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Evaluative Conditioning May Incur Attentional Costs

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Evaluative conditioning (EC) refers to changes in the liking of an affectively neutral stimulus (*conditioned stimulus*, or CS) after pairing this stimulus with an affect-laden stimulus (*unconditioned stimulus*, or US). Several authors proposed that EC incurs little or no attentional cost. Using a rigorous design, we provide evidence that a reduction in attentional resources may have a negative impact on EC. Additional analyses also revealed that participants correctly encoded fewer CS–US pairings when their attentional resources were depleted. Replicating Pleyers, Corneille, Luminet, and Yzerbyt's (2007) findings, EC was also obtained only for CSs that could be correctly linked to their associated US in the context of an identification task. This research clarifies the role of higher order processes in EC and has significant practical implications.

Keywords: evaluative conditioning, affective learning, memory, attitudes, advertising

Evaluative conditioning (EC) consists of assimilating the valence of a neutral stimulus (the *conditioned stimulus*, or CS) to that of an affective stimulus (the *unconditioned stimulus*, or US) subsequent to the CS–US pairing. EC is a robust phenomenon (De Houwer, Baeyens, & Field, 2005) with a wide range of applications in the commercial (e.g., Stuart, Shimp, & Engle, 1987; Walther & Grigoriadis, 2004), sociopsychological (Walther, Nagengast, & Trasselli, 2005), and political (Pleyers, 2006; Razran, 1954) domains. Unfortunately, despite decades of research on EC, the mechanism underlying EC and its moderators remain poorly understood (De Houwer et al., 2005). In particular, the critical role of attentional resources has been examined only in a handful of studies that have led to contradictory conclusions.

Obtaining evidence for the role of attentional resources in EC has important theoretical and practical implications. At a theoretical level, several researchers equated EC with a low-level learning process that incurs little or no attentional cost (e.g., Fulcher & Hammerl, 2001; Walther, 2002; Walther et al., 2005) and emerges independently of participants' awareness of the CS–US pairings (Baeyens, Eelen, & Van den Bergh, 1990; Fulcher & Cocks, 1997; Hammerl, Bloch, & Silverthorne, 1997; Hammerl & Grabitz, 2000; Levey & Martin, 1975, 1987; Martin & Levey, 1987; Trodank, Byrnes, Wrzesniewski, & Rozin, 1995). Hence, showing that EC is impaired by a shortage in attentional resources and is associated with a state of awareness would suggest that this process may be less automatic than some have proposed (Moors & De Houwer, 2006). A clarification of the role of attentional resources in EC also has important practical implications. If EC is impaired by a shortage in attentional resources, EC should be easier to obtain when individuals (e.g., patients, consumers) are employing their full attentional resources during the conditioning procedure.

Only four published studies have examined the influence of attentional resources in EC. Walther (2002, Experiment 5) asked participants to remember an eight-digit number during the conditioning phase. She found a marginally smaller EC effect ($p = .07$) in the no-load condition than in the load condition, therefore suggesting a negative impact of attentional resources in affective learning through evaluative conditioning. In contrast to Walther's finding, Field and Moore (2005, Experiment 1) obtained a reduced EC effect among participants whose secondary task consisted of counting backward from the Number 300. Regrettably, this group was only compared to an "attention enhanced" group, making it impossible to conclude whether attention reduction or attention enhancement contributed to their findings. Finally, in two prior experiments, Fulcher and Hammerl (2001, Experiments 1 & 2) asked half of the participants ($N = 12$) to solve arithmetical problems presented acoustically while they were visually exposed to the CS–US pairings. The remaining participants were explicitly asked to pay attention to the pairings in the absence of a secondary task. The authors found a significant EC effect in the former condition. This effect was also larger than the one observed in the condition in which participants received attention instructions.

