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Changing CS features alters evaluative responses in evaluative conditioning

Christian Unkelbach *, Christoph Stahl, Sabine Förderer

Universität zu Köln, Germany

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ABSTRACT

Evaluative conditioning (EC) refers to changes in people's evaluative responses toward initially neutral stimuli (CSs) by mere spatial and temporal contiguity with other positive or negative stimuli (USs). We investigate whether changing CS features from conditioning to evaluation also changes people's evaluative response toward these CSs. We used computer-generated male faces as CSs and paired them with other positively or negatively evaluated faces. When participants evaluated the CS faces, they either appeared unchanged, with glasses, with beards, or glasses and beards. Unchanged faces showed a clear conditioning effect, while all other face versions showed no significant conditioning effects. The conditioning effect also depended on participants' awareness of a CS's respective US. These results mirror configural explanations of stimulus generalization in classical conditioning, with implications for EC as explanation for attitude acquisition and learning of likes and dislikes in everyday life.

Basic learning processes provide parsimonious and elegant explanations for many psychological phenomena and offer a fascinating research area. One of the most prominent topics within this area is evaluative conditioning (EC). EC posits that if neutral stimuli (CSs) appear repeatedly in spatial and temporal contiguity with positive or negative stimuli (USs), participants afterwards evaluate the initially neutral stimuli in accordance with US valence (Levey & Martin, 1975). This change in participants' evaluative response toward the CSs may explain phenomena in several general areas such as attitude acquisition (e.g., Olson & Fazio, 2001; Walther, Weil, & Düsing, 2011) and advertizing (Sweldens, van Osselaer, & Janiszewski, 2010; Walther & Grigoriadis, 2004), and in some more specific areas, such as the "kill-the-messenger" effect; that is, when bearers of good or bad news take on the valence of their message (i.e., the valence of the information they communicate; Skowronski, Carlston, Mae, & Crawford, 1998).

However, when EC is used as an explanation in these areas, and in particular for social psychological phenomena (see Walther, Nagengast, & Trasselli, 2005), there is one silent but crucial assumption: valence must be conditioned to an abstract memory representation of that stimulus, and not to a specific representation stored in memory (e.g., the concept of the brand NIKE vs. a specific representation of the letter combination *N-i-k-e*). In other words, if people start to like or dislike a person due to EC procedures, their evaluative responses should generalize from a given situation and perceptual impression to all further encounters with that person, even when specific features of that person's appearance change. The present research investigates this question of whether evaluative responses to CSs (i.e., evaluative ratings) remain stable when CSs change their appearance from conditioning to CS evaluation.

* Corresponding author at: Department Psychologie, Universität zu Köln, 50969 Cologne, Germany.
E-mail address: christian.unkelbach@uni-koeln.de (C. Unkelbach).

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Let us illustrate this problem with a typical EC paradigm in social psychology (e.g., Fiedler & Unkelbach, 2010; Walther, 2002): in a pre-test phase, participants rate a large set of faces. In a conditioning phase, the most positively and negatively rated faces are used as USs, and the most neutral rated faces are used as CSs. In a post-test phase, CS faces are rated again; the typical result is a change in evaluative ratings in the direction of the respective US valence. In virtually all experiments, identical CSs are used in the pre-test, in the conditioning phase, and in the post-test; for example, the exact same head-and-shoulders pictures (e.g., Walther, 2002) or the exact same geometrical shapes (e.g., Förderer & Unkelbach, 2011, Exp. 4). However, in real-life situations, stimuli hardly ever remain identical, but they change their appearances. This already happens when perceivers' visual angles change from one encounter with a stimulus to the next. Given general object and stimulus constancy in humans (e.g., Piaget & Inhelder, 1987), this poses less of a problem for EC effects in humans, as even pigeons generalize from the original CS to its presentation at different visual angles (e.g., when stimuli are rotated in depth; Wasserman et al., 1996).

More problematic are physical changes in CS appearance. For example, an observer might see an unknown, neutral person (i.e., the CS) wearing contact lenses appearing together with a likeable person (i.e., the US). EC predicts that the observer should like the CS more at the next encounter. What happens, however, if the CS wears glasses at the next encounter, or if a male person does not shave for a couple of days and appears again with a stubby chin? Will the person be liked regardless of glasses and/or beard? Does the evaluative response change gradually as a function of similarity between CS appearance at learning and CS appearance at judgment? Or is there a threshold, such that the CS activates the evaluative response in an all-or-none fashion? Although these are important questions for theories and applications of EC, to the best of our knowledge, they have been neglected in EC research.

