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The Role of Awareness in Attitude Formation Through Evaluative Conditioning

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Abstract

This article provides a review of past and contemporary debates regarding the role of awareness in attitude formation through evaluative conditioning (EC), that is, by repeatedly pairing a stimulus with other stimuli of positive or negative valence. Because EC is considered the most prototypical method to form and change the network of evaluative associations in memory, the role of awareness in this effect is critical to the question of whether attitudes may be formed and changed through dual processes. We analyze the reasons why there has been so much discussion and disagreement regarding the role of awareness, review past and contemporary methodologies and their limitations, discuss the role of mental processes and conditioning procedures, and identify promising directions for future research in this area.

Keywords

attitudes, social cognition, automatic/implicit processes

Attitudes are considered one of the most fundamental drivers of human behavior because they determine which stimuli we approach or avoid. Not surprisingly then, for almost a century the study of how people's attitudes develop and change has been a core subject in social psychology (Allport, 1935). In this domain, the study of evaluative conditioning (EC) takes a central place as one of the most basic procedures to create and change attitudes toward almost any kind of target stimulus. In essence, all that is required is for the target stimulus to co-occur repeatedly in close spatio-temporal contiguity with another stimulus (or other stimuli) of positive or negative valence—the definition of an EC procedure. The target stimulus is often, but not always, initially neutral in valence and is classically called the conditioned stimulus (CS). The positively or negatively valenced stimulus paired with it is called the unconditioned stimulus (US). As a result of the repeated co-occurrences of the two (the EC procedure), people's attitudes toward the CS change in the direction of the valence of the US, a phenomenon known as the EC effect (for reviews, see De Houwer, Thomas, & Baeyens, 2001; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Jones, Olson, & Fazio, 2010).

The EC effect has proven to be remarkably robust and has now been documented in over 250 studies (Hofmann et al., 2010). For example, EC procedures have been shown to be effective in changing attitudes toward consumer brands (Gibson, 2008; Kim, Allen, & Kardes, 1996; Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Stuart, Shimp, & Engle, 1987; Sweldens, van Osselaer, & Janiszewski, 2010), unknown people (Baeyens, Eelen, Crombez, & Vandenbergh, 1992; Baeyens, Eelen, Vandenbergh, & Crombez, 1992; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012), cartoon characters (Olson & Fazio, 2001, 2002), foods (Baeyens, Vansteenwegen, De Houwer, & Crombez, 1996; Dwyer, Jarratt, & Dick, 2007; Zellner, Rozin, Aron, & Kulish, 1983), the self (Baccus, Baldwin, & Packer, 2004; Dijksterhuis, 2004), and people of other races (Olson & Fazio, 2006). It was also obtained in different sensory modalities, involving visual (e.g., Levey & Martin, 1975), gustatory (e.g., Zellner et al., 1983), auditory (e.g., Blair & Shimp, 1992), olfactory (Epple & Herz, 1999), and haptic (e.g., Hammerl & Grabitz, 2000) stimuli.

In addition to testing the applicability of EC in different domains, research has also investigated several functional properties of the EC effect. Several studies have shown that EC effects are resistant to extinction, meaning that post-conditioning encounters of the CS alone (i.e., without further accompaniment by the US) often do not reduce the EC effect (Baeyens, Crombez, Vandenbergh, & Eelen, 1988; Diaz, Ruiz, & Baeyens, 2005; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006; see however Lipp,

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Oughton, & LeLievre, 2003, and the meta-analysis in Hofmann et al., 2010, for evidence that EC can be sensitive to extinction). On a similar note, it has been shown that EC effects are robust over time and can extend across days or even weeks (Förderer & Unkelbach, 2013; Grossman & Till, 1998; Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2011). This combination of properties implies that attitudes established through EC are relatively stable and can persist until the CS is later paired with a US of the opposite valence (in what is known as a counterconditioning procedure; Baeyens, Eelen, Vandenbergh, & Crombez, 1989; Kerkhof et al., 2011) or the valence of the US is changed (in what is known as a US revaluation effect; Baeyens, Eelen, Vandenbergh, & Crombez, 1992; Sweldens et al., 2010; Walther, Gawronski, Blank, & Langer, 2009).[1]

Another fundamental characteristic of EC is that it seems to be determined mainly by the mere co-occurrences of CS and US (i.e., their contiguity) rather than by the predictive power of the CS for the occurrence of the US (i.e., their statistical contingency; Baeyens, Crombez, De Houwer, & Eelen, 1996; Baeyens, Hendrickx, Crombez, & Hermans, 1998; Baeyens, Hermans, & Eelen, 1993; Kattner, 2014). Relatedly, it has also been shown that EC effects are not sensitive to blocking—when a first CS is already associated with a US, this doesn't prevent a second CS which co-occurs later with the first one from acquiring the association with the US (Beckers, De Vicq, & Baeyens, 2009). These properties imply that the mere co-occurrence of CS and US is sufficient to change attitudes, irrespective of, for example, the CS or US base-rate occurrences or pre-existing associations between the US and other CS.

These properties are both theoretically and practically important. Practically, it can be concluded that the EC effect is well established, has wide applicability, generates robust changes in attitudes, and can do so by simply presenting target stimuli together with valenced events. Therefore, it is of obvious societal importance, underlying phenomena ranging from the development of brand and political attitudes to the development of phobias. Theoretically, these properties distinguish EC effects from effects established in classical conditioning paradigms (e.g., changes in skin conductance in response to a tone, caused by tone [CS]–shock [US] pairings), which are well-known to be sensitive to blocking, extinction, and statistical contingency (De Houwer et al., 2001). These differences are deemed to result from the fact that what people learn during classical conditioning is fundamentally different from what they learn during EC. In classical conditioning, participants learn to *predict* the occurrence of biologically relevant outcomes (US) based on cues (CS). In other words, the CS becomes a signal, leading the participant to expect the occurrence of the US. This is why learning in classical conditioning is also referred to as signal learning or predictive learning. In EC, organisms do not learn to predict or expect the occurrence of a US based on the CS and hence the CS does not become a signal for the occurrence of the US (Martin & Levey, 1987). For example, in EC consumers can learn an association between a brand (CS) and a celebrity endorser (US), thus changing their brand evaluations (EC effect), but the CS–US association is referential, rather than predictive in nature. A referential association implies that perception of the CS activates the representation of the US in memory, yet without the accompanying expectation or prediction that the US will actually occur (Baeyens, Eelen, & Vandenbergh, 1990).

Whereas the preceding properties are more or less generally accepted, the focus of this review is on the one property that has divided this field of research for decades—the question whether EC effects can occur without participants' awareness of the relation (the "contingency") between CS and US. No other question in this field has received the same amount of research attention. For example, of the 282 articles listing "EC" in their *title* or *abstract*, 69 also mention "awareness" (PsycINFO database, January 2014), implying that about 25% of the research in this field has directly investigated this question. Even more striking is that the conclusions from these articles are often diametrically opposite to each other. It seems that for every article claiming that EC procedures can change attitudes without participants' awareness (e.g., Baeyens, Eelen, Crombez, & Vandenbergh, 1992; Baeyens et al., 1990; Balas & Gawronski, 2012; De Houwer, Baeyens, & Eelen, 1994; De Houwer, Hendrickx, & Baeyens, 1997; Field & Moore, 2005; Fulcher & Hammerl, 2001; Hütter & Sweldens, 2013; Hütter et al., 2012; Jones, Fazio, & Olson, 2009; Krosnick, Betz, Jussim, & Lynn, 1992; Olson & Fazio, 2001, 2002, 2006; Staats & Staats, 1957; Sweldens et al., 2010; Walther & Nagengast, 2006) there is an article claiming that EC does not happen without awareness (e.g., Allen & Janiszewski, 1989; Bar-Anan, De Houwer, & Nosek, 2010; Dawson, Rissling, Schell, & Wilcox, 2007; Dedonder, Corneille, Yzerbyt, & Kuppens, 2010; Field, 2000; Gast, De Houwer, & De Schryver, 2012; Hofmann et al., 2010; Lipp & Purkis, 2005; Perugini, Richetin, & Zogmaister, 2014; Pleyers et al., 2007; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Stahl & Unkelbach, 2009; Stahl, Unkelbach, & Corneille, 2009).

In this review, we try to shed light on the reasons why there have been so much research and enduring controversy related to this single research question. To do so, a first thing to realize is the paramount theoretical importance of this issue for attitude formation theories specifically and human learning theories in general. As its theoretical significance is the main reason for such a sustained interest and debate on the issue, this review starts with an overview of the theoretical context.

A second reason for the enduring controversy and conflicting results stems from the fact that researchers have differed in their definitions of the very construct of awareness; that is, what kind of awareness they considered important to assess. We provide an overview of different definitions of awareness and illuminate how each approach has different theoretical implications.

A third piece of the puzzle is that even when researchers have agreed on the construct to be measured, they have often still differed in their measurement approach. We review the different methodological approaches researchers in this field have taken and investigate how each approach influenced the conclusions that were reached. Over the years, several methods have been developed, each one aiming at remedying deficiencies inherent in the previous approaches. Unfortunately, several methodological innovations introduced new problems of their own and to this date no perfect method has been found.

In addition to its general importance for theories on learning and attitude formation, a fourth reason why there are such enduring controversies relates to theories on EC more specifically. Even though there is general agreement on what constitutes an EC *procedure* and an EC *effect*, there is much more uncertainty about the EC *process* or the psychological mechanism(s) leading to the change in attitudes toward the CS. Whereas early research tried to outline the characteristics of a single process responsible for EC effects (Baeyens, Eelen, Vandenbergh, & Crombez, 1992; De Houwer et al., 2001), more recently it has been proposed that several processes may operate in parallel to produce EC effects (De Houwer, 2007; Gawronski & Bodenhausen, 2006; Jones et al., 2010). Some of these processes could be characterized by awareness whereas others could be independent from awareness.

Another related recent insight is that the psychological processes underlying the EC effect might be determined by properties of the EC procedure, such that different EC procedures generate EC effects by means of different processes (Sweldens et al., 2010). As a result, to understand why a certain study arrives at a particular conclusion regarding the role of awareness, a researcher needs to consider jointly the limitations of the awareness measure that was used *and* the details of the study's conditioning procedure, which promote the operation of aware or unaware processes. One goal of this review is to offer researchers the insights required to make both of these considerations.