In sum, past research provided mixed findings regarding the role of attentional resources in EC. Walther (2002) reported EC to be marginally larger in conditions of attention reduction. Field and Moore (2005) obtained a significantly smaller EC effect in conditions of attention reduction, but directly compared attention reduction to attention enhancement conditions. Finally, Fulcher and Hammerl (2001) obtained a significantly larger EC effect in condition of attention reduction compared to a condition in which participants were explicitly asked to take note of the CS–US pairings during the learning phase.

In this research, we set out to gather further evidence for the role of attentional resources in EC. We predicted that EC would suffer from a depletion in attentional resources. Our hypothesis was consistent with recent work by Pleyers, Corneille, Luminet, and

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Yzerbyt (2007) who proposed that, given the use of appropriate designs and sensitive measures and analyses for the role of contingency awareness in EC, EC effects can be shown to emerge only when there is awareness for the CS–US pairings (for similar recent demonstrations, see Dawson, Rissling, Schell, & Wilco, 2007; Wardle, Mitchell, & Lovibond, 2007). In line with Lovibond and Shanks (2002); Pleyers et al. argued that studies that concluded otherwise were problematic either in their method (i.e., inappropriate designs, insensitive measures of contingency awareness), in their analyses, or even in both of these aspects. Given the space constraints for the present report, interested readers may want to consult Pleyers et al. (see also Lovibond & Shanks, 2002) for a detailed treatment of this point. In that paper, we also discussed why "subliminal EC" studies should be interpreted with caution.

Specifically, if EC emerges on contingency-aware items only and if participants' ability to store the CS–US pairings depends on their attentional resources, then participants whose attentional resources are depleted should show on average both less contingency awareness and less EC. Consistent with this reasoning, we predicted on average a worse memory for CS–US pairings among participants whose attentional resources were depleted than among control participants. We also predicted on average less EC among participants whose attentional resources were depleted than among control participants. Although less central to the aim of the present research, we also predicted that the correctly encoded CS–US pairings in the attention reduction condition, even if less numerous, would be as likely to lead to EC as the many correctly encoded CS–US pairings observed in the control condition.

Method

Participants and Design

Seventy-seven French-speaking undergraduate students at the Catholic University of Louvain at Louvain-la-Neuve (Belgium) participated for course credits. They were randomly assigned to the two conditions of 2 (Attentional resources: control vs. reduced) × 2 (CS type: CS^+ [i.e., CS paired with an US of positive valence vs. CS^- [i.e., CS paired with an US of negative valence]) mixed design with the first factor varying between participants and the second one varying within them.

Conditioning Materials

CSs. The eight CSs were common consumption products. The brands used were unknown to the participants. Each CS was also pretested to (a) elicit a neutral affective response[1] and (b) be different from existing brands within the product category.

USs. The eight USs consisted of four positive (USs^+) and four negative (USs^-) pictures taken from the International Affective Picture System (IAPS ; Lang, Bradley, & Cuthbert, 1999). The US pictures were chosen to be nongender-specific. As indexed by the IAPS data, the USs^+ and USs^- were of opposite valence but of equivalent emotional intensity. The IAPS numbers of the US pictures are reported in Appendix A.

Procedure

Participants were tested in a computer room in groups from 3 to 10 individuals. They were greeted by a male experimenter and seated in front of an individual computer. The first screen displayed the instructions whose specific content varied as a function of the condition.

The 39 participants assigned to the control condition received the following instructions:

> The study deals with perceptual processing of various stimuli. It comprises two phases. In the first phase, you will see various stimuli appearing on the screen. These stimuli will be presented in a random order by the computer program (you don't have to memorize them, no recall task will be used). In the second phase, you will simply be asked to spontaneously answer a set of questions. Please put on your headphones and press the spacebar to start the experiment.

