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# **Re-evaluating Evaluative Conditioning: A nonassociative explanation of conditioning effects in the visual evaluative conditioning paradigm**

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Running Head: Evaluative Conditioning Effects

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## **ABSTRACT**

Two studies are described that investigate whether evaluative conditioning (EC) is an associative phenomenon. Experiment 1 compared a standard EC paradigm with nonpaired and no-treatment control conditions. EC effects were obtained only when the conditioned stimulus (CS) and unconditioned stimulus (UCS) were rated as perceptually similar. However, similar EC effects were obtained in both control groups. An earlier failure to obtain EC effects was reanalysed in Experiment 2: conditioning-like effects were found when comparing a CS to the most perceptually similar UCSs used in the procedure, but not when analysing a CS rating with respect to the UCS with which it was paired during conditioning. The implication is that EC effects found in many studies are not due to associative learning, and that the special characteristics of EC (conditioning without awareness and resistance to extinction) are probably nonassociative artefacts of the EC paradigm.

Evaluative conditioning (EC) can be defined as the transfer of affect from one stimulus to another by contiguously pairing the two stimuli in a classical conditioning paradigm. Usually, an affectively neutral stimulus (a conditioned stimulus, CS) is paired with either a liked or disliked stimulus (the unconditioned stimulus, UCS), resulting in the CS acquiring the same valence as the UCS with which it was paired (Levey and Martin, 1975). Although EC is a paradigmatic example of classical conditioning, it is unlike conventional autonomic conditioning in humans because (1) it appears to occur without subjects possessing awareness of the contingencies involved (Baeyens, Eelen & Van den Bergh, 1990a) and (2) seems to be resistant to extinction (Baeyens, Crombez, Van den Bergh & Eelen, 1988). This appears to make EC qualitatively distinct from more traditional human autonomic conditioning (cf. Davey, 1994). Using a typical visual EC paradigm, Baeyens *et al.* (1990a) used pictures of human faces as stimuli in a three-stage procedure. In the first stage, subjects rated the pictures of human faces along a 21 point scale ranging from -100 (dislike) through zero (neutral) to +100 (like). At the end of this stage, the experimenter selected the three most liked stimuli, the three most disliked stimuli and three neutral stimuli (stimuli with ratings between -10 and +10) to act as the UCSs, and a further 9 neutrally-rated faces to act as the CSs. This resulted in nine CS-UCS pairings: 3 × Neutral-Like (N-L); 3 × Neutral-Dislike (N-D); and 3 × Neutral-Neutral (N-N). In the second stage, the nine CS-UCS pairs were presented several times in semi-randomised order. Finally, subjects re-rated all of the CSs and UCSs using the same like-dislike scale as in the first stage. The standard findings in such an experiment are that, after conditioning, CSs paired with liked UCSs are rated more positively whereas CSs paired with disliked UCSs are rated more negatively.

Using this paradigm, Baeyens *et al.* (1990a) reported that EC effects appeared to occur without the subject being aware of the CS-UCS contingencies. They measured contingency awareness both concurrently and postexperimentally and concluded that ‘the number of contingencies a subject was aware of during conditioning *in no way* [italics added] influenced evaluative conditioning results’ (p. 14), suggesting that EC differed from more traditional autonomic conditioning by being

acquired without contingency awareness (but see Davey 1994; Field, 1997 for criticisms of these conclusions).

The finding that EC is resistant to extinction is derived from studies by Baeyens *et al.* (1988 — see also, Baeyens, Eelen, Van den Bergh & Crombez, 1989a) who used the standard visual EC procedure described earlier. However, after the postconditioning evaluative ratings had been taken, subjects experienced an extinction phase where the nine CSs were randomly presented five or ten times *without* contingent presentations of liked, disliked and neutral UCSs. Subjects then re-rated the CSs for a third time. Baeyens *et al.* found that EC was resistant to extinction — even when the CSs were presented several times without reinforcement, the acquired valence of the CS remained. In a follow-up study two months later the ratings of the CSs had still not changed.

### **Nonassociative Explanations of EC and the use of Control Conditions**

An important concern regarding the studies that have implied that EC has special characteristics is the absence of between-subject control conditions. The main contention stems from the observation by Shanks and Dickinson (1990) that in the typical EC paradigm CSs and UCSs are selected by subjects and, in some studies, paired on the basis of perceptual similarity. In short, Shanks and Dickinson suggest that this CS-UCS assignment procedure may interact with the effects of stimulus exposure to create the illusion of conditioning. They argue that true conditioning effects can be isolated only if the pairing of a particular CS with a particular UCS is counterbalanced across subjects. If this criterion is not met then it is possible that any conditioning-like effects could be due to nonassociative factors arising from the paradigm. One such factor might be similarity between the CS and UCS, which can facilitate EC effects (Levey & Martin, 1975; Martin & Levey, 1978). Stimulus similarity is a known confound of other learning processes such as classification learning (Wattenmaker, Nakamura & Medin, 1988) and incidental learning (Cock, Berry & Gaffan, 1994) and so could contribute to conditioning-like effects. In visual EC paradigms, CS-UCS combinations are typically not balanced because they are selected on the basis of a subject's ratings

of the stimulus set. Therefore, the influence of nonassociative factors (such as stimulus similarity) cannot be ruled out.

Field and Davey (1998) suggest that to demonstrate that EC effects are the result of specific CS-UCS associations, rather than the result of biases in the way in which stimuli are selected and paired together, a necessary condition must be fulfilled: experimental effects should not be shown in a condition where all associations are eliminated. If conditioning-like effects are found in such a condition, then experimental results must be due to nonassociative factors.

There has been considerable debate over what constitutes an adequate between-group control (See Davey, 1994; Baeyens & De Houwer, 1995). Field (1996, 1997) has proposed the Block/sub-block control (BSB control), which eliminates all CS-UCS associations, holds presentational factors constant and controls for effects resulting from stimulus selection procedures. In this procedure, CSs and UCSs are selected and assigned to a CS-UCS pair as in the normal visual EC paradigm but during the presentation stage these CS-UCS pairs are not presented in any contiguous or contingent pattern. Instead, each stimulus is presented with itself, as a pairing, such that it appears as many times as a stimulus in the conditioning procedure proper. To control for exposure effects, identical presentation parameters to the conditioning procedure (e.g. the duration of stimulus presentations, the inter-stimulus interval and the inter-pair interval) are used. A set of self-presentations is called a *block* and there are both *CS-blocks* (in which a CS is paired with itself) and *UCS-blocks* (in which a UCS is paired with itself). For half of the subjects, each of the many CS-blocks are presented in random order before the UCS-blocks; for the remaining subjects the UCS-blocks are shown before the CS-blocks. By keeping the CS blocks separate from the UCS blocks it is possible to ensure that subjects never see a CS appearing contingently with the corresponding UCS. Also, randomising the presentation order of the blocks makes it possible to eliminate any possibility that subjects could detect which CS and UCS were matched together before the presentation stage.

Although the BSB control procedure meets with Field and Davey's (1998) criterion for an adequate control for association, Field (1997) also recommends the use of a no-treatment condition

in which subjects are exposed to no stimulus presentations. A no-treatment control provides a situation in which *all* associations are eliminated and so it acts as a good gauge of subjects' expectancies when they come to re-rate the stimuli after conditioning. In addition, it controls for the possibility that effects are due to the stimulus selection procedure (because subjects are not exposed to any CSs or UCSs during the conditioning stage of the experiment). However, unlike the BSB control, it does not control for the effects of exposure. Although the use of the BSB control alone does allow conclusions to be drawn about the associative nature of conditioning, it does not allow conclusions to be drawn about the role of presentation. By using both a no-treatment condition, and a BSB control condition, effects due to exposure to the stimuli can be dissociated from effects due directly to the stimulus selection procedure and subjects' experimental expectancies.

Interestingly, Shanks and Dickinson (1990) used a between-subject blocked control group similar to the BSB control. The main difference to the BSB control was that each CS-block presentation was followed by the presentation of the corresponding UCS-block. Hence, although their procedure controlled for presentational factors (because all CSs and UCSs were presented the same number of times, and for the same duration, as in the experimental condition), it did not necessarily control for association because CS-blocks were not presented independently of the UCSs blocks. Their results showed no between-groups differences indicating that the conditioning-type effects shown in the group exposed to CS-UCS pairings were not the result of associative learning. This finding supported their fears that a bias in the visual EC paradigm created conditioning-like effects. Unfortunately, Shanks and Dickinson's findings have been largely overlooked because of the shortcomings of their blocked control. For example, Davey (1994) argued that subjects exposed to Shanks and Dickinson's control procedure still effectively receive CS-UCS pairings, but in block presentations, and that genuine conditioning could survive. For this reason it is important that EC effects be established in comparison to control conditions in which no CS-UCS associations could be made: only then can conclusions be drawn about whether EC effects are associative.