Pavlovian conditioning, on the other hand, offers some theoretical insights into this problem of CS identity (e.g., Stevens, 1951; Terrace, 2010). In Pavlovian or classical conditioning, there is early evidence for gradients in conditioning (e.g., Spence, 1937), as evinced in discrimination learning. For example, when the hue of a conditioned color changes (e.g., from deep blue to light blue), or when the shape of a conditioned shape changes (e.g., from quadratic to rectangular), animals show graded decreases in the strength of the conditioned response (e.g., Grice & Saltz, 1950), or their ability to discriminate between a reinforced but changed CS and a new stimulus (e.g., Harlow & Poch, 1945; Rescorla, 1976). These generalization decrements occur along various stimulus dimensions (Mednick & Freedman, 1960), and similar patterns are found in Pavlovian conditioning with humans (e.g., Laberge, 1961). For EC effects in humans, however, it is of greater interest to find out what happens when one or more CS features change.

Theoretical approaches for this problem of CS identity and CS representation in conditioning fall largely into two clusters; an elemental approach (e.g., Brandon & Wagner, 1998) and a configural approach (e.g., Pearce, 1987; see Harris, 2006, for an overview). Brandon and Wagner argued for specific cues that compose the CS in combination with the contextual background, while Pearce argued that each CS is represented holistically in a unique node. These two approaches correspond to the following problem when the CS is a face: is the conditioned evaluative response tied to features of the face (i.e., to specific cues or elements in a given context) or to the whole face depicted in the picture (i.e., to the configural representation). The feature model would predict a gradual decrease in the strength of the evaluative response, while the configural model would predict a threshold somewhere along the similarity dimension; either a CS passes or does not pass the threshold and activates the evaluative response.

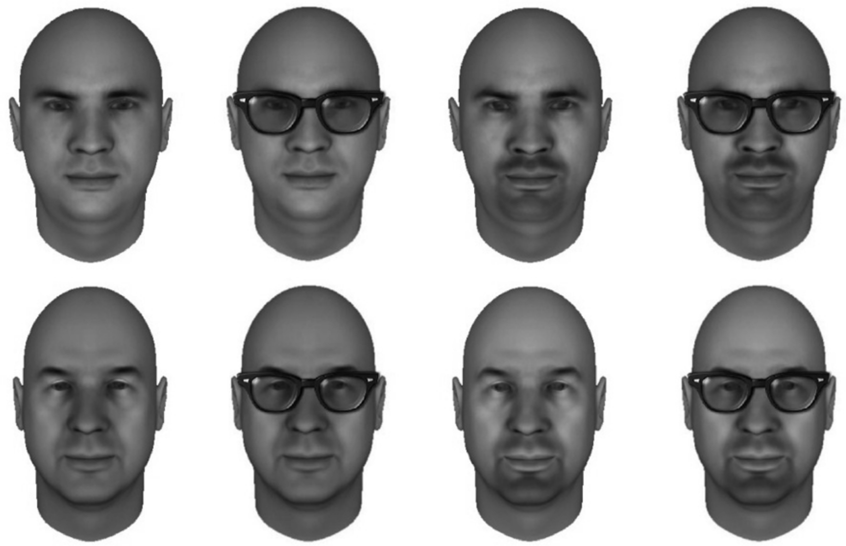
However, as EC does not follow the laws of Pavlovian conditioning in all respects (Baeyens & De Houwer, 1994; see also Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010), it is an intriguing question whether EC effects in the picture–picture paradigm with faces conform to an elemental or a configural approach. More specifically, when CS faces change from learning to test, for example, by wearing glasses or sporting a beard, does the evaluative response show a linear decrease with increases in features changed, or does it follow a threshold model? To investigate this question, the following experiment employs CSs that show naturally occurring variations from conditioning to evaluation.

The question of CS identity is tied into another issue in EC research, namely whether or not awareness of CS–US co-occurrences is necessary for EC effects to emerge (e.g., Fulcher & Hammerl, 2001; Pleyers, Corneille, Luminet, & Yzerbyt, 2007). If such awareness is necessary, then it must also be necessary to recognize a given CS face at the time of test, as this is the pre-condition for awareness of CS–US pairings. If awareness is also a sufficient condition for EC effects, CS changes should be of no consequence as long as participants recognize the CS as the stimulus paired with a given US.

The present experiment used a standard EC picture–picture paradigm with faces, in which initially neutral CS faces are presented repeatedly with likeable (US+) or non-likeable (US−) faces in a conditioning phase. The standard result is that the respective CS+ (CS−) faces are rated more likeable (non-likeable) in an evaluation phase. Here, we changed CS appearances from the conditioning phase to the evaluation phase in a meaningful manner; that is, we presented the to-be-rated CS faces either unchanged, with glasses, with beards, or with both. To do this, we used computer-generated faces that allowed equipping them with beards and glasses in a standardized fashion. All faces were male. Table 1 provides examples of the four face versions. Based on the theoretical considerations above, there are two possible outcomes: EC effects may show a linear decrease from unchanged CS faces to CS faces with glasses and beards; alternatively, EC effects may follow a threshold pattern, which would imply a steep drop in the strength of the effect somewhere along these four levels. We tested these hypotheses using planned contrasts. In addition, EC effects might depend on participants' ability to remember that a given CS was paired with a certain US in the conditioning phase, that is, participants' identity awareness (Stahl & Unkelbach, 2009; Stahl, Unkelbach, & Corneille, 2009). Thus, we also assessed participants' identity awareness and investigated EC effects as a function of identity awareness. Finally, as the CSs consisted of computer-generated faces, we present a pilot study

Table 1
Two examples from the eight computer-generated CS faces used in the experiments. Each face exists in the four versions as shown in the table.

unchanged	glasses	beard	glasses and beard



showing that people are able to discriminate these faces, and that discrimination ability follows the ordering of the changes as presented in Table 1.