As for the 38 participants assigned to the attention reduction condition, they received the following instructions for a concurrent two-back task:

> The study deals with perceptual processing of various stimuli. It comprises two phases. In the first phase, you will be submitted to a relatively simple attention task: you will be hearing a series of numbers through your headphones. Press the spacebar as quickly as possible when a number is identical to the one you heard "two places before" (for instance, if you hear the number "7" and before that you heard a "3" and before that a "7"). At the same time as you will be performing this task, please look at your screen, on which the computer will randomly display various distracting pictures. In the second part of the experiment, you will simply be asked to spontaneously answer a set of questions. Please put on your headphones and press the spacebar to start the experiment.

All participants then put on headphones that played neutral music to the participants assigned to the control condition[2] and numbers to the ones assigned to the "depletion condition" during the conditioning phase of the experiment. The conditioning phase relied on a procedure similar to the one used by Pleyers et al. (2007). For each participant, four CSs were superimposed on a positive picture (CSs^+) and 4 CSs were superimposed on a negative picture (CSs^-). An example of CS–US^+ and of CS–US^- is shown in Figures 1 and 2. We chose to superimpose the CS on the US to improve the ecological validity of our research as most advertisement strategies based on EC effects make use of simultaneous CS–US presentations. More important to the present research, prior work by Pleyers et al. also showed that this procedure is conducive of EC effects on both valence acquisition and product evaluation.

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[1] This pretest was carried out by asking 48 participants (different from those who took part in the experiment) to express their spontaneous feelings towards a set of 20 unknown brand products whose presentation order was counterbalanced across the pretest participants. Each product was evaluated by means of a Likert-type scale ranging from 1 (*negative feelings*) to 7 (*positive feelings*). We selected 8 products as the critical CSs. These products pertained to different categories (to avoid, for example, having two CSs depicting toothpaste) and none of their ratings differed significantly from the midpoint of the scale (M = 4.23, SD = 1.10), $t(47)$ = 1.45 for CS1; (M = 3.92, SD = 1.13), $t(47)$ = –.51 for CS2; (M = 4.21, SD = 1.07), $t(47)$ = 1.35 for CS3; (M = 4.08, SD = 1.20), $t(47)$=.48 for CS4; (M = 4.02, SD = 1.25), $t(47)$=.12 for CS5; (M = 4.25, SD = 1.18), $t(47)$=1.47 for CS6; (M = 4.19, SD = .94), $t(47)$ = 1.39 for CS7; (M = 4.06, SD = 1.19), $t(47)$=.36 for CS8.

[2] This neutral music, "Common Tones in Simple Time" by John Adams (1979), was tested and used by Niedenthal and Halberstadt (2000).

For any given participant, a given CS picture was always paired with the same US picture. CS–US assignments were counterbalanced across participants (four different CS–US assignments were used). Even though this procedure does not guarantee that all CSs were neutral for each participant (despite the pretest), it contributes to making slight variations in CS evaluations fairly evenly distributed across conditions. This procedure rules out undesirable stimulus selection effects (e.g., Field & Davey, 1999). The CS–US pairings appeared five times for 1 s each and were presented in a random order at the center of the screen.

Following the conditioning phase, participants removed their headphones and evaluated the CSs. They were asked to spontaneously express their global feelings toward the CSs (the order of which was counterbalanced) on a 9-point scale ranging from 1 (*very negative feelings*) to 9 (*very positive feelings*).[3] A given CS was presented at the center of the screen (using the same size as in the conditioning phase) with the global feelings scale presented beneath it

Finally, participants completed the awareness assessment task. For each of the eight CS pictures (the order of which was randomized), participants were presented with eight US pictures used during the conditioning phase and asked to indicate (by hitting the correspondent number of the US on the keyboard) the one with which it had been paired. They could also respond "I don't know" by pressing the number "9." Similar to Pleyers et al. (2007, Experiments 2 & 3), we asked participants to report the content instead of the valence of the CS picture in the awareness task to minimize the risk that participants would simply infer the valence of the US on the basis of their feeling toward the (acquired) valence of the CSs. If they selected an US, they were asked to communicate how confident they were about their answer by indicating a number ranging from 1 (*quite uncertain*) to 6 (*quite certain*).[4]

When all participants had completed the dependent measures, they were debriefed, thanked, and dismissed.

