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Dissociating Contingency Awareness and Conditioned Attitudes: Evidence of Contingency-Unaware Evaluative Conditioning

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Whether human evaluative conditioning can occur without contingency awareness has been the subject of an intense and ongoing debate for decades, troubled by a wide array of methodological difficulties. Following recent methodological innovations, the available evidence currently points to the conclusion that evaluative conditioning effects do not occur without contingency awareness. In a simulation, we demonstrate, however, that these innovations are strongly biased toward the conclusion that evaluative conditioning requires contingency awareness, confounding the measurement of contingency memory with conditioned attitudes. We adopt a process-dissociation procedure to separate the memory and attitude components. In 4 studies, the attitude parameter is validated using existing attitudes and applied to probe for contingency-unaware evaluative conditioning. A fifth experiment incorporates a time-delay manipulation confirming the dissociability of the attitude and memory components. The results indicate that evaluative conditioning can produce attitudes without conscious awareness of the contingencies. Implications for theories of evaluative conditioning and associative learning are discussed.

Keywords: evaluative conditioning, multinomial modeling, attitude formation, contingency awareness, process-dissociation procedure

Evaluative conditioning (EC) is defined as the change in liking of a conditioned stimulus (CS) caused by its co-occurrence in close spatiotemporal proximity with valent, unconditioned stimuli (US; De Houwer, Thomas, & Baeyens, 2001). The degree to which the co-occurrence of CS and US is consciously recognized has been termed contingency awareness. Whereas there is more or less general agreement that the effects of classical, Pavlovian conditioning do not occur without contingency awareness (Brewer, 1974; Holyoak, Koh, & Nisbett, 1989; Lovibond, 2003), this very property is highly contested for EC. The difference is deemed to result from the fact that whereas the CS in a Pavlovian conditioning paradigm acquires a *predictive value* for the US, the CS in an EC paradigm merely needs to attain the *affective quality* of the US (De Houwer et al., 2001; Gawronski & Bodenhausen, 2006). Therefore, EC has been considered more likely to occur without awareness than other forms of conditioning or associative learning, and empirical evidence supporting this conjecture has repeatedly been presented (Baeyens, Eelen, Crombez, & Van den Bergh, 1992; Jones, Fazio, & Olson, 2009; Martin & Levey, 1994; Olson & Fazio, 2001, 2002, 2006; Sweldens, van Osselaer, & Janiszewski, 2010; Walther & Nagengast, 2006). However, more recent studies featuring methodological improvements in the measures of contingency awareness have consistently failed to find evidence for unaware EC (Bar-Anan, De Houwer, & Nosek, 2010; Dedonder, Corneille, Yzerbyt, & Kuppens, 2010; Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Stahl & Unkelbach, 2009; Stahl, Unkelbach, & Corneille, 2009). This is important not just for the study of EC but also for the broader conceptualization of human learning and memory. For example, the recent failure to find evidence of unaware EC has resulted in a strong backlash against dual process theories that differentiate between associative and propositional routes of learning (e.g., Gawronski & Bodenhausen, 2006; Hayes & Broadbent, 1988; Sloman, 1996; Smith & DeCoster, 2000; Strack & Deutsch, 2004). As unaware associative learning could not even be demonstrated in the evaluative domain (where it was deemed most likely to occur), theorists have started to challenge the epistemological value of the entire dual process conceptualization (Kruglanski & Gigerenzer, 2011; Mitchell, De Houwer, & Lovibond, 2009).

The main reason why there has been so much discussion and disagreement about the possibility of unaware EC stems from the many methodological difficulties inherent in this topic (Lovibond

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& Shanks, 2002; Pleyers et al., 2007). In this article, we first provide a brief overview of the methodological evolution in contingency awareness measures. We then argue that recent methodological advances intrinsically favor the conclusion that EC depends on contingency awareness to the extent that they make it practically impossible to demonstrate unaware EC. As we show below, the major problem is that they confound the measurement of contingency memory with the measurement of conditioned (and preexisting) affect. Next, we propose a new methodology based on a process-dissociation procedure (Jacoby, 1991), which allows dissociating the effects of memory for the CS–US pairings from the conditioned attitudes proper. In five studies, we test and validate the methodology's applicability and present evidence that EC can, in fact, establish attitudinal effects independent of one's memory of the CS–US pairings.

The Evolution of Contingency Awareness Measures

Investigations of contingency awareness in EC have often measured contingency awareness at the participant level and generally supported the conclusion that EC can occur without awareness of the CS–US contingency (Baeyens, Crombez, Van den Bergh, & Eelen, 1988; Baeyens et al., 1992; Baeyens, Eelen, & Van den Bergh, 1990; Fulcher & Hammerl, 2001; Hammerl & Fulcher, 2005; Jones et al., 2009; Martin & Levey, 1994; Olson & Fazio, 2001; Walther & Nagengast, 2006). However, the classification of participants as aware versus unaware has been criticized for being insensitive to differential learning during attitude acquisition because typically neither all nor none of the CS–US contingencies are remembered (Field, 2000; Pleyers et al., 2007; Shanks & St. John, 1994). Thus, Pleyers and colleagues (2007) argued convincingly that a more fine-grained analysis is necessary. Specifically, they argued, one should differentiate within participants the EC effect for CSs with and without contingency awareness. In other words, the analysis has to be CS-based, rather than participant-based. They proposed a CS–US identity measure of contingency awareness in which participants indicate for every CS the exact US it was paired with in the conditioning phase. The next step involves comparing within subjects the EC effect on "aware CSs" (for which the correct US was indicated) with the EC effect on "unaware CSs" (for which an incorrect US was indicated). Pleyers and colleagues failed to find evidence for unaware EC with this CS-based measure. A recent meta-analysis confirmed their findings by showing a strong impact of contingency awareness on EC such that only contingency-aware CSs produce significant EC effects (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010).

More recently, another methodological improvement has been proposed in which the CS-based measurement of contingency awareness is retained but CS–US valence awareness replaces CS–US identity awareness as the appropriate level of measurement (Stahl & Unkelbach, 2009; Stahl et al., 2009). Stahl and colleagues (2009) argued that awareness tests should probe participants' memory for US valence, that is, whether a particular CS was paired with positive or negative USs, rather than probe for the specific US identity. After all, even if the US identity cannot be retrieved, participants could still be aware of the US valence. For example, participants might not remember that a particular CS occurred with a specific positive stimulus but could remember that the CS occurred consistently with something positive. Therefore, to substantiate the claim that EC occurs without memory of the CS–US pairings, the EC effect should be demonstrated independently of such valence awareness. Furthermore, strict US identity measures are only suitable when a CS is always presented with the same US (e.g., Pleyers et al., 2007), but they are not suitable in many studies where a CS is presented with multiple, different USs sharing the same valence (Jones et al., 2009; Olson & Fazio, 2001, 2002, 2006; Olson, Kendrick, & Fazio, 2009; Stahl & Unkelbach, 2009; Sweldens et al., 2010). In their studies featuring CS-based valence awareness analyses, Stahl and colleagues did not find evidence for EC with unaware CSs for which an incorrect US valence was recalled. Surprisingly, in some studies, they even found a reversed EC effect for these unaware CSs.

The critiques by Pleyers and colleagues (2007) and Stahl and colleagues (2009) of previous methodologies are entirely justified, and their CS-based contingency awareness measures are an important improvement. Yet, while we fully agree with Stahl and colleagues that the investigation of US valence awareness is of primary importance, there are important shortcomings in the CS-based valence awareness methodology. As we show below, the method is biased toward the conclusion that EC depends on participants' conscious knowledge of the contingencies. In the following section, we explain why there is, once again, a need for an updated methodology.

Confounding Memory With Conditioned Attitudes in Valence Awareness Measures

There are statistical reasons why CS-based valence awareness measures make it harder to detect unaware EC. As Stahl and colleagues (2009) reported, CS–US pairings are remembered above chance, leading to higher frequencies of aware classifications than of unaware classifications and hence to higher statistical power for aware CSs compared with unaware CSs.[1] Whereas such problems could potentially be solved by increasing statistical power (Bar-Anan et al., 2010), a more fundamental problem arises from the cognitive processes underlying responses in the memory task. When answering the question "Was this [CS] paired with positive or negative images?", participants would likely first rely on their explicit memory of US valence to determine their response. However, in the absence of explicit memory, they would trust their feelings toward the CS to answer this question, relying on affect-as-information (Schwarz & Clore, 1983). After all, the conditioned attitude can serve as a valid cue for the correct response, and two correlational studies by Bar-Anan and col-

[1] A universal finding in all the studies investigating US valence awareness (Pleyers et al., 2007; Stahl & Unkelbach, 2009; Stahl et al., 2009) is that US valence is remembered above chance. It is important to point out, however, that this does not necessarily mean that participants really have explicit memory for the US valence for such a large proportion of CSs. As pointed out in the simulation below, even if participants merely remember US valence for 50% of the CSs, they would still appear to be aware for at least 75% of CSs in a US valence awareness test if they rely on CS attitudes in the absence of clear US valence memory. Moreover, it could also be proven that even in the complete absence of explicit US valence memory (i.e., when participants are truly unaware), US valence awareness would still appear above chance as long as EC influences CS attitudes and participants rely on their CS attitudes in the US valence awareness test.

leagues (2010) demonstrated that participants in fact do rely on their attitudes when answering the memory question. This is highly problematic for the CS-based valence awareness methodology. As we show below, when people rely on their attitudes toward the CS when answering the US valence awareness question, it has a distorting effect in favor of the conclusion that EC effects only occur when one is aware of the US valence. In a straightforward simulation, we show the consequences of relying on explicit US valence memory first and—in its absence—on CS attitudes when answering the US valence awareness question. We make two assumptions. First, we assume that participants' postconditioning CS attitudes are a joint function of a preconditioning attitude component (reflecting a natural liking or dislike of a particular stimulus) and an EC effect that can vary in size. In EC research, CSs are usually selected to be initially neutral, but often neutral is defined across subjects (Pleyers et al., 2007; Stahl & Unkelbach, 2009; Stahl et al., 2009). Hence, for individual participants, there will almost always be some CSs that are intrinsically liked more than others, even though across participants each CS is liked neutrally. Second, for each CS, participants can either have explicit memory of the US valence or not. If explicit US valence memory is present, they will rely on it to answer the US valence question in the contingency awareness test. If no explicit US valence memory is present, they will rely on their postconditioning CS attitude instead. For the following simulation, we keep the strength of the preconditioned attitude effect constant. We vary the relative size of the EC effect from zero (no EC effect), over small (the effect of EC is smaller than the preconditioned attitude effect) and intermediate (the effect of EC is equal to the preconditioned attitude effect), to large (the effect of EC is larger than the preconditioned attitude effect).[2] The logic and flow of this simulation are presented in Table 1. Its outcomes are visualized in Figure 1.

The simulation demonstrates, first of all, which outcomes would be observed by a researcher employing a US valence awareness test for the different relative sizes of the EC effect. These observed outcomes are visualized in the large graphs of Figure 1. The simulation also outlines the unobservable partial contributions by those CSs with and without explicit US valence memory, as indicated in the smaller side graphs of each panel. The first thing to realize is that CSs classified as aware following the US valence awareness test consist not only of CSs for which one has explicit US valence memory (these CSs are justly classified as aware). In addition, the aware category also contains CSs for which no explicit US valence memory is present but whose postconditioning attitude happens to conform to the CS condition (those CSs are falsely classified as aware). Put differently, in the absence of explicit US valence memory, positively conditioned stimuli or CS+s that a participant happens to like end up being classified as aware, as do negatively conditioned stimuli or CS−s that a participant happens to dislike. As a result, an artifactual EC effect emerges on aware CSs, favoring the conclusion that EC is successful when participants are purportedly aware of the US valence. Therefore, the US valence awareness test could lead a researcher to conclude that EC was successful for aware CSs even when EC did not influence attitudes at all (see the first simulation condition). Hence, there is an inherent bias in the method toward detecting successful EC for aware CSs.

The methodological problems are further aggravated for unaware CSs, which is especially troubling when one considers the central research question underlying this stream of research: Can an EC procedure change CS attitudes in the absence of explicit US valence memory? A positive answer to this question would require the demonstration of a main effect of CS condition (i.e., CS+s liked more than CS–s) when no explicit US valence memory is present (i.e., the researcher is actually interested in the overall mean difference between CS+ and CS– in each of the lower side graphs in Figure 1). The problem is that these data cannot be observed; they can only be visualized in a simulation. Specifically, the existing method does not allow distinguishing CSs with explicit US valence memory from CSs without explicit US valence memory. It only allows a distinction based on the observed response in the US valence awareness test. As outlined in the previous paragraph, when there is no explicit US valence memory, all the CSs of which the attitude conforms to the CS condition end up being classified as aware. Conversely, the only CSs that end up being classified as unaware are those CSs for which the attitude is actually opposite to CS condition. Hence, one cannot demonstrate successful EC for unaware CSs with this method as long as participants can and do rely on CS attitudes in the US valence awareness test. On the contrary, the simulation reveals that this method will often indicate a reversed EC effect for unaware CSs, which is exactly what has been observed in many studies using this methodology (Pleyers et al., 2007, Study 1; Stahl et al., 2009[3]).