Finally, Baeyens and De Houwer (1995) point out that there are many EC studies that either have used balanced CS-UCS combinations (e.g. Baeyens *et al.*, 1990b, 1995), or have not used perceptual similarity as a basis for pair construction (e.g. Baeyens *et al.*, 1992, 1993). Results from these paradigms are less likely to be explicable in terms of the kinds of artefact described by Shanks and Dickinson and so provide better evidence that EC is associative in nature. However, in two studies that used balanced CS-UCS combinations (Baeyens *et al.*, 1990b, 1995), the CSs paired with liked UCSs showed either minimal shifts, or negative shifts, and so there was no affective transfer to these stimuli. Other studies using counterbalancing of stimuli have shown only marginal conditioning effects (which were nonsignificant) and have failed to include the counterbalancing manipulation as part of the analysis, thus concealing any effects due to the stimuli themselves (see Field & Davey, 1998 for a review). The studies that have used random CS-UCS allocations still rely on subject selecting their own CSs and UCSs and so do not meet Shanks and Dickinson's criteria for a well balanced within- and between-subject design. Although it is less obvious in these cases how biases might influence the procedure, these studies have not ruled out the possibility that they do.

The purpose of the studies reported in this paper is to investigate the functional characteristics of EC, using some of the between-subject controls outlined above. It is hoped that the use of these controls will provide further information about the associative nature of EC and determine whether its special characteristics are truly the result of associative processes or artefacts of the EC paradigm.

## **EXPERIMENT 1**

Following several failures to replicate even the most basic EC effects in our laboratory using a random procedure for matching CSs and UCSs, it was felt that the role of perceptual similarity between the CS and UCS may be an important contributing factor. There is much evidence that

some degree of similarity between the CS and UCS is an important element in establishing conditioning effects (Martin and Levey, 1978; Levey and Martin, 1975; but see Baeyens, Eelen, Van den Bergh & Crombez, 1989b) in the visual paradigm. If similarity between the CS and UCS is a key factor in EC, responding should be established when the CSs and UCSs are matched for perceptual similarity. This study is, therefore, a direct replication of the procedure used by Baeyens and his colleagues in many of their seminal studies (Baeyens *et al.* 1988; Baeyens *et al.* 1989a). An extinction procedure was also used in an attempt to verify the finding that EC is resistant to extinction. Unlike Baeyens and his colleagues' study, two control groups were used to unequivocally demonstrate that (1) any observed effects are associative phenomenon (the BSB Control), and (2) any observed effects do not arise from the stimulus selection process (the no treatment control condition).

## **Method**

### **Subjects**

Forty-eight subjects were used, 16 per condition. In the experimental condition, there were seven females and nine males, their ages ranged from 19 to 52 years ( $M = 28.07$  years,  $SD = 10.44$  years). In the BSB control there were eight females and eight males, whose ages ranged from 18 to 35 ( $M = 23.33$  years,  $SD = 5.00$  years). In the no treatment condition there were 12 females and 4 males, whose ages ranged from 18 to 45 ( $M = 23.94$  years,  $SD = 6.48$  years). All subjects were tested separately and were volunteers who were paid a small sum of money for their participation. Across the conditions, five additional subjects began, but did not complete, the study: their initial ratings of the stimuli made it impossible to construct N-D pairings (because they rated all of the stimuli as likeable).

### **Stimuli**

Seventy colour passport-style photographs of human faces were converted into colour bitmap computer files. All of the images had a white background so that they appeared on the computer screen as just the head and shoulders of a person.

## Apparatus

The experiment was run on a Pentium PC using custom written computer software: *ECtests* (Field, Matthias, Siddens-Corby & Ives, 1996). The experimental cubicle contained a table, a chair and the computer, monitor and mouse. Similarity ratings were taken using a custom written computer program called *PairView* for Acorn RiscOS (Field & Field, 1997).

## Procedure

The experimental procedure was based on the EC study conducted by Baeyens *et al.* (1988). Subjects were given initial written instructions before being taken through a dummy run of the first stage of the experiment: to ensure that they understood how to operate an on-screen rating scale using the computer mouse. When subjects were completely happy with what they were required to do, the experimenter left the experimental cubicle and closed the door — leaving the subject alone to proceed through the experiment. There were five stages to the experiment and before each stage instructions appeared on the computer screen to remind the subject of what was required of them. The stages were as follows:

**Stage 1: Baseline Assessment.** In this stage, subjects were randomly presented with the 70 images of human faces. Each picture appeared in the centre of the computer screen with a rating scale positioned directly below it. The scale ranged from -100 (dislike) through 0 (neutral) to +100 (like), in intervals of 5. There was a pointer on the scale that subjects could move by dragging it with the computer mouse. As the pointer moved, a screen button below the scale displayed the exact value of the rating currently being indicated. Subjects could fine tune their ratings by clicking on one of two arrows situated at either end of the scale: clicking these arrows moved the pointer along the scale in single intervals of 5. To proceed to the next photograph, subjects clicked on the screen button displaying the current rating; this ensured that subjects paid attention to the value of the rating they had given. The ratings given at this stage were the first evaluative responses (ER1). Subjects were told that their ratings were confidential, that they should be

completely honest about their evaluations, and that they should rely on their first, immediate and spontaneous reaction to each picture.

Subjects were asked to leave the experimental cubicle while the experimenter 'loaded the next part of the computer program'. At this point, the experimenter accessed the stimulus selection section of the computer program. This part of the program was safeguarded by a password to ensure that subjects could not access it inadvertently.

**Stimulus Selection.** The computer program selected the three most highly rated liked and most highly rated disliked faces from stage one: these stimuli were used as the UCSs. In addition, 12 neutral faces were selected: nine to be used as CSs and three to be used as control UCSs. These neutral faces were defined as pictures with a rating of zero. In the event of there being an insufficient number of faces rated exactly at zero, the computer selected the pictures with the next lowest ratings between  $\pm 10$ . In the rare event that more CS were still required, the computer selected pictures with the lowest ratings between  $\pm 20$ . If at this point there were still not the required numbers of neutral faces the experiment was terminated. This happened on only five occasions and these subjects took no further part in the study (see subjects section).

Once inside the cubicle, the experimenter entered the password and the computer displayed all of the available CSs on the left side of the screen and all of the available UCSs on the right. The experimenter was given no indication as to which UCSs the subject had rated as liked, disliked or neutral: this was to ensure that the experimenter's judgements were made solely on the basis of stimulus similarity, and were not biased in any other way. The experimenter then paired together CSs and UCSs on the basis of perceptual similarity. Nine CS-UCS stimulus pairs were constructed in all: 3  $\times$  Neutral-Like (N-L), 3  $\times$  Neutral-Dislike (N-D), and 3  $\times$  Neutral-Neutral (N-N). The pairing procedure typically took only a few minutes, after which the experimenter left the cubicle and asked the subject resume the experiment.

**Stage 2: Acquisition.** There were three possible presentation schedules at this stage of the experiment, which varied according to the condition the subject was assigned to:

## **Paired Condition**

Subjects were instructed that they would be shown a series of faces on the computer screen and that they should attend to them very carefully. The CS-UCS pairs were presented 10 times in a randomised order (but with the constraint that the same pair could not appear on more than two consecutive occasions). Each stimulus appeared on the screen for 1 second, the interval between stimuli in a pair (the inter-stimulus interval, or ISI) was 4 seconds and the interval between the offset of one pair and the onset of the next pair (the inter-trial interval, or ITI) was 8 seconds. These parameters were in keeping with those used by Baeyens *et al.*, 1988 and 1990a.

## **BSB Control**

Subjects were given the same instructions as in the paired condition. The faces were presented in a BSB control procedure (Field, 1996). In this condition, CSs and UCSs were selected and matched together on the basis of perceptual similarity before conditioning — just as in the experimental condition. However, during conditioning the CSs and UCSs were not presented in a contiguous or contingent pattern. Instead, each stimulus was presented with itself, as a pairing, 5 times (so subjects saw each stimulus presented 10 times — as in the paired condition), using the same parameters as the paired condition. Thus, a stimulus appeared for 1 second, followed by a blank screen for 4 seconds, followed by the same stimulus presented for 1 second, followed by a blank screen for 8 seconds, and so on until that stimulus had been presented 10 times. This set of self-presentations is a block of pairings. There were 9 different CS-UCS pairs in the experimental condition, so this control condition contained 9 CS blocks and 9 UCS blocks.

Half of the subjects saw the 9 CS blocks presented in random order followed by the 9 UCS blocks, also in random order, and half saw the UCS blocks before the CS blocks. Keeping the CS blocks separate from the UCS blocks ensured that subjects never saw a CS appearing contingently with a UCS. By randomising the presentation order of the blocks the possibility that subjects could detect the UCS that corresponded to a CS was eliminated: because, for example, a CS might appear as the first CS-block, whereas the corresponding UCS might appear as the fifth

UCS-block presented. So, even if subjects were aware that there were CS-UCS pairings, which is unlikely, it is improbable that they could determine exactly which CS was assigned to which UCS.

If no conditioning effects are observed in this condition, then nonassociative accounts of the effects observed in the experimental condition can be ruled out.

### **No-Treatment Control**

In this condition, CSs and UCSs were paired together before conditioning in the same way as the paired and BSB conditions. However, during Stage 2 subjects were shown a blank computer screen for the same length of time as the paired presentation procedure took, and thus saw no CS or UCS presentations. To prevent boredom, subjects were asked to read an affectively neutral piece of text about the history of Prague<sup>1</sup> during this stage.

