregg, Seibt, & Banaji, 2006). This cannot explain, however, why the implicit measure shows a revaluation effect on the USs in Experiment 1 but not in Experiment 2. In the descriptive data analyses, it can be seen that in Experiment 2, possibly due to the lack of the evaluative task, US valence in the congruent conditions was less extreme both on the implicit and on the explicit measure. Because of this, there might have been less power to detect a difference to the incongruent revaluation condition in Experiment 2. Whatever the reason for the lack of the basic effects on the implicit measure might be, revaluation effects on the CSs thus cannot be expected, either – irrespective of whether one follows a CS-ER or a CS-US hypothesis.

Taken together, results from Experiment 2 suggest that the EC effects in this experiment were due to CS-US rather than CS-ER learning. As the affective priming data from this experiment could not be interpreted in favour or against any of the models, conclusions from this experiment should be considered with caution.

Taken together Experiments 1 and 2 demonstrate that if evaluative responses are actually given during the learning phase, EC effects can be based on learning a CS-ER link. It seems that in these cases the contingency between the CS and the evaluative response is the most relevant one for the learning effect. This led us to the conclusion that a valence change in a CS should also be found if the CS is paired with an evaluative response only but not – as is usually the case – with a US which does or does not produce an evaluative response.

Experiment 3

The goal of Experiment 3 was to test whether mere CS-ER contingencies can lead to a valence change in the CSs. CSs were thus paired with enforced evaluative responses (speaking out the word likeable or the word dislikeable) and with no USs. Valence changes in the CSs resulting from this procedure can therefore not be explained with CS-US associations. To the best of our knowledge, this approach to study CS-US vs. CS-ER associations has not been realized in previous studies, although it follows the general principle that either the stimulus or the response property of the reinforcing event is eliminated (Rescorla & Holland, 1982). Although an enforced response is not a prototypical response, it seems to be an approximation to an evaluative response that might even trigger sensations and bodily responses that are typical for the according real evaluative response (e.g., Zuckerman, Klorman, Larrance, & Spiegel, 1981). In any case, it seems reasonable to assume that this operationalization is closer to an evaluative response than to an evaluative stimulus and that an evaluative change that might be observed due to this procedure might also show due to the pairing with real evaluative responses.

CS valence after the pairings with evaluative responses was measured with the Affective Misattribution Procedure (AMP; Payne et al., 2005) as an implicit measure. In the AMP, prime stimuli are shown briefly before a Chinese ideograph. The participant's task is to evaluate the ideographs. Payne and colleagues showed that the ideograph evaluation is influenced by the valence of the primes. Ideographs that are presented after positive primes are more likely to be evaluated positively than ideographs that are presented after negative primes. Therefore, if the CSs are used as primes, the AMP can be used as an implicit measure of the CSs.

Method

Participants

Thirty-nine students from different faculties of the University of Jena participated in the experiment and were compensated with 2 Euro. Two of the participants responded with the same key to all or nearly all (> 95 %) stimuli in the AMP. Data from these participants were excluded from the reported analyses. This did not influence the results. Twenty-six of the remaining participants were women. Ages ranged from 19 to 33 years (M = 22.5, SD = 3.3).

Material

The CSs were color portraits taken from the database of Minear and Park (2004), and cut to depict the face and neck of a person. Pictures used were selected individually (see pre-conditioning rating below). The set from which they were taken consisted of 44 portraits, the majority of which was evaluated neutrally in a previous study. About half of the pictures depicted women, the other half men.

The positive and negative CSs were used as primes in the AMP procedure; a grey square of the same size as the CSs was used as baseline prime. Forty-nine Chinese ideographs, which were taken from the website of Keith Payne (Payne, n.d.), were used as targets in the AMP procedure.

Procedure

Participants were tested individually in sound attenuated experimental chambers. They received all instructions from the computer screen. The experiment consisted of three main phases, the pre-conditioning rating, the conditioning phase, and the AMP as a measure of CS valence.

Pre-conditioning rating. Participants were shown portraits and asked to indicate the likeability of the depicted persons. They were encouraged to give their subjective impression but at the same time to be as precise as possible. The 44 portraits were shown in random order one by one on the screen with the response scale described for Experiment 1. The rating phase always started with 5 additional anchor stimuli, portraits of which two had been evaluated positively, two had been evaluated negatively, and one had been evaluated neutrally in a previous study.