It should be noted that Stahl and colleagues (2009) recognized the potentially biasing effect that could arise if participants rely on CS attitudes to answer the US valence awareness question (they termed this the *inference account*). To test whether affect is used as information in the valence awareness test, they proposed that participants should always infer US valence from their (dis)liking of the CS. Thus, they argued, if participants rely on their attitudes to answer the memory question, then their response in the valence awareness measure should consistently be in line with their evaluative rating irrespective of whether the EC effect is normal or reversed. Stahl and colleagues observed that participants' choices

[2] The fourth simulation case, in which the EC effect size is larger than the effect of preconditioning attitudes, also represents the situation in which the preconditioned CS attitudes would be truly neutral and the real EC effect can be of any positive size.

[3] Note that Stahl and colleagues (2009) included a "don't know" response option in the memory task to reduce the contamination by guessing processes in their Experiments 2–4. This response option was selected in a substantial proportion of cases. In these cases, on average, neither a regular nor a reversed EC effect was observed. This fits with the present assumption that participants only use affect-as-information in the memory test when the postconditioning attitude provides a clear signal. This assumption also explains the reversed EC effects observed by Stahl and colleagues: If a CS does provide a clear signal and consequently the "negative" or "positive" response option is chosen, CSs showing regular EC effects are classified as aware, but CSs classified as unaware should show a reversed EC effect. This reversed EC effect for unaware CSs was found in their Experiment 3 and in a meta-analysis of Experiments 2–4. Hence, the predictions from the simulation correspond well to the data reported by Stahl and colleagues. However, as we did not fit a quantitative model to the actual data, we do not want to make the claim that the simulation provides an exhaustive account of the data pattern observed by Stahl and colleagues.

Table 1
Simulation of Relying on US Valence Memory First and Postconditioned CS Attitudes Second When Answering the US Valence Awareness Question of a Contingency Awareness Test

CS	Simulation condition	US valence memory	CS condition	Preconditioned CS attitude (A)	EC effect (B)	Postconditioned CS attitude (A + B)	Response in contingency awareness test	Classification in contingency awareness test	Postconditioned CS attitude on 1–7 scale (A + B + 4)	Observed EC effect	Choice in awareness test consistent with CS attitude?
1	No EC effect	Memory	CS+	−1	0	−1	Positive	Aware	3	Reversed	Inconsistent
2	No EC effect	Memory	CS+	1	0	1	Positive	Aware	5	Normal	Consistent
3	No EC effect	Memory	CS−	−1	0	−1	Negative	Aware	3	Normal	Consistent
4	No EC effect	Memory	CS−	1	0	1	Negative	Aware	5	Reversed	Inconsistent
5	No EC effect	No memory	CS+	−1	0	−1	Negative	Unaware	3	Reversed	Consistent
6	No EC effect	No memory	CS+	1	0	1	Positive	Aware	5	Normal	Consistent
7	No EC effect	No memory	CS−	−1	0	−1	Negative	Aware	3	Normal	Consistent
8	No EC effect	No memory	CS−	1	0	1	Positive	Unaware	5	Reversed	Consistent
1	Small EC effect	Memory	CS+	−1	0.5	−0.5	Positive	Aware	3.5	Reversed	Inconsistent
2	Small EC effect	Memory	CS+	1	0.5	1.5	Positive	Aware	5.5	Normal	Consistent
3	Small EC effect	Memory	CS−	−1	−0.5	−1.5	Negative	Aware	2.5	Normal	Consistent
4	Small EC effect	Memory	CS−	1	−0.5	0.5	Negative	Aware	4.5	Reversed	Inconsistent
5	Small EC effect	No memory	CS+	−1	0.5	−0.5	Negative	Unaware	3.5	Reversed	Consistent
6	Small EC effect	No memory	CS+	1	0.5	1.5	Positive	Aware	5.5	Normal	Consistent
7	Small EC effect	No memory	CS−	−1	−0.5	−1.5	Negative	Aware	2.5	Normal	Consistent
8	Small EC effect	No memory	CS−	1	−0.5	0.5	Positive	Unaware	4.5	Reversed	Consistent
1	Intermediate EC	Memory	CS+	−1	1	0	Positive	Aware	4	None	—
2	Intermediate EC	Memory	CS+	−1	1	0	Positive	Aware	4	None	—
3	Intermediate EC	Memory	CS+	1	1	2	Positive	Aware	6	Normal	Consistent
4	Intermediate EC	Memory	CS+	1	1	2	Positive	Aware	6	Normal	Consistent
5	Intermediate EC	Memory	CS−	−1	−1	−2	Negative	Aware	2	Normal	Consistent
6	Intermediate EC	Memory	CS−	−1	−1	−2	Negative	Aware	2	Normal	Consistent
7	Intermediate EC	Memory	CS−	1	−1	0	Negative	Aware	4	None	—
8	Intermediate EC	Memory	CS−	1	−1	0	Negative	Aware	4	None	—
9	Intermediate EC	No memory	CS+	−1	1	0	Positive (Random)	Aware	4	None	—
10	Intermediate EC	No memory	CS+	−1	1	0	Negative (Random)	Unaware	4	None	—
11	Intermediate EC	No memory	CS+	1	1	2	Positive	Aware	6	Normal	Consistent
12	Intermediate EC	No memory	CS+	1	1	2	Positive	Aware	6	Normal	Consistent
13	Intermediate EC	No memory	CS−	−1	−1	−2	Negative	Aware	2	Normal	Consistent
14	Intermediate EC	No memory	CS−	−1	−1	−2	Negative	Aware	2	Normal	Consistent
15	Intermediate EC	No memory	CS−	1	−1	0	Positive (Random)	Unaware	4	None	—
16	Intermediate EC	No memory	CS−	1	−1	0	Negative (Random)	Aware	4	None	—
1	Large EC effect	Memory	CS+	−1	2	1	Positive	Aware	5	Normal	Consistent
2	Large EC effect	Memory	CS+	1	2	3	Positive	Aware	7	Normal	Consistent
3	Large EC effect	Memory	CS−	−1	−2	−3	Negative	Aware	1	Normal	Consistent
4	Large EC effect	Memory	CS−	1	−2	−1	Negative	Aware	3	Normal	Consistent
5	Large EC effect	No memory	CS+	−1	2	1	Positive	Aware	5	Normal	Consistent
6	Large EC effect	No memory	CS+	1	2	3	Positive	Aware	7	Normal	Consistent
7	Large EC effect	No memory	CS−	−1	−2	−3	Negative	Aware	1	Normal	Consistent
8	Large EC effect	No memory	CS−	1	−2	−1	Negative	Aware	3	Normal	Consistent

Note. A CS+ is paired with positive USs in the conditioning phase; a CS− is paired with negative USs. Participants either have a real memory for US valence (they are truly contingency aware) or not. If they do, they rely on US valence memory when answering the US valence awareness test in the contingency awareness measure. If they do not have a real memory, they apply the "how do I feel about it" heuristic and rely on their attitudes toward the CS instead. In this case, a positive (negative) attitude will trigger a "positive" ("negative") response in the awareness test. Hence, a CS is classified as aware when the postconditioned CS attitude is consistent with CS condition and as unaware when inconsistent. When the postconditioned CS attitude is completely neutral (0; as in the intermediate EC condition), the response in the valence awareness test would lead to aware or unaware classification with equal probability. To simulate this random response behavior, the number of CSs was doubled in this condition. Dashes in the last column indicate that the classification of the awareness test choices as consistent or inconsistent with CS attitude is not applicable when the latter is neutral. Postconditioned CS attitudes are eventually transformed to a traditional 1–7 scale for ease of exposition in Figure 1. CS = conditioned stimulus; CS+ = positively conditioned stimulus; CS− = negatively conditioned stimulus; EC = evaluative conditioning; US = unconditioned stimulus.

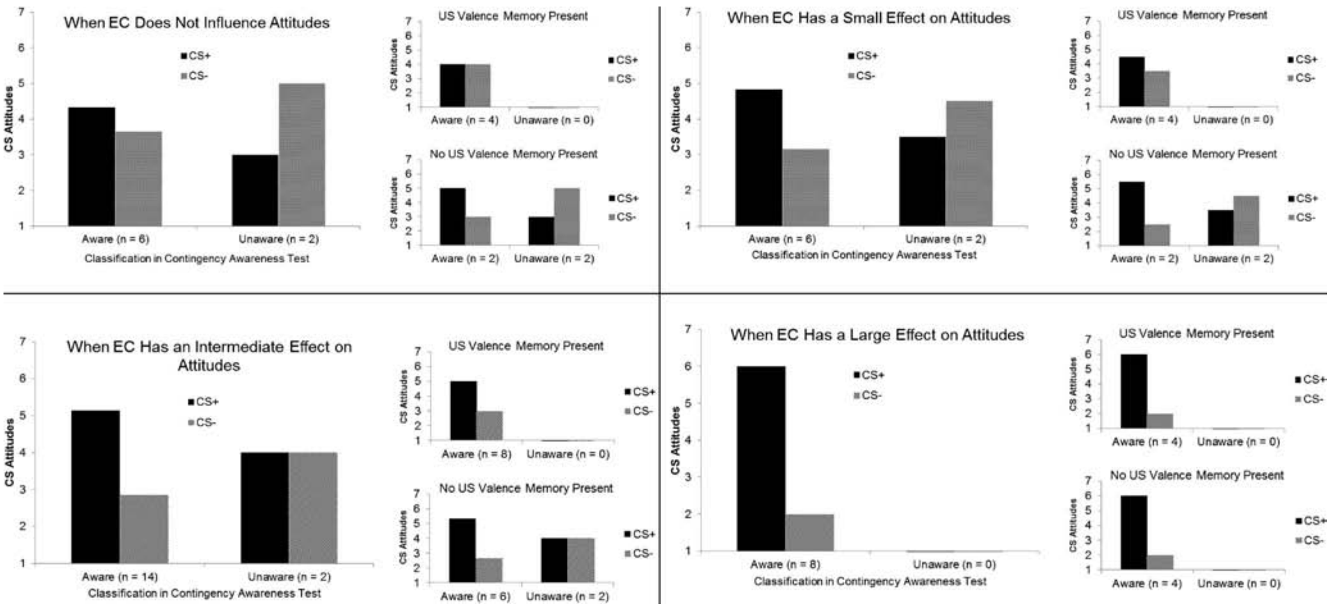

Figure 1. Results of simulating the classification of CSs as aware or unaware when participants first rely on explicit memory of US valence and, in the absence of explicit memory, rely on CS attitudes in the US valence awareness test. The four panes reflect the four possible relative sizes of the EC effect compared with preconditioning CS attitudes (zero EC, smaller, equal, and larger). In each pane, the main figure represents CS attitudes for CSs classified as aware or unaware as would be observed following a US valence awareness test. The subfigures represent the unobservable relative contribution to this classification of those CSs where the participant either has or has no explicit US valence memory. The mean CS attitudes were arrived at by aggregating the relevant rows in Table 1, thereby assuming 50% contingency awareness in the main figures. However, the pattern remains the same over the entire range of different proportions of contingency (un)awareness. CS = conditioned stimulus; EC = evaluative conditioning; US = unconditioned stimulus.

in the US valence awareness test were only consistently in line with their CS attitudes when the EC effect was normal, but not when it was reversed. Hence, they concluded that participants do not rely on affect-as-information in the US valence awareness test.

However, if we assume that the assumptions underlying our simulation hold for the data reported by Stahl and colleagues (2009), participants may still have relied on CS attitudes to answer the US valence awareness question. Consider that participants sometimes do have explicit memory of US valence and that they will rely on this before relying on CS attitudes. The final two columns in Table 1 show indeed that, when the observed EC effect is positive (normal), both US valence memory and CS attitudes point to the same response, leading to consistency in observations. Conversely, when the EC effect is reversed, the choice in the US valence awareness test cannot be expected to be consistent with CS attitudes all, or even most, of the time. This is because, in the case of reversed EC, whenever participants have explicit memory of US valence, it will lead to a choice inconsistent with their CS attitude.[4]

The predictions by the simulation thus match the existing empirical data particularly well, including the predominance of aware classifications, the observation of a reversed EC effect for unaware CSs, and the fact that participants' choices in the awareness test are often inconsistent with their attitudes in cases of reversed EC. It can be concluded that to answer the question of whether EC effects can occur in the absence of US valence awareness, it is imperative that (a) CSs be selected that are initially neutral for each participant, not just across participants, and (b) a methodology be developed in which the effects of US valence memory and CS attitudes can be disentangled.