**Stage 3: Postacquisition Assessment.** Subjects were told that they would see some more photographs of faces and that they must rate each one along a rating scale to indicate how much they liked, disliked or felt neutral about it. They were again reminded to rely on their first, immediate and spontaneous reaction to each picture. In this stage the CSs and UCSs from the acquisition stage were presented in random order along with the same rating scale as used in the baseline assessment stage. The ratings taken at this stage were the second evaluative responses (ER2). Following this stage there was a gap of 30 seconds during which the computer screen was blank.

**Stage 4: Extinction.** This stage was the same in all three conditions. Subjects were instructed that they would be shown some more photographs of faces and that they should pay careful attention to them. The nine CSs were presented alone, in semi-randomised order, *without* the presentation of any UCSs. The stimulus duration was 1 second, the ITI (in this case the time between the offset of

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<sup>1</sup>This piece of text was chosen as it was reasonably interesting, but contained factual, and not emotionally valenced, information. Subjects read the text from paper rather than the computer screen.

one CS and the onset of the next) was set at 8 seconds. Each CS was presented 10 times. These parameters were in keeping with those used by Baeyens *et al.* (1988).

**Stage 5: Postextinction Assessment.** Subjects were again told that they would be shown some faces that they should rate according to how much they liked, disliked or felt neutral about them. It was again stressed that subjects rely on their instinctive and genuine reaction to each face. The CSs were then presented in random order with the same rating scale as used in the other two assessment stages. Ratings obtained during this stage were the third evaluative ratings (ER3).

At the end of the experiment subjects were asked whether or not they had believed the cover story that preceded stimulus selection. All subjects believed that it was actually necessary for the experimenter to load the second part of the program and were not suspicious about this part of the study.

### **Postexperimental Study: Similarity ratings**

Although the experimenter constructed CS-UCS pairs on the basis of perceptual similarity, because the stimuli available to the experimenter were dependent on the subject's initial ratings, there was no guarantee that these pairings would be of equal similarity. To obtain a measure of perceptual similarity for each CS-UCS pair, eight naive judges rated the pairings from all three experimental conditions on a similarity scale ranging from 1 (very similar) to 10 (very dissimilar). Five naive judges rated all 432 pairs (so these judges rated every pairing from each of the three experimental conditions), while a further three judges rated all 144 pairs from only *one* of the experimental conditions. So, for example, in the experimental condition, there were five judges who also rated pairings from the two control conditions, and three judges who rated only the pairings from the experimental condition. Therefore, in total, 14 different judges were used (five who rated all pairings, and nine additional judges — three per experimental condition — who rated pairings from only one of the three experimental groups). Using a mixture of the same and different judges maintained consistency across conditions while ensuring that the results obtained were not attributable to using the same judges across conditions. The average similarity rating

between the eight judges was used as an overall measure of similarity between a CS and UCS. For the paired condition, similarity ratings ranged from 3.25 to 9.50 ( $M = 6.45$ ,  $SD = 1.36$ ), for the BSB control the similarity ratings ranged from 2.13 to 9.38 ( $M = 6.01$ ,  $SD = 1.71$ ), and for the no-treatment condition, ratings ranged from 2.50 to 9.50 ( $M = 6.26$ ,  $SD = 1.56$ ). All of the mean similarity ratings were greater than 5.50 (the midpoint of the scale) — which represents dissimilarity — so overall the matching procedure was unsuccessful in generating similarity between the CSs and UCSs, which, based on past research (for example, Martin & Levey, 1978), will, if anything, inhibit conditioning. Reliability between the eight judges in each condition was good and consistent (Reliability of ratings for the pairs in the experimental condition, Cronbach's  $\alpha = 0.82$ ; in the BSB control condition, Cronbach's  $\alpha = 0.87$ ; in the no treatment control condition, Cronbach's  $\alpha = 0.85$ ).

## Results

The mean evaluative ratings of the UCSs were 54.06 (N-L pairs,  $SD = 18.90$ ), -50.73 (N-D pairs,  $SD = 25.83$ ) and 0.00 (N-N pairs,  $SD = 5.36$ ) in the experimental group. In the BSB control group the mean evaluative ratings of the UCSs were 60.00 (N-L pairs,  $SD = 20.29$ ), - 53.65 (N-D pairs,  $SD = 25.13$ ) and 1.77 (N-N pairs,  $SD = 6.06$ ). Finally, in the no-treatment group the mean evaluative ratings of the UCSs were 56.04 (N-L pairs,  $SD = 17.65$ ), -52.50 (N-D pairs,  $SD = 20.37$ ) and 0.83 (N-N pairs,  $SD = 6.79$ ).

## CS Ratings

The ratings of similarity given by the judges were used to separate each subject's pairs into those that were perceptually similar (had an average similarity rating below 5.5 on the similarity scale) and those that were dissimilar (had an average similarity rating above 5.5). For each subject in the experiment, there were some pairs that were similar and some that were dissimilar.

Figure 1 shows graphs of the CS ratings at baseline (ER1), after acquisition (ER2) and after extinction (ER3), for each type of pairing, in each of the three conditions dependent upon whether the pairs were similar or dissimilar.



In the paired condition, a differential response pattern, supportive of EC, can be seen, but only in pairs that were perceptually similar. In the BSB control, a response profile was observed in which strong differential shifts between CSs paired with liked and disliked UCSs were seen in pairs rated as perceptually similar, but not in pairs rated as perceptually dissimilar. In the no-treatment condition, a very similar response profile was observed.

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Insert Figure 1 Here

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Using similarity as a covariate in the analysis was deemed inappropriate because this assumes a linear relationship between the similarity ratings and CS ratings (which may not be the case). In addition, even if similarity and the strength of the ER were linearly related, a positive relationship in N-L pairs and a negative relationship in N-D pairs would be expected, which would complicate the logistics of the analysis considerably. Instead, similarity was used as a factor (similar vs. dissimilar), because all subjects received some pairings that were similar and some that were dissimilar. For each pair type, the average ratings at each stage of the experiment for pairs that were similar and pairs that were dissimilar were calculated. This did result in a few cases of missing data (where, for example, all of the three N-D pairs had been rated as dissimilar), in such cases the missing data was replaced with the mean of the remaining subjects in that cell — to create a fully balanced design. This data replacement was minimal (6.9% of 288 cases including repeated measures).

The data were analysed with a four way 3 (Group: paired, BSB control, no treatment)  $\times$  2 (Similarity: similar pairs vs. dissimilar pairs)  $\times$  3 (Pair Type: N-L, N-D, N-N)  $\times$  3 (Phase: baseline, postacquisition, postextinction) ANOVA with repeated measures on the last three variables. Joint Univariate Bonferroni Reverse-Helmert contrasts were performed on the repeated measures

variables. Simple contrasts were performed on the group factor (comparing each of the control groups to the paired condition). Tests involving the Similarity  $\times$  Pair Type interaction [Mauchly  $W = 0.867$ ], the Pair Type  $\times$  Phase interaction [Mauchly  $W = 0.632$ ] and the Similarity  $\times$  Pair Type  $\times$  Phase interaction [Mauchly,  $W = 0.492$ ] violated the sphericity assumption and so Greenhouse-Geisser corrected  $F$  values were used throughout.

Using a cut off point of  $p = 0.05$ , the analysis revealed a significant main effect of Pair Type [ $F(2, 90) = 9.33$ ] indicating that the type of UCS that a CS was paired with, did have some effect on its subsequent ratings. However, the Group  $\times$  Pair Type interaction was not significant [ $F(4, 90) < 1$ ] showing that these pair-type differences were the same across the three groups.

The Similarity  $\times$  Pair Type interaction was significant [ $F(1.77, 79.44) = 4.86$ ] showing that the pattern of responding to CSs paired with different valenced UCSs was different in similar pairs to dissimilar pairs. The Bonferroni confidence intervals revealed specifically that the response profiles to CSs in N-L pairs, compared to those in N-D pairs, were significantly different between similar and dissimilar pairs [ $CI_{0.95} = 0.34$  (lower), 6.95 (upper);  $t = 2.22$ ]. In addition, the responses to CSs in N-N pairs, compared to those in N-L and N-D pairs, were significantly different between similar and dissimilar pairs [ $CI_{0.95} = 0.43$  (lower), 9.95 (upper);  $t = 2.19$ ]. This reflects the fact that subjects responded differently to CSs paired with different valenced UCSs when the pairs were similar, but not when they were dissimilar. Interestingly, the Group  $\times$  Similarity  $\times$  Pair Type interaction was not significant [ $F(3.53, 79.44) = 1.75$ ] which shows that this combined effect of Similarity and Pair Type was the same across all three conditions.

The Pair Type  $\times$  Phase interaction was significant [ $F(3.20, 144.14) = 5.58$ ] as expected, indicating that CSs were rated differently at some stages of the experiment, contingent upon the type of UCS with which they were paired. Contrasts revealed that there was a significant difference between ratings of CSs in N-L and N-D pairings when comparing the ratings after acquisition, to those at baseline [ $CI_{0.95} = -7.79$  (lower), -2.99 (upper);  $t = -4.52$ ]. However, there was no effect of comparing the ratings of these stimulus pairs from extinction to before and after conditioning. This

shows that although significant shifts were observed after acquisition, there were no subsequent shifts after extinction. Interestingly, the Group  $\times$  Pair Type  $\times$  Phase interaction was not significant [ $F(6.41, 144.14) = 1.98$ ].