Pilot study

We asked 60 participants who had just completed another experiment whether they were willing to engage in an additional face recognition task. The experiment was computer-based; a Visual Basic program controlled stimulus presentation and instructions and recorded the dependent variables. Instructions informed participants that they would see a face and then would have to recognize and select this face from a set of four faces. A trial was set up as follows: the program presented an unchanged target face for 2 s; after a delay of 3 s, a test display with four faces appeared for participants to choose from. All four faces in a given test display were from the same face versions; thus, they all appeared either unchanged, with glasses, with beards, or with beards and glasses (see Table 1 for examples). The target face and the three foils were presented in a two-by-two matrix. The position of the target face was determined randomly and the foils were also selected randomly from the remaining faces. Participants selected a face by clicking on one of the four faces. Participants could only proceed by clicking on one of the faces. Each face served as target four times, once for each type of test display (i.e., unchanged faces, faces with glasses, with beard, or with both). The program recorded decisions and latencies. After completing the trials, participants were thanked and debriefed.

We deleted latencies smaller than 300 ms and the corresponding decisions and set latencies larger than 3000 ms to 3000. Correct responses were coded as “1” and incorrect responses as “0”. Table 2 presents the mean correct decisions and mean latencies as a function of degree of variation between target face at presentation and target face at recognition. We had no a priori reason to rank-order faces with beards and faces with glasses (i.e., one feature changed), but Table 2 shows that beards make recognition slower and more difficult compared to glasses.

These data show two important points. First, participants were able to discriminate the target face, even when glasses, a beard, or both were added, within the set of these quite similar computer-generated faces. Second, recognition became more difficult in a linear fashion from unchanged faces, to faces with glasses, to faces with beards, to faces with glasses and beards. The recognition rate dropped from about 95% to 81%, and the decision time increased from about 2 s to 2.5 s. For

Table 2
Mean correct recognition rates and mean response latencies in ms in the pre-test for the four CS face versions for all eight CS faces ($n = 60$; standard deviations in parentheses).

	Unchanged	Glasses	Beard	Glasses and beard
Recognition rate	.946 (.087)	.881 (.141)	.822 (.144)	.804 (.148)
Latencies	2046 (374)	2341 (314)	2449 (314)	2581 (283)

both the recognition rate and latencies, all comparisons between the change levels were significant (all $Fs > 13$, $ps < .001$), with one exception: the recognition rate drop from faces with beards to faces with glasses and beards was not significant. Based on these data, we assumed a decline in recognition from unchanged CS faces to CS faces with glasses and beards for the main experiment. The ordering in Table 1 was at first arbitrary for glasses and beards, as both represent one changed feature, but their order in fact anticipated the pilot data.

Main experiment – method

Design and participants. One hundred and twenty-one attendees at a student cafeteria (77 female, 44 male, $M_{age} = 22.69$, $SD = 2.99$) participated for payment of 5 Euros.[1] They were randomly assigned to one of the four CS conditions (*unchanged*, *glasses*, *beards*, and *glasses and beards*). CS+ and CS− faces were paired with likeable or non-likeable US faces within participants.

Materials. The eight faces from the pilot study served as CSs (see Table 1 for examples). US faces were 58 black and white head and shoulder pictures of males that varied naturally in likeability and had been used successfully as USs in previous EC studies (e.g., Fiedler & Unkelbach, 2010; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2011). A Visual Basic computer program controlled presentation of CS and US faces and instructions and recorded the dependent variables.

Procedure. The experiment was conducted in a room adjacent to a student cafeteria. Experimenters recruited participants from this cafeteria, led them to the room, seated them at a table with a laptop computer and started the computer program. Instructions informed participants that they would observe and rate a large number of faces. If participants had no further questions, the selection phase started.

The program presented each possible US face in the middle of the screen with a scroll bar beneath; the endpoints of the bar were labeled “very likeable” and “non-likeable”. Initially, the cursor was always in the middle of the scroll bar. Participants could adjust the cursor on the bar using the mouse and could proceed at their own pace with an available “continue” button. Presentation order was randomized anew for each participant. For each face, the program converted the cursor position to a value between +100 (highest possible likeability score) and −100 (lowest possible likeability score). Based on these ratings, the program selected the four most likeable and four most non-likeable faces as US+ faces and US− faces, respectively. The program then randomly assigned eight CS faces to these US faces and the conditioning phase started.