Results

Attentional Resources and Awareness

A CS was categorized as "contingency aware" when the US with which it was paired was correctly identified. CSs that did not meet this criterion were categorized as "contingency unaware." Out of a maximum of eight, the mean number of contingency-aware items was 4.06 ($SD = 2.83$) when considering all participants. Confirming the success of our attention reduction manipulation and in line with predictions, the number of contingency aware items was significantly larger among control participants ($M = 5.77$, $SD = 2.45$) than among participants whose attentional resources were depleted ($M = 1.68$, $SD = .98$), $t(65) = 8.34$, $p < .001$. In other words, participants were less able overall to correctly report the CS–US pairings when their attentional resources were reduced than when they were not.

Attentional Resources and EC

We ran a mixed-design analysis of variance (ANOVA) to examine the mean evaluation of the CSs as a function of resources and CS type. A significant effect of valence emerged, with more positive ratings of the CSs$^+$ than of the CSs$^-$ ($M_{CSs+} = 5.04$, $SD_{CSs+} = 1.55$ vs. $M_{CSs-} = 4.36$, $SD_{CSs-} = 1.27$), $F(1, 76) = 11.53$, $p < .002$. Thus, evidence was obtained for an EC effect. More important, we obtained a significant CS Type × Resources interaction, $F(1, 76) = 9.1$, $p < .005$. Complementary analyses revealed that CSs$^+$ were evaluated more positively than CSs$^-$ in the control condition ($M_{CSs+} = 5.60$, $SD_{CSs+} = 1.39$ vs. $M_{CSs-} = 4.35$, $SD_{CSs-} = 1.15$), $F(1, 38) = 16.29$, $p < .001$, whereas they were not in the attention reduction condition ($M_{CSs+} = 4.46$, $SD_{CSs+} = 1.50$ vs. $M_{CSs-} = 4.36$, $SD_{CSs-} = 1.39$), $F(1, 37) = .20$, *ns*. This pattern supports our prediction that EC is less likely to emerge when participants' attentional resources are reduced.

Complementary Analyses for the Role of Resources and Awareness in EC

Pleyers and colleagues (2007) argued that past research that failed to provide evidence for the role of awareness in EC relied on problematic designs and/or relied on awareness measures and analytic strategies that lacked sensitivity. As a matter of fact, they recommended that item-based rather than group-based analyses be conducted to achieve greater sensitivity when examining the role of contingency awareness in EC. Obviously, the group-based analyses reported above were sensitive enough to confirm the impact of contingency awareness at the group level, with less EC obtained on average in those conditions in which participants' attentional resources were depleted and their awareness for the CS–US pairings on average weaker. Consistent with the recommendation of Pleyers and colleagues, we nevertheless decided to run complementary item-based analyses for examining the role of attentional resources and contingency awareness in EC.

To conduct these item-based analyses, we first standardized participants' evaluations of the eight CSs within each participant. We then multiplied the obtained scores by a vector representing the valence of the USs (-1 for US$^-$ and $+1$ for US$^+$) with which the CSs were paired. For each participant, these eight scores thus indicated whether the EC effect was present and in the expected direction (i.e., congruent or not with the valence of the associated US, with positive scores indicating congruency). These scores then served as the criterion variable in a within-subject regression analysis using the corresponding awareness score as the predictor (0 = *unaware* and 1 = *aware*). This resulted in two unstandardized coefficients for each participant, one for the intercept (i.e., corresponding to the EC effect found on items for which participants were unaware of the contingency) and one for awareness

[3] Participants also evaluated each CS on three specific evaluative dimensions (attractiveness, pleasantness, intention to purchase the product) but these dependent measures did not reveal consistent results (and, therefore, will not be considered further). Actually, specific dimensions do not seem appropriate for assessing EC effects. Indeed, various researchers have mentioned that they found EC effects only when participants were strongly encouraged to evaluate the stimuli on the basis of their immediate and spontaneous feelings and were invited not to think too much about their evaluation (De Houwer, Baeyens & Field, 2005).