Finally, the Similarity  $\times$  Pair Type  $\times$  Phase interaction was significant [ $F(2.94, 132.11) = 3.52$ ] which shows that similarity influenced responses to CSs paired with different valenced UCSs, at different stages of the experiment. The Group  $\times$  Similarity  $\times$  Pair Type  $\times$  Phase interaction [ $F(5.87, 132.11) = 2.31, p = 0.038$ ] was also significant implying that there were group differences but contrasts revealed that this difference was between the two control conditions. The Bonferroni contrasts showed that, specifically, similarity had a significant effect when comparing ratings after acquisition to those at baseline in N-L and N-D pairs [ $CI_{0.95} = 0.51$  (lower), 4.67 (upper);  $t = 2.51$ ]. However, this effect was not significantly different between the paired and BSB control groups ( $p = 0.51$ ) or the paired and no-treatment group ( $p = 0.17$ ). This is a crucial result as it shows that there was a significant conditioning-like effect, but only in similar pairings, and that this effect existed in both of the control groups. There was no significant effect of similarity when comparing ratings after extinction with those at baseline and conditioning between N-L and N-D pairs overall ( $p = 0.29$ ) but there was when comparing the paired condition to the BSB control [ $CI_{0.95} = -16.69$  (lower), -2.39 (upper);  $t = -3.10$ ]. There was also a significant effect of similarity when comparing ratings after acquisition to those before acquisition in N-N pairs compared to N-D and N-L pairs [ $CI_{0.95} = 1.18$  (lower), 6.07 (upper);  $t = 2.99$ ].

In summary, the results show that the differential responding to CSs in N-L and N-D pairs that are similar, was significantly different to the responding towards CSs in dissimilar pairings. Similarity and Pair Type had a combined influence: similar pairings produced a differential response between N-L and N-D pairs after conditioning, but dissimilar pairs did not. However, these effects were seen not only in the paired condition, but also in the two control conditions. So, even when subjects had not seen CSs and UCSs paired together, there was still a conditioning-like effect in perceptually similar pairs. The difference between control groups suggests that exposure to

the stimuli may enhance these conditioning-like effects. The extinction procedure resulted in nonsignificant overall differences in CS ratings compared to the earlier ratings.

## Discussion

This study has two important findings (1) evaluative conditioning effects could be found, but only when CS-UCS pairs were rated as perceptually similar, and (2) conditioning-like effects were also observed in a nonpaired and no-treatment control group.

At face value, this experiment failed to replicate the findings of Baeyens and his colleagues: no differential responding was observed between CSs paired with liked and disliked stimuli. However, when the pairings were separated into those that were perceptually similar and those that were perceptually dissimilar, differential responses were observed but only in those pairs that had some level of perceptual similarity. The first conclusion that can be drawn from this experiment is that in the visual EC paradigm, perceptual similarity between the CS and UCS appears necessary to establish differential responding to CSs in N-L and N-D pairs. This supports much of the early literature (e.g. Martin & Levey, 1978; Levey & Martin, 1975).

The reason why the overall results did not replicate Baeyens *et al.*'s findings is likely to be because the matching procedure in Experiment 1 was relatively unsuccessful in creating similar CS-UCS pairs (across conditions, the mean similarity score for our pairs indicating that, on average, pairs were dissimilar). On the other hand, when referring to a paradigmatically identical procedure (Baeyens *et al.*, 1989a) based on comparable similarity ratings by independent judges, Baeyens concluded that their '... similarity matching procedure indeed was successful' (Baeyens & De Houwer, 1995: p. 826). It is, therefore, reasonable to assume that the overall failure to achieve conditioning in Experiment 1 was a result of the failure to successfully match similar CSs and UCSs. Baeyens and De Houwer (1995) concluded that similarity could not account statistically for the effects observed in the Baeyens *et al.* (1989a) study. Contrary to their conclusions, Experiment 1 does show that similarity can account for conditioning effects. This difference in findings may be due to the shortcomings of the statistical analyses carried out by Baeyens and De Houwer (1995).

For example, if similarity does have some effect on EC, then it is reasonable to assume that it will have a positive relationship to conditioning in N-L pairings (i.e. an increase in similarity results in a more positive rating). In N-D pairs, however, the expected shifts are in a negative direction, and so similarity should have a negative relationship with conditioning (i.e. an increase in similarity should result in a more negative rating). Furthermore, for CSs in the N-N control pairs, similarity should have no effect at all. In Baeyens and De Houwer's analysis, similarity ratings were included as a covariate in an ANCOVA, without taking account of the different ways in which similarity might effect conditioning depending upon the type of UCS used. It is perhaps not surprising that they conclude that similarity has no effect. Also, a covariate analysis such as theirs assumes that similarity is *linearly* related to conditioning, yet it seems more likely that there is a more complex relationship between the two — indeed, Martin and Levey (1978) suggest that if stimuli are too similar, conditioning is impeded (see Field, 1997 for more detail).

The more important issue arising from this study is that EC was observed in conditions where (1) subjects received exposure to the CSs and UCSs but not in a contingent or contiguous presentation order (the BSB Control); and (2) where subjects received no CS and UCS presentations at all during stage 2 (the no treatment control). What is clear from the data, is that differential responding, as indicative of EC, can be achieved in pairings even when subjects receive no presentations of the stimuli. Consequently, there is good reason to suppose that when images have been successfully matched for perceptual similarity, results may not reflect associative learning but are an artefact of the stimulus selection process.

This raises the question of how the stimulus selection procedure might lead to conditioning-like effects. It is useful in this instance, to draw a parallel between the baseline assessment stage of an EC experiment and the categorisation study of Reed (1972) in which subjects were required to categorize a series of schematic faces having seen only a few examples of known category members. Results showed that during the experimental procedure, subjects abstracted an idea of what a prototypical face would be for each category and then classified each exemplar according to

its similarity to each prototype. It seems plausible that subjects in EC studies might also abstract some form of prototype for what makes a likeable or dislikeable stimulus, or store actual category exemplars, within the context of the experiment (e.g. Brooks, 1978, 1987) and then base subsequent ratings on this information. Support for this proposition comes from Field and Davey (1997), who used an analogue of the EC paradigm to look at whether subjects' decisions about category membership could be influenced through conditioning. A set of schematic faces was used. A simple polymorphous concept rule could be applied to these faces to determine whether a face belonged to one of two categories of alien (a Martian or Venusian). Some additional faces were designed to be conceptually neutral. Some of these neutral faces (CSs) were then paired with faces that were highly representative of one of the two categories: so, some neutral faces were paired with highly representative Venusian UCSs, while others were paired with highly representative Martian UCSs. CS-UCS pairs were constructed based on the number of features shared by the CS and UCS. Field and Davey found that differential responding was achieved (CS ratings shifted in the direction of the UCS with which they were paired) but these effects were not due to subjects associating CSs and UCSs. In fact, the responses were due to a bias in the way in which CS-UCS pairs were constructed: CSs consistently selected to be paired with a certain type of UCS across subjects were placed in the same conceptual category as the UCS with which they were paired. This was not true of CSs that were selected to be paired, across subjects, with conceptually different UCSs, because CS-UCS pairings were based upon conceptual similarity, CSs that were consistently selected to be paired with a certain category of UCS would be ones with a high degree of conceptual similarity to these UCSs. Hence, the results could be due to subjects storing salient categorical exemplars and then basing subsequent CS ratings on similarity to these exemplars.

In summary, Experiment 1 has shown that similarity does have a role in establishing EC effects, but that this role may have its effect on EC by creating an experimental artefact rather than influencing the conditioning process itself. The implication is that in studies where the stimulus

selection process is based on similarity, the results may not be attributable to conditioning, but to a nonassociative process.

## EXPERIMENT 2

The findings from Experiment 1 have particular importance for another experiment, conducted in our laboratory, where CSs and UCSs were paired together on a completely random basis. If, as the previous experiment indicated, EC is merely an artefact of the stimulus selection process, then failures to establish EC could be attributed to procedural factors. The experiment was an attempt to replicate the finding that EC is resistant to extinction yet it failed to find evidence of evaluative conditioning. The main difference between the paradigm used and that of Baeyens *et al.* (1990a, 1988) was that CSs were allocated to UCSs on a strictly random basis by a computer (thus eliminating the possibility of experimenter bias in the selection process). If, as suggested in the discussion of Experiment 1, subjects' postacquisition judgements of the CSs depend upon comparisons with salient categorical exemplars that were stored during the baseline rating stage, then CS ratings ought to shift in the direction of the exemplars *to which they are most similar — and not necessarily in the direction of the UCS with which they were paired during the conditioning stage.*

One way to examine this experimentally is to establish which liked and disliked category exemplars are salient to a subject, then assess a CS's similarity to these exemplars, and subsequently determine whether the CS's rating shifts towards the category exemplars that it most resembles. If a CS's rating changes in the direction of the category exemplars to which it is most similar, rather than shifting in the direction of the UCS with which it was paired, then there is good reason to suppose that apparent conditioning effects result from the kind of exemplar-comparison process outlined in the discussion of Experiment 1.

In the experiment, the UCSs were the three most liked and disliked faces, and so these faces represent category exemplars that the subject found most salient. Therefore, we can use a subject's

UCSs as an approximation to their most salient liked and disliked faces. An overall similarity between a CS and the 3 stimuli that represent salient liked and disliked category exemplars can then be calculated. It will then be possible to see whether a CS's rating changes in the direction of the category exemplars to which it is most similar, rather than the UCS with which it was paired during the conditioning procedure.