The Theoretical Significance of EC Without Awareness

Attitudes—defined as evaluative summaries toward entities such as people, objects, and behaviors (Fazio, 1989)—have long been argued to be the most basic determinant of behavior because people tend to approach the things they like and avoid the things they dislike (Allport, 1935). Historically, the study of attitudes has been characterized by a pendulum movement between single- and dual-process theories and between associative and more cognitive approaches. Early behaviorist work regarded the development of emotional responses as the result of associative learning about CS and US, resulting in the development of a conditioned response to the CS. Most famous is the study by Watson and Rayner (1920), demonstrating that fear responses can be conditioned in infants toward initially liked CS (e.g., a white rat toy) as a result of its co-occurrence with a disliked US (e.g., a loud sound). Later research traditions were more cognitive in nature and started to focus on the effectiveness of messages in changing attitudes, investigating various source, message, and audience variables that made message acceptance (and resulting attitude change) more or less likely. Attitude change was then regarded as a strictly cognitive and linear process, starting with attention to a message, leading to comprehension and subsequent acceptance (or rejection), ultimately resulting in attitude change (Hovland, Janis, & Kelley, 1953; McGuire, 1968).

Single- Versus Dual-Process Theories in Attitude Formation and Change

In more recent years, research started to integrate the contribution of low-level and more high-level processes. The most influential early theories such as the elaboration likelihood model (ELM; Petty & Cacioppo, 1986) and the heuristic systematic model (HSM; Chaiken, Liberman, & Eagly, 1989) shared an emphasis on the existence of two qualitatively different processing routes: one central and characterized by conscious processing and careful weighting of central message arguments, the other quick and peripheral (in case of the ELM) or heuristic (HSM) in nature, more involved in the processing of extra-message cues and mainly at work when people's motivation or opportunity to carefully process the message are low. The fact that attitudes could be changed through simple conditioning procedures was one important reason to posit the existence of a qualitatively different peripheral processing route, given that attitudinal conditioning was considered to invoke minimal processing resources and operate without awareness (Petty & Wegener, 1999).

These early dual-process theories of attitude formation were criticized, however, because the differential effects of extra-message cues and central message arguments were largely confounded with differences in their processing difficulty. As a result, a competing unimodel was proposed which could more parsimoniously explain the findings with just one processing system, with the depth of processing determined by people's motivation and opportunity (Kruglanski & Thompson, 1999).

Interestingly, this was only one swing of the pendulum movement between single- and dual-process theories of attitude formation. The dual-process theories would soon make a comeback, but this time they would be more closely aligned with dual-process theories of learning, reasoning, and information processing (Evans, 2003; Kahneman, 2003; Kahneman & Frederick, 2002; Lieberman, Gaunt, Gilbert, & Trope, 2002; Sloman, 1996; Smith & DeCoster, 2000; Strack & Deutsch, 2004). Going back to the distinction originally

proposed by Reber (1967), these theories generally distinguish between an implicit and explicit learning system. The implicit system is often called "System 1" as it is evolutionarily old (humans share it with lower animals). It is considered "intuitive" in nature, meaning that it is characterized as automatic, effortless, associative, rapid, parallel, and, crucially, unaware in that people generally have no conscious insight into its operations. The explicit system is called "System 2" as it is evolutionarily more recent (uniquely human or perhaps only shared with higher primates). It is "reflective" in nature, its processing characterized as controlled, effortful, deductive, slow, serial, and, crucially, self-aware. The ability of the implicit system to learn without awareness is considered to be the key dimension by which the systems can be distinguished (Shanks & St. John, 1994).

This distinction between an implicit and explicit learning system most recently made its way into the theories of attitude change under the form of the influential "associative and propositional processes in evaluation" (APE) model (Gawronski & Bodenhausen, 2006). The APE model conceives of evaluations as a product of both associative (implicit) and propositional (explicit) processes, with associative processes underlying implicit evaluations, and propositional processes forming the basis of explicit evaluations. The APE model is so influential because, by specifying a variety of possible interactions between the associative and propositional systems, it is able to explain why in some cases explicit evaluations change while implicit evaluations remain unchanged (e.g., Gawronski & Strack, 2004) whereas in other cases the opposite pattern may be observed (e.g., Dasgupta & Greenwald, 2001; Olson & Fazio, 2006).

Despite its explanatory power, the APE model too has been criticized by proponents of a more parsimonious unimodel who deny the existence of two qualitatively different sorts of processes. In particular, unimodel researchers doubt the existence of association formation processes operating without awareness (Kruglanski & Gigerenzer, 2011; Mitchell, De Houwer, & Lovibond, 2009; Newell & Shanks, 2014). Unimodel proponents do not deny that it is possible to create associations between concepts in human memory, but they question the fact that such associations could be formed by an automatic link-formation system operating without awareness. According to their interpretation of the literature, these authors conclude that there is little or no unambiguous evidence for the existence of an automatic link-formation system in humans. After all, research on classical (Pavlovian) conditioning concluded that classical conditioning effects in humans are not established without participants' conscious knowledge of the CS–US contingencies (Brewer, 1974; Holyoak, Koh, & Nisbett, 1989; Lovibond, 2003).

Interestingly enough, to the extent that there was evidence for associative learning without awareness, it came from EC studies. Unfortunately, much early EC research on contingency awareness suffered from methodological flaws (Lovibond & Shanks, 2002), and more recent investigations which proposed an updated and more fine-grained methodology consistently failed to find evidence for EC without awareness (Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014; Dedonder et al., 2010; Pleyers et al., 2007; Pleyers et al., 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009). Invoking the parsimony argument, Mitchell and colleagues (2009) therefore concluded that "there is very little to be lost, and much to be gained, by the rejection of the dual-system approach that incorporates an automatic link-formation mechanism" (p. 185).

Clearly the recent failures to find evidence for EC without awareness have important implications extending beyond the theories of attitude formation and have helped fuel a rejection by some scholars of the entire dual-process approach in learning, reasoning, and information processing (Kruglanski & Gigerenzer, 2011; Mitchell et al., 2009; Newell & Shanks, 2014). As Shanks (2005) noted, "Bearing in mind that conditioning represents one of the simplest learning preparation imaginable, (. . .) that conditioning does not occur without awareness would seem to place a very major question mark over the possibility of learning without awareness" (p. 208). As a rare and potentially demonstrable case of associative learning without awareness, the question of whether EC can or cannot occur without participants' awareness lies at the heart of this fundamental controversy.

Relation to the Mere Exposure Literature

As indicated in the previous section, the possibility that EC effects can be established without contingency awareness is a potentially crucial piece of evidence in the debate on whether *associations* can be learned unconsciously. It should be noted though that EC research does not constitute the only evidence that *attitudes* can be changed via low-level processes without awareness or deliberation. Specifically, in the mere exposure literature several authors have claimed that attitudes toward stimuli increase as a logarithmic function of the number of times those stimuli are encountered, without deliberation and especially when participants are not aware that these stimuli were presented (e.g., Bornstein, 1989; Kunst-Wilson & Zajonc, 1980; Monahan, Murphy, & Zajonc, 2000). EC and mere exposure are similar in the sense that both are paradigms generating attitude change toward stimuli which are repeatedly presented. The crucial difference is that in the mere exposure literature stimuli are presented in isolation, whereas in EC stimuli (CS) are presented together with other stimuli which already evoke a certain affective response (US). Because the mere exposure effect ostensibly does not involve association formation processes between stimuli, it is at first sight not relevant in the debate on whether humans can learn associations without awareness. It is, however, of clear relevance to the question of whether attitude change can occur via dual processes.

The mere exposure effect could even be of relevance to the question of whether humans learn associations without

awareness if more evidence were mustered for the thesis in Zajonc's later work that the mere exposure effect can be considered a conditioning effect whereby the US would consist of "the absence of aversive events." Zajonc (2001) draws on this hypothesis to explain that the positive effects of mere exposure can extend to other stimuli which were not presented before, but which would benefit from the positive mood instilled by the mere exposure effect (Monahan et al., 2000). However, it is unclear whether the absence of a stimulus can actually be considered a stimulus and the idea that mere exposure can be considered a conditioning effect awaits more empirical verification. Interestingly, one further parallel between the mere exposure and EC literatures is precisely the issue of whether the effects can occur without awareness. Even though many articles have claimed that mere exposure effects are established without participants' awareness of the stimulus presentations, this claim is not entirely uncontested and counter-evidence has been presented as well (de Zilva, Vu, Newell, & Pearson, 2013; Newell & Shanks, 2007). Some of the methodological challenges involved in demonstrating mere exposure effects without awareness are analogous to the challenges in the EC literature which will be reviewed below. One example is the fact that awareness tests are often administered *after*, rather than during, the presentation stage, which turns them effectively into tests of long-term memory rather than tests of awareness during learning (de Zilva et al., 2013). While providing a more complete review of the mere exposure literature lies outside the scope of this article, we do believe readers with a primary interest in this literature can find inspiration in our review of the methodological difficulties and solutions that have permeated the study of awareness in EC.

The Construct: Definitions and Criteria of Awareness

A second reason why there has been so much research and enduring controversy regarding the awareness issue in EC is because researchers have had various definitions of "awareness." They have measured alternately whether participants were aware of the experimental hypotheses, of the contingencies between CS and US identities, of the contingencies between CS and US valence, or even whether they were aware of the very presence of the CS (or the US; for example, in subliminal presentation paradigms). Often, awareness measures probed for a mix of these elements. As a clear consensus on what an awareness test is supposed to measure was lacking, it is not surprising that diverging conclusions were reached regarding its role. In this section, we provide an overview of different approaches to the measure of awareness. We discuss the rationale behind each approach and the theoretical implications of finding (un)aware EC effects with each approach. We also highlight which definition of awareness has, in our view, the most important theoretical implications.

It is useful however to first highlight a few broad characteristics that any good awareness measure should have. The essential logic behind awareness tests in EC studies rests on obtaining dissociation between the attitude measure and the awareness measure. When the conditioning procedure results in a significant change on the attitude measure, but not on the awareness measure, a researcher would conclude that the EC effect was established independently of awareness.

In an influential early review of the problems inherent in dissociating processing systems, Shanks and St. John (1994) noted that this logic is only valid when the awareness measure satisfies at least two criteria. The first principle is called the *information criterion*, meaning that the information being probed by the awareness test should be the same information "aware" participants would rely on when providing their evaluation. The second principle is called the *sensitivity criterion*, meaning that the awareness test should be sensitive to all the relevant conscious knowledge and be at least as sensitive as the attitude measure. In a later review, Lovibond and Shanks (2002) also added a third principle, called the *immediacy criterion*, meaning that the awareness test should follow the learning episode as quickly as possible to avoid forgetting, interference, or intrusion of invalid material.