The Process-Dissociation Approach

We applied the process-dissociation approach to overcome the methodological problems associated with CS-based valence awareness measures. The process-dissociation framework was introduced by Jacoby (1991) to separate explicit, intentional memory

[4] Stahl and colleagues (2009) also fitted a multinomial processing tree model analysis of the responses in the memory task for CSs with reversed EC, and this too yielded no support for an inference process. In this model, they compared the processes involved in the memory judgments of CSs with a neutral evaluative rating with those CSs where the EC effect was reversed. They argued that participants would infer US valence only for CSs with a reversed rating. In their model, US valence memory and guessing could fully account for the responses in the US valence awareness task. The parameter capturing the inference process was not significant. However, this too is consistent with the simulation, which indicates that in cases of reversed EC, the prevalence of responses in line with attitudes should not necessarily exceed chance level. Hence, if we assume that the assumptions underlying the simulation apply to Stahl and colleagues' data, their finding that the inference parameter was not significantly different from zero does not exclude the possibility that affect-as-information processes may nevertheless have been used.

processes ("recollection") from implicit, automatic memory processes ("familiarity"). Jacoby criticized the identification of certain tasks with certain cognitive processes, arguing that any task is typically affected by more than one process. He therefore used different instructions to dissociate the latent processes involved within one task. In a seminal study, he determined the proportion of recollection and familiarity in recognition memory. Participants' task was to classify as old or new words that had previously been generated as solutions to anagrams or that had been heard before. In the inclusion condition, participants were to respond "old" to previously encountered words of both kinds—those heard before and those seen as anagram solutions. In contrast, in the exclusion condition, participants were to respond "new" if they remembered the respective word from the anagram phase. In these conditions, familiarity and recollection have different effects: Whereas familiarity contributes to "old" responses in both conditions, recollection of anagram words can be used to respond "old" in the inclusion condition. In the exclusion condition, recollection can be used to actively select against the "old" response and, instead, select the "new" response. By subtracting the proportion of "old" responses to anagrams in the exclusion condition from the respective proportion in the inclusion condition, the proportion of recollection for the anagrams can be calculated, and subsequently, the proportion due to familiarity can be determined. Moreover, by implementing manipulations that should affect one process and not the other(s), the parameters' validity can be tested. The process-dissociation paradigm has successfully been applied to several fields of study (Begg, Anas, & Farinacci, 1992; Buchner & Wippich, 1996; Lindsay & Jacoby, 1994; Payne, 2001, 2005; Stahl & Degner, 2007; Unkelbach & Stahl, 2009; Yonelinas & Jacoby, 1995). It should be particularly suited to the study of contingency awareness in EC because the contingency awareness measure is likely influenced by participants' conditioned attitudes. Therefore, it is crucial to develop a method able to distinguish contingency awareness and conditioned attitudes in one and the same task.

In the present research, the process-dissociation paradigm is introduced as a fairer and more valid test of the hypothesis that there may be learning mechanisms in EC that occur in the absence of explicit memory for the contingencies. We developed a memory task that allows dissociating (a) memory for the pairings, (b) the conditioned attitude in the absence of memory, and (c) guessing processes. In this task, participants are asked to report whether a given CS was paired with pleasant or unpleasant USs. A special property of this task is that participants are instructed to use their attitude toward the CS to respond when they do not remember the positive versus negative pairings. To dissociate memory and attitude processes, participants are instructed differently in inclusion and exclusion conditions.

In the inclusion condition, they are instructed to respond "pleasant" if and when they remember a CS was paired with positive USs and "unpleasant" if and when the CS was paired with negative USs. Participants are also instructed to use their evaluation of the CS when they lack memory of the pairings. That is, they select "pleasant" for liked CSs and "unpleasant" for disliked CSs. A multinomial processing tree (MPT) model (Batchelder & Riefer, 1999) is applied to this task. The MPT model of the inclusion condition is depicted in Figure 2. The model parameters are formulated conditionally according to the instructions that prioritize memory over attitude. If an explicit memory of US valence is present, it takes priority in the response. The probability of this process is expressed by the memory parameter m. Thus, in the present paradigm, contingency awareness is assessed retrospectively as the probability that a participant has explicit US valence memory for a particular CS in the contingency awareness test. If participants do not remember the US valence (with the probability $1 - m$), they are instructed to base their response on their evaluation of the CS. The relative contribution of this process is described by the attitude parameter a. Third, if neither memory nor CS evaluation produces a clear signal for the response, participants are assumed to respond randomly. In this case, the response parameter r models response tendencies that express a preference for "pleasant" or "unpleasant" responses.

In the inclusion condition, explicit memory and attitude processes both lead to the same response if EC was successful. To disentangle the processes involved in the memory task, exclusion conditions were designed. These conditions reverse the responses based on one of the aforementioned processes so that memory and attitude lead to different responses. The exclusion instructions varied between experiments. In Experiments 1a and 2a, participants were asked to reverse their memory responses, that is, they were asked to respond "pleasant" if they remembered that the CS was paired with negative USs and "unpleasant" if it was paired with positive USs. The model for this memory exclusion condition is illustrated in Figure 3. In Experiments 1b, 2b, and 3, participants were instructed to reverse their responses based on the attitude. As can be seen in Figure 4, in the absence of memory for the valence of the pairings, they were to respond "pleasant" if they evaluated the CS negatively and "unpleasant" if they evaluated the CS positively. The separate estimation of the memory and attitude parameters is based on comparing the response frequencies in the inclusion and exclusion conditions as in the traditional process-dissociation model. Specifically, the difference between conditions can be traced back to the one process that leads to different responses in the inclusion and exclusion conditions.

To test whether contingency unaware EC was possible, the attitude parameter was tested for a significant deviation from zero. Due to the parameter being contingent on the absence of explicit US valence memory, substantial parameter estimates would thus indicate that EC can influence attitudes without explicit US valence memory.

Overview of Experiments

In this article, three sets of experiments are presented. The first set employed CSs that already possessed valence initially. This procedure was introduced to validate the attitude parameter, that is, to ascertain that the attitude parameter was indeed able to capture existing attitudes. The second set of experiments paired neutral CSs with positive or negative USs and thus represented standard EC experiments. Here, a significant a parameter, measuring attitudes in the absence of US valence memory, indicates contingency-unaware EC effects. Experiments a and b of each set implemented the different exclusion conditions depicted in Figures 3 and 4. That is, in Experiments 1a and 2a, the memory-based responses were to be reversed. In Experiments 1b and 2b, the reversal of attitude-based responses was required. This switch rules out two possible complications. First, the retrieval of memory or attitude might be impaired by their reversal. Second, partici-

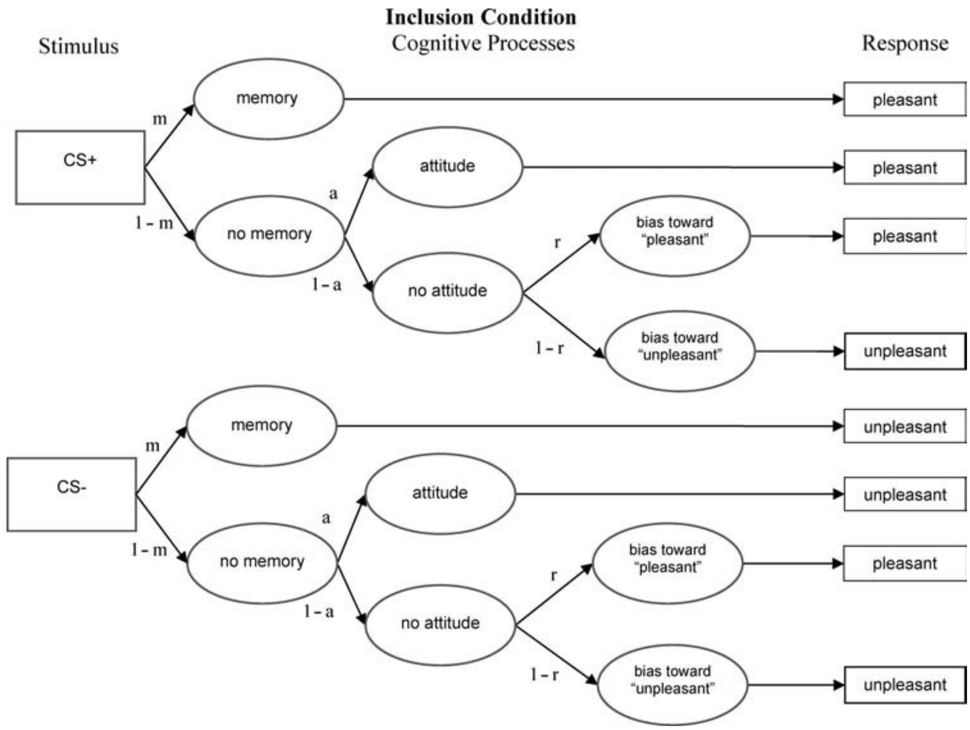

Figure 2. Processing tree model of performance in the memory task in the inclusion condition. The rectangles on the left denote the stimuli, the rectangles on the right the responses. The branches of the processing tree represent the combination of cognitive processes postulated by the model. m = probability of remembering the valence of the US; a = probability of relying on CS attitude given memory failure; r = response tendency toward "pleasant" when neither memory nor attitude is available; CS = conditioned stimulus; US = unconditioned stimulus.

pants might forget to execute the switch in the exclusion condition, thereby abating the size of the nonreversed parameter. The model's validity can thus be tested by introducing a joint model of each set's experiments. If the joint model fits the data of both experiments and the parameter estimates do not differ between the different exclusion instructions, then the parameter estimates are robust and independent of whether participants have to reverse their memory or attitude responses.

In Experiment 3, we introduced a time delay between the conditioning phase and the dependent measures to test whether the parameter estimates behave in accordance with previous findings on memory and EC. Specifically, the attitudinal effect is hypothesized to be stable over time and resistant to extinction (Grossman & Till, 1998; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006), whereas explicit memory for US valence should deteriorate more quickly over time (Rubin & Wenzel, 1996). Successfully establishing this dissociation would further validate the memory and attitude parameters.

Experiment Set 1: Validation of the MPT Model on Existing Attitudes

The first two experiments tested for the ability of the MPT model to capture attitudes by using valent CSs instead of neutral CSs. Thus, the attitude toward the CSs does not need to be established by EC. The experiment nevertheless administered an EC routine to (a) obtain evidence for validity of the attitude parameter of the process-dissociation model in a situation as parallel to the subsequent proper EC experiment as possible and (b) estimate the full set of parameters contained in the MPT model.

Clearly valent CSs were selected from a large set of stimuli on the basis of each participant's evaluative ratings of the entire set as those receiving the most polarized pleasant and unpleasant ratings. There is a paucity of studies that have attempted to modify existing attitudes via EC, but the tentative conclusion drawn from these studies is that it may be more difficult to modify preexisting attitudes via EC than to create new attitudes toward initially neutral stimuli (e.g., Hofmann et al., 2010; Shimp, Stuart, & Engle, 1991). For this reason, we did not expect strong changes in evaluative ratings as a consequence of undergoing the EC routine. As CSs were, however, selected on the basis of evaluative extremity in ratings, regression to the mean should lead to somewhat less polarized CS ratings after the EC procedure, irrespective of whether the CSs were paired with positive or negative USs, for well-understood statistical reasons (e.g., Stigler, 1997). The validation of the model's a parameter only requires a significant attitudinal difference between initially positive and initially negative CSs at the time of the memory task. This validation is otherwise independent from regression to the mean and from whether EC modified the initial attitudes.

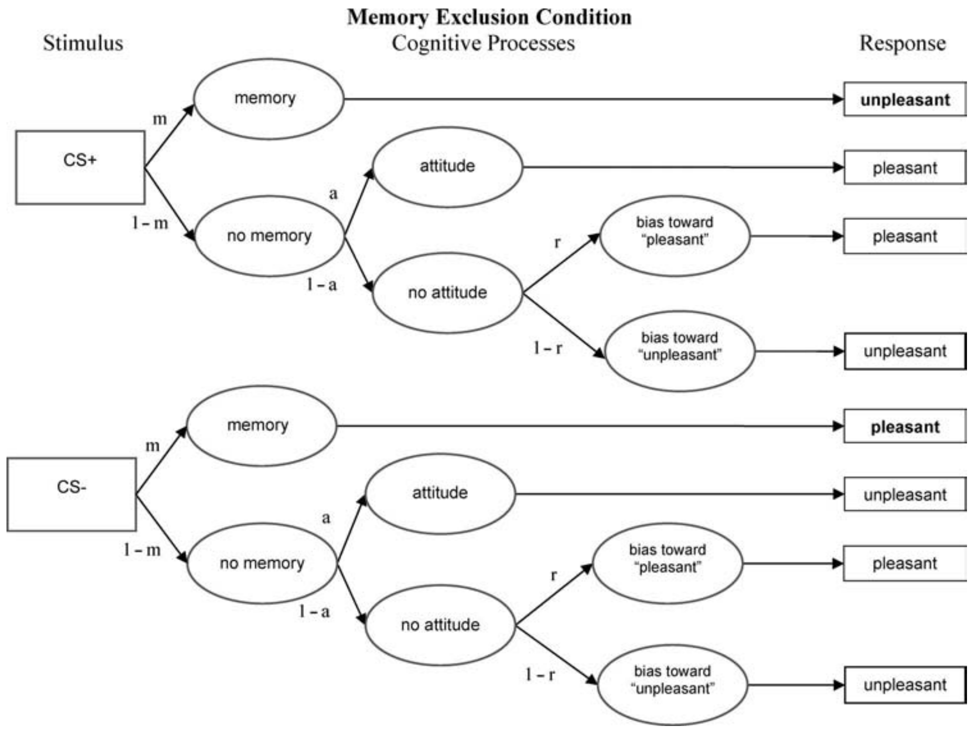

Figure 3. Processing tree model of performance in the memory task in the memory exclusion condition. The rectangles on the left denote the stimuli, the rectangles on the right the responses. The branches of the processing tree represent the combination of cognitive processes postulated by the model. Deviations from the inclusion condition are in bold. m = probability of remembering the valence of the US; a = probability of relying on CS attitude given memory failure; r = response tendency toward "pleasant" when neither memory nor attitude is available; CS = conditioned stimulus; US = unconditioned stimulus.