Each unchanged CS face was paired eight times with its assigned US face, resulting in 64 conditioning trials. The conditioning sequence was fully randomized. For each trial, a given CS face appeared for 1 s, followed by the respective US face appearing below for 2.5 s with the CS still on the screen. After a 1.5 s break, the next trial started. After the 64 conditioning trials, participants provided evaluative ratings of the CS faces. Depending on condition, the program presented all CS faces in the rating phase either unchanged, with glasses, with beards, or with glasses and beards. A given CS face would appear in the middle of the screen with a radio-button scale ranging from 1 (not likeable) to 8 (very likeable). Participants made their evaluation by clicking on a button; after the rating, they proceeded by clicking on a “continue” button. The eight CS faces were presented in random order.

Finally, participants performed a recognition test based on Stahl and Unkelbach (2009) to assess their memory for the pairings of a given CS with its US. Each CS face appeared in the center of the screen with four US faces matched to its conditioned valence in each corner of the screen; that is, a CS+ face appeared with four positive US faces and a CS− face appeared with four negative US faces. One face was the correct one and the other three were foils. CS faces appeared according to CS condition and thus were identical to those used in the CS evaluation (i.e., unchanged, with glasses, with beards, or with beards and glasses), as the interesting question is whether participants could recognize the face while evaluating it. Participants clicked on the face they believed the CS face had been paired with. After a break of 1 s, the next CS face appeared with four US faces in the screen corners.

Upon completing the recognition test, experimenters thanked, paid, and thoroughly debriefed participants. Experimental sessions lasted between 20 and 30 min (depending on individual speed) and up to five persons participated in parallel.

Results

First, we analyzed the initial evaluative ratings as a function of CS condition (unchanged, glasses, beards, glasses and beards) in a between-participants ANOVA. This analysis showed that CS changes influenced the overall ratings, $F(3, 117) = 3.95$, $p < .01$, independently from any conditioning effects. More specifically, contrasting faces with and without beards showed that CS faces with beards were overall rated less likeable ($M = 3.38$, $SD = 1.08$) than CS faces without beards ($M = 4.00$, $SD = 1.00$), $F(1, 117) = 10.84$, $p < .005$, $d = 0.61$. The comparison of faces with and without glasses showed no effect, $F < 1$, *ns*. Thus, participants liked the computer-generated faces less when they were presented with beards, but glasses did not influence likeability ratings.

[1] We collected the data in two phases: 61 people participated in the first, and 60 in the second phase. The second collection phase was prompted by reviewers’ comments that sample sizes were too small. Collection phase (first vs. second) as a factor had no main or interaction effects, and we report the experiment without this additional factor.

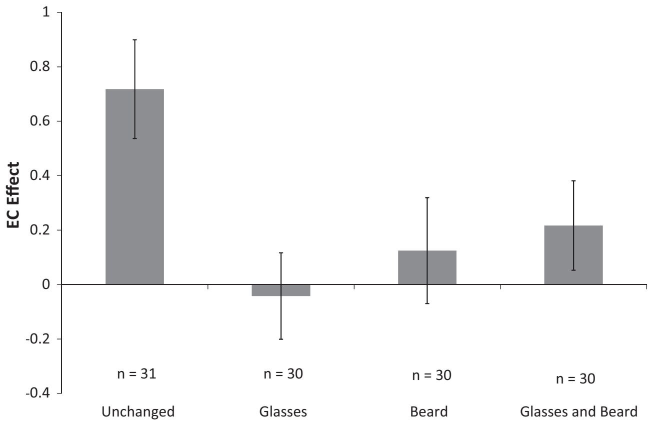


Fig. 1. Mean EC effects in the four CS conditions. Error bars represent standard errors of the means.

As this overall influence of beards on evaluative ratings could obscure the conditioning data pattern, we centered each participants' evaluative ratings around zero (Aiken & West, 1991). Accordingly, positive (negative) values indicate a relative increase (decrease) in evaluative ratings relative to participants' idiosyncratic rating mean, thereby correcting for the between-participants main effects of beards and glasses on the evaluative ratings of the CS faces. Then we computed the EC effect as the difference between the ratings of CS+ and CS− faces. This way, positive values indicate successful evaluative conditioning; as we only subtracted a constant, all effects were identical to the non-centered scores. Linear transformations do not change any statistical parameters, but they make the pattern of the means more intelligible.

Overall, we found a significant evaluative conditioning effect ($M = 0.26$, $SD = 1.00$), $t(120) = 2.85$, $p < .01$, $d = 0.52$. Participants judged the computer-generated faces paired with likeable male faces as more positive than faces paired with non-likable male faces. Of greater interest, however, is the EC effect across the four CS conditions. Fig. 1 displays the four means in the respective conditions. We analyzed these means with an ANOVA with CS condition as a between faces factor (*unchanged* vs. *glasses* vs. *beards* vs. *beards and glasses*). As the means suggest, this analysis showed an effect of CS condition on the EC effect, $F(3, 117) = 3.52$, $p < .05$.