Hypothesis Awareness: Can EC Effects be Explained by Experimental Demand?

The original purpose of awareness tests in EC research was to guard against alternative explanations based on experimental demand effects (Rosenthal, 1969). In a famous review of the classical conditioning literature, Brewer (1974) criticized conditioning studies on adults arguing that the observed effects can be explained by the fact that participants develop conscious hypotheses and expectations about the experiment. Analogous critiques were raised against EC studies (Page, 1969, 1974). As observed by Page (1974, p. 486), " . . . the straightforward simplicity of a conditioning hypothesis makes it difficult to design a study so that no subject can discern the hypothesis from the research operations." There is an intricate relation between experimental demand effects, hypothesis awareness, and contingency awareness in the sense that EC effects can only be reduced to experimental demand effects if participants are both hypothesis and contingency aware. That is, participants need to know which CSs were paired with positive versus negative US (i.e., they need to be contingency aware) *and* know that the experimenter expects them to like CSs that were paired with positive US better than CSs paired with negative US (i.e., they need to be hypothesis aware) before they can intentionally provide answers in line with the research hypothesis should they want to (i.e., demonstrate demand compliance; Meersmans, De Houwer, Baeyens, Randell, & Eelen, 2005).

To preempt alternative explanations based on experimental demand, even the very first EC experiments featured awareness checks of some sort. For example, in an early demonstration of EC effects, Staats and Staats (1957, p. 77) asked participants "to write down anything they had thought about the experiment, especially the purpose of it, and so on, or anything they had thought of during the experiment." Participants who expressed awareness about the relation between the stimuli in their experiment were excluded from the analysis. Since EC effects were still observed on the remaining participants, the authors concluded that the conditioning effects could occur *without awareness and without cognition*.

An open-ended question like this clearly violates the criteria for awareness measures proposed by Shanks and St. John (1994). First, the question's vague wording is inconsistent with the information criterion, as it is not clear which consciously accessible information it is designed to tap. The question specifically enquires about participants' awareness of the purpose of the experiment (i.e., hypothesis awareness). If participants were clearly unaware of the experiment's purpose, this would allow the authors to conclude that the EC effect is not a demand artifact caused by hypothesis awareness. However, their interpretation that the EC effect is established "without awareness and without cognition" implies that they also interpreted the responses as indicating a lack of awareness of the associations between CS and US during the conditioning phase (i.e., contingency awareness).

Later approaches tried to be much clearer in their wording, for example by designing separate questions to assess hypothesis and contingency awareness in a funneled approach (e.g., Allen & Janiszewski, 1989). However, one could argue that any open-ended questions of awareness yield misleading interpretations because they violate the second criterion for valid awareness measures—the sensitivity criterion.

Consider, for example, the (not so uncommon) case of a participant who aims to minimize the effort spent on the experiment, yet is fully aware of the relation between the stimuli and the experimental hypothesis. Whereas providing an evaluative judgment about the CS when prompted would be relatively quick and effortless (e.g., merely indicating the corresponding number on a 1-7 scale), answering the open-ended questions designed to probe awareness would require significantly more effort from the participant. Disturbingly, the less the participant decides to write, the greater the likelihood he or she would be mistakenly classified as "unaware." Hence, the conclusion that conditioning effects are obtained in the absence of awareness could be entirely artifactual, due to a difference in the sensitivity of the attitude and awareness measures.

So to what extent does EC depend on hypothesis awareness and experimental demand effects? Despite some initial controversy and evidence to the contrary (Page, 1969, 1974), several converging lines of evidence suggest that EC effects are not the result of experimental demand effects. A first line of evidence comes from several studies in which care was taken to hide the true purpose of the experiment from the participants. One way of doing so is by using unrelated task paradigms in which participants are prevented from seeing a connection between the conditioning procedure and the attitude assessment phase (Zanna, Kiesler, & Pilkonis, 1970). Another possibility is to design the conditioning procedure in such a way that participants get a different idea about the experiment's purpose. One ingenious example is the "surveillance procedure" developed by Olson and Fazio (2001). In this procedure, participants are instructed to be on guard for the recurring occurrence of a particular cartoon character in a continuous stream of hundreds of images and words. Unbeknownst to the participants, the experimenter's interest is in fact focused on two other cartoon characters (the CSs), which would appear either with positive or with negative images or words (USs) over the course of the surveillance procedure. The use of such an elaborate guise and conditioning procedure typically leads to low levels of awareness of the experiment's true purpose. As a matter of fact, the surveillance procedure has successfully been used in several studies (Jones et al., 2009; Kendrick & Olson, 2012; Olson & Fazio, 2001, 2002, 2006; Olson, Kendrick, & Fazio, 2009).

A second line of evidence comes from studies in which participants' hypothesis awareness was manipulated or measured. Allen and Janiszewski (1989) both manipulated and measured hypothesis awareness and found that it did not influence the EC effect. Sweldens and colleagues (2010, Study 1) investigated the effects of post-conditioning changes in US valence on CS attitudes (i.e., US revaluation effects) in different kinds of conditioning procedures. Participants' level of awareness of the experimental hypotheses was coded to create different categories of awareness. Whereas the majority of participants were classified as hypothesis unaware, some expressed beliefs that were at least partially correct regarding the experiment's purpose. These were captured in three other categories of hypothesis awareness, reflecting increased insights into the true nature and goals of the experiment. However, the same overall pattern of results was observed in each category of awareness.

A third line of evidence comes from many studies that prevented or significantly reduced participants' capacity to rely on strategic inferences while providing their CS evaluations. This has been done by using indirect evaluative measures, including response time (De Houwer, Hermans, & Eelen, 1998; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002; Kerkhof et al., 2009; Meersmans et al., 2005; Mitchell, Anderson, & Lovibond, 2003; Olson & Fazio, 2001, 2002, 2006; Pleyers et al., 2007; Stahl & Unkelbach, 2009; Stahl et al., 2009), physiological measures (Dawson et al., 2007; Vansteenwegen et al., 2006), and neurological measures (Klucken et al., 2009). Indirect evaluative measures are unlikely to reflect participants' strategic control over their evaluative responses. As a matter of fact, some of

these measures do not require participants to actively evaluate the CS at all (e.g., the evaluative priming task developed by Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Note however that finding EC effects on indirect measures of evaluation does not exclude the possibility that participants may have deliberately formed attitudes during the learning or encoding stage of the experiment. These explicitly formed attitudes may subsequently influence indirect evaluative measures, even if responses to those are less controllable. In other words, indirect evaluative measures only get rid of controllability or awareness issues at the evaluation stage. They do not necessarily imply that attitudes are acquired beyond participants' control and awareness at the learning stage.

Overall, several studies show that EC effects are observed when participants are misguided about the true nature of the experiment, whereas others show that the degree of hypothesis awareness is unrelated to the EC effect, and still others show EC effects on measures with little or no deliberate control. In light of this body of evidence, it seems unreasonable to claim that EC effects are nothing but an artifact caused by experimental demand.

US Identity Versus US Valence Awareness

As Shanks and St. John (1994) argued, contingency awareness tests should be at least as sensitive as the attitude measure. To satisfy this sensitivity criterion, researchers have relied on recognition tests of contingency awareness, rather than free recall tasks or open-ended questions. There are, however, two fundamentally different kinds of recognition tests. In one variant, the participant is presented with the CSs that occurred in the conditioning phase of the experiment, and asked to indicate which of several possible US had been paired with that CS previously. Typically, the target US is presented amidst a range of distracters, such as other affective stimuli of the same or opposite valence. Because the participant is required to indicate the precise US paired with the CS, this is a *US identity awareness test.* In the other variant, the participant is also presented with the CSs that were presented in the conditioning phase, but is only asked to indicate the valence (e.g., negative, neutral or positive) of the US paired with it. This is called a *US valence awareness test* (Stahl et al., 2009).

Both kinds of tests have been used before in various ways. Some articles relied solely on US identity awareness tests (e.g., Pleyers et al., 2009; Sweldens et al., 2010; Walther & Nagengast, 2006), others relied only on US valence awareness tests (e.g., Balas & Gawronski, 2012), whereas still others used US valence awareness tests in some studies and US identity awareness tests in others (e.g., Pleyers et al., 2007). Several authors even relied on a hybrid approach in which participants are presented with the CS and are first asked to indicate the paired US identity and—in case they don't know—are asked to indicate US valence next (Baeyens et al., 1990; Fulcher & Hammerl, 2001; Kattner, Ellermeier, & Tavakoli, 2012).

We argue that the choice of awareness measure should be a function of the research question. Although seemingly obvious, the variety of approaches used in previous research illustrates that this has been insufficiently considered, or at least, that authors disagree on what would constitute the right measure. Most research referenced above looked for an answer to the question "Do EC effects emerge independently of participants' awareness of the CS–US contingency?" The EC effect is defined as the *change in valence* of the CS following co-occurrences with a US. To answer this primary research question, we believe the measurement of US valence should be preferred over the measurement of US identity for three main reasons.

First, US valence awareness measures are superior on the information criterion. Attitude questions require participants to make a judgment on a valence dimension. Hence, even if participants hold US identity information in memory, they would still need to "translate" that to US valence information to answer the attitude question.

Second, US valence awareness measures are also superior on the sensitivity criterion. A participant who encodes US identity would still have access to US valence information (as this can be derived from US identity). However, a participant encoding US valence would not have access to US identity information anymore. Hence, a question probing US identity awareness runs the risk as classifying as "unaware" participants who do know US valence, but don't know US identity. Knowledge of US valence is, however, sufficient to answer the attitude question in line with the EC effect (Dedonder et al., 2010; Stahl et al., 2009).