Experiment 1a

Method

Participants. Participants were 30 students (25 women, five men) of different majors at the University of Freiburg (Freiburg, Germany). Their ages ranged from 19 to 26 years (M = 22.17, SD = 2.17). They received monetary compensation of €3.50 (approximately U.S. $4.70).

Design. A 2 (time of evaluative rating: before vs. after conditioning) × 2 (CS valence: positive vs. negative) × 2 (US valence: positive vs. negative) × 2 (instruction: inclusion vs. exclusion condition) mixed design was implemented with repeated measures on the first three factors.

Materials. A set of 102 black-and-white pictures of human faces (58 males, 44 females) was used as the CS repertory. The pictures have successfully been used in previous experiments on EC (e.g., Fiedler & Unkelbach, 2011). For each participant, CSs were selected from that pool based on an initial evaluative rating. Picture size was standardized to 384 × 472 pixels.

Fifty pleasant and 50 unpleasant pictures from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2005) served as USs. Pleasant and unpleasant pictures differed in their valence with pleasant pictures being more positive than unpleasant pictures, $t(98) = 60.77$, $p < .001$. They did not differ in terms of arousal, $t(98) = -0.02$, $p = .98$, but differed in potency, $t(98) = 19.66$, $p < .001$. Hence, pleasant pictures were more dominant than unpleasant pictures. The size of the USs was set to 512 × 384 pixels.

Procedure. All the instructions, presentations, and measures were implemented in a customized C++ computer program. Participants first rated the valence of the 102 facial pictures on a continuous scale with the endpoints "very unpleasant" and "very pleasant" that was translated into a 200-point scale by the computer program. For each participant, a total of 24 CSs were selected idiosyncratically according to their valence. In this experiment, the 12 most extremely valent pictures from the positive end of the scale and the 12 most extremely valent pictures from the negative end of the scale were selected.

In the subsequent conditioning phase, the CSs were paired with the USs. Participants were simply instructed to look at the pictures without information about the purpose of the pairings. Twelve (i.e., six positively valenced and six negatively valenced) faces were paired with eight different negative USs each; the other 12 faces were paired with eight different positive USs, with all the assignments randomized anew for each participant. However, a US could not be used more than twice, and each CS was paired with a given US only once. Furthermore, neither a CS nor a US was presented twice in a row. Each picture pair was presented simultaneously for the duration of 2,000 ms. The interstimulus interval between pairs was 100 ms.

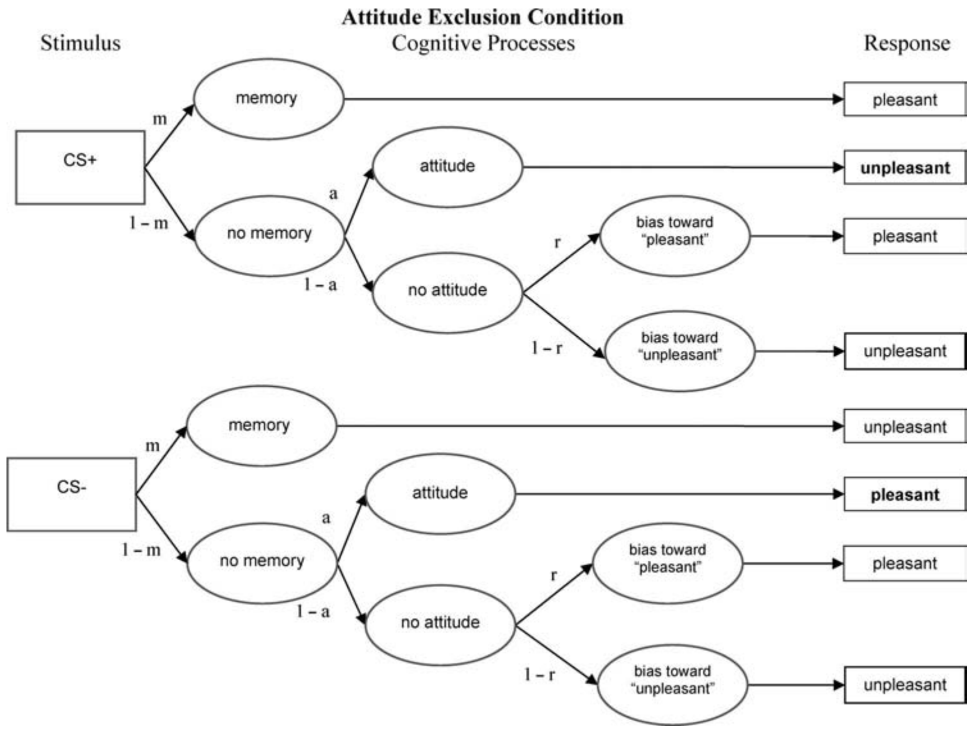

Figure 4. Processing tree model of performance in the memory task in the attitude exclusion condition. The rectangles on the left denote the stimuli, the rectangles on the right the responses. The branches of the processing tree represent the combination of cognitive processes postulated by the model. Deviations from the inclusion condition are in bold. m = probability of remembering the valence of the US; a = probability of relying on CS attitude given memory failure; r = response tendency toward "pleasant" when neither memory nor attitude is available; CS = conditioned stimulus; US = unconditioned stimulus.

After the conditioning phase, the memory task was administered. For each of the 24 CSs, participants reported whether it had been paired with pleasant or unpleasant pictures by clicking on one of the two category boxes labeled *pleasant* and *unpleasant.* Participants in the inclusion condition were instructed to respond in accordance with their memory. In the exclusion condition, participants were instructed to reverse their responses according to their memory of the pairings. Participants in both groups were also instructed to report their attitude toward the face (without reversal of response) when they did not remember the pairings.

Finally, evaluative ratings of the 24 CS faces were obtained a second time. After the completion of the experiment, participants were thanked and dismissed.

Results

Evaluative ratings. The evaluative ratings for all the experiments are reported in Table 2. A 2 (time of evaluative rating) × 2 (CS valence) × 2 (US valence) × 2 (instruction) mixed analysis of variance (ANOVA) was conducted. As expected, we found regression to the mean as evidenced by the significant interaction of the factors CS valence and time of evaluative rating, $F(1, 28) = 182.69$, $p < .001$, $\eta^2 = .07$.[5] Thus, as CSs were selected for evaluative extremity on the basis of the first rating provided, ratings regressed to the mean in the second rating. However, the positive and negative CSs still differed in their ratings regardless of whether they were paired with positive USs, $t(29) = 11.49$, $p < .001$, $g = 2.62$,[6] or negative USs, $t(29) = 13.78$, $p < .001$, $g = 3.96$. The three-way interaction was not significant, $F(1, 28) = 1.23$, $p = .28$, indicating that there was no regular EC effect. None of the effects and interactions was moderated by instruction condition (all ps > .10).

Model analyses. The data from the memory task were analyzed using MPT modeling, employing the computer program HMMTree (Stahl & Klauer, 2007). The MPT model expresses the frequencies of "pleasant" and "unpleasant" responses as a function of memory processes, attitudes, and guessing. Response frequencies and the respective proportions of responses congruent with US

[5] Eta squared is the proportion of the total variance (SS_{total}) explained by an effect (SS_{effect}): $\eta^2 = \frac{SS_{effect}}{SS_{total}}$.

[6] Hedges's g (Hedges, 1982) is reported as a measure of effect size for the planned comparisons. The measure uses the pooled sample standard deviations instead of the population's standard deviation used by Cohen's d (Cohen, 1988). Hedges's g is thus better suited for relatively small sample sizes. The sample standard deviations were pooled according to the following formula (Hedges, 1981): $SD_{pooled} = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}$.

Table 2
Evaluative Ratings With Means and Standard Deviations by Experiment, Time of Measurement, and US Valence, as Well as CS Valence, in Experiments 1a and 1b and Time Lag Condition in Experiment 3

		Prerating				Postrating			
		CS−		CS+		CS−		CS+	
Experiment	Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
		Valent CSs							
1a	Positive CSs	163.10	15.98	163.53	13.99	148.97	14.70	129.61	24.81
	Negative CSs	47.51	19.31	48.94	19.07	79.92	19.41	66.94	22.42
1b	Positive CSs	158.16	17.67	158.79	19.10	145.11	19.94	137.29	22.06
	Negative CSs	46.79	20.77	45.66	21.43	69.98	19.13	62.23	20.06
		Neutral CSs							
2a		109.33	17.75	109.34	17.81	98.75	16.74	111.50	18.30
2b		105.29	11.52	105.42	11.45	98.22	11.74	105.32	10.99
3	Immediate	105.66	14.07	105.67	13.99	92.72	22.32	109.72	20.35
	Delay	101.58	10.32	101.69	10.22	95.13	13.56	105.32	12.00

Note. CS = conditioned stimulus; CS+ = positively conditioned stimulus; CS− = negatively conditioned stimulus; US = unconditioned stimulus.

valence in the memory task are given in Table 3 for all the experiments by conditions. As can be seen in the table, the exclusion instruction generally leads to a smaller proportion of responses in the congruent category because responses based on memory (or attitude) have to be reversed. The difference in proportions is used to estimate the size of the parameter representing the process reversed in the exclusion condition. The remaining parameters can then also be determined. The model's predictions are compared with the observed frequencies, with a nonsignificant fit statistic G^2 indicating a good fit.

In the experiments using valent CSs, the attitude parameter reflects responses according to CS valence, conditional on the absence of memory for the nature of the CS–US pairings.

The unrestricted model, which incorporated four memory parameters, one attitude parameter, and two response tendency parameters, described the data well, $G^2(1) = 1.98$, $p = .16$. The memory parameters were first estimated separately for valence-congruent pairings, in which the CS valence was the same as the US valence, $m_{con} = .46$, 95% confidence interval (CI) [.37, .55], $\Delta G^2(1) = 0.90$, $p = .34$, and valence-incongruent CS–US pairings, in which the CS and US valence were opposite, $m_{inc} = .21$, 95% CI [.11, .31], $\Delta G^2(1) = 1.54$, $p = .21$. Restricting the model to a joint memory parameter for congruent and incongruent pairings leads to a significant decrease in model fit, $\Delta G^2(1) = 13.55$, $p < .001$. Importantly, the attitude parameter has to be estimated across positive and negative pairings to warrant the identifiability of the

Table 3
Observed Frequencies in the Pleasant and Unpleasant Response Categories by Experiment as a Function of Instruction Condition and US Valence, as Well as CS Valence, in Experiments 1a and 2a and Time Lag Condition in Experiment 3

		Inclusion						Exclusion					
		CS−			CS+			CS−			CS+		
Experiment	Condition	− (*f*)	+ (*f*)	p_c	− (*f*)	+ (*f*)	p_c	− (*f*)	+ (*f*)	p_c	− (*f*)	+ (*f*)	p_c
	Initially valent CSs												
1a	Positive CSs	46	44	.51	12	78	.87	22	68	.24	58	32	.36
	Negative CSs	77	13	.86	51	39	.57	39	51	.43	64	26	.29
1b	Positive CSs	52	38	.58	14	76	.84	78	12	.86	25	65	.72
	Negative CSs	72	18	.80	44	46	.51	59	31	.66	24	66	.73
	Initially neutral CSs												
2a		172	68	.72	67	173	.72	86	154	.36	156	84	.35
2b		138	42	.77	50	130	.72	114	66	.63	59	121	.67
3	Immediate	132	36	.79	47	121	.72	147	57	.72	64	140	.69
	Delay	143	61	.70	85	119	.58	113	79	.59	93	99	.52

Note. The proportion of US valence-congruent responses (p_c) varies with instruction condition. The difference in proportions between the inclusion and exclusion conditions can be traced back to the processes reversed, that is, memory for the pairings in Experiments 1a and 2a and attitude in the absence of memory in Experiments 1b, 2b, and 3. CS = conditioned stimulus; CS+ = positively conditioned stimulus; CS− = negatively conditioned stimulus; *f* = observed frequency; US = unconditioned stimulus; + = pleasant response category; − = unpleasant response category.

model. Its estimate is $a = .38$, 95% CI [.28, .48], which differs significantly from zero, $\Delta G^2(1) = 54.61$, $p < .001$.[7] This means that in roughly 40% of the cases without memory for the CS–US contingency, participants responded on the basis of an existing attitude, whereas they guessed in the remaining proportion of those cases. The estimate of the guessing parameter is $r = .48$, 95% CI [.40, .56], across the inclusion and exclusion conditions, $\Delta G^2(1) = 0.25$, $p = .62$. Thus, the guessing parameter revealed no response tendency. The parameter estimates of the final model that fits the data well, $G^2(4) = 4.68$, $p = .32$, are shown in Figure 5.