As this CS condition effect has three degrees of freedom, we used planned contrasts to analyze this pattern further according to the hypotheses of a linear decrease (as predicted by an elemental approach) and a threshold (as predicted by a configural approach) of evaluative ratings. We coded the threshold contrast for the CS conditions with 3, −1, −1, and −1, for the *unchanged*, *glasses*, *beards*, and *beards and glasses* conditions, respectively.[2] As suggested by Fig. 1's means, this threshold contrast is significant, $F(1, 117) = 9.44$, $p < .005$, $d = 0.57$.

Alternatively, we coded the linear contrast for CS condition with 2, 1, −1 and −2, for the *unchanged*, *glasses*, *beards*, and *beards and glasses* conditions, respectively. This contrast yields only a non-significant trend, $F(1, 117) = 2.28$, $p = .135$, $d = 0.28$. Given that these contrasts are correlated, it is informative that one contrast is clearly significant and the other is not. Simple *t*-tests of the EC effect against zero in each condition further corroborate the threshold contrast; only the EC effect in the *unchanged* condition is significantly different from zero, $M = 0.72$, $SD = 1.01$; $t(30) = 3.96$, $p < .001$, $d = 1.45$, while all other means are not (*glasses* condition: $M = -0.04$, $SD = 0.87$; $t(29) = -0.26$, $p = .796$; *beard* condition: $M = 0.13$, $SD = 1.07$; $t(29) = 0.64$, $p = .526$; *glasses and beard* condition: $M = 0.217$, $SD = 0.90$; $t(29) = 1.32$, $p = .198$).

So far, the data indicated a threshold. Yet, based on recent evidence for the importance of higher-order processes in conditioning and EC in particular (Fiedler & Unkelbach, 2010; Mitchell, De Houwever, & Lovibond, 2009; Pleyers et al., 2007; Shanks, 2010), a crucial variable might be awareness of the contiguity between a given CS and the US with which it was paired (see Stahl & Unkelbach, 2009; Stahl et al., 2009). As CS recognition is a pre-condition for awareness of a specific CS–US contiguity at test, and as participants might be better able to recognize a given CS in the *unchanged* condition, awareness might be higher in that condition, which could result in stronger EC effects. In addition, participants might recognize that a CS has been paired with a given US, and base their judgment on their memory of US valence, without any conditioning proper (i.e., a demand effect; Hütter et al., 2011).

The data from the recognition test allowed us to investigate this hypothesis. Participants should show differential evaluative responses depending on whether or not they recognized the CS face as the one that was paired with a given US. We coded correct classifications in the recognition test (i.e., selecting the correct corresponding US face) as "1" and misclassifications as "0". The resulting mean ($M = .406$, $SD = 0.243$) reflected recognition performance at above-chance levels (i.e., above .25), $t(120) = 7.07$, $p < .001$. We analyzed participants' average recognition scores as a function of CS condition. This analysis

[2] Theoretically, a possible threshold could lie anywhere between the changed features along a similarity dimension; the present threshold contrast is simply a plausible test. The possible threshold alternatives between the *glasses* and *beards* conditions (contrast coded 1, 1, −1, −1) and between the *beards* and *glasses* and beards conditions (contrast coded 1, 1, 1, −3) are not supported empirically, *F*s < 1, *ns*.

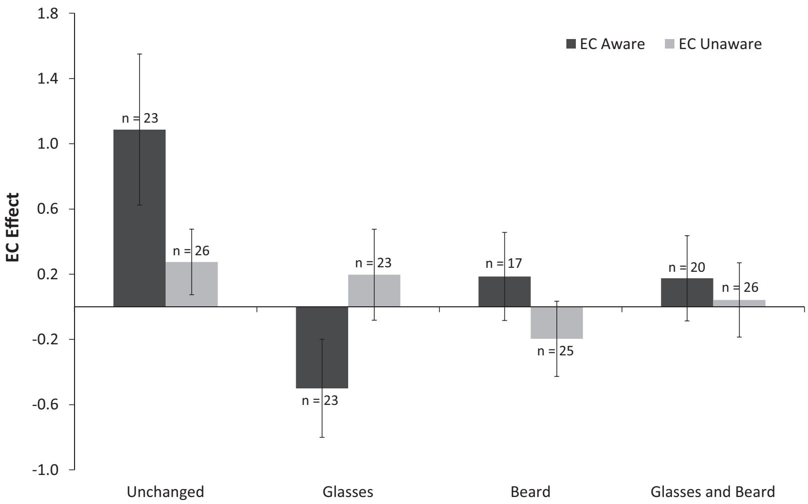


Fig. 2. Mean EC effects in the four CS conditions as a function of awareness of the CS–US pairings. Error bars represent standard errors of the means.

showed no effect at all, all *F*s < 1, *ns*. Recognition means did not vary systematically between conditions ($M_{\text{unchanged}} = .431$, $M_{\text{glasses}} = .429$, $M_{\text{beards}} = .346$, $M_{\text{glasses and beards}} = .417$) and participants did not differentially select the correct corresponding US faces based on the changes in the CS features.