Third, US identity awareness measures are more difficult to apply to EC procedures in which a CS is paired with many different USs, all sharing the same valence (e.g., Hütter et al., 2012; Olson & Fazio, 2001, 2002, 2006; Sweldens et al., 2010). It is especially difficult in these cases to define the criterion that would indicate "identity awareness" for a particular CS. Consider for example a procedure in which a CS is presented with five different USs sharing a certain valence. When should a participant be considered aware of US identity for this particular CS? Should he or she be aware of all five US identities? That seems overly restrictive. Is awareness of one US identity sufficient? In theory, this could be sufficient to explain an EC effect. However, such low performance levels on the memory test would be very hard to distinguish from chance performance when multiple identity awareness questions are asked. It should be noted however that sensible identity awareness measures could in theory be constructed. Notably, Olson and Fazio (2001) and Jones et al. (2009) developed an approach in which confidence judgments of CS–US contingencies are compared between actual CS–US pairs and distractor pairs. Such an approach allows an assessment of whether identity awareness is significant across participants. However, it is currently unclear whether

such a method can be applied to investigate whether an individual participant is identity aware, or—in the case of procedures containing many CS—whether he or she is identity aware of some CS but not of others. As we will explain in the next section of this review, the study of awareness in EC is increasingly characterized by such refinement. Contrary to identity awareness measures, valence awareness measures can easily be applied to procedures in which CS are paired with multiple US. This is an important advantage because—as we discuss in the final part of this review—such procedures might be more conducive to attitude change in the absence of contingency awareness (Sweldens et al., 2010).

In sum, the measurement of US valence awareness should be preferred over US identity awareness when the research question applies to the role of contingency awareness in the emergence of EC effects which are defined as a change in CS attitudes (valence). However, as we will also discuss in the next section, measuring valence awareness can have important downsides as well and can even be entirely misleading if the measurement is not corrected for the use of affect-as-information (Hütter et al., 2012).

Furthermore, it should be noted that there are still research questions for which the study of US identity awareness remains important. One example is research on US revaluation effects—the study of what happens to CS attitudes when the valence of a US is changed *after* the conditioning procedure (Baeyens, Eelen, Vandenbergh, & Crombez, 1992; Baeyens, Vanhouche, Crombez, & Eelen, 1998; Sweldens et al., 2010; Walther et al., 2009). US revaluation paradigms are often used to distinguish whether stimulus–stimulus (CS–US) or stimulus–response (CS–affective response) associations are learned during conditioning (Rescorla, 1974; Sweldens et al., 2010). Researchers in this area might be interested in whether US revaluation effects are dependent on participants' memory of the CS–US association as established during conditioning. In such a case, measuring US identity awareness would be more relevant than studying US valence awareness. More generally, we believe there is extensive scope for future research on the link between US identity and US valence awareness. Currently, very little is known about whether US valence and identity awareness interact in their development. It is likely that US identity awareness leads to US valence awareness through abstraction processes. Conversely, it is also conceivable that US valence awareness leads to US identity awareness. For example, a participant who is getting the sense that a particular CS regularly co-occurs with positively valenced US (i.e., is becoming valence aware) could (a) reconstruct past pairings that are consistent with this idea and (b) pay more attention to subsequent pairings, so increasing identity awareness.[2] We believe further research on this topic is important because it might go to the heart of a second fundamental question concerning dual-processing systems in human learning. In their review on the characteristics of dissociable human learning systems, Shanks and St. John (1994) distinguished learning processes first on the basis of whether they occur with versus without awareness, and second on whether they involve the encoding of instances versus the induction of rules. In EC, one could conceive the development of US identity awareness as an encoding process of instances, whereas the development of US valence awareness could be conceived as a rule induction process integrating the experience of several instances (USs sharing positive versus negative valence). Therefore, studying the development of US identity versus US valence awareness in EC has the potential to simultaneously inform both fundamental questions regarding dual processes in learning.

Having discussed how awareness may be conceptualized, we now consider how it classically was, and more currently is, analyzed when examining its implications for EC effects. We first discuss the correlational approach to this issue and then turn to the experimental approach.

The Correlational Approach: From Participants to CSs and From Correlation to Dissociation

The analysis of contingency awareness in EC is characterized by continuous methodological refinement and sophistication in both measurement and analysis. The measures have typically evolved from generally worded, open-ended recall questions (e.g., Bierley, McSweeney, & Vannieuwkerk, 1985; Jones et al., 2009; Olson & Fazio, 2001, 2002, 2006; Page, 1974; Staats & Staats, 1957; Stuart et al., 1987) to more sensitive recognition measures better suited to the sensitivity and information criteria (e.g., Pleyers et al., 2007; Pleyers et al., 2009; Stahl & Unkelbach, 2009). The corresponding statistical analyses have similarly progressed in sophistication and sensitivity.

Early approaches typically studied the link between contingency awareness and EC effects at the participant level, either by classifying participants as "aware" or "unaware" (e.g., Fulcher & Hammerl, 2001; Hammerl, 2000; Hammerl & Fulcher, 2005; Walther & Nagengast, 2006) or by investigating the correlation between participants' awareness scores and EC effects. Both approaches have important limitations. Classifying participants as "aware" or "unaware" is often not feasible because participants are rarely aware of either all or none of the contingencies. In addition, it has been shown that looking at EC effects in a sample of participants who score below chance on an awareness measure is a treacherous practice (Shanks, 2010).

Relying on correlations between awareness scores and EC effects is not a satisfactory option either. In this approach, the absence of a significant correlation between awareness scores and EC effects is considered evidence that EC effects are independent of contingency awareness (Baeyens et al., 1988; Baeyens, Eelen, Crombez, & Vandenbergh, 1992; Baeyens et al., 1993; Olson & Fazio, 2001). There are, however, many reasons why a correlation between two variables

can fail to be significant. Imagine, for example, a study in which participants would all be highly aware of the CS–US contingencies. Due to the lack of variability in the awareness scores, the correlation between awareness scores and EC effects would be non-significant, providing entirely spurious evidence for the independence of EC from contingency awareness.

Furthermore, just like the absence of a significant correlation would not constitute convincing evidence for the independence of EC from contingency awareness, the opposite finding (a significant correlation between contingency awareness and the EC effect) would not constitute evidence *against* the contribution of an implicit process in attitude formation either, for the following two reasons. First, the possibility exists that participants would rely on affect-as-information when answering the contingency awareness questions (Bar-Anan & Amzaleg-David, 2013; Hütter et al., 2012). This problem is especially acute with valence (as opposed to identity) awareness questions—precisely the kind of questions that should be favored as we argued in the previous section. For instance, imagine the case of a participant whose CS attitudes were changed in the direction of US valence (i.e., she shows a regular EC effect) without awareness of the CS–US contingency. When faced with the question "was this (CS) paired with a positive, neutral, or negative (US)," she could rely on her conditioned attitude (e.g., "positive" if the CS was paired with a positive US) to arrive at the correct response. As a result, the correlation between awareness scores and EC effects would be positive and significant, even in the absence of explicit awareness of CS–US contingencies.

Second, a positive correlation between awareness and EC does not exclude the possibility that an associative process operating without awareness contributes to the EC effect as long as one accepts the possibility that there might be multiple processes contributing to the final EC effect (Jones et al., 2010). After all, there is little doubt that conscious, propositional reasoning can lead to EC effects (Mitchell et al., 2009). The question is whether *in addition*, there are also implicit, associative processes contributing to the EC effect. Observing a positive correlation between contingency awareness and the EC effects is at best consistent with the propositional account, if one assumes participants do not rely on affect-as-information. However, this does not preclude the possibility that an implicit process operating without awareness is contributing to the EC effect as well.

The problems with analyses at the participant level prompted Pleyers and colleagues (2007) to develop an analysis method at the item (CS) level. They developed a conditioning procedure in which the EC effect would be replicated across multiple CSs. Over the course of multiple rounds of presentations, four CSs (brands of fast-moving consumer goods unknown to participants) would consistently be paired with positive USs, while four other CSs would be paired with negative USs. One advantage of replicating the EC effect across multiple stimuli is that it increases statistical power. A second and crucial methodological advantage is that using multiple CSs allows one to investigate within participants whether the EC effects differ between CSs for which participants are aware of the associated US identity and CSs for which they are not. Stahl and colleagues (2009) further refined this method, making a case for the importance of measuring awareness of US valence, rather than US identity. Item-based contingency awareness analyses were conducted in several studies, none of which found any evidence for significant EC effects among CSs classified as "unaware." Of note, this absence of significant EC effects on contingency-unaware parings was observed both for implicit and explicit evaluative measures and both for meaningful and nonsensical stimuli (Pleyers et al., 2007; Pleyers et al., 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009). The same message emerged in studies that made use of physiological measures (Dawson et al., 2007) and neurological measures (Klucken et al., 2009). On the contrary, in some studies (and in a meta-analysis across studies) an unexplained *reversed* EC effect was apparent for contingency-unaware CSs (Förderer & Unkelbach, 2013; Stahl et al., 2009). Clearly, the item-based contingency awareness analyses constitute an important methodological improvement over the previous participant-based analyses. The persistent failure to observe EC effects on unaware CSs was therefore regarded as particularly damaging for the idea that there might be implicit, associative processes active in EC specifically and in learning more generally (Kruglanski & Gigerenzer, 2011; Mitchell et al., 2009; Shanks, 2010).

Most recently, however, a simulation demonstrated that item-based measures are biased against the possible detection of contingency-unaware EC effects when participants rely on affect-as-information in answering the contingency awareness questions (Hütter et al., 2012). Consider what happens when a participant has no explicit memory for a certain CS's associated US valence. If the participant's attitude toward the CS happens to correspond to the associated US valence, she will mention the correct US valence in the awareness test when relying on her feelings toward the CS. As a result, that CS will be classified as "aware" and contribute positively to the EC effect observed with aware CSs (as the CS attitudes are in line with the associated US valence). If, on the other hand, the participant's attitude toward the CS is counter to its associated US valence, she will mention the incorrect US valence in the awareness test when relying on her feelings toward the CS. As a result, that CS will be classified as "unaware" and contribute *negatively* to the EC effect observed with unaware CSs (as the CS attitudes are opposite from the associated US valence). In sum, the use of affect-as-information will increase the EC effect observed with CSs classified as "aware," but will decrease the EC effect observed with CSs classified as "unaware." This can explain the emergence of a reversed EC effect for unaware CSs observed by Stahl et al. (2009; see also Förderer &

Unkelbach, 2013). In addition, recent research has shown that participants do in fact rely on their feelings when answering contingency awareness questions (Bar-Anan & Amzaleg-David, in press), confirming the concerns raised in the simulation conducted by Hütter et al. (2012).