The measure of similarity between a CS and all of the UCSs is, therefore, a gauge of similarity between a CS and a sample of salient conceptual exemplars stored in memory. The prediction, based on Experiment 1, is that the CS ratings will change according to whether the CS is most similar to the liked or disliked category exemplars that the subjects find salient.

## **Method**

### **Subjects**

Fifteen subjects were used in the experimental condition: eight females and seven males. Their ages ranged from 18 to 57 years with a mean age of 24.6 years ( $SD = 9.85$  years). A further 16 subjects took part in a block/sub-block control condition. These subjects ranged in age from 22 to 44 ( $M = 28.56$  years,  $SD = 6.43$ ) and had a 9:7 male to female ratio. All subjects were tested separately and were volunteers who were paid a small sum for their participation.

### **Stimuli**

The seventy colour bitmap images of human faces used in Experiment 1 were again used in this experiment.

### **Apparatus**

The apparatus were the same as for Experiment 1.

### **Procedure**

The procedure used was in essence the same as that used by Baeyens *et al.* (1988), except that the whole procedure was automated on a computer rather than using slide projections. As such,



the procedure was identical to Experiment 1 except that CS-UCS pairings were constructed randomly rather than basing them on perceptual similarity and the ISI was reduced to 200ms.

**Stage 1: Baseline Assessment.** This stage was identical to that described for Experiment 1.

**Stimulus Selection.** At the end of stage 1, the computer program selected the three faces with the highest ratings and the three faces with the lowest ratings, to be used as the valenced UCSs. In addition, 12 neutral images were selected, which were defined as in Experiment 1. Having selected the stimuli, the computer constructed nine stimulus pairs: 3 × Neutral-Like (N-L), 3 × Neutral-Dislike (N-D), and 3 × Neutral-Neutral (N-N). These pairs were constructed on an entirely random basis.

**Stage 2: Acquisition.** The presentation schedule for the paired and BSB control conditions were identical to those described in Experiment 1 except that the ISI was 200ms rather than 4 seconds.

**Stage 3: Postacquisition Assessment.** This stage was exactly as described for Experiment 1.

**Stage 4: Extinction.** This stage was exactly as described for Experiment 1.

**Stage 5: Postextinction Assessment.** This stage was exactly as described for Experiment 1

## Similarity Ratings

Five Independent raters were used. Their ages ranged from 21 to 34 years with a mean age of 24.75 years (SD = 6.24 years). All raters were tested individually in seven different sessions and were volunteers who were paid a small sum for their participation.

The design was the same as the postexperimental procedure described for Experiment 1. A list

was made of all of the pairs of images used in affective CS-UCS pairings (i.e. only the N-L and N-D pairs) in the main experiment. In total, there were 186 CS-UCS pairings<sup>2</sup> used in the experiment. To see whether each CS was most similar to a subject's liked or disliked category exemplars, it was necessary to obtain similarity ratings for each CS compared to *all of the UCSs* that the subject was exposed to (because these UCSs were used as an approximation of the liked and disliked category exemplars that the subject found salient). By taking similarity ratings for every CS compared to every UCS a subject was exposed to, it was possible to calculate a CS's overall similarity to a subject's liked and disliked exemplars. Each subject from the experiment experienced 6 pairings that had used affective UCSs. So, for each subject there were 6 CSs that were of interest for our analysis. The similarity between each of these CSs and each of the 6 UCSs (3 liked and 3 disliked) used for a particular subject was measured (resulting in six different similarity ratings for each CS: 3 Relating to liked UCSs and 3 relating to disliked UCSs). This resulted in 1116<sup>3</sup> stimulus pair combinations that were of interest.

The PairView computer program described in Experiment 1 was used to collect ratings of similarity between the various CS-UCS combinations and because there so many combinations of pairs of faces, the total set of combinations was split randomly into seven approximately equal blocks of pairs. Each judge was shown the blocks in semi-random order such that no two subjects rated the same two blocks consecutively.

Reliability of ratings between the five raters was acceptable (Cronbach's  $\alpha = 0.69$ , with this value not being substantially effected by the removal of any one judge). In addition, when inter-rater reliability between pairs of raters was calculated using Cohen's Kappa it was highly significant ( $p < 0.001$ ) for all pairs. This indicated that raters agreed very highly on whether a CS-UCS pair was similar or dissimilar.

Having collected the similarity ratings for the 1116 different pairs of faces and established the level of reliability between the raters, a single similarity score was calculated for each CS-UCS pair using the average of the five judges' ratings. This similarity score was used throughout the data analysis.

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<sup>2</sup>Pairings for Experiment 2: Paired = 15 subjects  $\times$  6 affective CS-UCS pairs = 90

Pairings for Experiment 2: BSB = 16 subjects  $\times$  6 affective CS-UCS pairs = 96

<sup>3</sup>Pairings for Experiment 2: Paired = 15 subjects  $\times$  6 CSs  $\times$  6 UCSs = 540

Pairings for Experiment 2: Paired = 16 subjects  $\times$  6 CSs  $\times$  6 UCSs = 576

These similarity scores were used to ascertain the similarity between a CS and a subject's liked and disliked UCSs. The similarity between a CS and a subject's liked UCSs was calculated by taking an average of the similarity scores between that CS and the three liked UCSs. Likewise, the similarity between that same CS and the subject's disliked UCSs was calculated by taking the average of the similarity scores between that CS and the three disliked UCSs used for that subject. So, for each CS experienced by a subject, there were two scores: one representing the CS's similarity to that subject's liked UCSs; and one representing its similarity to the subject's disliked UCSs. From these two scores, it was possible to establish whether a particular CS most resembled the subject's liked or disliked UCSs (by looking at which similarity score was lowest).

If the artefactual account from Experiment 1 is correct, then differential shifts should be observed between CSs that were most similar to the liked UCSs and CSs that were most similar to the disliked UCSs. However, no differential responding should be found between CSs based on the UCSs with which they were actually paired.

## Results

The mean evaluative ratings of the UCSs were 53.56 (N-L pairs, SD = 23.97), -59.00 (N-D pairs, SD = 24.28) and 0.56 (N-N pairs, SD = 7.71) in the paired condition. In the BSB control group the mean evaluative ratings of the UCSs were 54.17 (N-L pairs, SD = 19.03), -42.71 (N-D pairs, SD = 19.81) and -0.21 (N-N pairs, SD = 5.74).

## Conditioning Effects

Figure 2 shows the change in CS ratings across the three stages of conditioning based upon the Type of UCS with which the CS was paired. The graph shows that the differential response patterns shown in Baeyens *et al.*'s (1988) study are not present here: following conditioning there are positive shifts in the ratings of neutral CSs regardless of the valence of the UCS with which it was paired or the presentation schedule used.

A three way 2 (Group: paired or BSB control)  $\times$  3 (UCS Type: N-L, N-D, N-N)  $\times$  3 (Phase: baseline, postacquisition, postextinction) ANOVA was conducted on the CS ratings, with repeated

measures on the last two variables. At a 0.05 level of significance there were no significant effects involving the UCS Type variable [all  $F$ s < 1] indicating that differential conditioning effects were not present. The only effect to reach significance was the main effect of Phase [ $F$  (1.66, 48.04) = 17.38] and this effect indicates that there was a significant increase in preference for all CSs in the experiment. This increase in preference is consistent with the effect of mere exposure (Zajonc, 1968). In summary, the analysis revealed that conditioning was not successful in establishing differential evaluative responses. In short, no evaluative conditioning was observed.

### Similarity Effects

Figure 3 shows graphs displaying the mean CS ratings in both the paired condition and the BSB control with CSs being divided according to whether they most resembled the subject's liked or disliked category exemplars<sup>4</sup>. In the paired condition, 58 CSs were rated as most similar to the liked exemplars and 31 were rated as most similar to the disliked exemplars with 1 CS being rated as equally similar to both. In the BSB control condition, 72 were rated as most similar to the liked exemplars and 24 were rated as most similar to the disliked exemplars.

As predicted, there were differential shifts in ratings between CSs most similar to the liked category exemplars compared to those most similar to the disliked category exemplars in both the paired condition and the BSB control condition. All of the negative shifts were quite small but this is not surprising given that when the data were grouped according to the affective value of the UCS used all shifts were positive (see Figure 2). The important point is that there are large differential shifts in ratings after conditioning between CSs that were more similar to a subject's liked category exemplars, compared to those CSs that were most similar to the disliked category exemplars.

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Insert Figure 3 Here

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<sup>4</sup> By 'similarity to the subject's liked and disliked category exemplars' we simply mean the averaged similarity to the liked and disliked UCSs respectively. These UCSs are used as examples how a particular subjects defines the categories of *like* and *dislike* within this stimulus set.