Discussion

In line with expectations, participants still had strong attitudes toward the CSs after the conditioning phase even though regression to the mean was apparent. The joint MPT model for the inclusion and exclusion conditions revealed an attitude parameter estimate that was significantly different from zero. This finding indicates that the model, as well as the attitude parameter in particular, validly picks up existing attitudes in an experimental setting closely approximating proper EC experiments.

There was a memory advantage for congruent CS–US pairings (where CS valence was the same as US valence) relative to incongruent CS–US pairings (where it was not). The congruency effect observed here is interesting in its own right, but it is not the focus of our studies, and we did not implement additional manipulations (e.g., of attention, cognitive load, and so forth) to elucidate it further. It is consistent with a long tradition of research on the effects of evaluative consistency and inconsistency in person memory, and many studies have considered conditions that govern whether consistent or inconsistent information will enjoy a memory advantage (e.g., Ehrenberg & Klauer, 2005; Sherman, Lee, Bessenoff, & Frost, 1998). According to one set of theories, conceptual processing is easier for congruent than for incongruent information, whereas the encoding of perceptual detail will often be enhanced for incongruent over congruent information (Sherman et al., 1998). Because memory for the valence of pairings between CS and US calls for conceptual memory rather than memory for perceptual detail, a congruency advantage would perhaps be expected to occur in the present context, although we hasten to add that it is at best tentative to generalize from findings and theories in the domain of person memory to the present task. The congruency effect was, however, replicated in Experiment 1b, which employed different memory instructions.

Given clearly valent CSs, one might have expected the attitude parameter to be larger than it was, with $a = .38$. Note, however, that attitudes toward the unknown CS faces did not deviate strongly from the scale midpoint of 100, indicating that even the most extremely rated faces were still associated with only moderately strong attitudes. In addition, as described by the phenomenon of regression to the mean, selecting faces on the basis of extremity in preratings will capitalize on chance and thereby overestimate the degree of attitude polarization. In fact, CSs selected as positive and negative, although clearly separable statistically in postratings, showed considerable overlap in postratings so that some of the CSs selected as positive received a more negative rating than some of the CSs selected as negative for almost every participant. Such overlap directly subtracts from the overall level of the *a* parameter.

Experiment 1b

Experiment 1b was a replication of Experiment 1a with modified exclusion instructions in the memory task. Instead of reversing the memory response, participants in all the conditions were now required to respond according to their memory. They were asked to reverse their responses based on their attitude in the exclusion condition.

Method

Participants. Thirty-one students from the University of Freiburg took part in this experiment. One was excluded from the analyses due to repeatedly false responses in the newly introduced practice trials that tested the comprehension of the memory task instructions. The remaining 30 participants were 21 women and nine men between 19 and 40 years old ($M = 24.83$, $SD = 4.76$). They received monetary compensation of €3.50 (approximately U.S. $4.70).

Design, materials, and procedure. The experimental design and materials were the same as in Experiment 1a with the following two exceptions. First, in the exclusion condition of the memory task, participants were required to respond according to their memory of US valence but were required to reverse their responses based on their attitude toward the CS if and when they did not remember the US valence. Second, to verify that participants comprehended the memory task instructions, practice trials were included after the instructions were given. The practice trials comprised verbal scenarios that systematically varied the factor valence of the paired pictures by valence of the face. For example, participants were told that a face was shown with pleasant pictures and that at the same time they evaluated the face positively. They were asked to indicate their response in cases where (a) they remembered the pairings and (b) they did not remember the pairings. For each scenario, participants had to indicate the appropriate response for cases a and b. In the case of false responses, the instructions were repeated and another practice round started. The instructions and practice trials were conducted up to three times. If the participant still made errors in the final repetition, the memory task and evaluative ratings were administered as usual, but the participant's data were excluded from the analyses. As mentioned, this occurred in one case.

Results

Evaluative ratings. A 2 (time of evaluative rating) × 2 (CS valence) × 2 (US valence) × 2 (instruction) mixed ANOVA was conducted. Again, we found regression to the mean as indicated by the two-way interaction between time of evaluative rating and CS valence, $F(1, 28) = 161.69$, $p < .001$, $\eta^2 = .04$. The main effect of CS valence was also significant, $F(1, 28) = 307.31$, $p < .001$, $\eta^2 = .90$. Even after the conditioning phase, there was a significant

[7] Because the null hypothesis of this test, H_0: $a = 0$, is on the boundary of the parameter space (*a*, being a probability, cannot be negative), the appropriate reference distribution is an equal mixture of a chi-square distribution with zero degrees of freedom and one with one degree of freedom (Self & Liang, 1987). The *p* values reported are based on this distribution.

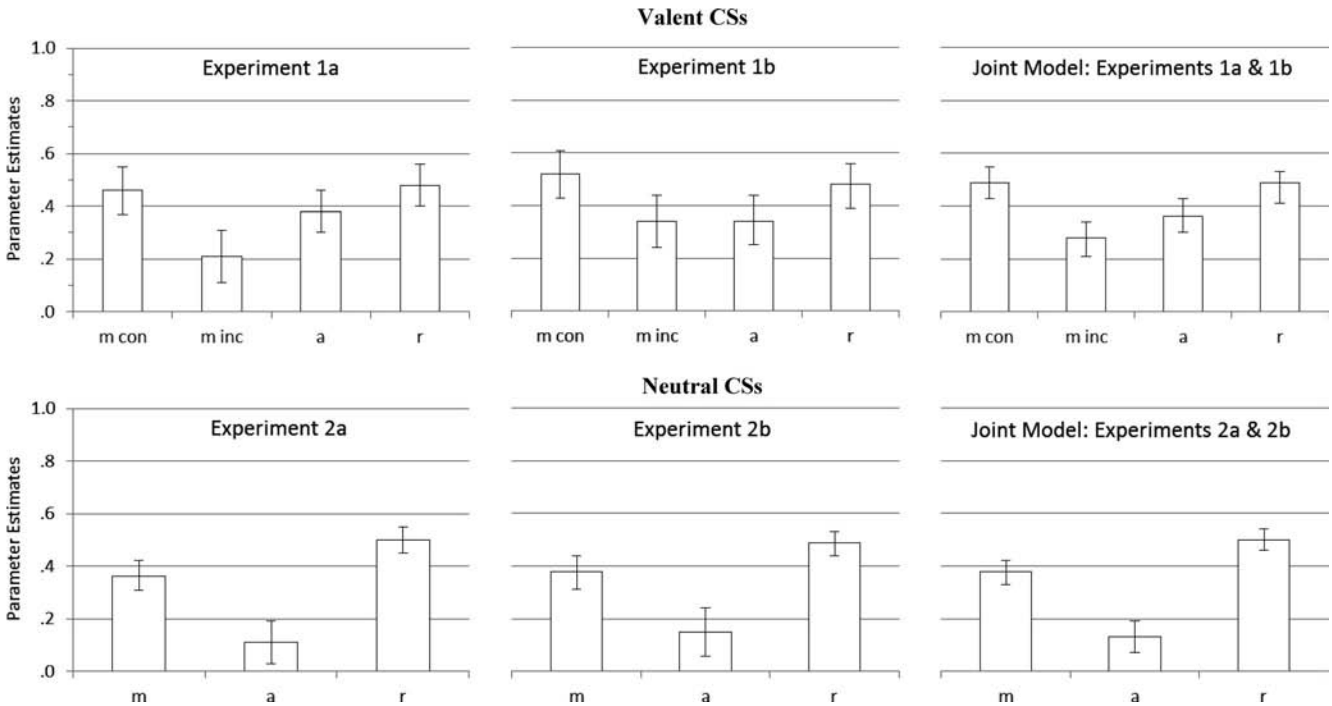

Figure 5. Parameter estimates in the experiments with joint models for Experiments 1a and 2a and for Experiments 1b and 2b. *m* denotes the memory parameter with the additions "con" or "inc" specifying parameter estimates for congruent and incongruent pairings, respectively; *a* denotes the attitude parameter; *r* indicates the response tendency toward "pleasant" when neither memory nor attitude are available. The error bars show the 95% confidence interval of the parameter estimates. CS = conditioned stimulus.

difference in evaluative ratings between initially positive and negative CSs irrespective of positive pairings, $t(29) = 12.00$, $p < .001$, $g = 3.51$, or negative pairings, $t(29) = 12.38$, $p < .001$, $g = 3.80$. The ANOVA revealed no significant EC effect as indicated by the three-way interaction of CS valence, US valence, and time of evaluative rating, $F(1, 28) = 0.30$, $p = .59$. None of the effects and interactions was moderated by instruction condition (all *p*s $>$ .10).

Model analyses. We tested the fit of the MPT model that was used in Experiment 1a. The model fit was satisfactory, $G^2(4) = 7.90$, $p = .10$. The model's parameter estimates are depicted in Figure 4. Replicating the findings of Experiment 1a, the memory parameters showed a larger estimate for valence-congruent pairings, $m_{con} = .52$, 95% CI [.43, .61], than for valence-incongruent pairings, $m_{inc} = .34$, 95% CI [.24, .44]. This difference in estimates is significant, $\Delta G^2(1) = 7.54$, $p < .01$. The attitude parameter is estimated to be $a = .34$, 95% CI [.23, .46]. This parameter differs significantly from zero, $\Delta G^2(1) = 33.45$, $p < .001$. The guessing parameter reveals no response tendency, $r = .48$, 95% CI [.39, .56].

Joint model with Experiment 1a. As Experiments 1a and 1b differ in the exclusion instructions only, it is possible to fit a joint model. Incorporating adequate coding of the data accounts for the differences between instruction conditions. That is, we formulated an MPT model for every single condition according to the expected responses in the memory task. If the parameters can be set equal across the studies without significant loss in model fit, this would enhance one's confidence in the model's validity.

The preliminary joint model that incorporates two memory parameters for congruent and incongruent pairings, one attitude parameter, and one guessing parameter demonstrates a satisfactory fit, $G^2(8) = 12.19$, $p = .14$. Each of the parameters can be set equal across the experiments, m_{con}: $\Delta G^2(1) = 0.80$, $p = .37$; m_{inc}: $\Delta G^2(1) = 3.23$, $p = .07$; a: $\Delta G^2(1) = 0.76$, $p = .38$; r: $\Delta G^2(1) = 0.18$, $p = .67$. As can be seen in Figure 5, the joint memory parameters are estimated to be $m_{con} = .49$, 95% CI [.43, .55], for congruent pairings and $m_{inc} = .28$, 95% CI [.21, .34], for incongruent pairings. The difference in estimates is significant, $\Delta G^2(1) = 20.86$, $p < .001$. The overall attitude parameter estimate is $a = .36$, 95% CI [.29, .44], which is significantly different from zero, $\Delta G^2(1) = 89.06$, $p < .001$. The response tendency parameter $r = .49$, 95% CI [.41, .53], shows guessing on a chance level. The final model shows a satisfactory fit, $G^2(12) = 17.16$, $p = .14$. Thus, the model is able to account for the data from both experiments with the same parameter values.

Discussion

The MPT model for the attitude exclusion paradigm adequately captures CS valence effects. The comparison with Experiment 1a shows that the parameters do not differ as a function of the type of exclusion instruction task. Consequently, the cognitive processes captured in the model appear not to be affected by the instructions in the memory task.

As in Experiment 1a, we found evidence of differential memory performance depending on the congruency of CS valence and US valence. Memory parameters indicate that valence-congruent pairings are more easily remembered than valence-incongruent pairings.

Experiment Set 2: Applying the MPT Model to Evaluative Conditioning

This set of experiments tested whether EC leads to systematic changes in the evaluation of initially neutral CSs in accordance with US valence. Most importantly, applying the MPT model to this paradigm allows us to test for the acquisition of attitudes in the absence of contingency memory.

Experiment 2a

In the exclusion condition of Experiment 2a, the memory-based responses need to be reversed.

Method

Participants. Forty University of Freiburg students (24 women, 16 men), aged between 18 and 42 years (M = 23.00, SD = 5.18), participated in this experiment. They received monetary compensation of €3.50 (approximately U.S. $4.70).

Design. A 2 (time of evaluative rating: before vs. after conditioning) × 2 (US valence: positive vs. negative) × 2 (memory instruction: inclusion vs. exclusion condition) mixed design was implemented, with the first two factors manipulated within subjects.

Materials and procedure. The materials and procedure equaled those of Experiment 1a, with the exception that 24 faces with a medium rating were selected as neutral CSs.