These problems have ultimately led to the development by Hütter and colleagues (2012) of a method in which the effects of contingency memory can be distinguished from attitudes conditioned in the absence of contingency memory. The authors developed a process dissociation procedure (PDP) based on the seminal work of Jacoby (1991). In the standard conditions ("inclusion conditions" in PDP terminology) both explicit memory for the pairings and attitudes conditioned in the absence of contingency memory lead to the same response in a contingency awareness test (i.e., the procedure is essentially incorporating the use of affect-as-information). Conversely, in the reversal conditions ("exclusion conditions"), participants were asked to reverse the influence of one of these processes. For example, in a memory exclusion condition, participants are instructed to respond "negative" if they remember a CS was paired with positive USs, and vice versa, and to simply report their attitude toward the CS without reversal when participants could not remember whether the CS was paired with positive or negative US. Likewise, it is possible to design attitude exclusion conditions, in which participants are instructed to report their memory for the US valence in a straightforward fashion, but, in the absence of memory, have to report the opposite from how they feel about the CS instead. A multinomial processing tree model can then be fitted to the responses in the awareness test across inclusion and exclusion conditions, estimating the contributions of the memory and attitude-without-memory processes. Irrespective of the kind of exclusion condition implemented, the authors find consistent support for the existence of attitudes conditioned in the absence of contingency memory (and the parameter estimates are robust to the kind of reversal participants are asked to perform). Interestingly, the authors also find that the attitudinal effect of explicit contingency memory deteriorates over time (after a one day delay), whereas the effect of attitudes conditioned in the absence of contingency memory remains constant over time. This can explain a conundrum in the EC literature. On the one hand, it has been shown that contingency memory is by far the strongest predictor of EC effects (Hofmann et al., 2010), yet we also know that explicit memory deteriorates quickly over time (Rubin & Wenzel, 1996). This would be hard to reconcile with other research showing that EC effects are often resistant to extinction and quite stable over time (Baeyens et al., 1988; Diaz et al., 2005; Förderer & Unkelbach, 2013; Grossman & Till, 1998; Kerkhof et al., 2011; Vansteenwegen et al., 2006). Therefore, the data from Hütter and colleagues offer the best evidence to date that multiple memory processes, both explicit and implicit, are contributing to the development or sustainability of EC effects. In the absence of evidence to the contrary, we recommend the PDP as the best correlational approach to study whether attitudes can be conditioned without contingency awareness.

Does the development of the PDP by Hütter et al. (2012) imply that the quest for ever-improving measures of contingency awareness has finally come to an end? Unfortunately, there are at least two limitations to the method, as acknowledged by the authors in the general discussion of their article. A first potential limitation is the inherent assumption in process dissociation methods that the contribution of explicit and implicit processes is constant in the exclusion and inclusion conditions, which might not necessarily be the case. If this assumption were violated, it could lead to biased parameter estimates. However, the fact that the parameters respond as predicted to a time delay manipulation is reassuring as to their validity.

A second limitation the method has in common with previous approaches is that the awareness measure is administered after, rather than during, the learning phase or conditioning episode. It is currently unclear how to implement awareness measures during the learning phase. Previous research which asked participants to indicate US expectations during learning found that such online measures inflate contingency awareness, thus interfering with the target of measurement (Baeyens et al., 1990; Purkis & Lipp, 2001). Nevertheless, this limitation is important with regard to the conclusions that can validly be drawn from the research by Hütter et al. (2012). It is possible to conclude that after learning people show CS evaluations in line with US valence without explicit memory for the CS–US valence contingency as it occurred during learning. Put differently, this means that people's attitudes can show evidence of change even when they do not remember the source of the change from a few minutes before. Strictly speaking, however, it is still not possible to conclude attitudes can be changed without explicit awareness of CS–US contingencies *at the time of learning*. It is still theoretically possible that the learning process is characterized by awareness of the contingencies, which are forgotten by the time of the awareness test[3] (Gawronski & Walther, 2012). Even though there were only a few minutes between the time of learning and the time of the awareness test, this limitation is important because it is precisely in the domain of learning where there is most uncertainty about the possible contribution of implicit processes operating without awareness (Shanks, 2010).

The Experimental Approach: Controlling Exposure Time, Attention, and Location

As reviewed above, a key limitation of even the most sophisticated methods relying on memory-based measures of contingency awareness is their inability to distinguish contingency awareness at retrieval (the time of the memory test) from awareness at encoding (during the conditioning

phase). Consistent with this conclusion, Gawronski and Walther (2012) recently noted that "memory performance data of the traditional correlational paradigm remain ambiguous about the exact role of contingency awareness during the encoding of CS–US pairings." These authors therefore suggested "that researchers move beyond the traditional correlational paradigm, which remains inherently ambiguous about the causal relation between memory performance and evaluation" and wished for "the development of experimental approaches to study of the role of contingency awareness in EC, which may help to provide deeper insights into this notoriously recurring, but fascinating question" (p. 622).

We discuss in this section three experimental approaches that anticipated Gawronski and Walther's (2012) recommendation to shed an experimental light on the role of contingency awareness in EC: the subliminal approach, the attentional load approach, and a third more recent approach manipulating the spatial location of the CSs.

Subliminal EC: Can EC Effects Occur With Subliminal CS or US Presentations?

One experimental approach that in principle may provide strong evidence for EC without awareness at encoding relies on subliminal stimulus presentations (i.e., with presentation durations that are too brief to be consciously perceived; Bargh & Chartrand, 2000). Several articles have been published claiming evidence for subliminal EC effects (De Houwer et al., 1994; De Houwer et al., 1997; Dijksterhuis, 2004; Field & Moore, 2005; Fulcher & Hammerl, 2001; Krosnick et al., 1992; Niedenthal, 1990). There are, however, a number of empirical and methodological as well as theoretical concerns to be raised with regard to these studies.

At the empirical level, there are at least two methodological pitfalls ensnaring previously published studies. The first is the use of inappropriate designs in which CS valence (i.e., whether a CS is paired with positive, neutral, or negative USs) is manipulated between participants rather than within them. In EC experiments, it is generally desirable to manipulate CS valence within participants, because evaluative changes may otherwise reflect changes in mood rather than an effect of the CS–US pairings per se. For example, Krosnick et al. (1992) report two experiments suffering from this limitation. In each experiment, the CS (a person) was paired with subliminally presented positive versus negative images, using a between-subjects design. The authors found that the CS was evaluated more positively in the condition where the subliminally presented images were positive rather than negative. However, it is impossible to conclude from such a design that this difference in evaluations is a result of a process forming associations between CS and US without awareness. It could just as well be that participants in the positive US condition were in a better mood, or simply primed with positivity, which spilled over into their evaluative ratings. An analogous analysis can be made for the data presented by Niedenthal (1990).

Another line of work that is often cited as providing evidence for subliminal EC effects was conducted by Dijksterhuis (2004) who showed in five experiments (all featuring between-subjects designs) that presenting the word "I" (CS) subliminally with positive trait words (US) can increase implicit self-esteem (i.e., CS evaluations). The first experiment suffered from the same limitation as outlined above: Positive trait words were only presented in the "positive self-esteem condition" but not in the control condition, opening the door for a non-associative alternative explanation for the observed increase in self-esteem in that condition. Acknowledging this concern, the author changed the design of the subliminal EC procedure in Experiments 2 to 5. In those experiments, equal numbers of positive trait words were shown in both conditions. However, this time around, the "I" word was only presented in the "positive self-esteem condition," and not in the control condition. Again this allows for a non-associative explanation of the results: The higher self-esteem observed in the positive self-esteem condition might be due to the fact that in that condition alone the word "I" was presented 15 times, whereas "I" never appeared in the control condition.

One notable exception comes from a study by Rydell, McConnell, Mackie, and Strain (2006). These authors primed a CS character ("Bob") with subliminal US words of negative (or positive) valence while at the same time providing explicit information of positive (or negative) valence about him. After learning, participants were invited to complete both direct and indirect evaluative measures about Bob. Results showed evaluations of conflicting valence on the direct and indirect measures: Whereas the implicit measure reflected the valence of the subliminally presented words, the explicit measure reflected the valence of the information communicated explicitly about Bob. In this study, it is unlikely that mood drove the EC effects as explicit and implicit measures showed divergent patterns. As an additional asset, the US words were flashed for 25 msecs—a rather short presentation time—and a post-test probed the subliminal nature of these presentations. There are however three limitations with the study by Rydell et al. First, to the best of our knowledge, it has not been replicated, which is important considering the general unreliability of subliminal EC effects (Lovibond & Shanks, 2002). Second, the awareness check involved a memory component (i.e., participants retrospectively had to identify among foils which US words they had been exposed to) and was not complemented by an online awareness probe. Third, the US rather than the CS was presented subliminally. We now address this third issue in more detail.

As a matter of fact, the second methodological pitfall in subliminal EC studies comes from the difficulties in assessing whether a stimulus was indeed presented briefly enough to prevent awareness of what was presented. Although this is

a concern in general, it is especially acute for the presentation of valenced, emotional stimuli (USs). Several studies have shown that the emotional valence and even the entire meaning of emotional words can be extracted with extremely brief stimulus presentations (Dijksterhuis & Aarts, 2003; Nasrallah, Lavie, & Carmel, 2009; Zeelenberg, Wagenmakers, & Rotteveel, 2006). One reason for the processing advantage of emotional stimuli could be that the amygdala provides the equivalent of a perception highway for emotionally significant stimuli (Anderson & Phelps, 2001). As a result, subliminal EC studies would be more convincing if the CS, rather than the US, were subliminally presented. However, to our knowledge, the only article reporting EC effects with subliminally presented CSs is the one by Dijksterhuis (2004), which suffered from inappropriate control conditions (as outlined above). All of the other articles claiming evidence for subliminal EC presented the US "subliminally" (De Houwer et al., 1994; De Houwer et al., 1997; Field & Moore, 2005; Fulcher & Hammerl, 2001; Krosnick et al., 1992; Niedenthal, 1990; Rydell et al., 2006).