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To see whether these differential responses were significant, a three way 2 (Group: paired or BSB control)  $\times$  2 (Category Exemplars: CS was most similar to the liked category exemplars vs. CS was most similar to the disliked category exemplars)  $\times$  3 (Phase: baseline, postconditioning, postextinction) mixed ANOVA with repeated measures on the latter two variables was carried out. To do this analysis, a mean shift for CSs resembling each set of category exemplars was calculated for each subject. Effects involving the Phase variable violated sphericity and so Greenhouse-Geisser corrected  $F$ -ratios were used. At a 0.05 level of significance, there was a significant main effect of Category Exemplars [ $F(1, 24) = 17.95$ ] and, more importantly the Category Exemplars  $\times$  Phase interaction [ $F(1.24, 29.64) = 7.29$ ]. This latter result shows that ratings of CSs changed significantly across the three stages of the experiment, but that the nature of this change was dependent upon whether the CS most resembled the subject's liked or disliked category exemplars. Repeated contrasts were performed on the Category Exemplars  $\times$  Phase interaction and revealed that the interaction was highly significant when comparing ratings after conditioning to the baseline ratings [ $F(1, 24) = 28.34, p < 0.001$ ]. However, the interaction was not significant when comparing ratings after the extinction phase to those after the conditioning stage [ $F < 1$ ]. These contrasts tell us that after conditioning, ratings to CSs most resembling the liked exemplars were significantly different to ratings of the CSs most similar to the subjects disliked exemplars but that these differences were the same after the extinction stage. These results therefore emulate what has typically been shown in EC studies including apparent resistance to extinction effects. Crucially, there were no other significant effects and so the profile of responses was consistent across both the paired and BSB control conditions demonstrating that the results are not associative in nature.

### **Can Similarity to Category Exemplars Predict the Change in Direction of CS Ratings?**

To see whether similarity to the category exemplars is the most important factor in how the rating of a CS changes, a logistic regression was carried out. The analysis included the direction of

rating change (positive or negative) as the dichotomous dependent variable. The categorical predictors were: Category Exemplars (whether a CS was most similar to the subject's liked or disliked exemplars); UCS value (the valence of the UCS with which the CS was actually paired); and Group (paired or BSB control). All two-way and higher-order interactions were included in the analysis.

The analysis revealed only one significant predictor of the direction in which the rating of the CS changed. This predictor was the category exemplars that the CS resembled most [-2 Log Likelihood ratio = 16.35,  $p < 0.0001$ ]. This revealed that if a CS were to change from being more similar to the liked exemplars to being more similar to the disliked ones then the probability of its rating shifting positively decreases. The predicted probabilities of a positive shift occurring were calculated from the regression model and showed that the probability of a positive shift in a CS's rating was 0.77 when the CS was most similar to the liked exemplars compared to only 0.41 when the CS was most similar to the disliked exemplars. Hence, given that the CS resembles the subject's liked exemplars, there is a 77% chance that the rating of that CS will subsequently shift positively; if that same CS was more similar to the subject's disliked exemplars there is a 59% chance that its rating would shift negatively. This was true across both the experimental and control condition (as shown by the absence of any interactions involving the Group factor).

Crucially, what this analysis reveals that the prior analyses did not, is that the affective valence of the UCS with which the CS was *actually paired* in no way contributed to predicting how that CS was subsequently rated. This quite conclusively demonstrates that an evaluative conditioning response profile was obtained when examining the data in terms of the similarity between a CS and the salient liked and disliked categorical exemplars. The one thing that did not predict the changes in CS ratings was the pairing process itself<sup>5</sup>.

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<sup>5</sup> A second experiment using an identical paradigm but with the 4 second ISI used by Baeyens et al. (1988, 1990a) showed statistically comparable results to the study reported here. In addition, a third study using a contingency awareness measure also showed the same results as Experiment 2, and in addition emulated the finding that the differential effects obtained were present in contingency-unaware subjects. Details of these other studies can be found in Field (1997) or by writing to the authors.

## Discussion

Differential EC responding was found with CSs rated as most perceptually similar to a subject's liked or disliked category exemplars. Furthermore, this was true even in a condition where the CSs were not presented contingently or contiguously with their accompanying UCSs. Experiment 2 initially failed to replicate the basic EC phenomenon, and this failure can now be seen within the context of an entirely different set of processes to those supposed by Baeyens and his colleagues. Specifically, it seems that the contingent or contiguous pairing of a CS and UCS has little bearing on evaluative responding in the visual paradigm, which can instead be explained in terms of comparisons with set of salient category exemplars. The implications of this experiment are that the conditioning anomalies associated with EC can almost certainly be explained as an artefact of the experimental paradigm, and do not necessarily result from the CS needing to be contiguously or contingently paired with the UCS.

Of course, for this artefactual account to explain successful EC studies, the EC paradigm must ensure that the value of the UCS selected for conditioning is the same as the value of the exemplars to which the CS is most similar. An EC paradigm utilising a procedure where CSs and UCSs are *successfully* matched on the basis of perceptual similarity does a great deal to ensure that the affective value of a UCS assigned to a CS is the same as the affective value of the exemplars that the CS most resembles. By the very nature of the paradigm, UCSs will always be strong exemplars of each category, and so if a CS is successfully matched to a similar UCS, it ensures that that CS has a strong similarity to a salient categorical exemplar. Thus, it appears that conditioning-like effects result from the comparison of a CS to salient categorical exemplars, and not from associative learning.

Experiment 2 also showed that when analysing studies with respect to similarity to salient categorical exemplars, resistance to extinction was emulated. This finding suggests that this special characteristic of EC can be attributable to a nonassociative process and so EC using visual stimuli may not deserve its status as a distinct form of conditioning.



## GENERAL DISCUSSION

The experiments in this paper have shown how laboratory-produced EC effects appear to be an artefact of factors inherent in the paradigm used in many influential EC experiments. Specifically, this paradigm has been used to systematically demonstrate resistance to extinction and conditioning without contingency awareness. Experiment 1 demonstrated that conditioned responding could be obtained only in CS-UCS pairs where the CS and UCS were perceptually similar, and not in pairings that were perceptually dissimilar. This finding was also true (1) when the CSs and UCSs were not explicitly paired (and so the observed effects were not due to either contiguous or contingent pairing of the CS and UCS); and (2) when the CSs and UCSs were not presented at all (indicating that the results were not dependent on exposure during the acquisition stage). In addition, Experiment 2 showed that EC effects could be produced by a nonassociative process where subjects compared the similarity between each CS and a set of salient exemplars representing the concepts of like and dislike. Specifically, the rating of a CS changed in the direction of the exemplars that the CS most resembled.

The conclusion thus far is that, in EC experiments where the CS and UCS are matched according to perceptual similarity, a bias is introduced whereby the CS becomes paired with a strong categorical exemplar. Experiment 2 revealed substantial evidence that ratings of a CS after conditioning result from subjects comparing it with a combination of salient exemplars, and then changing their rating according to whether the CS was more similar to the liked or to the disliked exemplars. This process leads to discriminative responding, which, in the absence of control conditions, would typically be interpreted as evidence for evaluative conditioning. There are two important questions that arise from these conclusions. First, to what extent can these findings explain the functional characteristics that are claimed to be peculiar to EC? Second, to what extent do these findings jeopardise the status of EC as a robust learning phenomenon?

The only systematic investigation of the role of contingency awareness in EC (Baeyens *et al.*, 1990) used the paradigm described in the studies reported in this paper and so is likely to have been prone to the artefact unveiled here. In addition, the first systematic investigation into resistance to extinction (Baeyens *et al.*, 1988) also used such a paradigm and so the results can be equally questioned. As such, the studies reported here do cast doubt over whether EC deserves its status as a functionally distinct learning system. However, there is much evidence (albeit less systematically investigated) from studies using tastes as CSs and UCSs. These studies suggest that affective judgements about neutral tastes can be learnt, without contingency awareness, through pairing with liked and disliked tastes and that these acquired ratings are resistant to extinction (e.g. Baeyens *et al.*, 1990b, 1995; but see Field & Davey, 1998). However, Stevenson, Boakes & Single (submitted) have provided good evidence that these special characteristics may be peculiar to flavor-taste CS-UCS associations and that extinction, for example, does occur when using colour-taste CS-UCS pairings (see also Stevenson, Boakes & Prescott, in press). These results show that the functional characteristics that have been seen to distinguish EC from other forms of Pavlovian learning, and perhaps EC itself, may be restricted to a very specific type of association (namely flavours paired with liked or disliked tastes).

As a final point, it is worth considering how comparing CSs to exemplars might lead to conditioning-type effects. Much of the research on classification learning has used a fairly standard experimental paradigm that is not dissimilar to the three-stage EC paradigm. Typically (for example see Medin and Schaffer, 1978; Lamberts, 1994), a set of abstract stimuli is constructed of which subjects have no prior experience. The types of stimuli typically consist of several feature dimensions that define to which of two categories they belong. Subjects are first given a training stage where several training stimuli are shown to them and they have to guess to which of two categories the stimulus belongs. The subject is immediately given feedback about whether the decision was correct. Some minutes later, the subjects are given a transfer test where a different set of stimuli is presented: these stimuli contain the same feature dimensions as the training stimuli, but

set in different configurations. Subjects then classify each new stimulus as well as the training stimuli into the same two categories as in the training stage. Typically, these studies show that subjects are able to correctly classify novel categorical exemplars by referring to previously experienced exemplars that they have stored in memory during the training stage of the experiment.