[4] The confidence measure did not reveal significant results and will not be discussed further. The correlation between the EC effect and the mean level of confidence on the contingency aware CS–US pairings was r=.23 for the global feelings and r=.17 for the evaluative index.

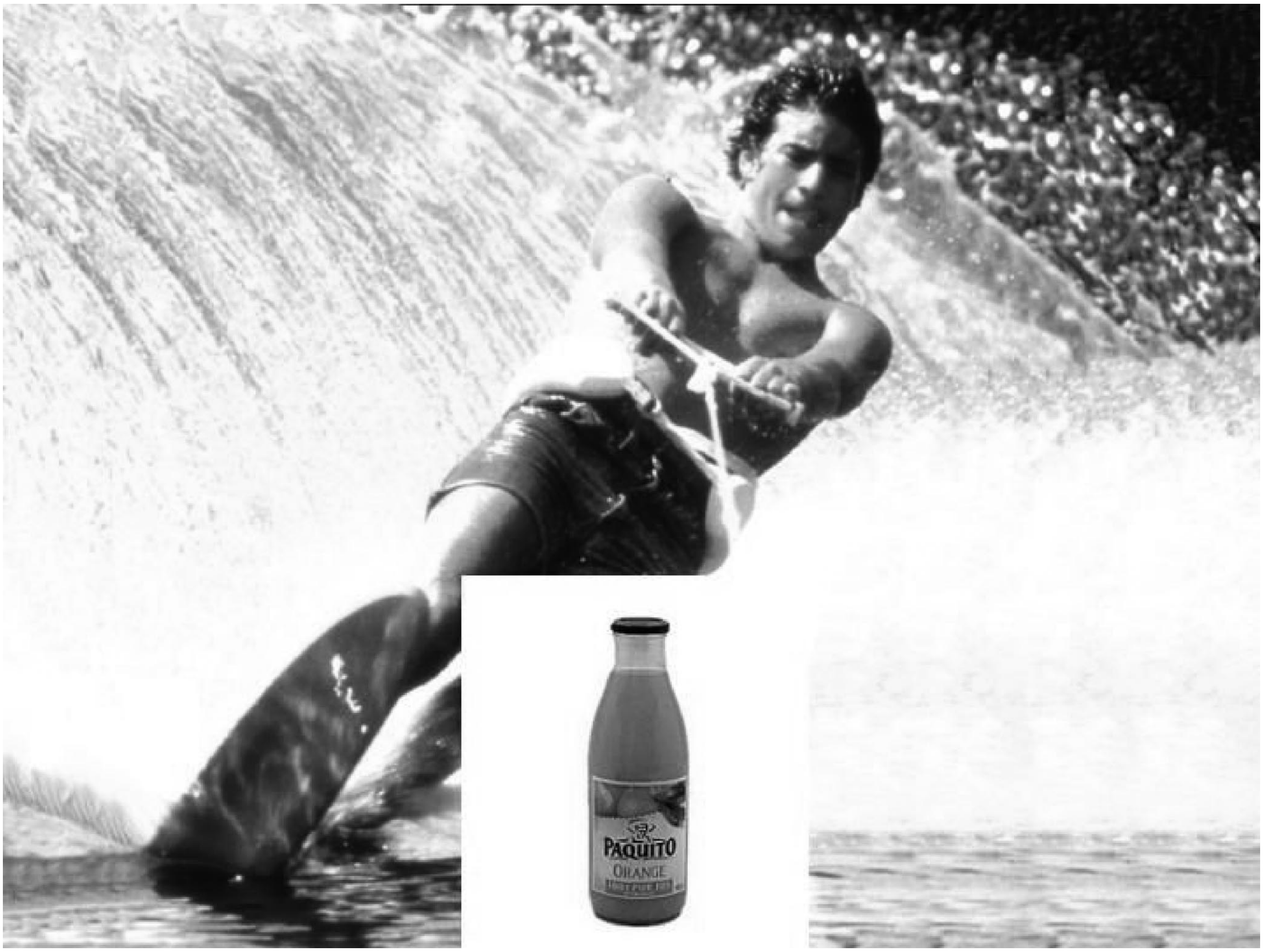

Figure 1. Example of CS–US$^+$.