The individual pre-ratings were used to select for each participant the 10 pictures that he or she evaluated most neutrally as CSs for the conditioning phase. In a first step, pictures with ratings of 0 were selected. In case less than 10 were available, pictures with ratings of -1 and +1 were selected in a second step, and, if necessary, pictures with ratings of -2 and +2 in a third step. If more than 10 pictures were available in a single step, the selection was randomized. All participants rated at least 10 portraits in the range between -2 and +2. Of the

10 selected pictures, five were randomly assigned to a *positive evaluative response* condition and five to a *negative evaluative response* condition for the subsequent conditioning phase.

Conditioning phase. The conditioning phase consisted of four blocks in which only positive evaluative responses were given and four blocks in which only negative evaluative responses were given. The blocks were presented in alternating order. It was counterbalanced across participants whether the starting block was positive or negative. In each block, all five pictures that were assigned to the positive or negative evaluative response condition, respectively, were presented twice as CSs. Within a block, the pictures were shown in random order. Altogether, each CS was presented eight times in the conditioning phase.

Each of the eight blocks started with an instruction slide that informed the participant that he/she would see a number of portraits. At the beginning of each positive evaluative response block, the instruction further explained that the task would be to speak out loudly the word “sympathisch” (“likeable”) during the presentation of each face; At the beginning of each negative evaluative response block, it explained that the task would be to speak out the word “unsympathisch” (“dislikeable”). Participants were asked to give these responses as soon as a small grey square appeared on the face. The use of a blocked structure made further cues to indicate which response should be given unnecessary. Avoiding such cues, precludes the alternative explanation that EC effects found with this procedure are due to an association between the CS and the cue.

Each trial started with the presentation of the face slightly above the center of the screen. To focus participants’ attention to the stimuli on the screen, they could give their response only after the small (approximately 5 mm by 5 mm) grey square appeared on a random location in the area between the mouth and the forehead of the depicted person. It was randomly determined whether the square appeared after 1000 or 1400 ms. Face and square remained on the screen for 1500 ms during which the participant had time to give his or her response. After each trial, there was an inter-stimulus interval of 3000 ms during which the experimenter coded whether the participant had responded correctly.

Affective Misattribution procedure. In the AMP procedure, the CSs were used as primes and were presented before Chinese ideographs, which had to be evaluated by the participants. Participants were told that in each trial they would see a portrait and a Chinese ideograph in rapid succession and that their task would be to indicate with a keypress whether they found the ideograph more or less visually pleasant than the average Chinese ideograph. As recommended by the authors of the AMP (Payne et al., 2005), participants were instructed to try their best not to let their judgment be biased by the portrait.

Every AMP trial started with the presentation of one of the CSs or a grey square as prime for 75 ms. Then, the screen was blank white for 125 ms. Following this, a randomly chosen Chinese ideograph was shown for 100 ms. After this, a pattern mask, consisting of black and white “visual noise” appeared which remained on the screen until the participant responded, or up to twenty seconds. The participant responded by pressing one of two marked keys (right key, “L”, for the response “pleasant”; left key, “D”, for the response “unpleasant”). The inter-trial-interval was 800 ms. During one AMP cycle, all five positive CSs, all five negative CSs, and five grey squares were shown in combination with a randomly chosen ideograph. To compromise for the low number of AMP trials, participants completed two AMP cycles. Trials within a block were presented in random order.

Results and Discussion

For the three prime types (CS_{pos}, CS_{neg}, baseline) separately, the ratio of positive responses to all responses was calculated. The ratios were compared using a one-factorial repeated measures ANOVA. The response ratios differed between conditions, $F(2,72) = 4.19$, $MSE = 0.03$, $p < .05$, $\eta^2_{partial} = .10$. A contrast analysis showed that the ratio of positive responses in the condition CS_{pos} ($M = 0.62$, $SD = 0.20$) was not significantly different from the ratio of positive responses in the baseline condition (*M* = 0.63, *SD* = 0.16), $F < 1$. The mean of these two conditions, however, differed significantly from the condition CS_{neg} (*M* = 0.52, *SD* = 0.20), $F(1,36) = 8.14$, $MSE = 0.05$, $p < .01$, $\eta^2_{partial} = .18$.