In an EC paradigm, subjects first classify a set of novel stimuli along a conceptual continuum. This baseline stage is similar to the training stage described above except that category membership is determined by the existing conceptual framework that the subjects possess (i.e. liked—disliked). So, instead of subjects categorising novel stimuli and being given feedback, they categorise novel stimuli without feedback (because the correctness of their classifications are entirely subjective). After a conditioning stage, subjects again rate the stimuli along a category continuum: this re-rating of stimuli is analogous to the transfer task in a classification study except that no new stimuli are presented for evaluation. One possible explanation of the results reported in this paper is in the form of an exemplar-comparison model (ECM). The ECM explanation of EC derives from the type of classification learning described in the previous section. The first stage of the EC procedure represents a classification task in which subjects are asked to sort a series of novel stimuli into three categories (like, dislike or neutral). The initial rating stage can be likened to the concept learning stage of a classification experiment, because subjects are required to classify a set of novel stimuli on the basis of conceptual exemplars (which in this case are the exemplars that already exist in their mind). Subjects are likely to store exemplar information during this stage because (1) there is uncertainty about what future experimental task demands might be (Lamberts, 1994), (2) exemplar storage is promoted in situations where category membership is determined by a complex conjunctive or disjunctive combination of features (Brooks, 1976, 1978), and (3) exemplar storage is more likely to be used when the stimuli are complex than when they are simple (Spalding and Ross, 1994 — Experiment 2). These conditions are present in visual EC studies. Therefore, the evidence suggests that although subjects use their existing conceptual framework of like-dislike to

categorise the stimuli during the baseline rating stage of an EC study, they are also likely to store incidentally representative exemplars from the stimulus set while they categorise them.

In the type of classification studies described earlier, subjects use acquired exemplar knowledge to categorise new categorical exemplars (which they can often not distinguish from old test exemplars — see Medin and Schaffer, 1978). Likewise, in EC studies, subjects use the exemplar knowledge acquired during the initial rating stage to re-evaluate the CSs and UCSs. A change in CS evaluation after conditioning could occur because subjects have a new conceptual criterion: during the baseline assessment stage, subjects use their *existing conceptual framework* to categorise the stimuli and in doing so they store representative exemplars that define their categories of like and dislike, but after conditioning, subjects have new information and new stored exemplars that are used to classify the CSs and UCSs. A second possibility is that exposure to the stimuli during condition makes subjects more aware of the similarities between the CSs and the salient exemplars they have stored. Indeed, Experiment 1 suggested that repeated exposure may enhance similarity effects (although these effects exist to a lesser degree even in the absence of repeated exposure). Experiment 2 suggests that subjects compare CSs, on the basis of perceptual similarity, to the exemplars that they have stored during acquisition. When CS-UCS pairings have been constructed on the basis of similarity, this procedure creates the illusion of evaluative conditioning: it ensures that each CS is perceptually similar to its corresponding UCS, which, in turn, is one of the stored exemplars because, by the nature of the paradigm, the UCS is always a salient category exemplar. This account is speculative, but the results of Experiment 2 suggest that it is worthy of further investigation.

## Summary

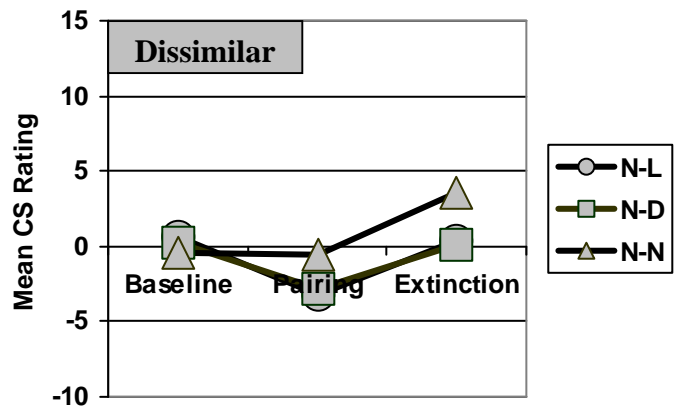
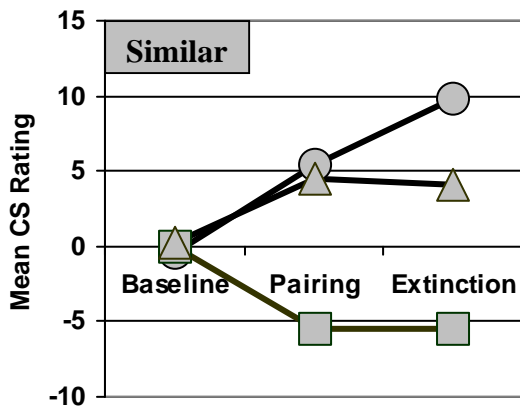
This paper has shown how conditioning-type effects can result, in a visual evaluative conditioning paradigm, from a process quite different from associative learning. The paradigm used was one that was prevalent in the early EC literature, and was used to systematically demonstrate

some of the well-accepted functional characteristics of EC. The present study casts doubt over this early work and highlights the need to use controls for association such as the BSB and no-treatment controls before presuming that conditioning-type effects are actually associative in nature. Whilst evidence remains that EC exists outside of the visual modality, the present paper questions whether EC using only visual stimuli is an associative phenomenon. From the results of the present studies it also seems advisable that the functional characteristics of EC be *systematically* demonstrated outside of the visual paradigm. Only then can we be confident that EC is a functionally distinct, associative phenomenon.

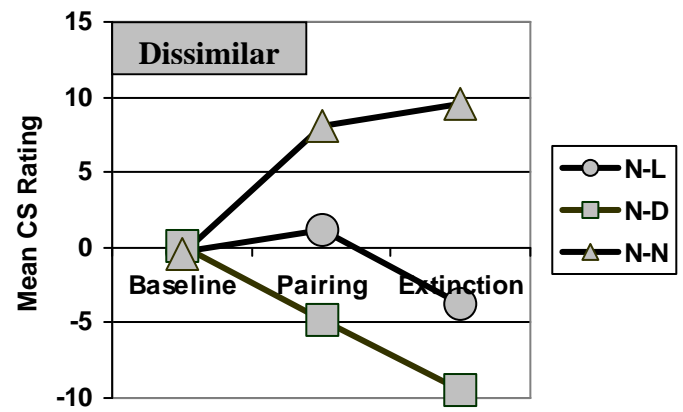
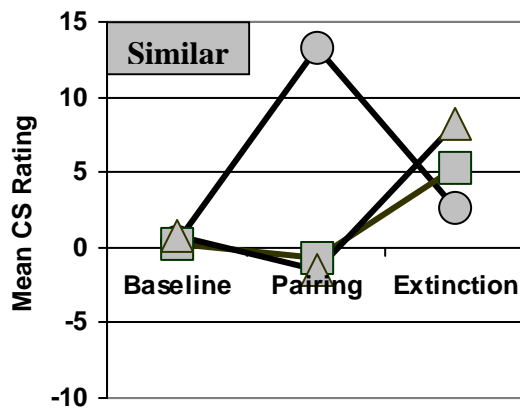
## FIGURE CAPTIONS

- Figure 1** Graphs showing the mean CS ratings at each stage of the experiment according to whether the pairings were perceptually similar, or perceptually dissimilar.
- Figure 2** Graphs showing the mean CS ratings before conditioning, after conditioning and after an extinction procedure according to whether the CS was paired with a Liked, Disliked or Neutral UCS.
- Figure 3** Graphs to show the mean CS ratings at the baseline, postconditioning and postextinction assessment stages of Experiment 2. CSs are divided into those that were most similar to the subject's liked category exemplars and those most similar to the subject's disliked category exemplars.

### Paired Condition



### BSB Control



### No Treatment

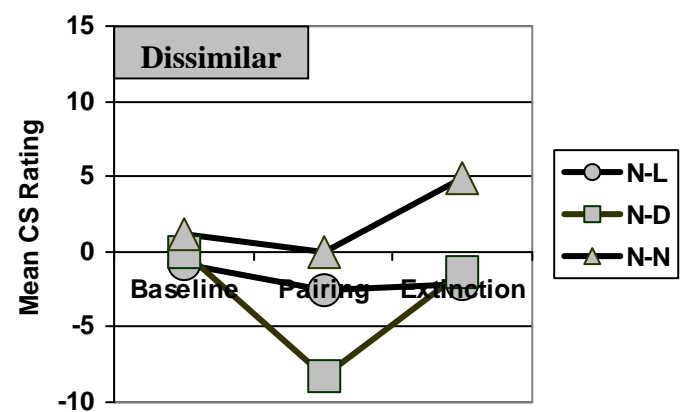
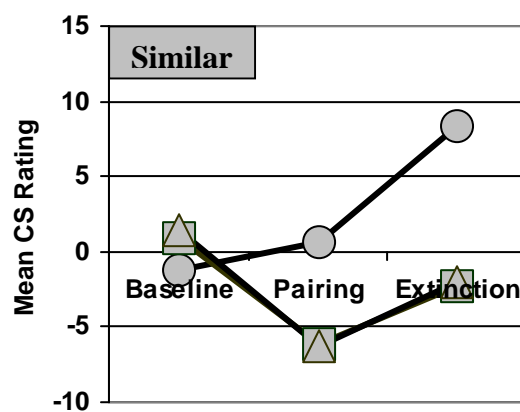