(i.e., corresponding to the EC effect found on items for which participants were aware of the contingency).

These coefficients were then entered as criterion in two separate between-subjects regressions with attentional resources as the predictor (-1 = *depleted* and 1 = *control*). The EC effect shown by participants on the unaware items was neither different from 0, $b = -.01$, $t(48) = -.23$, *ns*; nor affected by attentional resources, $b = .02$, $t(48) = .28$, *ns*. In sharp contrast, contingency awareness led to the emergence of a significant EC effect. $b = .28$, $t(48) = 2.10$, $p < .05$, which was not moderated by attentional resources, $b = -.02$, $t(48) = -.12$, *ns*. In other words, EC was obtained only on those items that were associated with a state of awareness and, although these stimuli were less numerous in the attention reduction than in the control condition, they led to the same EC effect in both conditions.

Discussion

The present report aimed at gathering further evidence on the role of attentional resources in EC for visual stimuli. Despite the theoretical importance and practical implications of this issue, we could locate only a limited number of relevant studies. Moreover, the available empirical work is often characterized by methodological limitations resulting, not surprisingly perhaps, in inconsistent conclusions. Whereas some authors suggested that EC may be impaired by a shortage in attentional resources, others concluded that EC may actually benefit from it. The latter conclusion would be supportive of the view that EC consists of a low-level learning device that incurs little to no attentional cost. The present experiment relied on a design in which we reduced the attentional resources of half of the participants and then examined the EC along with their contingency awareness as measured in the context of an identification (rather than recall) task. The data provide evidence that a reduction in attentional resources can be detrimental to valence acquisition through EC.

A critical reader may argue that the reason why no EC occurred in the attention reduction condition is that participants in this condition simply did not look at the computer screen when completing the arithmetic task. We deem this possibility unlikely for a variety of reasons. First, the attentional load was manipulated in an acoustic modality whereas the CS–US pairings were presented on

Figure 2. Example of CS–US^{-}.

a visual modality. Thus, nothing prevented participants from looking at the pairings as they completed the concurrent task. Second, instructions in the "resources depletion" condition insisted on the necessity of continuously looking at the screen. Third, the experimenter carefully attended to each experimental session in order to ensure that all participants followed the instructions.

To further ensure that participants in the attention reduction condition actually monitored the visual information presented on the screen, we decided to run a follow-up study with a new sample of 13 participants submitted to the "resources depletion" condition. Immediately after their exposure to the pairings, participants were given a sheet of paper that depicted (in a mixed and counterbalanced order) the 8 previously presented CSs intermixed with 8 previously unseen brand products of similar categories (e.g., yoghurt, honey). Participants were asked to select, among the 16 products, the 8 products they had seen in the exposure phase of the experiment (i.e., during the conditioning phase). They were 76% accurate in this identification task, an identification performance that is well above chance level, $t(12) = 6.72$, $p < .001$. Observing such a high level of recognition accuracy is very unlikely if participants had been blind to the visual information presented on the screen.

A tricky issue is whether the attentional load decreased participants' ability to encode the CSs, the USs, or the CS–US pairings. To be sure, encoding a pairing can hardly take place without encoding its components. In any event, it would be interesting to clarify which type of encoding is specifically impaired by attentional load. Clearly, the present research cannot answer this question. However, our argument is somewhat remote from the latter issue. In our view, EC effects have the potential to emerge when a CS–US pairing is successfully encoded in memory whereas it may not emerge when this pairing is not successfully encoded, irrespective of whether this unsuccessful encoding concerns the CS–US associative link or its isolated components.