This experiment showed that pairing neutral stimuli with evaluative responses leads to a valence change in neutral stimuli as measured with the AMP. This EC effect was visible only in the difference between the negative CSs from both the positive CSs and the baseline condition. The baseline itself, however, was slightly elevated above the midpoint of the scale, which is not an uncommon finding with this paradigm (Payne et al., 2005; Payne, McClernon, & Dobbins, 2007). A possible explanation might be that most participants had a general liking for the Chinese ideographs. The interpretation that the effect is entirely due to the negative condition can therefore not be made.

The EC effect found in this experiment cannot be due to a CS-US association because no stimulus except for the CSs and the grey square (which was identical in positive and negative trials) was presented in the conditioning trials. As with the AMP an implicit measure of valence was used, it is unlikely that the found effects are due to demand compliance. This experiment therefore provides further evidence for a genuine valence change due to the learning of a CS-ER link. Furthermore, this experiment suggests that this effect can be generalized to cases in which no US is present and the CSs are paired with evaluative responses only.

General Discussion

Three experiments were reported that suggest that EC effects resulting from a procedure in which evaluative responses are given are primarily based on the formation of CS-ER associations. In Experiment 1, an EC effect resulted from a procedure in which CS-US pairs were presented, which participants had to evaluate. It was demonstrated with a US revaluation procedure that this effect was based on learning a CS-ER link. This result concurs with the result obtained by Baeyens and colleagues (1998) with likeable and dislikeable tastes as USs. Experiment 2 was a replication of Experiment 1 without the evaluative responses during the conditioning phase. While the affective priming data from this experiment were inconclusive, the rating data were in line with a CS-US interpretation. This finding concurs with findings from Walther and colleagues (2009) and Baeyens and colleagues (1992) and suggests that the crucial difference between the experiments that do find CS-ER based EC and the experiments that do not, consists in the expression of evaluative responses during the conditioning phase. Although this specific explanation has to be made with caution, this does not question the general conclusion that the EC effect that we found in Experiment 1 was due to CS-ER learning. In Experiment 3 it was shown that the valence of a CS changes also if it is paired only with an evaluative response and with no US.

Taken together, the results suggest that EC effects can be based on CS-ER links if evaluative responses during conditioning are given – as it was the case in Experiments 1 and 3. In these cases, storing the evaluative response might be a particularly adaptive or economical process, as it prepares the immediate activation of an evaluative behaviour when the stimulus occurs again. If no such evaluative responses are given, but stimulus-stimulus contingencies are available, EC effects seem to be rather based on CS-US associations. We thus think that the valence of a neutral stimulus can be changed both by linking it to a valent stimulus or by linking it to an evaluative response. Although more speculative, the absence or presence of evaluative responses might explain why evidence for CS-ER associations was found in previous studies using tastes as stimuli (Baeyens et al., 1998), but not in those using pictures as stimuli (Baeyens et al., 1992; Walther et al., 2009).

The finding that the pairing of a stimulus and an evaluative response can lead to a valence change in the stimulus is of practical and theoretical importance. (1) On the practical side, it leads to the prediction of valence changes in situations in which only an evaluative response is combined with a stimulus, for example, if a person merely states that he or she likes (or dislikes) a present or a person, in spite of genuinely feeling nothing (or even the opposite). The present results suggest that such statements that may have their roots in a tendency to respond in a socially desirable fashion might actually change the genuine liking in the direction of the stated liking. (2) On the theoretical side, the results point out a possible process that can lead to an evaluative change that differs from the process of mentally linking the neutral stimulus with a valent stimulus, which is usually assumed to underlie EC effects.

The role of CS-ER contingency learning as basis for acquiring a new attitude can be related to a number of findings from learning, cognitive, and social psychology. First, in the domain of classical animal conditioning, CS-US associations are typically assumed to underlie first-order conditioning, while second-order conditioning has repeatedly been shown to be rather based on CS-UR associations (e.g. Holland & Resorla, 1975). In this sense, the effects reported here seem to be more similar to second- than to first-order classical conditioning. Indeed, EC has been argued to be more similar to second- than to first-order conditioning, mainly because the valence of the stimuli used is typically acquired rather than innate (Baeyens, Eelen, Van den Bergh, & Crombez, 1992). Arguably, a parallel between the studies reported here and those on second-order classical conditioning is that in both cases the evaluative response is not triggered unconditionally by a US, but rather needs some effort or cognitive capacity to be produced. This could increase the probability that the response is associated to a co-occurring stimulus or it could – due to limited working memory capacity – undermine the formation of the competing association on the stimulus-stimulus level (cf. Holland, 1980).