Results

Evaluative ratings. The evaluative ratings were analyzed by a 2 (time of evaluative rating) × 2 (US valence) × 2 (instruction condition) mixed ANOVA. A significant interaction between time of evaluative rating and US valence showed that the conditioning procedure was successful, $F(1, 38) = 22.22$, $p < .001$, $\eta^2 = .04$. The change in valence between pre- and postrating was significant in negatively paired CSs, $t(39) = -4.67$, $p < .001$, $g = 0.61$, but not in positively paired CSs, $t(39) = 0.90$, $p = .35$, $g = 0.12$. The difference between positively and negatively paired CSs at the time of postrating was significant, $t(39) = 4.67$, $p < .001$, $g = 0.72$. None of the effects and interactions was moderated by instruction condition (all ps > .10).

Model analyses. As there is a significant difference between positively and negatively paired CSs in the evaluative ratings, the impact of the US valence should also be reflected by the attitude parameter estimates. A limitation of the present version of our model, to be overcome in the following experiment, is that it does not allow us to identify separate parameters for positively paired and negatively paired CSs. Consequently, the estimated attitude parameter reflects an average value of the amount of attitude acquisition in positively paired and negatively paired CSs that occurred in the absence of contingency memory.

The model fit was good, $G^2(1) = 0.04$, $p = .84$, indicating that the model describes the empirical data well. Figure 5 shows the parameter estimates. The memory parameter was estimated to be $m = .36$, 95% CI [.31, .42]. The attitude parameter was significantly different from zero, $a = .11$, 95% CI [.02, .21], $\Delta G^2 = 5.90$, $p < .05$. The response tendency parameter indicates no significant preference for responding “pleasant” or “unpleasant,” $r = .50$, 95% CI [.45, .55].

Discussion

As an important prerequisite for the modeling exercise, EC was successful, as seen in the effects on evaluative ratings. The valence of the CSs changed according to the valence of the USs they were paired with. However, negative USs caused a stronger shift in valence than positive USs, indicating a processing advantage for negative stimuli, a finding repeatedly observed in EC (e.g., Baeyens et al., 1988; Martin & Levey, 1994; Rydell & Jones, 2009; Walther, Gawronski, Blank, & Langer, 2009).

The process-dissociation paradigm implemented in the memory task ensures that the attitude parameter a can be regarded as an indicator of attitude acquisition by EC that occurs in the absence of contingency awareness. The MPT model revealed an attitude parameter estimate that differs significantly from zero. Therefore, contingency-unaware EC appears to account for a significant portion of the present effect.

The memory exclusion instruction does not allow separate estimates of the attitude parameter for the positively and negatively paired CSs; the model is not identifiable when separate attitude parameters are used. Hence, it is not possible to test whether the negativity bias in the evaluative ratings is reproduced in the attitude parameters. Switching from the memory exclusion to attitude exclusion instructions in the following experiments enables this additional validation of the model. Most importantly, it enables a robustness check of the parameter estimates across two different implementations of the process-dissociation logic.

Experiment 2b

Experiment 2b replicates Experiment 2a with a modification of the memory task instructions in the exclusion condition. No longer were participants required to reverse their memory-based responses. Instead, they were asked to reverse responses based on their attitude in the exclusion condition.

Method

Participants. A total of 30 University of Freiburg students of different majors took part in this experiment. The sample consisted of 22 women and eight men between 19 and 31 years of age (M = 23.50, SD = 3.00). They received monetary compensation of €3.50 (approximately U.S. $4.70).

Design, materials, and procedure. The design, materials, and procedure equaled those of Experiment 2a, with the following exception. In the exclusion condition of the memory task, participants were now required to respond according to their memory of US valence but were required to reverse their responses based on their attitude toward the CS if and when they did not remember the US valence.

Results

Evaluative ratings. A 2 (time of evaluative rating) × 2 (US valence) × 2 (instruction condition) mixed ANOVA revealed a significant interaction between time of evaluative rating and US valence that demonstrated the success of the conditioning procedure, $F(1, 28) = 9.96$, $p < .01$, $\eta^2 = .03$. The change in valence between pre- and postrating was significant in negatively paired CSs, $t(29) = -3.17$, $p < .01$, $g = 0.60$, but not in positively paired CSs, $t(29) = -0.06$, $p = .96$, $g = 0.01$. The difference between positively and negatively paired CSs at the time of postrating was significant, $t(29) = 3.69$, $p < .001$, $g = 0.62$. None of the effects and interactions was moderated by instruction condition (all ps $> .10$).

Model analyses. The same model that was fitted in Experiment 1 describes the data of the inclusion and exclusion conditions well, $G^2(1) = 1.50$, $p = .22$. Figure 5 shows the parameter estimates. The estimate of the memory parameter is $m = .40$, 95% CI [.33, .46], and the estimate of the attitude parameter is $a = .15$, 95% CI [.04, .26]. Setting this latter parameter to zero causes a significant decline in model fit, $\Delta G^2(1) = 7.23$, $p < .01$. The guessing parameter $r = .49$, 95% CI [.43, .56], again reveals no response tendencies favoring "pleasant" or "unpleasant."

Estimating separate attitude parameters for the US valence conditions revealed differences between positively and negatively paired CSs aligned with the evaluative rating results. The model fitted the data, $G^2(0) = 0.00$.[8] While the parameter estimate for negative pairings was significant, $a_{neg} = .22$, 95% CI [.07, .38], $\Delta G^2(1) = 7.67$, $p < .01$, the parameter estimate for positive pairings, $a_{pos} = .08$, 95% CI [.00, .24], did not differ significantly from zero, $\Delta G^2(1) = 1.07$, $p = .15$.[9]

Joint model with Experiment 2a. The data of the inclusion and exclusion conditions can be modeled jointly with the data of Experiment 2a. The initial model that incorporates one memory, one attitude, and one guessing parameter describes the data of both experiments well, $G^2(2) = 1.54$, $p = .46$. Each of the parameters can be set equal without a decrease in model fit, m: $\Delta G^2(1) = 0.52$, $p = .47$; a: $\Delta G^2(1) = 0.22$, $p = .64$; r: $\Delta G^2(1) = 0.01$, $p = .92$. The memory parameter's estimate is $m = .38$, 95% CI [.33, .42]. The estimate of the attitude parameter is $a = .13$, 95% CI [.06, .20]. This overall estimate differs significantly from zero, $\Delta G^2(1) = 12.89$, $p < .001$. Across both experiments, there were no response tendencies in guessing, $r = .50$, 95% CI [.46, .54]. The parameters of the fitted model that describes the data of both experiments well, $G^2(5) = 2.29$, $p = .13$, are depicted in Figure 5. Thus, the model is able to account for the data from both experiments with the same parameter values.

Discussion

Experiment 2b replicates the pattern of parameter estimates from Experiment 2a, and a joint model across experiments indicates that the sizes of the parameter estimates do not differ between them. This implies that the parameter estimates are independent of the particular type of reversal instruction (i.e., it does not matter whether participants have to reverse their memory- or attitude-based responses). In both experiments, the attitude parameter, which is contingent on the absence of explicit US valence memory, is significantly greater than zero. Hence, in addition to propositional processes that capitalize on contingency awareness, there appear to be attitudinal learning processes in EC that do not require contingency awareness. Moreover, in this experiment, it was possible to independently estimate the attitude parameters for CSs paired with positive versus negative USs. The negativity bias in EC (the observation that negative USs have a stronger impact on CS attitudes than positive CSs) was reflected in these independent attitude parameter estimates. For CSs paired with negative USs (where an EC effect was observed), the model indicates that part of this effect occurred without explicit US valence memory (as indicated by the significant a_{neg} parameter). For CSs paired with positive USs (where no EC effect was observed), the model does not indicate an attitudinal effect independent of US valence memory (as indicated by the nonsignificant a_{pos} parameter).

In the following study, we provide further evidence for the validity as well as the dissociability of the memory and attitudinal processes defined in the MPT model. Specifically, we investigate whether a time-delay manipulation has the predicted effects on the memory and attitude parameters.

Experiment 3: Dissociation of the Memory and Attitude Parameters

To demonstrate the independence of the model's memory and attitude processes, their parameter estimates should be sensitive to manipulations known to influence both processes differently. Therefore, we manipulate the presence of a time lag between the conditioning phase and the dependent measures (the memory task and the evaluative ratings). We expect the memory parameter to decrease as time elapses, whereas the attitude parameter that represents a conditioned attitude without explicit contingency memory should be unaffected by time. This prediction is derived from the observation that EC effects are surprisingly robust across time (Grossman & Till, 1998) and difficult to extinguish (Baeyens et al., 1988; De Houwer et al., 2001; Vansteenwegen et al., 2006; Walther, 2002). Conversely, explicit memory is known to decrease over time (Rubin & Wenzel, 1996).

[8] The model is saturated as it has as many parameters as there are independent data points, leading to zero degrees of freedom for evaluating the model fit. A G^2 value larger than zero is nevertheless possible for a saturated model if and when the model imposes inequality restrictions on the data, as is the case in the present model (e.g., the exclusion condition should lead to more incorrect responses than the inclusion condition). A G^2 value of zero as obtained here means that the inequality restrictions were satisfied by the data.

[9] For further validation of the explicit US valence memory parameter m, a control condition ($n = 15$) was also included. In this condition, participants were required to report their memory for the USs the face was paired with, without receiving any instructions on using their attitude toward the CSs. An attitude parameter is not defined, but a memory parameter m and a response tendency parameter r can be estimated. The data for the inclusion and exclusion conditions and the control condition were modeled jointly with separate memory and guessing parameters for the control condition and the other two conditions. The memory parameters did not differ between conditions, $\Delta G^2(1) = 1.14$, $p = .29$, and neither did the response tendency parameters, $\Delta G^2(1) = 0.16$, $p = .69$. The resulting joint memory parameter's estimate was $m = .38$, 95% CI [.31, .44]. The estimate of the joint response tendency parameter was $r = .49$, 95% CI [.44, .53]. The model fit was good, $G^2(3) = 2.80$, $p = .42$. This suggests that reliance on explicit memory of US valence was not biased by the attitude-related instructions.

Method

Participants. A total of 70 students at the University of Heidelberg (Heidelberg, Germany) took part in this experiment. They received monetary compensation of €4.00 (approximately U.S. $5.40). Six participants had to be omitted from the analyses due to repeated false responses in the practice trials. Another two participants were excluded because they gave the same response in all trials of the memory task. Finally, one participant was excluded because she answered a phone call during the experimental session. The final sample consisted of 61 participants (43 women, 27 men), with age ranging between 18 and 41 years (M = 21.79, SD = 3.43).

Design. The experiment employed a 2 (time of evaluative rating: before vs. after conditioning) × 2 (US valence: positive vs. negative) × 2 (memory instruction: inclusion condition vs. exclusion condition) × 2 (time lag between conditioning phase and dependent measures: immediately vs. after 1 day) mixed design with the first two factors manipulated within subjects.

Materials and procedure. The materials and procedure equaled those of the previous experiments, with the exception that the time-lag condition required half of the participants to return the next day. In the exclusion condition, we opted for the attitude exclusion paradigm as in Experiment 2b.

Results

Evaluative ratings. A 2 (time of evaluative rating) × 2 (US valence) × 2 (time lag) × 2 (instruction condition) mixed ANOVA was conducted on the evaluative ratings. Table 2 shows the mean evaluative ratings by condition. A significant two-way interaction between time of evaluative rating and US valence demonstrated the success of the conditioning procedure, $F(1, 57) = 39.52$, $p < .001$, $\eta^2 = .07$, and was not moderated by time-lag condition, $F(1, 57) = 2.55$, $p = .12$, $\eta^2 = .004$. Overall, there was an EC effect for positive pairings, $t(60) = 2.27$, $p < .05$, $g = 0.26$, as well as for negative pairings, $t(60) = -4.32$, $p < .01$, $g = 0.61$. The difference between positively and negatively paired CSs was significant, $t(60) = 6.26$, $p < .001$, $g = 0.77$. None of the effects and interactions was moderated by instruction condition (all ps $> .10$).

Model analyses. The observed frequencies of "pleasant" and "unpleasant" responses in the memory task are given in Table 3. The basic model that incorporated one memory, one attitude, and one guessing parameter for each of the two time-lag conditions captures the data well, $G^2(2) = 0.65$, $p = .72$. The memory parameter had to be estimated separately for the two time-lag conditions as it was larger in the condition without a delay, $m_{t\_0} = .46$, 95% CI [.39, .52], than with the 24-hour delay, $m_{t\_1} = .19$, 95% CI [.13, .26]. Setting the memory parameters equal results in a significant decrease in model fit, $\Delta G^2(1) = 30.24$, $p < .001$. The attitude parameters for the two time-lag conditions are both significant and very similar in size: $a_{t\_0} = .10$, 95% CI [.00, .22],[10] $\Delta G^2(1) = 3.03$, $p < .05$; $a_{t\_1} = .11$, 95% CI [.03, .20], $\Delta G^2(1) = 6.89$, $p < .01$. They can be combined to a joint estimate of $a = .11$, 95% CI [.04, .17], without a decrease in model fit, $\Delta G^2(1) = 0.05$, $p = .82$. Setting the a parameter to zero causes a significant decline in model fit, $\Delta G^2(1) = 9.22$, $p < .01$. The response tendency parameter $r = .45$, 95% CI [.41, .48], reveals a slight tendency to favor the "unpleasant" response over the "pleasant" response across both time-lag conditions, $\Delta G^2(1) = 0.16$, $p = .69$. The parameters of the fitted model describe the empirical data well, $G^2(4) = 0.88$, $p = .99$, and are illustrated in Figure 6.