There are, however, a few studies in closely related research areas which presented evidence of conditioning effects with subliminally presented CSs. First, there are a number of studies in the literature on motivation and goal pursuit that subliminally presented a goal or behavior concept (the CS, e.g., "drinking") in combination with affective stimuli in well-controlled designs. These studies have generally shown that subliminally presenting a behavioral goal together with positive affect motivates people to engage in that behavior (Aarts, Custers, & Marien, 2008; Custers & Aarts, 2005; Veltkamp, Custers, & Aarts, 2011). These studies did feature well-controlled between-subjects designs in which all CSs and USs were shown equally often to all participants and only the crucial property of whether CS and US were actually paired was varied between conditions. However, it is important to note that they typically did not measure whether the subliminal conditioning procedure actually changed people's *attitudes* toward the goal or behavior (but see Study 2B in Custers & Aarts, 2005 for an exception). In addition, the sensitivity of their measure of stimulus discriminability is unclear, leaving some doubt on whether participants were indeed unaware of the subliminally presented CSs. In sum, even though they are promising, the studies do not provide direct evidence for subliminal EC effects. Adapting Custers and Aarts' procedures to investigate whether they can also cause more permanent attitudinal changes supplemented with sensitive measures of stimulus discriminability would therefore constitute a promising avenue for future research. A second example is an article in the domain of semantic conditioning. Galli and Gorn (2011) subliminally presented Chinese characters (CS) before the concepts black or white and noted this procedure slowed down response times to target words with opposite semantic meaning and influenced liking of these characters when used as brand names for black versus white products (e.g., cola vs. soymilk). A sensitive measure of awareness of the CS presentations indicated, however, that at least some participants were aware of some CS presentations, even though overall awareness levels were low.

All in all, it is fair to say that on empirical and methodological grounds a number of concerns can be raised with regard to the currently existing evidence of subliminal EC effects. However, in addition to these issues, we see at least two theoretical reservations with regard to the potential implications of subliminal EC. First, if reliable EC effects would indeed be observed with subliminal CS presentations, with appropriate designs and complemented by careful checks of perceptual stimulus discriminability, this would indeed constitute important evidence that attitudes can be changed outside of awareness. Inarguably, this would provide an important argument for dual-process theories of attitude generation and learning. Such a demonstration would, however, still leave unanswered the broader question of whether dual-process theories are also of relevance when stimuli are presented supraliminally and are consciously perceived. Given that subliminal presentation durations are mostly confined to experimental psychology laboratories and are even outlawed in some jurisdictions,[4] the question of how attitudes are changed in normal circumstances would remain entirely open.

A second theoretical reservation is that studying subliminal effects to infer whether people can learn associations without contingency awareness imposes an unnecessary burden on System 1. As a matter of fact, the theoretical question to be answered is whether it is possible to learn associations without awareness of the *contingencies* between stimuli, rather than without awareness of the stimuli themselves. Quoting Bargh and Morsella (2008),

> We [. . .] oppose the cognitive psychology equation of the unconscious with subliminal information processing [. . .]. Subliminal stimuli do not occur naturally—they are by definition too weak or brief to enter conscious awareness. Thus, it is unfair to measure the capability of the unconscious in terms of how well it processes subliminal stimuli because unconscious (like conscious) processes evolved to deal and respond to naturally occurring (regular strength) stimuli; assessing the unconscious in terms of processing subliminal stimuli is analogous to evaluating the intelligence of a fish based on its behavior out of water. And as one might expect, the operational definition of the unconscious in terms of subliminal information processing has in fact led to the conclusion of the field that the unconscious is, well, rather dumb. (p. 74)

The Role of Attentional Resources in EC: Does EC Emerge Under Attention Depletion Conditions?

A second experimental approach for investigating the role of awareness in EC effects consists of manipulating participants' attentional resources as they go through the learning

stage of the EC procedure. Studies relying on this approach often assume a direct link between attentional resources and awareness. However, it should be noted that the different features or "horsemen" of automaticity (intentionality, resource efficiency, awareness, and controllability) can vary independently of each other (Bargh, 1994; Moors & De Houwer, 2006). Specifically concerning the link between attentional resources and awareness, recent research has shown that visual attention and awareness can be dissociated such that people can attend to stimuli without becoming aware of them (Koch & Tsuchiya, 2012). Similarly, it is theoretically possible that participants become aware of CS–US relations, even when attentional resources are depleted. One can expect, however, that when attentional resources are taxed, the likelihood that people become aware of CS–US relations is reduced. Importantly, given the somewhat tenuous link between the attentional resource and awareness constructs, studies featuring attentional load manipulations should still feature sensitive awareness measures if they aim to be informative regarding the debate about whether EC can occur without awareness. Note, however, that these studies can be informative regarding the dependency of EC on attentional resources, even without awareness measures.

Only a few studies have manipulated attentional resources in EC. These studies reported divergent conclusions (enhancement vs. reduction of EC effects under load and no-load conditions), but also presented interpretative limitations in addition to those mentioned above. In several studies, the absence of load or distraction was confounded with the presence of attention enhancement instructions (Field & Moore, 2005; Fulcher & Hammerl, 2001; Kattner, 2012). In some studies where no significant effect of load on EC was observed, the obtained pattern could be due to the use of a weak attentional load manipulation (Walther, 2002).

In two more recent and arguably less problematic studies, Pleyers et al. (2009) and Dedonder et al. (2010) randomly assigned participants to a low attentional load condition (e.g., listening to neutral music) or to a high attentional load condition (e.g., completing an auditory 2-back numeric task) as they were exposed to the CS–US pairings. Note that the load manipulation (which was quite demanding) and the conditioning procedure were completed through different sensory modalities (auditory and visual, respectively). This reduces the possibility that participants in the load condition would show no EC effects because they would not have perceptually processed the CS–US pairings.

The authors reasoned that explicit CS–US encoding should be reduced under the load manipulation. And, if EC requires explicit encoding of the CS–US pairings, a reduced EC effect would then be observed in the load condition. In line with this reasoning, contingency awareness did not depart from chance level and EC effects were entirely absent in the high-load condition. These findings, which were obtained for both meaningful (Pleyers et al., 2009) and nonsensical (Dedonder et al., 2010) CSs, suggest that, irrespective of the presence or absence of prior knowledge about the CS, EC effects require attentional resources that are used for explicitly encoding CS–US pairings. Similar findings were recently obtained in a flavor-flavor conditioning paradigm, both on direct and indirect behavioral measures (Davies, El-Deredy, Zandstra, & Blanchette, 2012).

Whereas the studies by Pleyers et al. (2009), Davies et al. (2012), and Dedonder et al. (2010) indicate that EC effects can be dependent on attentional resources, no study featured process dissociation measures of awareness. Therefore, we should be careful in concluding from these studies that EC could not occur without awareness. To date, we are not aware of a study that combined attentional load manipulations with process dissociation measures of awareness. We regard such studies as a promising avenue for future research. By combining a manipulation of attentional resources during encoding with a sensitive process dissociation measure of contingency awareness, such studies could help overcome one of the remaining limitations of the process dissociation methodology—the fact that it does not distinguish between awareness at encoding (i.e., during the conditioning procedure) and retrieval (i.e., during the memory test; see our discussion of this method earlier).

The Role of Spatial Location in EC: Does EC Emerge for Parafoveal CS Presentation?

The findings obtained by Pleyers et al. (2009) and Dedonder et al. (2010) are apparently inconsistent with the idea that EC effects may be acquired through resource-independent associative processes. However, several notes of caution are in order here. First, these findings were obtained in a specific EC paradigm. It may well be that other EC procedures are more conducive to implicit learning effects (more on this in the next section). Second, these effects were obtained on a direct evaluative measure. As suggested by Rydell and colleagues' (2006) study and Gawronski and Bodenhausen's (2006) APE model, more indirect evaluative measures may be more sensitive to implicit effects. Third, the numeric two-back task may have distracted participants from an evaluative processing of the CS–US pairings. Hence, different goals may have been activated in the low-load and high-load conditions (evaluative in the low-load condition and non-evaluative in the high-load condition). This might be important as EC effects have been shown to be sensitive to goal activation at learning (Corneille, Yzerbyt, Pleyers, & Mussweiler, 2009) and in particular to evaluative goal activation (Gast & Rothermund, 2011b). This is consistent with research showing that affective priming manipulations only influence behavior when attention is focused on affective stimulus information (Spruyt, De Houwer, & Hermans, 2009).

To avoid this confound with goal activation, Dedonder et al. (2014) recently turned to a *within*-subject manipulation of contingency awareness in a study that exposed each participant to both foveally presented and parafoveally presented

CSs. The US was always presented in a central (foveal) location in this study. The CS was presented in a foveal or parafoveal location depending on the experimental trial. In line with prior parafoveal studies conducted in social cognition (e.g., Aarts et al., 2010; Chartrand & Bargh, 1996), these authors reasoned that parafoveal presentations would possibly allow for implicit behavioral effects on CS evaluations, whereas they would preclude an explicit processing of the CS–US pairings. Hence, assuming EC effects can be acquired through implicit processes, explicit encoding of the CS–US pairings should be observed for the foveal presentations only, but EC effects should be observed for both foveal and parafoveal presentations. Conversely, if EC effects depend on the explicit encoding of CS–US pairings, above-chance contingency awareness and EC effects should be observed for the foveal presentations CSs only. The latter findings were obtained, with above-chance recognition of CS–US pairings and significant EC effects only for the foveal presentations, again suggesting that attitude acquisition through EC depends on explicit learning.

Four additional comments are in order here. First, a further study making use of an online (rather than memory-based) assessment of the CS–US contingencies ruled out the possibility that participants were not conditioned with parafoveal CSs simply because they could not see them. Contrary to this interpretation, the findings obtained in this research collectively suggested that parafoveal presentations made it possible to process at least superficial features of the CS, but that this type of presentation interfered with the explicit encoding of the CS–US contingencies. Second, the authors failed to obtain any significant evidence for EC effects on an indirect evaluative measure. Hence, again the possibility exists that different findings would be observed for an indirect evaluative measure or for another EC procedure (more on this in the next section). Third, by assuming that implicit processes should be revealed under parafoveal presentations, this approach is subject to Bargh and Morsella' (2008) criticism with regard to the use of subliminal presentations to detect the operations of System I. Finally, it is possible that an implicitly operating process in EC depends on the proximity of CS to US and was therefore hindered by the parafoveal presentations (see our upcoming discussion of the implicit misattribution of affect). In this respect, it should also be noted that the US appeared at a central location in this study, making it unlikely that participants would misattribute the source of their affective reactions to another stimulus.