In cognitive psychology, the binding of stimuli and task related responses based on incidental learning constitutes an established finding (Hommel, 1998; Logan, 1988; Rothermund, Wentura, & De Houwer, 2005). Other findings fit well with our conclusion that such stimulus-response learning might be relevant for the acquisition of likes and dislikes. In an earlier series of studies we found that EC effects were stronger if the CS-US pairs had to be evaluated during the conditioning phase compared to a condition in which participants had to make other judgments (Gast & Rothermund, in press). A possible explanation for this result is that only in the condition in which people evaluate stimuli, CS-ER associations are learned (possibly in addition to CS-US associations), which then produce or contribute to the EC effect. Similarly, research on approach and avoidance behaviour suggests that responses play an important role in the acquisition of likes and dislikes (Cacioppo, Priester, & Berntson, 1993; Kawakami, Phills, Steele, & Dovodio, 2007; Woud, Becker, & Rinck, 2008). For instance, in a study by Woud et al. (2008), previously neutral faces that were zoomed in with a pulling joystick-movement are evaluated more positively than faces that were zoomed out in a pushing joystick-movement. If one assumes that the joystick-movements are evaluative responses, this result can easily be explained with a CS-ER model of EC.

A terminological point that could be raised about the procedure in Experiment 3 is whether it should be seen as an EC effect. EC was defined as a change in liking due to the pairing of stimuli (De Houwer, 2007). In Experiment 3, however the CSs were not paired with other stimuli but with an evaluative response. Whether or not such a procedure should be called EC is unclear. As it includes at least two events (the CS and the response) it cannot be a variant of single event learning like habituation or mere exposure. Also the term operant evaluative conditioning (Woud et al., 2008) seems not to fit well to our procedure, because *operant* conditioning crucially depends on whether the *effect* of the response is positive or negative and not on whether the response itself is positive or negative. However the procedure might be called, we consider it relevant for EC research because it enabled us to single out a process that might play a role in standard EC procedures but is there confounded with the process of linking the CS with the US.

Another point that could be raised is that the evaluative responses given by the participants are in some respect also stimuli. After all, they have sensory properties. If a person says “likeable”, the person hears him- or herself saying “likeable”. It could be argued that the auditory stimulus “likeable” acts as a US that can later be activated by the CS and then triggers an evaluative response. Following this argument, even a valence change in a stimulus that is only paired with an evaluative response might be based on a CS-US link. In principle, one could try to reduce the sensory component of the evaluative response, for example by preventing participants from hearing their own responses. A complete elimination of sensory feedback on evaluative responses, however, (if for example evaluative responses were given on a keyboard without labels or feedback) would render the responses meaningless.

The question what distinguishes a stimulus from a response is general and we can only treat it tentatively here. No clear line separates responding from perception (Prinz, 1997). Evaluative responses are complex and can cause sensations, while some stimuli elicit distinct responses. The conceptual distinction between stimuli and (evaluative) responses is nevertheless theoretically important and can possibly be made on the basis of their primary feature (while other aspects can be caused by this feature). A stimulus primarily has sensory content while a behavioural component might be caused by it. A response primarily has a behavioural component (broadly defined) while sensations might be caused by it.

The current research shows that the co-occurrence of evaluative responses with stimuli influences the later evaluation of the stimuli and it suggests that this is due to a link that is learned between the stimulus and the evaluative response. Such a process might play a role in evaluative conditioning contexts in which different stimuli co-occur, but also in situations in which the stimulus does not co-occur with another (valent) stimulus, but only with an evaluative response. It might thus prove to be a process that is highly relevant for the development of new likes and dislikes.

References

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1992). The content of learning in human evaluative conditioning: Acquired valence is sensitive to US-revaluation. *Learning and Motivation, 23*, 200-224.