However, as Pleyers et al. (2007) argued, analyses on the level of participants might be misleading, and thus, based on the methodology suggested by Pleyers et al., we calculated two level-of-stimulus based EC scores (based on the centered CS+ ratings minus CS− ratings; positive scores again reflect successful EC): the first score was based on ratings of CS faces for which participants were able to correctly select the corresponding US face. We labeled this score "EC aware". The second score was based on the CS faces for which participants were unable to correctly select the corresponding US face. We labeled this score "EC unaware".[3] As the computation of the EC score requires at least one "aware" CS+ and CS−, participants are only included in this analysis when they correctly remembered at least one CS–US relation from each valence; the same is true for the "EC unaware" score. Fig. 2 shows the corresponding mean aware and unaware EC scores as a function of CS condition.

We analyzed both scores with the same linear and threshold contrasts used for the overall score; the aware EC score showed no linear trend, $F(1, 79) = 1.01$, *ns*, but a clear threshold effect, $F(1, 79) = 8.40$, $p < .005$, $d = 0.65$; and similar to the overall EC score, the only significant EC effect was in the *unchanged* condition, $t(22) = 2.35$, $p < .05$, $d = 1.00$; none of the EC scores in the three other conditions was significantly different from zero, all *t*s < 1.67. The unaware EC score showed neither a linear trend, $F(1, 96) = 1.96$, $p = 0.170$, nor a threshold effect, $F(1, 96) = 1.68$, $p = .199$; none of the EC scores was significantly different from zero, all *t*s < 1.60. Thus, participants recognized a similar number of faces across conditions, but this did not lead to similar EC effects across conditions. EC effects also depended on unchanged CS features; we will discuss this dissociation in more detail below.

Discussion

We delineated a problem of concurrent EC research, namely: What is the stimulus to which an evaluative response is conditioned? If EC underlies attitude acquisition and learning of likes and dislikes in general, conditioned responses should not be restricted to specific perceptual instances of a CS, for example, a specific CS image, but to a more abstract representation of the CS in memory. The resulting questions are about the nature of this representation and the how and when of the activation of the conditioned response. We investigated this problem in an experiment that changed CS appearances from conditioning to rating, asking whether these CS changes alter participants' evaluative responses. Building on a social psychological background, we used faces as stimuli in a picture–picture paradigm and implemented the changes with meaningful and naturally occurring variations in faces, such as wearing glasses or growing a beard. Male computer-generated faces served as CSs, and we presented them with glasses, beards, or glasses and beards in the evaluation phase. In other words, we realized a situation that is common in the social world, in which a person's appearance does not remain constant, but changes over time.

[3] Stahl et al. (2009) introduced the distinction of participants' awareness of US identity vs. US valence to reconcile apparent discrepancies in the literature. The present design restricts the analysis to identity awareness; it does not allow distinguishing participants' valence awareness from participants inferences about the correct answer (i.e., "positive" or "negative") based on their evaluative response toward a given CS. Participants might infer that a CS was paired with a positive US, because they have a strong positive reaction toward the CS. On the other hand, US identity awareness is assessed within a given US valence (i.e., which one of the four positive/negative faces?), and hence, does not suffer from this problem.

Based on ideas from Pavlovian conditioning, we hypothesized that these changes might lead to a linear decrease in the strength of the evaluative response. This hypothesis corresponds to the ideas of an elemental approach (e.g., Brandon & Wagner, 1998). The alternative hypothesis was that these changes would lead to a steep drop in evaluative response strength when CS features changed, as the changed CS no longer activates the original CS's representation node. This corresponds to the prediction based on the configural approach (Pearce, 1987). The data showed clearly that changing the CS from learning to rating led to a steep drop in the evaluative response: the relative difference between the rated likeability of CS+ and CS− faces was only significant when faces were presented unchanged.

In addition, we performed analyses based on the comparison of faces for which participants did or did not show awareness of the pairing with their respective US faces (see Pleyers et al., 2007). If awareness is a necessary condition for EC effects, changes in CS appearances might impair awareness, which would also provide an explanation for the changes in the evaluative response when CS features change.

For CS faces that participants correctly recognized as being paired with a given US, the data still showed a threshold. In contrast, for CS faces that participants did not recognize as being paired with a given US, the data showed no support for a linear trend or a threshold model. We found no significant EC effects when participants could not correctly identify a given CS–US relation. This finding is in line with assumed higher-order cognitive processes in EC (e.g., De Houwer, 2009; Fiedler & Unkelbach, 2010; Mitchell et al., 2009). While there is also support for accounts which do not depend on awareness and higher-order cognition, but rather on pure association (e.g., Hütter et al., 2011; Olson & Fazio, 2002), the present data show that awareness of the CS–US relation is necessary for EC effects to emerge.