Consistent with this reasoning, the present findings suggest that when their attentional resources were depleted, participants were less able to correctly encode the CS–US pairings. Because EC may not emerge in the absence of awareness of the CS–US pairings, EC may then become less likely to emerge overall. It is worth noting here that contingency-aware individuals may also use attentional resources that are available to them for correcting the contaminating influence of the pairings if motivated to do so. The latter process may prevent EC from occurring among contingency-aware participants, and might even occasionally lead to contrastive EC effects. Yet, given a severe shortage of attentional resources, EC may be unlikely to emerge in the first place.

At the theoretical level, the present set of finding dovetails nicely with the "strong single-process model" of conditioning proposed by Lovibond and Shanks (2002). Yet, factors other than attentional resources may also exert an impact on EC by promoting or preventing contingency awareness. For instance, it may be assumed that "need for cognition" (e.g., Cacioppo & Petty, 1982), a personality variable reflecting the extent to which people engage in and enjoy effortful cognitive activities, could increase the cognitive processing of the stimuli presented in an EC procedure, thus enhancing the awareness of the CS–US contingencies and (consequently) the EC effects. Admittedly, the possibility also exists that attentional resources exert independent influences on EC and on contingency awareness.

Yet another possibility is that enhanced attentional resources and contingency awareness led to more EC by enhancing demand awareness among participants unwilling to correct for the contaminating influence of EC effects. According to this account, contingency awareness would magnify EC effects by increasing participants' motivation to please the experimenter. Presumably, participants would do so by evaluating the CS along the valence of it's associated US. We consider that this account in terms of demand characteristics is unsatisfactory for at least three reasons. First, by definition, participants can please the experimenter only when they are aware of the content of the CS–US contingency. If they are not, they find themselves unable to do so. Hence, this demand account ought to be consistent with the view that contingency awareness is needed for EC to occur. Second, in the present research EC effects on contingency aware CSs were of the same magnitude in the control condition (in which a high number of CS–US pairings were correctly reported) as in the depletion condition (in which a low number of CS–US pairings were correctly reported). Thus, although these conditions likely varied with regard to the amount of experiment demand they elicited, they led to similar conclusions as far as the role of awareness in EC is concerned. Finally, and perhaps even more important, Pleyers et al. (2007; Experiment 3) provided evidence for the role of contingency awareness in EC by relying on an implicit evaluative measure, a procedure that prevents participants from controlling their evaluations of the CS. In other words, these authors provided evidence suggesting that the impact of contingency awareness on EC may already operate at the valence acquisition stage.

Whatever the specific causal mechanism involved, the present research questions the idea that EC is a low-level (i.e., implicit, automatic) learning mechanism. Indeed, we found EC to be sensitive both to people's amount of attentional resources and to their awareness of the CS–US pairings. At the practical level, the present research stresses the importance of ensuring that individuals can count on a respectable level of attentional resources when one is seeking to change their attitudes through an EC procedure. In the marketing domain, for instance, the present conclusion justifies efforts made and new technologies used (e.g., animated or flagrant advertisings) for catching consumers' attention as they are performing secondary tasks (e.g., driving).

As a final note of caution, we would like to emphasize here that the present research does not pretend to settle the issue once and for all. In particular, we would like to note that the present findings were obtained on visual materials. As already mentioned, De Houwer et al. (2005) warned that the processes involved in EC may notably depend on the nature of the stimuli used. Although it may be pointed out that recent studies support the decisive role of contingency awareness in EC when using other kinds of stimuli (e.g., Wardle et al., 2007), future research should definitely examine the extent to which our findings generalize to other materials, and possibly to other experimental designs, to improve our understanding of the processes underlying EC.

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Appendix

IAPS Numbers of the USs Used

Valence	IAPS numbers
USs+	4608, 4700, 8200, 8460
US−	2715, 2750, 6360, 6561

Note. IAPS = International Affective Picture System; US = unconditioned stimulus.

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