Discussion

In this experiment, the EC effect was persistent over the period of 1 day. Importantly, the MPT model shows a dissociation between memory and attitude with elapsing time. Whereas the explicit memory of US valence decreases significantly, the conditioned attitude (conditional on the absence of US valence memory) remains unchanged. The dissociation observed in this experiment further validates the model in that the memory and attitude parameters capture separable processes that function independently.

General Discussion

Whether EC procedures can establish attitudinal effects without contingency awareness has been the subject of an intense debate for decades, largely due to a wide variety of methodological difficulties. Whereas early investigations often appeared to show evidence for unaware EC, these results were criticized: More recent methodologies have consistently indicated that EC effects are only evident when participants are contingency aware (Dedonder et al., 2010; Pleyers et al., 2007; Stahl & Unkelbach, 2009; Stahl et al., 2009). However, in a simulation, we have demonstrated that the most recently proposed methodology is biased in favor of detecting contingency-aware EC and against the detection of contingency-unaware EC. The problems originate mainly from the fact that contingency-unaware participants can infer the correct answer to the contingency awareness question from their attitudes toward the CS. As was demonstrated, reliance on this inference effectively makes the detection of unaware EC impossible. Therefore, it is crucial to develop a methodology that allows researchers to distinguish the effects of explicit US valence memory from a person's attitudes toward the CS. To this end, we adapted Jacoby's (1991) process-dissociation procedure to the study of contingency awareness in EC.

Methodological Contributions

In five experiments, we tested the validity of the process-dissociation procedure and investigated whether EC could establish attitudinal effects that were independent from explicit contingency awareness. The first set of experiments tested for the reflection of already existing attitudes in the proposed MPT model contingent on the absence of contingency memory. In the second set of experiments, attitudes were established by an EC procedure. Both sets of experiments implemented two versions of the process-dissociation procedure's exclusion condition, with memory task instructions alternating which process's output (memory or attitudes) had to be reversed. The fifth experiment introduced a time-delay manipulation between the conditioning procedure and

[10] Due to the boundary problem discussed in Footnote 7, the confidence interval containing zero is misleading here as it suggests that the parameter value is not significantly larger than zero. The relevant and accurate result is the p value that is based on the appropriate reference distribution, taking the boundary issue into account (Self & Liang, 1987).

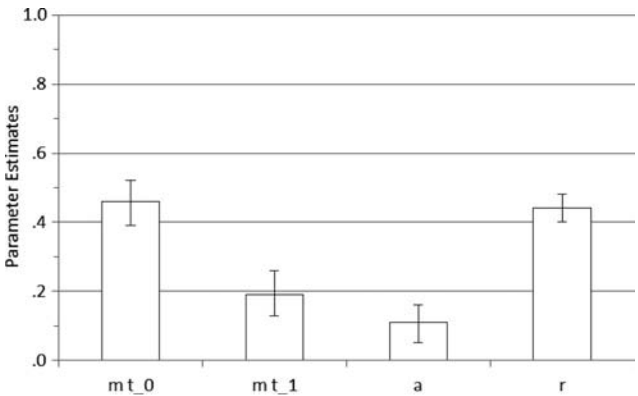

Figure 6. Parameter estimates in Experiment 3. *m* denotes the memory parameter with additions specifying parameter estimates for the immediate (t_0) and delay (t_1) conditions; *a* denotes the attitude parameter; *r* indicates the guessing parameter capturing the response tendencies. The error bars show the 95% confidence interval of the parameter estimates.

the attitude and memory measures. All of the experiments implementing initially neutral CSs indicated a significant conditioning effect on attitudes occurring in the absence of explicit US valence memory. Hence, EC can influence attitudes without contingency awareness.

Several lines of evidence enhance our confidence in the validity of the procedure and parameter estimates. First, using valent CSs in the first set, both experiments yielded attitude parameter estimates that were significantly above zero. Second, we found that the crucial *a* parameter is tied to the emergence and size of the attitude observed in the evaluative ratings. That is, using valent CSs, the parameter estimates were larger than the estimates for the less extreme conditioned attitudes. Moreover, the *a* parameter, which indicates a conditioning effect on attitudes in the absence of US valence memory when using neutral CSs, covaries with the observable EC effect on attitudes. For example, in Experiment 2b, the *a* parameter was significant for CS−s, but not for CS+s, reflecting the observed negativity bias in EC. In all other cases where a significant EC effect emerged, the *a* parameter was significant as well. This combination of observations enhances confidence in the validity of the *a* parameter as a reflection of (contingency-unaware) EC effects on attitudes. Third, a successful robustness check was provided by a joint model of each set of experiments, demonstrating that the memory and attitude parameter estimates are independent of the particular instructions in the memory task or the type of process-dissociation procedure implemented. This finding is important because it alleviates the concern that the performance of either process would be impaired (or enhanced) depending on the idiosyncrasies of different process-dissociation procedures.

Finally, Experiment 3 established a dissociation of the memory and attitude parameters by introducing a time lag between the learning phase and the test phase among half of the participants. On the one hand, we found that the memory parameter decreased significantly over time—in accordance with predictions from memory research (Rubin & Wenzel, 1996). On the other hand, we found that the attitude parameter remained constant over time—in accordance with reports that attitudinal EC effects are stable over time and resistant to extinction (Grossman & Till, 1998; Vansteenwegen et al., 2006). This confirms that the attitude and memory parameters indeed capture qualitatively different processes, which respond differently to a manipulation presumed to impact one but not the other. Consequently, the attitude parameter does not, for example, merely represent low confidence memory.

Perhaps the most important advantage of our method is that it provides estimates both of contingency memory and of EC effects in the absence of contingency memory within one and the same task. It thereby avoids the many methodological difficulties that are incurred when separate tasks are used to operationalize contingency awareness and EC, such as differences in response formats and associated scale artifacts and the problematic assumption of each task being a relatively process-pure operationalization of the process it is assumed to tap (Lovibond & Shanks, 2002; Payne & Bishara, 2009).

Limitations

One limitation of the present research is that the experiments reported made use of a between-subjects design regarding the inclusion and exclusion conditions of the dissociation procedure. A within-subjects manipulation, on the other hand, would allow for the estimation of individual parameter values, opening the door for correlational analyses. Unfortunately, strong and robust carryover effects were found when inclusion and exclusion conditions were administered to the same person in succession in several unreported experiments. These carryover effects were not eliminated (a) by presenting different CSs in the two conditions or (b) by additionally introducing a 1-week delay between the two conditions. As a consequence, performing the memory task once appears to alter the nature of the second memory task in the present paradigm, forestalling the implementation of the present process-dissociation paradigm in a within-subjects design and the estimation of parameter values for individual participants. It is conceivable, however, that a within-subjects variant of the paradigm that eliminates transfer effects can be developed, despite our failed attempts.

Furthermore, the conclusions of this research are limited to the extent that a retrospective judgment may not reflect the actual learning processes that occur during the conditioning phase. Conversely, on-line measures of contingency awareness (e.g., Baeyens et al., 1990; Purkis & Lipp, 2001) have been criticized for artificially inflating contingency awareness during conditioning (Field, 2000). In an experiment by Baeyens and colleagues (1990), for example, a concurrent measure of contingency awareness quadrupled participants' performance in an adjacent recognition measure in comparison to a control group. Given the methodological difficulties that afflict the investigation of contingency awareness, the model presented here is unlikely to be the last word on this issue. We have argued extensively that our approach is likely to lead to more valid conclusions than previous approaches, but more research is clearly needed on the relative merits and drawbacks of the different methods to see which of them ultimately provides the closer approximation to the true state of affairs.

Implications for Theories on Evaluative Conditioning

EC procedures have long been assumed to establish attitudinal effects through a combination of, on the one hand, more conscious, explicit, propositional and rule-based processes and, on the other, more unconscious, implicit, associative processes (Gawronski & Bodenhausen, 2006). However, since the introduction of CS-based measures of contingency awareness (Pleyers et al., 2007; Stahl et al., 2009), studies have consistently failed to provide evidence for contingency-unaware EC effects, rendering propositional explanations of EC much more prominent. A recent meta-analysis confirmed this by showing a strong impact of contingency awareness on EC such that only contingency-aware items produce significant EC effects; unaware EC was only significant when participants' contingency awareness was determined at the participant, rather than at the CS, level (Hofmann et al., 2010). However, in a simulation, we have demonstrated that the recent CS-based US valence awareness tests (Stahl & Unkelbach, 2009; Stahl et al., 2009) are strongly biased toward the conclusion that EC requires contingency awareness. Furthermore, it can be shown that the alternative of using CS-based US identity awareness tests (Dedonder et al., 2010; Pleyers et al., 2007) is prone to the same biases as, again, a reliance on affect-as-information would favor the detection of aware EC effects but interfere with the detection of unaware EC effects. In addition, such tests in which the precise identity of a US (rather than its valence) needs to be indicated are only suitable when a CS is repeatedly paired with a single US, rather than with a multitude of USs sharing the same valence.

This distinction between single or multiple US pairings is important because recent theorizing has proposed that multiple mechanisms can produce EC effects and, crucially, that exactly which mechanism is operating in a certain experimental situation will depend on the presentation schedule of the CS–US pairings (Jones et al., 2009; Jones, Olson, & Fazio, 2010; Sweldens et al., 2010). One possible mechanism that could occur without contingency awareness is the implicit misattribution of affect from the US to the CS (Jones et al., 2009), also referred to as a direct transfer of affect, or stimulus–response learning (Sweldens et al., 2010). Such misattribution is deemed to arise from source confusability: the greater the participants' uncertainty regarding the actual source of the feelings they experience (i.e., the US), the more likely they will implicitly misattribute these feelings to a simultaneously present other stimulus (i.e., the CS). The simultaneity of the CS–US presentation and the repeated presentation of CSs with multiple, different USs have both been hypothesized to be particularly important for such implicit misattribution of affect or direct transfer of feelings (Jones et al., 2010; Sweldens et al., 2010). The EC procedure in our studies similarly consisted of simultaneous presentations of CSs with different USs. Thus, our observation of contingency-unaware EC effects is consistent with theories predicting implicit misattribution or direct transfer of affect in such procedures. This leaves open the question of whether contingency-unaware EC effects could also be involved in procedures that are less conducive to implicit misattribution, for example, when CS and US are presented sequentially or when a CS is presented consistently with the same US. We consider this a particularly interesting direction for future research. One important advantage of the process-dissociation procedure developed here is its universal applicability across different conditioning procedures.

With our procedure, we find both a learning mechanism that is based on memory and a learning mechanism that operates outside of awareness, a distinction that maps on a propositional and an associative part of EC. The fact that many recent articles have reported an effect of attention or cognitive load manipulations on EC is in accordance with the propositional part being an important constituent (Dedonder et al., 2010; Pleyers et al., 2007). The current research shows, however, that there is also a contribution of an unaware, associative process. Future research should thus investigate which factors facilitate one or the other learning mechanism (De Houwer, 2009).

Implications for Dual Process Theories of Learning

Over the past decades, dual process theories and models of learning and reasoning have been the focus of a large program of research and have gained increasing prominence in the understanding of human behavior. A common characteristic of dual process models is their assumption of two processes of learning and reasoning: one rule-based, propositional, and operating with conscious awareness; the other intuitive, associative, and operating outside conscious awareness (Gawronski & Bodenhausen, 2006; Hayes & Broadbent, 1988; Klauer, Beller, & Hütter, 2010; Sloman, 1996; Smith & DeCoster, 2000; Stanovich & West, 2000; Strack & Deutsch, 2004). Despite their popularity and explanatory value, dual process models are increasingly criticized by proponents of an integrative propositional and rule-based unimodel, which denies the existence of a qualitatively different associative learning process operating outside of awareness (Kruglanski & Gigerenzer, 2011; Mitchell et al., 2009). In this debate, the study of EC—and, more specifically, EC's ability to occur outside of awareness—takes a crucial place as a rare and demonstrable case of unaware associative learning (De Houwer et al., 2001; Gawronski & Bodenhausen, 2006). The fact that many recent studies failed to find evidence for unaware EC (Bar-Anan et al., 2010; Dedonder et al., 2010; Pleyers et al., 2007; Stahl & Unkelbach, 2009; Stahl et al., 2009) has resulted in a strong backlash against dual process theories. As unaware associative learning could not even be demonstrated in the evaluative domain, theorists have started to challenge the epistemological value of the entire dual process conceptualization (Kruglanski & Gigerenzer, 2011; Mitchell et al., 2009). In this debate, our research provides an important counterweight, first by explaining why recent research may have failed to find evidence for unaware EC, second by developing a methodology more suited to investigate this long-standing question, and third by providing evidence that EC can, in fact, change attitudes in the absence of contingency awareness. It appears that, for now at least, dual process theories of learning may live to see another day.