Relation Between EC Procedures, Mental Processes, and Contingency Awareness

As outlined in the introduction to this article, the question of whether EC can occur without contingency awareness is intimately tied to the question of whether multiple psychological processes are involved in attitude change by conditioning procedures. Despite half a century of research and increasing sophistication in measurement and analysis, the awareness question—and with it the debate on whether multiple processes play a role in EC—still has not been fully resolved. Whereas many different theoretical accounts for EC effects have been proposed, in this section we structure these in three categories: purely associative accounts, purely propositional accounts, and dual-process accounts which propose a mix of associative and propositional processes. In our discussion, we specify for every type of account the extent to which learning is assumed to be automatic and able to occur without awareness, the presumed content of what is learned, and the extent to which the theory can account for the data in the literature.

Purely Associative Accounts

According to these accounts, EC effects are driven by the *automatic* learning of associations. Therefore, EC should be characterized by the famous four features of automaticity and should occur without awareness, without intentionality, be uncontrollable, and be independent of processing resources (Bargh, 1994). In the study of any associative learning process, the content of the learned associations is a primary research question (Rescorla, 1988). When a CS is presented repeatedly with a US in an EC procedure, fundamentally there are two kinds of associations that could explain a change in attitudes toward the CS (the EC effect).

First, the CS could form associations with the US (or USs) it is presented with during the conditioning procedure, resulting in the formation of stimulus–stimulus (S–S) associations. Early theory formation on EC termed this process "*referential learning*" to distinguish this kind of association formation in EC from classical, Pavlovian conditioning, where the same type of associations can be learned, but including a predictive component (S $\rightarrow$ S), also known as "signal learning" or "expectancy learning" (Baeyens, Eelen, Crombez, & Vandenbergh, 1992; De Houwer et al., 2001). The referential learning system was assumed to automatically register co-occurrences of stimuli (CS) with valenced events. Future encounters of the CS will subsequently (consciously or unconsciously) activate US representations in memory (i.e., the CS will start "referencing" to the US, without triggering an actual expectation that the US would occur as in classical conditioning settings). Hence, the change in evaluative responses toward the CS is caused by intermediating activation of CS–US associations.

Second, the CS could form a direct association with the affective response generated by the US, called the unconditioned response (UR), resulting in the formation of stimulus–response (S–R) associations. This kind of learning was called "*intrinsic learning*" as according to this process the CS would intrinsically acquire the evaluative response, independent of intermediating CS–US associations. Both referential and intrinsic learning are consistent with several known functional properties of EC such as its sensitivity to stimulus contiguity,

rather than contingency, and its resistance to extinction (De Houwer et al., 2001). However, only referential learning is consistent with the observation that EC is sensitive to US revaluation effects: when the valence of the US is changed *after* conditioning (e.g., when a previously positive stimulus becomes negative), the affective responses to the CS change accordingly (Baeyens, Eelen, Vandenbergh, & Crombez, 1992; Walther et al., 2009; but see Sweldens et al., 2010).

Importantly, both referential and intrinsic learning accounts assume that S–S or S–R associations can be learned without awareness of the stimulus contiguities at the time of learning. Especially the referential learning system attributes great processing power to an unconsciously operating system that would store co-occurrences of stimuli with valenced events without awareness and with long-lasting effects. The existence of such an unconsciously operating associative system with large processing and storage capacity would be consistent with theories about the processing power of unconscious thought (Bargh & Morsella, 2008; Dijksterhuis & Nordgren, 2006; Wegner & Bargh, 1998). These associative theories are also not necessarily inconsistent with the fact that contingency awareness appears to be the largest predictor of EC effect sizes (Hofmann et al., 2010). Just like early behaviorist theories, they consider awareness as an epiphenomenon–rather than being the real cause of behavior or learning, it is merely a consequence or byproduct.

However, these theories would be questioned if it were reliably demonstrated that EC does *not* occur without awareness (e.g., Pleyers et al., 2007; Stahl et al., 2009; but see Hütter et al., 2012). The experimental work demonstrating that cognitive load and parafoveal presentations suppress EC effects (Dedonder et al., 2014; Dedonder et al., 2010; Pleyers et al., 2009) is inconsistent with a purely associative explanation of EC based on the automatic, resource-independent processing and storage of stimuli with valenced events. Without making additional assumptions, purely associative theories also cannot explain the results of studies showing that the type of relation participants construct between CS and US can significantly impact, and even reverse, EC effects. Fiedler and Unkelbach (2011) showed that when participants construct a "friend" relation between CS and US, regular EC effects are observed. However, when they construct an "enemy" relation, the EC effect reverses (see also Förderer & Unkelbach, 2012). Such findings propose a clear challenge to accounts like the referential learning model, which assumes that EC is determined by the unqualified integration and storage of CS–US occurrences.

Purely Propositional Accounts

Propositions differ from associations in that they don't just specify that stimuli are related, but also how they are related. Purely propositional accounts state that all learning is completely governed by high-level cognitive processes that give rise to propositional knowledge. Learning processes are assumed to operate only with awareness, but can be complemented by unconsciously operating processes involved in memory retrieval and perception (Kruglanski & Gigerenzer, 2011; Mitchell et al., 2009; Shanks, 2010). According to propositional accounts, there is no unconscious formation of associations between stimuli. Rather, EC effects are explained by the fact that participants during an EC procedure consciously reason about the relation between CS and US and store their knowledge as propositions about the CS–US relationship. The propositional account does allow for fast and unconscious memory retrieval processes afterwards (Mitchell et al., 2009). Therefore, the propositional account actually allows for EC effects without awareness at retrieval, but not at encoding. Put differently, according to this account people do not store any relations between CS and US without their full awareness *during* conditioning, However, when confronted with a CS *after* conditioning, people can retrieve their evaluation very quickly from memory and potentially even without awareness of the source of their evaluation. A propositional account of EC naturally predicts a strong role for awareness and is thus supported by the fact that contingency awareness is the strongest predictor of EC effects (Hofmann et al., 2010). It is also consistent with the aforementioned observations that EC effects are reduced by cognitive load manipulations (Dedonder et al., 2010; Pleyers et al., 2009) and under parafoveal presentations (Dedonder et al., 2014). Importantly, it is the only type of account that naturally predicts that relational elements provided about the CS–US relation can influence, or even reverse, EC effects (Fiedler & Unkelbach, 2011; Förderer & Unkelbach, 2012).

As the propositional account makes the strong claim that associative learning is never automatic and always requires controlled processes, the "demonstration of unaware conditioning would be highly damaging to the propositional approach and would provide strong evidence for a second (automatic) learning mechanism" (Mitchell et al., 2009, p. 189). Contrary to associations, propositions have almost limitless flexibility in the way they can be construed. Therefore, this quote highlights one of the few ways a purely propositional model for EC can be falsified and illustrates the crucial importance of the awareness question for the theoretical analysis of attitude formation. Furthermore, an influential review by Lovibond and Shanks (2002) identified EC as one of the only two cases in the literature where evidence for associative learning without awareness had been documented (the other case is the Perruchet effect; Perruchet, 1985), illustrating the importance of this issue for the human learning literature more generally.

Dual-Process Accounts and the Role of the Conditioning Procedure

There is little doubt that humans have a capacity for rational thinking and for forming propositions. As a matter of fact, few if any supporters of associative processes would deny

that rational thinking does take place. The real question appears to be whether all learning is characterized by propositional reasoning, or whether there is also a separate contribution of a more automatically operating associative system (Shanks, 2010). As we argued in the previous sections, correlational research relying purely on memory-based measures of contingency awareness will have a hard time indisputably ruling out a purely propositional account of evaluative learning. Studies relying on subliminal presentations can be criticized due to the difficulty of ensuring that subliminally presented stimuli indeed do not reach consciousness (they also impose unnecessary restrictions on the potential contribution of an implicitly operating associative system). Alternative experimental approaches, such as relying on attentional load or spatial location, come with their own limitations and await generalization in a more diverse set of conditioning settings.

In this part of our review, we focus on three recent articles that have taken the study of contingency awareness one step further by combining contingency awareness measures with manipulations of the conditioning procedure to generate patterns of results that are inconsistent with a purely propositional account and point to the existence of multiple learning systems in EC (Hütter & Sweldens, 2013; Jones et al., 2009; Sweldens et al., 2010).

Previous research has shown that people can misattribute their affective reactions to the wrong source (Murphy, Monahan, & Zajonc, 1995; Murphy & Zajonc, 1993; Payne, Cheng, Govorun, & Stewart, 2005; Schwarz & Clore, 1983). Therefore, Jones et al. (2009) and Sweldens et al. (2010) wondered whether such an affective misattribution process could have lasting effects on attitudes and hence could be a mechanism explaining EC effects. The authors reasoned that when people see both a neutral (CS) and affectively valenced stimulus (US) together, they might implicitly, without deliberation and without awareness, misattribute the unconditioned affective reaction (UR) caused by the US to the CS instead. In essence then, what they proposed is the existence of an *automatically operating associative learning system generating evaluative S–R associations*.

The factor deemed most crucial to enable implicit misattribution of evaluative responses is *source confusability*: The greater the (implicit) uncertainty about which stimulus generated the evaluative response, the greater the likelihood that the UR will be misattributed to the CS. Jones and colleagues (2009) tested four different predictions derived from source confusability. The authors argued that source confusability should increase if (a) participants make more eye movements between CS and US, (b) CS and US are spatially closer together, (c) the CS is of larger size than the size of the US, and (d) the US is a stimulus evoking only a mild, rather than strong affective reaction. In five experiments, all of these predictions were confirmed as (a), (b), (c), and (d) all generated larger EC effects in the "surveillance procedure" developed by Olson and Fazio (2001) for participants who expressed no conscious awareness of the contingency between CS and US.[5]

Properties (a) and perhaps property (b) could be explained by a purely propositional account of EC if one assumes that these manipulations would lead to greater contingency awareness. However, a recognition measure of awareness in the research by Jones and colleagues (2009) showed no evidence for such an effect. Furthermore, a propositional explanation for properties (c) and (d) is much more difficult to conceive. The findings by Jones and colleagues are consistent with the implicit misattribution of affective responses. However, they contain no direct evidence that it is indeed S–R associations that are being formed implicitly. If source confusability would foster the creation of S–S associations, the same pattern of results would be observed.