Baeyens, F., Vanhouche, W., Crombez, G., & Eelen, P. (1998). Human evaluative flavor-flavor conditioning is not sensitive to post-acquisition US-inflation. *Psychologica Belgica, 38*, 83-108.

Bargh, J. A. Chaiken, S., Raymond, P., & Hymes, C. (1996). The automatic evaluation effect: Unconditional automatic attitude activation with a pronunciation task. *Journal of Experimental and Social Psychology*, *32*, 104-128.

Berridge, K. C. (2000). Measuring hedonic impact in animals and infants: Microstructure of affective taste reactivity patterns. *Neuroscience and Biobehavioral Reviews, 24*, 173–198.

Brogden, W. J. (1939). Sensory pre-conditioning. *Journal of Experimental Psychology, 25*, 323-332.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology, 65*, 5-17.

Corneille, O., Yzerbyt, V. Y., Pleyers, G., & Mussweiler, T. (2009). Beyond awareness and resources: Evaluative conditioning may be sensitive to processing goals. *Journal of Experimental Social Psychology, 45*, 279-282.

De Houwer, J. (2007). A conceptual and theoretical analysis of evaluative conditioning. *The Spanish Journal of Psychology, 10*, 230-241.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*, 853-869.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175-191.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50*, 229-238.

Fulcher, E. P. (2001) Neurons with attitude: A connectionist account of evaluative learning. In S. Moore & M. Oaksford (Eds.), *Emotional cognition: From brain to behaviour*. (pp. 74-109). Amsterdam: John Benjamin Publishing.

Fulcher, E. P., & Cocks, R. P. (1997). Dissociative storage systems in human evaluative conditioning. *Behaviour Research and Therapy*, *35*, 1-10.

Gast, A. & De Houwer, J. (2010). *Evaluative Conditioning Effects Can Be Based on Inferred Pairings*. Manuscript submitted for publication.

Gast, A., & Rothermund, K. (2010). When old and frail is not the same. Dissociating category and stimulus effects in four implicit attitude measurement methods. *Quarterly Journal of Experimental Psychology*, *63*, 479-498.

Gast, A., & Rothermund, K. (2011). What you see is what will change: Evaluative conditioning effects depend on a focus on valence. *Cognition and Emotion*, *25*, 89-110.

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin*, *132*, 692-731.

Gawronski, B., Walther, E., & Blank, H. (2005). Cognitive consistency and the formation of interpersonal attitudes: Cognitive balance affects the encoding of social information. *Journal of Experimental Social Psychology, 41*, 618-626.

Gregg, A. P., Seibt, B., & Banaji, M. R. Easier done than undone. Asymmetry in the malleability of implicit preferences. *Journal of Personality and Social Psychology, 90*, 1-20.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*, 1464.

Hall, G. (2002). Associative structures in Pavlovian and instrumental conditioning. In C. R. Gallistel (Ed.), *Stevens' handbook of experimental psychology* (3rd ed., Vol. 3, pp. 1-45). New York: Wiley.

Hammerl, M., & Grabitz, H.-J. (1996). Human evaluative conditioning without experiencing a valued event. *Learning and Motivation, 27*, 278-293.

Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (2002). Expectancy-learning and evaluative learning in human classical conditioning: affective priming as an indirect and unobtrusive measure of conditioned stimulus valence. *Behaviour Research and Therapy, 40*, 217-234.

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136*, 390-421.

Holland. P. C. (1980). Second-order conditioning with and without unconditioned stimulus presentation. *Journal of Experimental Psychology: Animal Behavior Processes, 6*, 238-250.

Holland, P. C. & Rescorla, R. A. (1975). The effect of two ways of devaluing the unconditioned stimulus after first- and second-order appetitive conditioning. *Journal of Experimental Psychology: Animal Behavior Processes*, *1*, 355-363.

Hommel, B. (1998). Event files: Evidence for automatic integration of stimulus-response episodes. *Visual Cognition, 5*, 183-216.

Kawakami, K., Phills, C. E., Steele, J. R., & Dovidio, J. F. (2007). (Close) Distance makes the heart grow fonder: Improving implicit racial attitudes and interracial interactions through approach behaviors. *Journal of Personality and Social Psychology, 92,* 957-971.

