Review

Associative Attitude Learning: A Closer Look at Evidence and How It Relates to Attitude Models

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Abstract

Associative attitude learning is typically viewed as a low-level process that automatically registers mere co-occurrences between stimuli, independent of their validity and relational meaning. This view invites to critically examine how attitude formation conforms to four operating conditions (i.e., unawareness, efficiency, goal independence, and uncontrollability) and two operating principles (i.e., unqualified registration of mere co-occurrences between stimuli and formation of direct stimulus–response links), which is the main purpose of the present contribution. The general discussion examines how contemporary attitude models endorse these conditions and principles. Overall, this contribution calls for (a) a nuanced understanding of the nature and scope of associative attitude learning, (b) a fine-grained understanding of how contemporary attitude models endorse conditions and principles reviewed here and find them relevant to their theorization of attitude formation, (c) a clarification of how direct and indirect evaluative measures relate to these conditions and principles, and (d) enhanced efforts in specifying contemporary attitude formation models.

Keywords

attitude, associative attitude leaning, dual-process models, evaluative conditioning, learning, automaticity

Introduction

Attitude research has always been at the core of social psychology. Critical questions addressed in attitude research are how attitudes should be measured, how they are structured, how they relate to each other and to actual behaviors, how they vary across individuals and social groups, and how they may be changed. Another important question, leaning on the more cognitive side of social psychology, is how attitudes get to be learned in the first place. A widespread assumption in the attitude literature is that associative learning contributes to attitude formation. Associative learning is commonly conceptualized as an automatic encoding in memory of mere co-occurrences, unqualified by their validity and relational meaning. This calls for a critical examination of how attitude formation conforms to a set of operating conditions and principles (Gawronski & Bodenhausen, 2009, 2014) that are commonly viewed as representative of associative attitude learning.

Operating conditions here refer to the notion that attitudes can be formed automatically, that is, unconsciously (C1), efficiently (C2), independently of goals (C3), or uncontrollably (C4). Operating principles relate to the notion that attitude learning creates unqualified associative linkages for mere co-occurrences between stimuli, independent of their validity and relational meaning (P1), or links in memory a stimulus with the evaluative response triggered by another stimulus (P2). The main purpose of the present contribution is to discuss evidence for attitude formation consistent with these operating conditions and principles, as well as methodological and conceptual difficulties that come with their empirical examination.

Although associative attitude learning has been critically discussed in recent attitude research (e.g., Kruglanski & Thompson, 1999; Mitchell, De Houwer, & Lovibond, 2009; Sweldens, Corneille, & Yzerbyt, 2014), the present review goes well beyond previous contributions. It does so (a) because of its comprehensiveness (e.g., it does more than focusing on just one attitude model; it does more than just discussing the awareness question), (b) because of its distinct focus (e.g., it assesses evidence for four conditions and two principles commonly considered representative of associative attitude learning; it discusses distinct attitude models in light of this evidence), and (c) because it integrates a number of very recent empirical findings that invite revisiting

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conclusions drawn in both past and recent discussions of associative attitude learning (e.g., Sweldens et al., 2014).

Because research on evaluative conditioning (EC) is considered to bring the strongest support for the existence of an associative attitude learning process, we mainly focus on the EC paradigm. However, evidence from the mere-exposure and approach-avoidance (AA) training literature is also briefly discussed. Recent insights in the EC literature should not be underestimated, as EC research is accumulating at a very fast pace. As a matter of fact, EC research published in the last 5 years ($N = 166$) represents about 32% of the total number of EC publications referred to in Scopus in the last 60 years ($N = 504$). As we will see, recent EC findings have provided the best support ever to the existence of associative attitude learning, whereas others invite questioning well-established conclusions.

Below, we discuss evidence relevant to the aforementioned operating conditions and principles. In the general discussion, we examine how contemporary attitude models subscribing to associative attitude learning endorse these principles and conditions. The general discussion additionally addresses the broader theoretical and methodological implications of the present review for attitude research.