Yet, awareness of the CS–US relation as indexed by recognition rates at test seems not sufficient for EC effects. The overall recognition rate did not depend on the CS condition, while EC effects did. Participants recognized a similar number of CS–US relations in all conditions, but only in the unchanged condition did awareness of the relation lead to significant EC effects. Thus, EC effects depended not only on awareness per se, but also on unchanged CS features. Even when participants recognized the CS–US relation, their evaluative ratings showed no EC effects when CS features changed, showing that awareness of the CS–US relation is a necessary, but not sufficient condition. CSs only activated an evaluative response when participants remembered the CS–US relation and when CS features remained unchanged. Awareness alone is not able to explain the present data pattern.

Tentatively, this dissociation of EC effects and awareness as indexed by recognition rates has two implications. First, the present EC effects are not due to demand effects based on participants' memory. If this were the case, we should observe EC effects in all conditions in accordance with the recognition of CS–US relations. Thus, the present data set provides evidence that EC is a genuine phenomenon, and not a combination of memory and demand effects. Second, recognizing the CS and being aware of the CS–US relation is a pre-condition for elicitation of the conditioned evaluative response. Further, this evaluative response is only elicited by unchanged CS faces, thereby supporting a configural approach. In other words, participants must encode CS–US contiguity to such an extent that they are later able to remember the CS–US relation. Only given this sufficient encoding does an unchanged CS activate the respective evaluative response.

At this stage, however, it would be premature to fully dismiss an elemental approach in favor of a configural approach; more research is clearly necessary. The importance of showing that evaluative responses generalize is obvious – without this assumption, EC would lose much of its relevance as an explanatory construct. The present experiment started with an obvious choice for the acquisition of interpersonal attitudes, namely changing facial features that indeed might vary on a daily basis (i.e., glasses and beards). This choice follows from the often used picture–picture paradigm in social psychology using faces as CS and US. From a methodological perspective, however, there are other possibilities that will better allow us to investigate the underlying processes. Faces are important social stimuli, but to study CS changes from learning to evaluation, they are not optimally suited, as they do not easily allow for gradual changes. In addition, although participants could well discriminate between our computer-generated stimulus faces, as evinced in our pilot study, these faces have a high degree of similarity to start with (i.e., bald middle-aged men, cf. Table 1). Difficulties in discriminating these stimuli might have obscured a possible linear decline in the evaluative response. Other stimuli might be preferable. For example, abstract patterns such as random dot configurations, allow direct manipulation of the similarity between CSs presented at learning and at evaluation, thereby allowing more direct tests of generalization gradients. While we used evaluative ratings as a standard dependent variable, most research on generalization gradients in Pavlovian conditioning used discrimination learning as the dependent variable. Research in which participants select one of two stimuli as the more likeable (e.g., as in the present case, a conditioned and a new but neutral face) will provide a more powerful test compared to the standard rating condition for investigating generalization gradients in EC. The present data show that EC effects are largely diminished in the picture–picture paradigm when CSs change from conditioning to rating, but further research is necessary to determine if EC in general is better described and predicted by a configural, an elemental, or neither approach.

Conclusion

The present experiment investigated an important but so far neglected question in EC research: When CS features change from conditioning to test, does the evaluative response change as well? Empirically, the answer is clear cut – the strength of the evaluative response was weakened and no longer statistically significant when CS faces were changed in appearance. Theoretically, we suggested two possible explanations of these findings from Pavlovian conditioning – an elemental approach predicting a linear decline in response strength, and a configural approach predicting a threshold. The data supported a configural approach, and they also support the necessity of awareness of the CS–US relation for EC effects. Yet, the interpretation of the present findings is restricted to an ecologically valid but specific paradigm. Further experiments must address the question of generalizations across different versions of the same CS. Generalization gradients and their underlying mechanisms are of great importance if EC is to serve as an explanation for the acquisition of interpersonal attitudes, marketing preferences, and the learning of likes and dislikes in general.