Konorski, J. (1948). *Conditioned reflexes and neuron organization.* Cambridge: Cambridge University Press.

Levey, A. B. & Martin, I. (1987). Evaluative conditioning. A case for hedonic transfer. In H. J. Eysenck & I. Martin (Eds.), *Theoretical foundations of behaviour therapy*. (pp. 113-132). New York: Plenum Press.

Logan, G. D. (1988). Toward an instance theory of automatization. *Psychological Review, 95*, 492-527.

Lovibond, P. F., & Shanks, D. R. (2002). The role of awareness in Pavlovian conditioning: Empirical evidence and theoretical implications. *Journal of Experimental Psychology: Animal Behavior Processes, 28*, 3-26.

Martin, I., & Levey, A. B. (1978). Evaluative conditioning. *Advances in Behaviour Research and Therapy, 1*, 57-102.

Maxwell, S. E., & Delaney, H. D. (1990). *Designing experiments and analyzing data: A model comparison perspective*. Belmont, CA US: Wadsworth/Thomson Learning.

Minear, M., & Park, D. C. (2004). A lifespan database of adult facial stimuli. *Behavior Research Methods, Instruments, & Computers, 36*, 630-633.

Mitchell, C. J., De Houwer, J., & Lovibond, P., F. (2009). The propositional nature of human associative learning. *Behavioral and Brain Sciences, 32*, 183-198.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, Cognition, and Awareness: Affective Priming With Optimal and Suboptimal Stimulus Exposures. *Journal of Personality and Social Psychology, 64*, 723-739.

Payne, B. K. (n.d.). Research Materials. *Pictographs*. Retrieved January 23, 2009, from http://www.unc.edu/~bkpayne/materials.html

Field Code Changed

Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89*, 277-293.

Payne, B. K., McClernon, J. F., & Dobbins, I. G. (2007). Automatic affective responses to smoking cues. *Experimental and Clinical Psychopharmacology, 15*, 400-409.

Prestwich, A., Perugini, M., Hurling, R., & Richetin, J. (2010). Using the self to change implicit attitudes. *European Journal of Social Psychology*, *40*, 61-71.

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology, 9*, 129-154.

Rescorla, R. A. (1973). Effect of US habituation following conditioning. *Journal of Comparative and Physiological Psychology, 82*, 137-143.

Rescorla, R. A., & Holland, P. C. (1982). Behavioral studies of associative learning in animals. *Annual Review of Psychology, 33*, 265-308.

Rothermund, K., Wentura, D., & De Houwer, J. (2005). Retrieval of incidental stimulus-response associations as a source of negative priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 482-495.

Spruyt, A., De Houwer, J., Hermans, D., & Eelen, P. (2007). Affective priming of nonaffective semantic categorization responses. *Experimental Psychology, 54*, 44-53.

Spruyt, A., De Houwer, J., & Hermans, D. (2009). Modulation of automatic semantic priming by feature-specific attention allocation. *Journal of Memory and Language, 61*, 37-54.

Walther, E. (2002). Guilty by mere association: Evaluative conditioning and the spreading attitude effect. *Journal of Personality and Social Psychology, 82*, 919-934.

Walther, E., Gawronski, G., Blank, H., & Langer, T. (2009). Changing likes and dislikes through the back door, *Cognition and Emotion, 23*, 889-917.

Woud, M. L., Becker, E. S., & Rinck, M. (2008). Implicit evaluation bias induced by approach and avoidance. *Cognition and Emotion*, *22*, 1187-1197.

Zajonc, R.B. (1980). Feeling and Thinking. Preferences Need No Inferences. *American Psychologist, 35,* 151-175.

Zuckerman, M., Klorman, R., Larrance, D.T., & Spiegel, N. H (1981). Facial, Autonomic, and Subjective Components of Emotion: The Facial Feedback Hypothesis Versus the Externalizer-Internalizer Distinction. *Journal of Personality and Social Psychology, 41*, 929-944.

Figure 1. EC effects as measured with affective priming for the conditions congruent and incongruent US revaluation in Experiment 1. The EC effects are calculated as the difference between the evaluative score for CS_{pos} minus the evaluative score for CS_{neg}. The evaluative score for each CS is calculated as mean RT in ms on positive targets minus mean RT in ms on negative targets. Error bars represent standard errors for the EC effect in a condition.