Operating Conditions and Principles Commonly Related to Associative Attitude Learning

Associative attitude learning has been defined functionally as an *effect of pairing on behavior* (De Houwer, 2007, 2009). This definition relates to a procedure in which an attitude object (CS) is paired with a (positive or negative) stimulus that unconditionally elicits an attitudinal response (US), and this pairing affects later evaluative responses to the CS. The EC paradigm has strong "associative" face validity: In EC studies, the affective response to a neutral conditioned stimulus (CS; for example, an unfamiliar face, Chinese character, or cereal brand) changes after it is "associated" (i.e., paired) with an affectively loaded unconditioned stimulus (US; for example, a disagreeable haptic sensation, a pleasant picture). EC is a robust and widely studied effect (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010) that has broad social-psychological implications (Walther, Nagengast, & Trasselli, 2005). It is one of the simplest learning procedures one could think of, and conclusions regarding EC are relevant not just to social–psychological research but extend to learning in general (Shanks, 2005, 2010)

It is important to distinguish an associative attitude learning *effect* of pairing on evaluation (e.g., an EC effect) from the underlying *mental process(es)* that mediated this effect. The present article focuses on associative attitude learning as a mental process. In particular, it is undisputed that an associative attitude learning effect (as just defined) can be learned through propositional processes. As we will see, it is, however, less clear whether/when/to what extent such effect can result from a distinct, associative, mode of learning. It is, therefore, critical to figure out how an associative attitude learning process can be investigated, and what/how/when current evidence validates its existence or fails to unquestionably do so.

In social cognition and attitude research, associative attitude learning is typically considered a slow-pace mechanism that automatically registers mere co-occurrences between stimuli. In contrast, propositional or rule-based learning is often thought to involve the nonautomatic encoding of qualified links between stimuli (e.g., Gawronski & Bodenhausen, 2006, 2011; Rydell & McConnell, 2006; Rydell, McConnell, Strain, Claypool, & Hugenberg, 2007; Smith & DeCoster, 2000; Wilson, Lindsey, & Schooler, 2000). Critical dimensions involved in this distinction are (a) distinct conditions under which attitudes are formed and (b) distinct mental mechanisms through which they operate.

It is important to note that attitude models vary as to whether they endorse some or all these conditions and principles. For instance, the associative-propositional evaluation (APE) model (Gawronski & Bodenhausen, 2011) stresses that the relation between associative attitude learning and automatic learning is less straightforward that often thought

> An important question is how the distinction between associative and propositional processes relates to the distinction between automatic and controlled processes. This relation has been a common source of confusion, such that associative processes have sometimes been equated with automatic processes while propositional processes have been equated with controlled processes (e.g., Mitchell et al., 2009). (Gawronski & Bodenhausen, 2011, p. 61)

Attitude models may also change over time (which may be considered a healthy adaptation to the scope of evidence) or vary as to how they relate conditions and principles within and between each other. Finally, they may also vary or evolve as to how they relate these conditions and principles to direct and indirect evaluative measures. Hence, the idea here is certainly not to point to a unique and radical associative attitude learning view. Rather, it is to discuss one by one individual conditions and principles typically viewed as representative of associative attitude learning, no matter whether these views reflect current claims, past claims, or even common misinterpretations of current theories, and see how each of these are empirically supported. We believe that such bottom-up, theory-free, review of the existing evidence should prove helpful in adapting current attitude learning models or in promoting new ones. In addition, it may also contribute to identify empirical gaps in the current literature (e.g., are EC effects in an incidental learning paradigm goal independent?).

Operating conditions relate to the four horsemen of automaticity (Bargh, 1994). Questions examined here are whether EC effects emerge in the absence of CS–US awareness (C1), efficiently (C2), independently of goals (C3), and uncontrollably

(C4). All that is needed here is a demonstration that EC effects are partly driven by fully unconscious, fully efficient, fully goal independent, or fully uncontrollable processes. As we will see, however, such empirical demonstration is much trickier than one would wish.

Operating principles are conceptually independent from operating conditions and relate to *how* associative attitude learning operates (rather than to *when* it operates). Two distinct principles have been proposed so far. One principle (P1) states that associative attitude learning registers mere co-occurrences between stimuli, independently of what this relation means, and independently of whether it should even be considered valid at all. A second principle (P2) states that associative attitude learning links a stimulus to the affective response elicited by another one (i.e., stimulus–response or S–R).

Addressing attitude learning as a mental process (as compared with a behavioral outcome) is not a straightforward task. This is because mental processes are latent constructs that can never be directly observed. As it will become apparent in this review, using functional definitions of evaluative learning, such as when relating EC effects to operative conditions and principles, can help the study of mental processes in general, and of evaluative learning in particular (De, Houwer, Barnes-Holmes, & Moors, 2013). One should keep in mind, however, that evaluative responses may be determined at different cognitive stages: learning or encoding, storage, and retrieval or expression. Hence, it is often ultimately unclear whether observed effects relate to the way attitudes are learned, are encoded, are stored, are retrieved, or are expressed (or combinations of these). We will regularly emphasize this point as we now discuss empirical evidence relevant to C1 to C4 and P1 and P2, as well as methodological and conceptual challenges inherent to each of these lines of research.[1]

C1: Is EC Obtained Unconsciously?