References

Baeyens, F., Crombez, G., Van den Bergh, O., & Eelen, P. (1988). Once in contact always in contact: Evaluative conditioning is resistant to extinction. *Advances in Behaviour Research and Therapy, 10,* 179–199. doi:10.1016/0146-6402(88)90014-8

Baeyens, F., Eelen, P., Crombez, G., & Van den Bergh, O. (1992). Human evaluative conditioning: Acquisition trials, presentation schedule, evaluative style and contingency awareness. *Behaviour Research and Therapy, 30,* 133–142. doi:10.1016/0005-7967(92)90136-5

Baeyens, F., Eelen, P., & Van den Bergh, O. (1990). Contingency awareness in evaluative conditioning: A case for unaware affective-evaluative learning. *Cognition & Emotion, 4,* 3–18. doi:10.1080/02699939008406760

Bar-Anan, Y., De Houwer, J., & Nosek, B. A. (2010). Evaluative conditioning and conscious knowledge of contingencies: A correlational investigation with large samples. *Quarterly Journal of Experimental Psychology, 63,* 2313–2335. doi:10.1080/17470211003802442

Batchelder, W. H., & Riefer, D. M. (1999). Theoretical and empirical review of multinomial processing tree modeling. *Psychonomic Bulletin & Review, 6,* 57–86. doi:10.3758/BF03210812

Begg, I. M., Anas, A., & Farinacci, S. (1992). Dissociation of processes in belief: Source recollection, statement familiarity, and the illusion of truth. *Journal of Experimental Psychology: General, 121,* 446–458. doi:10.1037/0096-3445.121.4.446

Brewer, W. P. (1974). There is no convincing evidence for operant or classical conditioning in adult humans. In W. B. Weimer & D. S. Palermo (Eds.), *Cognition and the symbolic processes* (pp. 1–42). Hillsdale, NJ: Erlbaum.

Buchner, A., & Wippich, W. (1996). Unconscious gender bias in fame judgments? *Consciousness and Cognition, 5,* 197–220. doi:10.1006/ccog.1996.0012

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Dedonder, J., Corneille, O., Yzerbyt, V., & Kuppens, T. (2010). Evaluative conditioning of high-novelty stimuli does not seem to be based on an automatic form of associative learning. *Journal of Experimental Social Psychology, 46,* 1118–1121. doi:10.1016/j.jesp.2010.06.004

De Houwer, J. (2009). Conditioning as a source of liking: There is nothing simple about it. In M. Wänke (Ed.), *Frontiers of social psychology: Social psychology of consumer behavior* (pp. 151–166). New York, NY: Psychology Press.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127,* 853–869. doi:10.1037/0033-2909.127.6.853

Ehrenberg, K., & Klauer, K. C. (2005). Flexible use of source information: Processing components of the inconsistency effect in person memory. *Journal of Experimental Social Psychology, 41,* 369–387. doi:10.1016/j.jesp.2004.08.001

Fiedler, K., & Unkelbach, C. (2011). Evaluative conditioning depends on higher order encoding processes. *Cognition & Emotion, 25,* 639–656. doi:10.1080/02699931.2010.513497

Field, A. P. (2000). I like it, but I'm not sure why: Can evaluative conditioning occur without conscious awareness? *Consciousness and Cognition, 9,* 13–36. doi:10.1006/ccog.1999.0402

Fulcher, E. P., & Hammerl, M. (2001). When all is revealed: A dissociation between evaluative learning and contingency awareness. *Consciousness and Cognition, 10,* 524–549. doi:10.1006/ccog.2001.0525

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin, 132,* 692–731. doi:10.1037/0033-2909.132.5.692

Grossman, R. P., & Till, B. D. (1998). The persistence of classically conditioned brand attitudes. *Journal of Advertising, 27,* 23–31.

Hammerl, M., & Fulcher, E. P. (2005). Reactance in affective-evaluative learning: Outside of conscious control? *Cognition & Emotion, 19,* 197–216.

Hayes, N. A., & Broadbent, D. E. (1988). Two modes of learning for interactive tasks. *Cognition, 28,* 249–276. doi:10.1016/0010-0277(88)90015-7

Hedges, L. V. (1981). Distribution theory for Glass's estimator of effect size and related estimators. *Journal of Educational Statistics, 6,* 107–128. doi:10.2307/1164588

Hedges, L. V. (1982). Estimation of effect size from a series of independent experiments. *Psychological Bulletin, 92,* 490–499. doi:10.1037/0033-2909.92.2.490

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136,* 390–421. doi:10.1037/a0018916

Holyoak, K. J., Koh, K., & Nisbett, R. E. (1989). A theory of conditioning: Inductive learning within rule-based default hierarchies. *Psychological Review, 96,* 315–340. doi:10.1037/0033-295X.96.2.315

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513–541. doi:10.1016/0749-596X(91)90025-F

Jones, C. R., Fazio, R. H., & Olson, M. A. (2009). Implicit misattribution as a mechanism underlying evaluative conditioning. *Journal of Personality and Social Psychology, 96,* 933–948. doi:10.1037/a0014747

Jones, C. R., Olson, M. A., & Fazio, R. H. (2010). Evaluative conditioning: The "how" question. *Advances in Experimental Social Psychology, 43,* 205–255. doi:10.1016/S0065-2601(10)43005-1

Klauer, K. C., Beller, S., & Hütter, M. (2010). Conditional reasoning in context: A dual-source model of probabilistic inference. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36,* 298–323. doi:10.1037/a0018705

Kruglanski, A. W., & Gigerenzer, G. (2011). Intuitive and deliberate judgments are based on common principles. *Psychological Review, 118,* 97–109. doi:10.1037/a0020762

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual* (Technical Report A-6). Gainesville: University of Florida.

Lindsay, D. S., & Jacoby, L. L. (1994). Stroop process dissociations: The relationship between facilitation and interference. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 219–234. doi:10.1037/0096-1523.20.2.219

Lovibond, P. F. (2003). Causal beliefs and conditioned responses: Retrospective revaluation induced by experience and by instruction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29,* 97–106. doi:10.1037/0278-7393.29.1.97

Lovibond, P. F., & Shanks, D. R. (2002). The role of awareness in Pavlovian conditioning: Empirical evidence and theoretical implications. *Journal of Experimental Psychology: Animal Behavior Processes, 28,* 3–26. doi:10.1037/0097-7403.28.1.3

Martin, I., & Levey, A. B. (1994). The evaluative response: Primitive but necessary. *Behaviour Research and Therapy, 32,* 301–305. doi:10.1016/0005-7967(94)90125-2

Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). The propositional nature of human associative learning. *Behavioral and Brain Sciences, 32,* 183–198. doi:10.1017/S0140525X09000855

Olson, M. A., & Fazio, R. H. (2001). Implicit attitude formation through classical conditioning. *Psychological Science, 12,* 413–417. doi:10.1111/1467-9280.00376

Olson, M. A., & Fazio, R. H. (2002). Implicit acquisition and manifestation of classically conditioned attitudes. *Social Cognition, 20,* 89–104. doi:10.1521/soco.20.2.89.20992

Olson, M. A., & Fazio, R. H. (2006). Reducing automatically activated racial prejudice through implicit evaluative conditioning. *Personality and Social Psychology Bulletin, 32,* 421–433. doi:10.1177/0146167205284004

Olson, M. A., Kendrick, R. V., & Fazio, R. H. (2009). Implicit learning of evaluative vs. non-evaluative covariations: The role of dimension accessibility. *Journal of Experimental Social Psychology, 45,* 398–403. doi:10.1016/j.jesp.2008.10.007

Payne, B. K. (2001). Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology, 81,* 181–192. doi:10.1037/0022-3514.81.2.181

Payne, B. K. (2005). Conceptualizing control in social cognition: How executive functioning modulates the expression of automatic stereotyping. *Journal of Personality and Social Psychology, 89,* 488–503. doi:10.1037/0022-3514.89.4.488

Payne, B. K., & Bishara, A. J. (2009). An integrative review of process dissociation and related models in social cognition. *European Review of Social Psychology, 20,* 272–314. doi:10.1080/10463280903162177

Pleyers, G., Corneille, O., Luminet, O., & Yzerbyt, V. (2007). Aware and (dis)liking: Item-based analyses reveal that valence acquisition via evaluative conditioning emerges only when there is contingency awareness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 130–144. doi:10.1037/0278-7393.33.1.130

Purkis, H. M., & Lipp, O. V. (2001). Does affective learning exist in the absence of contingency awareness? *Learning and Motivation, 32,* 84–99. doi:10.1006/lmot.2000.1066

Rubin, D. C., & Wenzel, A. E. (1996). One hundred years of forgetting: A quantitative description of retention. *Psychological Review, 103,* 734–760. doi:10.1037/0033-295X.103.4.734

Rydell, R. J., & Jones, C. R. (2009). Competition between unconditioned stimuli in attitude formation: Negative asymmetry versus spatio-temporal contiguity. *Social Cognition, 27,* 905–916. doi:10.1521/soco.2009.27.6.905

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45,* 513–523. doi:10.1037/0022-3514.45.3.513

Self, S. G., & Liang, K.-Y. (1987). Asymptotic properties of maximum likelihood estimators and likelihood ratio tests under nonstandard conditions. *Journal of the American Statistical Association, 82,* 605–611. doi:10.2307/2289471

Shanks, D. R., & St. John, M. F. (1994). Characteristics of dissociable human learning systems. *Behavioral and Brain Sciences, 17,* 367–395. doi:10.1017/S0140525X00035032

Sherman, J. W., Lee, A. Y., Bessenoff, G. R., & Frost, L. A. (1998). Stereotype efficiency reconsidered: Encoding flexibility under cognitive load. *Journal of Personality and Social Psychology, 75,* 589–606. doi:10.1037/0022-3514.75.3.589

Shimp, T. A., Stuart, E. W., & Engle, R. W. (1991). A program of classical conditioning experiments testing variations in the conditioned stimulus and context. *Journal of Consumer Research, 18,* 1–12. doi:10.1086/209236

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin, 119,* 3–22. doi:10.1037/0033-2909.119.1.3

Smith, E. R., & DeCoster, J. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Personality and Social Psychology Review, 4,* 108–131. doi:10.1207/S15327957PSPR0402_01

Stahl, C., & Degner, J. (2007). Assessing automatic activation of valence: A multinomial model of EAST performance. *Experimental Psychology, 54,* 99–112. doi:10.1027/1618-3169.54.2.99

Stahl, C., & Klauer, K. C. (2007). HMMTree: A computer program for latent-class hierarchical multinomial processing tree models. *Behavior Research Methods, 39,* 267–273. doi:10.3758/BF03193157

Stahl, C., & Unkelbach, C. (2009). Evaluative learning with single versus multiple unconditioned stimuli: The role of contingency awareness. *Journal of Experimental Psychology: Animal Behavior Processes, 35,* 286–291. doi:10.1037/a0013255

Stahl, C., Unkelbach, C., & Corneille, O. (2009). On the respective contributions of awareness of unconditioned stimulus valence and unconditioned stimulus identity in attitude formation through evaluative conditioning. *Journal of Personality and Social Psychology, 97,* 404–420. doi:10.1037/a0016196

Stanovich, K. E., & West, R. F. (2000). Advancing the rationality debate. *Behavioral and Brain Sciences, 23,* 701–726.

Stigler, S. M. (1997). Regression toward the mean, historically considered. *Statistical Methods in Medical Research, 6,* 103–114. doi:10.1191/096228097676361431

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8,* 220–247. doi:10.1207/s15327957pspr0803_1

Sweldens, S., van Osselaer, S. M. J., & Janiszewski, C. (2010). Evaluative conditioning procedures and the resilience of conditioned brand attitudes. *Journal of Consumer Research, 37,* 473–489. doi:10.1086/653656

Unkelbach, C., & Stahl, C. (2009). A multinomial modeling approach to dissociate different components of the truth effect. *Consciousness and Cognition, 18,* 22–38. doi:10.1016/j.concog.2008.09.006

Vansteenwegen, D., Francken, G., Vervliet, B., De Clercq, A., & Eelen, P. (2006). Resistance to extinction in evaluative conditioning. *Journal of Experimental Psychology: Animal Behavior Processes, 32,* 71–79. doi:10.1037/0097-7403.32.1.71

Walther, E. (2002). Guilty by mere association: Evaluative conditioning and the spreading attitude effect. *Journal of Personality and Social Psychology, 82,* 919–934. doi:10.1037/0022-3514.82.6.919

Walther, E., Gawronski, B., Blank, H., & Langer, T. (2009). Changing likes and dislikes through the back door: The US-revaluation effect. *Cognition & Emotion, 23,* 889–917. doi:10.1080/02699930802212423

Walther, E., & Nagengast, B. (2006). Evaluative conditioning and the awareness issue: Assessing contingency awareness with the Four-Picture Recognition Test. *Journal of Experimental Psychology: Animal Behavior Processes, 32,* 454–459. doi:10.1037/0097-7403.32.4.454

Yonelinas, A. P., & Jacoby, L. L. (1995). Dissociating automatic and controlled processes in a memory-search task: Beyond implicit memory. *Psychological Research/Psychologische Forschung, 57,* 156–165. doi:10.1007/BF00431277

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