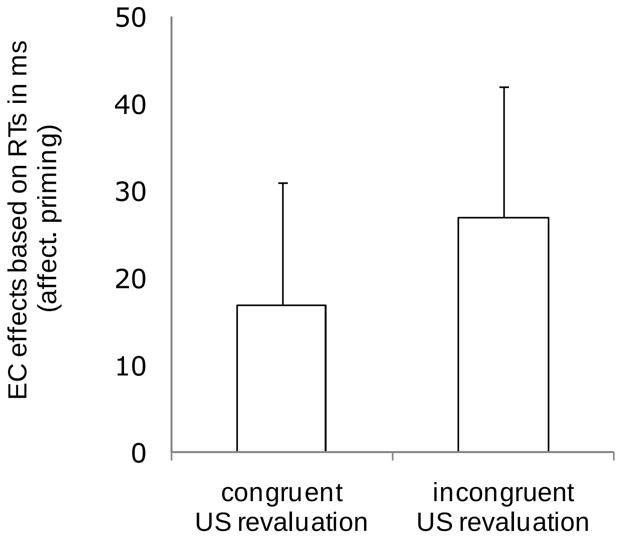

Figure 2. EC effects based on CS ratings (ratings for CS_{pos} minus ratings for CS_{neg}) for the congruent and incongruent US revaluation conditions for Experiments 1 (with evaluative responses) and 2 (without evaluative responses). Error bars represent standard errors for the EC effect in a condition.

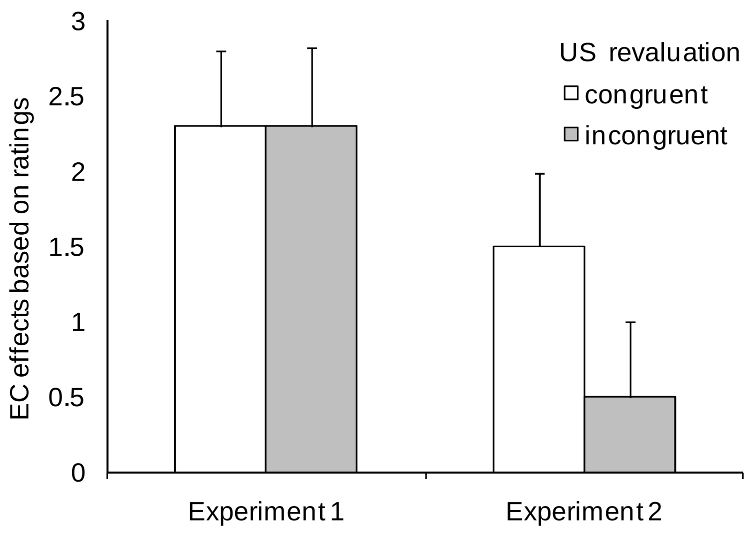

Table 1. Mean Implicit Evaluative Scores and Standard Deviations (in Brackets) of USs and CSs in the Conditions of Original US Valence and US Revaluation in Experiments 1 (USs) and 2 (USs and CSs) in Ms.

			Experiment 1		Experiment 2	
			revaluation		revaluation	
			congruent	incongruent	congruent	incongruent
USs	original US valence	positive	44 (72)	9 (82)	31 (57)	21 (45)
		negative	25 (80)	24 (82)	-3 (56)	-6 (53)
CSs	original US valence	positive			8 (58)	19 (48)
		negative			12 (62)	14 (57)

Table 2. Mean Ratings and Standard Deviations (in Brackets) of USs and CSs in the Conditions of Original US Valence and US Revaluation in Experiments 1 and 2.

			Experiment 1		Experiment 2	
			revaluation		revaluation	
			congruent	incongruent	congruent	incongruent
USs	original US valence	positive	6.0 (2.8)	2.1 (3.3)	5.2 (2.5)	1.8 (3.7)
		negative	-6.3 (2.3)	-3.6 (3.1)	-4.7 (3.3)	-3.3 (3.3)
CSs	original US valence	positive	2.1 (2.5)	1.7 (2.9)	1.7 (2.9)	1.7 (2.3)
		negative	-0.2 (2.7)	-0.6 (2.7)	0.1 (2.8)	1.2 (2.9)