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References

Aiken, L., & West, S. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA, US: Sage.
Baeyens, F., & De Houwer, J. (1994). Evaluative conditioning is a qualitatively distinct form of classical conditioning: A reply to Davey. *Behaviour Research and Therapy*, *33*, 825–831.
Brandon, S. E., & Wagner, A. R. (1998). Occasion setting: Influences of conditioned emotional responses and configural cues. In N. A. Schmajuk, & P. C. Holland (Eds.), *Occasion setting: Associative learning and cognition in animals* (pp. 343–382). Washington, DC: American Psychological Association.
De Houwer, J. (2009). The propositional approach to associative learning as an alternative for association formation models. *Learning & Behavior*, *37*, 1–20.
Fiedler, K., & Unkelbach, C. (2010). Evaluative conditioning depends on higher-order encoding processes. *Cognition and Emotion*, *25*, 639–656.
Förderer, S., & Unkelbach, C. (2011). Beyond evaluative conditioning! Evidence for transfer of non-evaluative attributes. *Social Psychological and Personality Science*, *2*, 479–486.
Fulcher, E. P., & Hammerl, M. (2001). When all is revealed: A dissociation between evaluative learning and contingency awareness. *Consciousness and Cognition*, *10*, 524–549.
Grice, G., & Saltz, E. (1950). The generalization of an instrumental response to stimuli varying in the size dimension. *Journal of Experimental Psychology*, *40*, 702–708.
Harlow, H. F., & Poch, S. S. (1945). Discrimination generalization by macaque monkeys to unidimensional and multidimensional stimuli. *Journal of Comparative Psychology*, *38*, 353–365.
Harris, J. A. (2006). Elemental representations of stimuli in associative learning. *Psychological Review*, *113*, 584–605.
Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin*, *136*, 390–421.
Hütter, M., Sweldens, S., Stahl, C., Unkelbach, C., & Klauer, K. C. (2011). Dissociating contingency awareness and conditioned attitudes: Evidence of contingency-unaware evaluative conditioning. *Journal of Experimental Psychology: General*, http://dx.doi.org/10.1037/a0026477
Laberge, D. (1961). Generalization gradients in a discrimination situation. *Journal of Experimental Psychology*, *62*, 88–94.
Levey, A. B., & Martin, I. (1975). Classical conditioning of human 'evaluative' responses. *Behaviour Research and Therapy*, *13*, 221–226.
Mednick, S. A., & Freedman, J. L. (1960). Stimulus generalization. *Psychological Bulletin*, *57*, 169–200.
Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). The propositional nature of human associative learning. *Behavioral and Brain Sciences*, *32*, 183–198.
Olson, M. A., & Fazio, R. H. (2001). Implicit attitude formation through classical conditioning. *Psychological Science*, *12*, 413–417.
Olson, M. A., & Fazio, R. H. (2002). Implicit acquisition and manifestation of classically conditioned attitudes. *Social Cognition*, *2*, 89–104.
Pearce, J. M. (1987). A model for stimulus generalization in Pavlovian conditioning. *Psychological Review*, *94*, 61–73.
Piaget, J. J., & Inhelder, R. R. (1987). The construction of reality. In J. Oates, & S. Sheldon (Eds.), *Cognitive development in infancy* (pp. 165–169). Hillsdale, NJ, England: Lawrence Erlbaum.
Pleyers, G., Corneille, O., Luminet, O., & Yzerbyt, V. (2007). Aware and (dis)liking: Item-based analyses reveal that valence acquisition via evaluative conditioning emerges only when there is contingency awareness. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*, 130–144.
Rescorla, R. A. (1976). Stimulus generalization: Some predictions from a model of Pavlovian conditioning. *Journal of Experimental Psychology: Animal Behavior Processes*, *2*, 88–96.
Shanks, D. (2010). Learning: From association to cognition. *Annual Review of Psychology*, *61*, 273–301.
Skowronski, J. J., Carlston, D. E., Mae, L., & Crawford, M. T. (1998). Spontaneous trait transference: Communicators take on the qualities they describe in others. *Journal of Personality and Social Psychology*, *74*, 837–848.
Spence, K. W. (1937). The differential response in animals to stimuli varying within a single dimension. *Psychological Review*, *44*, 430–444.
Stahl, C., & Unkelbach, C. (2009). Evaluative learning with single versus multiple USs: The role of contigency awareness. *Journal of Experimental Psychology: Animal Behavior Processes*, *35*, 286–291.
Stahl, C., Unkelbach, C., & Corneille, O. (2009). On the respective contributions of awareness of unconditioned stimulus valence and unconditioned stimulus identity in attitude formation through evaluative conditioning. *Journal of Personality and Social Psychology*, *97*, 404–420.
Stevens, S. S. (1951). *Handbook of experimental psychology*. New York: Wiley.
Sweldens, S. J., van Osselaer, S., & Janiszewski, C. (2010). Evaluative conditioning procedures and the resilience of conditioned brand attitudes. *Journal of Consumer Research*, *37*, 473–489.
Terrace, H. (2010). Defining the stimulus – A memoir. *Behavioural Processes*, *83*, 139–153.
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., & Grigoriadis, S. (2004). Why sad people like shoes better: The influence of mood on the evaluative conditioning of consumer attitudes. *Psychology & Marketing*, *21*, 755–773.
Walther, E., Nagengast, B., & Trasselli, C. (2005). Evaluative conditioning in social psychology: Facts and speculations. *Cognition and Emotion*, *19*, 175–196.
Walther, E., Weil, R., & Duesing, J. (2011). The role of evaluative conditioning in attitude formation. *Current Directions in Psychological Science*, *20*, 192–196.
Wasserman, E. A., Gagliardi, J. L., Cook, B. R., Kirkpatrick-Steger, K., Astley, S. L., & Biederman, I. (1996). The pigeon's recognition of drawings of depth-rotated stimuli. *Journal of Experimental Psychology: Animal Behavior Processes*, *22*, 205–221.