More direct evidence for the specific creation of S–R associations comes from the research by Sweldens et al. (2010). The authors made a theoretical analysis of the properties in conditioning procedures which would render the formation of S–S versus S–R associations more likely. Creating a long-term memory association between two stimuli becomes more likely when these stimuli are repeatedly held together in working memory (Raaijmakers & Shiffrin, 1981). Therefore, conditioning procedures in which a CS is repeatedly paired with the *same* US are most conducive of EC effects mediated by S–S associations. The creation of S–R associations, on the other hand, is assumed to depend on implicit misattribution of evaluative responses. As a positive evaluative response can be generated by many different kinds of stimuli, this process should not be dependent on presenting a CS repeatedly with the same US; *different* USs can be used, as long as they share the same valence. Crucial for the source confusability underlying implicit misattribution of affective responses is that CS and US are presented *simultaneously*. With *sequential* presentations of CS and US, there is much less ambivalence about which stimulus generated the affective response. Jones et al. (2010) view "simultaneous CS–US presentations as the most crucial methodological key to producing implicit misattribution" (p. 223).

In their first experiment, Sweldens et al. (2010) tested these predictions by means of a US revaluation procedure. Participants could learn, for example, that an attractive athlete, who had functioned as a positive US previously, had actually killed a child driving drunk. If the EC effect is mediated by CS–US associations, then post-conditioning changes in US valence will impact CS evaluations. If the EC effect is caused by CS–UR associations, then post-conditioning changes in US valence will no longer impact CS evaluations (Rescorla, 1974). The study showed that the EC effect in conditioning procedures that paired CSs repeatedly with the same US (irrespective of whether they were presented sequentially or simultaneously) were mediated by S–S associations (as the EC effect in those conditions was sensitive to post-conditioning changes in the valence of the US). Importantly, it was also shown that EC effects in procedures

where the CS was presented simultaneously with different USs were mediated by S–R associations (as the EC effect in that condition was impervious to post-conditioning changes in the valence of those USs). Interestingly, the experiment also showed that a sequential-different pairings conditioning procedure which was not conducive to S–S association formation (as the CS was presented with different USs) nor to S–R association formation (as CS and USs were presented sequentially) was not effective in generating an EC effect.

A second experiment further showed that when the EC effect is dependent on S–S associations (i.e., generated by a sequential–same pairing procedure), it is vulnerable to subsequent retroactive interference by new learning in the same domain (Wixted, 2004). However, EC effects generated by implicit misattribution of evaluative responses (S–R) were not affected by memory failures induced by retroactive interference. Finally, a third experiment showed that evaluative responses dependent on S–S associations are more easily controlled by participants than evaluative responses dependent on S–R associations (on an explicit, but not on an implicit measure of evaluation).

It should be noted that other research has indicated alternative means by which S–R associations can be formed and underlie EC effects, for example when participants pronounce the US's valence during the conditioning phase (Gast & Rothermund, 2011a). However, whereas a propositional explanation for the creation of S–R association through the pronunciation of US valence (i.e., the "R") can easily be conceived, the findings reported by Jones et al. (2009) and Sweldens et al. (2010) are much harder to reconcile with a purely propositional learning explanation of EC and support dual-process theories of evaluative learning. The findings also raise two important questions with regard to the role of awareness. First, is implicit misattribution of evaluative responses really implicit in the sense that it can occur without awareness? The findings by Jones et al. suggest so, but are not entirely conclusive in this regard because the awareness measures were either open-ended or did not control for the possible use of affect-as-information. Second, can S–S associations also be generated without awareness? Put differently, would contingency-unaware EC effects always be caused by implicit misattribution of evaluative responses?

Hütter and Sweldens (2013) aimed to answer these questions. They applied the PDP measure of contingency awareness and manipulated the properties of the conditioning procedure. In one condition, CSs were repeatedly presented in a *sequential* manner with the same US (2,000 ms interstimulus interval), which should allow for the formation of S–S, but not S–R associations. In the other condition, CSs were repeatedly presented *simultaneously* with the same US, which should allow for both S–S and S–R associations. Only when CS and US were presented simultaneously did the PDP indicate contingency-unaware EC effects. This study therefore implies that S–R associations can, but that S–S associations cannot be learned without valence awareness. Note that this study helps overcome the problem in the work by Hütter et al. (2012) that the PDP measure per se cannot distinguish the effects of contingency awareness during encoding (the conditioning phase) versus retrieval (the memory test). The experimental conditions in Hütter and Sweldens (2013) differed only during encoding (i.e., in the sequential versus simultaneous nature of the conditioning procedure) and not during retrieval. Therefore, it would be logical to infer that the different outcomes on the PDP measure are due to different encoding, rather than retrieval processes.

In sum, recent research points to the contribution of dual processes in specific EC procedures (Hütter & Sweldens, 2013; Hütter et al., 2012; Jones et al., 2009; Sweldens et al., 2010). One process generates EC effects by creating memory associations between CSs and USs. Repeated co-occurrences of a CS with the same US are important for this process, in order to reinforce the association between the stimuli in memory. There is currently no convincing evidence that such associations can be formed without awareness. Therefore, this kind of association formation could be entirely due to controlled, propositional reasoning. The second process generates EC effects by the implicit misattribution of evaluative responses. Simultaneous perceptions of CS and US are key to this process, which may occur in the absence of awareness. In addition to propositional reasoning, acknowledging the existence of an automatically operating associative learning system generating S–R associations may well be required to account for the findings in the EC literature. Further research should ideally pursue this fruitful line of reasoning by relying on mixed designs that involve process dissociation measures of awareness in combination with experimental manipulations influencing contingency awareness and the formation of S–S versus S–R associations.

Conclusions

The present review was aimed at clarifying current debates and at summarizing what has been learned so far about the role of awareness in EC. After forty years of work on EC, researchers keep on delivering divergent conclusions on this crucial question. Whereas some prominent EC researchers conclude that "evidence on unaware EC is still inconclusive" (De Houwer, 2011, p. 410), others reach a different conclusion, claiming that "(. . .) it cannot reasonably be denied that one or more processes can also intervene between spatiotemporal co-occurrence and attitude change that are not dependent upon contingency awareness" (Jones et al., 2010, p. 239). A primary goal of the present review was to highlight the critical aspects that caused so much disagreement. In so doing, we hope to provide researchers interested in this issue with the means to appraise both the contributions and limitations of EC articles featuring manipulations and measures of contingency awareness. In addition, we hope that this review can help researchers develop more fruitful avenues to achieve progress on this important issue.

There is one positive message and another less positive message emerging from this review on the role of awareness in EC. The positive message is that we now know a lot more on how to tackle this question. Research on EC has become collectively stronger over the years, due to methodological advances and conceptual clarifications. The less positive message is that, despite all the research efforts and methodological advances, a definite conclusion on this question has not yet been reached (see also, De Houwer, in press). Based on our review of the literature, we conclude it is still unclear whether a completely automatic process (i.e., characterized by all features of automaticity; Moors & De Houwer, 2006) contributes to attitude formation via EC. We do believe evidence is accumulating that EC effects can be established without contingency awareness and that a process playing a crucial role in this is likely to be the implicit (i.e., unaware) misattribution of evaluative responses from US to CS when both are perceived simultaneously (Hütter & Sweldens, 2013; Jones et al., 2010; Sweldens et al., 2010). However, the evidence regarding the other features of automaticity is currently stacked against the conclusion that EC would occur via a completely automatically operating process, as EC effects can be eliminated with attentional load or parafoveal presentations (indicating EC effects might require attentional resources) and require a focus on evaluative processing (indicating EC is sensitive to processing goals; Corneille et al., 2009; Dedonder et al., 2014; Dedonder et al., 2010; Gast & Rothermund, 2011b; Pleyers et al., 2009).

As is often the case in the history of science, such a state of affairs can generate both a prevention or promotion orientation among researchers. The prevention orientation consists in claiming that the propositional approach is to be favored over dual-learning models until we reach firmer conclusions about the possibility of producing automatic EC effects. In contrast, the promotion approach consists in claiming that the current evidence is good enough and that the dual-learning approach has pragmatic value in organizing research data, communicating about them, and generating new ideas.

Both approaches are useful and important. Specifically, their confrontation has made it possible to significantly advance the quality of research conducted in the field. In our view, the forthcoming generation of EC studies should be better able to establish the conditions under which, and the mental processes through which, EC effects may occur in the absence of contingency awareness. This research effort will probably require manipulating contingency awareness in pairing paradigms that differ in their procedures, yet involve adequate controls for addressing the impact of CS–US pairings on subsequent changes in evaluations and awareness. It is also likely that this future research will rely to a larger extent on process dissociation measures of contingency awareness and indirect evaluative measures. Finally, true progress depends on authors' clarity regarding their definition of "attention," "awareness," and even "EC." We very much hope that the present review contributes to the conceptual clarification of these core constructs in social cognition.

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Notes

1. In an unconditioned stimulus (US) revaluation procedure, the valence of the US is changed after the conditioning procedure (e.g., a positive stimulus becoming negative as in the case of a celebrity endorser who falls from the public's grace). A US revaluation procedure is especially useful to investigate whether the conditioned response to the conditioned stimulus (CS) depends on an intermediating CS–US association, or is independent of such a memory association. If the evaluative conditioning (EC) effect is mediated by CS–US associations, then post-conditioning changes in US valence will impact CS evaluations. If the EC effect is independent of CS–US associations, then post-conditioning changes in US valence will no longer impact CS evaluations (Rescorla, 1974).
2. We thank Russ Fazio for outlining this possibility.
3. One could argue that Study 3 in the article by Hütter, Sweldens, Stahl, Unkelbach, and Klauer (2012) helps overcome this limitation as well. If the a-parameter which measures EC effects *without* contingency awareness is indicative of an EC effect of which the source (US valence) is forgotten by the time of the memory test (rather than not encoded during conditioning), then this parameter would be reversely tied to the m-parameter which measures EC effects *with* contingency awareness (i.e., where US valence was not forgotten). In that case, the one day delay which caused a decrease of the m-parameter would have resulted in an accompanying increase of the a-parameter. This was not observed as the a-parameter remained constant over the time delay. This is further evidence for the independence of the parameters and the processes they measure.
4. Subliminal messages are outlawed in (among others) Britain and Australia. In the US, the Federal Communications Commission will revoke a company's broadcast license if the deliberate use of subliminal techniques is proven.
5. Although three of the studies in Jones, Fazio, and Olson (2009) featured an open-ended contingency awareness measure, two studies featured a more sensitive recognition measure of awareness. Most importantly, the evidential value from these studies comes from the interactions with variables (a) to (d). Furthermore, the fact that participants' attention in the

surveillance procedure was focused away from the contingency between CS and US led to generally low levels of contingency awareness.

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