Figure 1

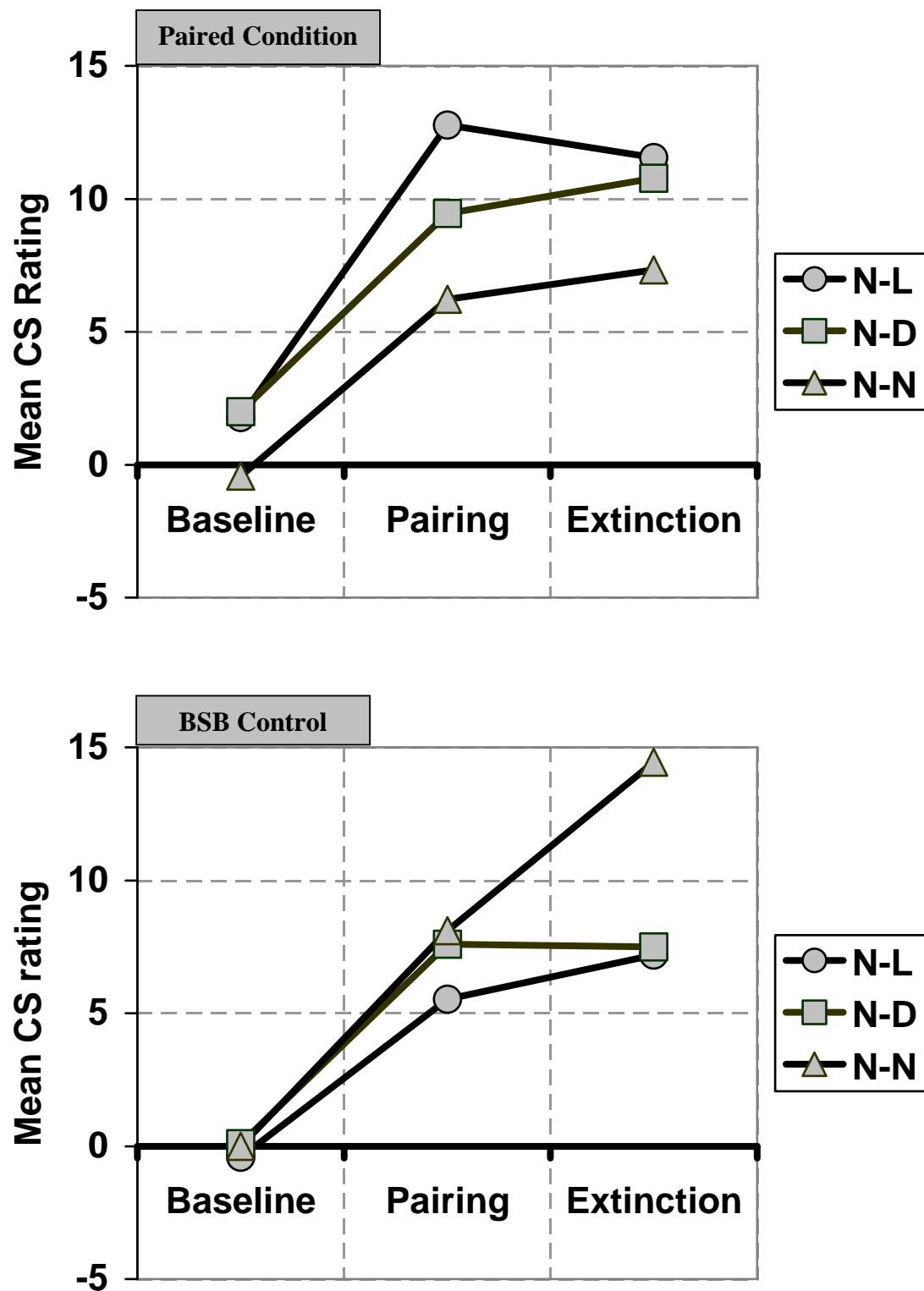


Figure 2



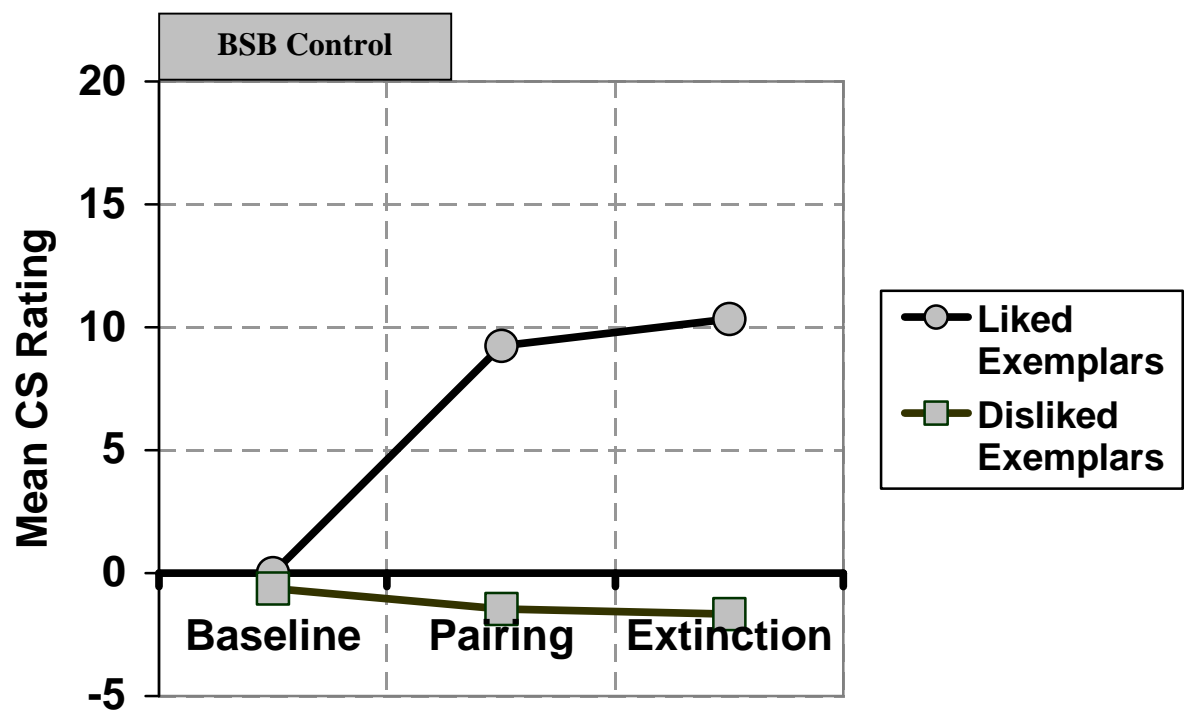
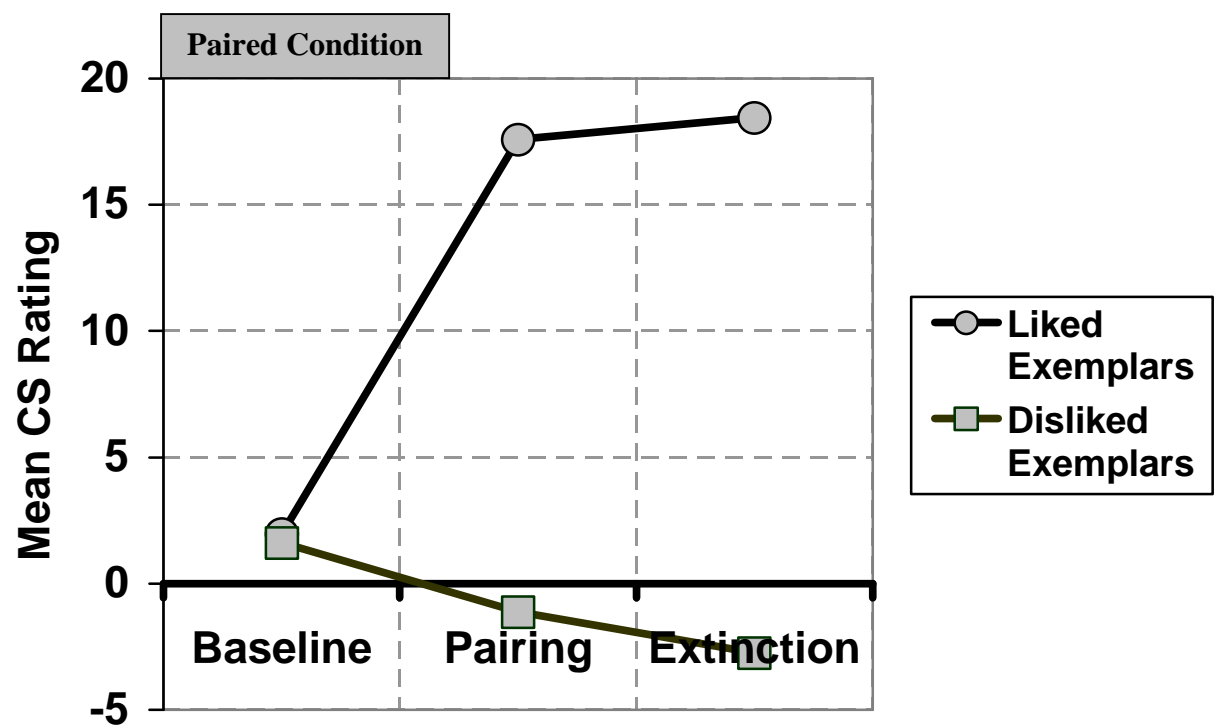


Figure 3

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