C1 posits that associative attitude learning may not simply occur in the absence of awareness (i.e., when awareness does not exceed chance) but also independently of awareness (i.e., no matter the level of awareness). The consciousness–independence notion, in its strongest version, should be distinguished from a weaker claim that attitude learning can operate under less-than-optimal consciousness. EC research, however, generally addressed the latter, weaker claim that EC is obtained without awareness.

The way consciousness or awareness has been traditionally addressed in attitude and social cognition research is relatively crude.[2] Across publications, it refers to the awareness of the stimuli involved in learning, or to the mechanism involved in learning, or to the experience of having learned something, or to the awareness of what has been learned, or to the impact that this learning has on one's behavior, or to the behavior itself. Without doubt, all these meanings of awareness may be important in attitude research. Yet, in the present review of the conditions under which associative learning occurs, awareness refers to the conscious processing of the CS–US pairing during learning. Specifically, learning is interpreted as consciousness independent if it occurred independently of the conscious processing and encoding in memory of the CS–US pairs.

EC research relied on correlational and experimental approaches to test C1. The correlational approach essentially linked EC effects to the identification of CS–US pairs following learning. The experimental approach manipulated participants' ability to encode CS–US pairs in memory. Below, we discuss the correlational approach first. Then, we turn to the experimental approach by discussing the case for parafoveal EC, EC for suppressed stimuli, and EC for low-strength stimuli (e.g., subliminal or near subliminal).

Correlational approach to C1. EC researchers have traditionally used CS–US memory measures as a proxy for CS–US awareness at encoding. That is, they invited participants to retrieve from memory information about the pairings they had seen. One advantage in using an *offline probe* is that checking for awareness online may disrupt the incidental nature of the pairings, a condition that may be conducive to associatively driven EC. This choice, however, implies that these studies examined how CS–US memory relates to EC, rather than whether EC effects can be elicited in the absence of consciousness at encoding. The latter, correlational and memory based, line of research has been critically discussed elsewhere (e.g., Gawronski & Walther, 2012; Sweldens et al., 2014). We will focus here on three important conclusions it has delivered.

A first important conclusion that emerged is that the role of CS–US memory in EC should be addressed at the item level, not at the level of participants (Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Stahl, Unkelbach, & Corneille, 2009). It is unlikely that a participant correctly encodes in memory either all or none of the CS–US pairings. Pleyers et al. (2007) showed that, if a classification as "aware" or "unaware" is made at the participant level, examining EC effects in presumably unaware participants may lead to the conclusion that EC effects can emerge independently of contingency awareness, whereas item-based analysis applied to the same set of data systematically leads to the opposite conclusion. Of note, the latter finding was observed both on direct and indirect evaluative measures (Pleyers et al., 2007; Stahl et al., 2009). Studies relying on psychophysiological measures (Dawson, Rissling, Schell, & Wilcox, 2007) and that examined EC effects in other sensorial modalities (Wardle, Mitchell, & Lovibond, 2007) similarly failed observed EC effects in the absence of memory for CS–US pairings.

Second, post hoc analyses involving the selection of specific subsets of the data (e.g., participants or items classified as "unaware" according to performance on an explicit-memory test) can generate misleading evidence for consciousness-independent EC. This point is elegantly demonstrated by Shanks (2017) based on a regression-to-the-mean analysis. Shanks explains that measurement errors are generally high on high data points and low on low data points. On the low-awareness data points, this leads to the misclassification of participants or items as unaware when they in fact are not. Of importance, because measurement errors are randomly distributed across variables, it is unlikely that a participant or item that is misclassified as unaware *also* shows an unusually low measurement error on a second dependent variable (in this case, the EC measure). As a consequence, regression-to-the-mean effects mechanically create data patterns suggesting a significant EC effect among items or participants misclassified as unaware. This analysis is consistent with the recommendation to turn to experimental manipulations of awareness at encoding, instead of relying on post hoc correlational analyses of contingency memory and EC effects (e.g., Gawronski & Walther, 2012).

Third, memory for US identity does not contribute to EC effects over and above US valence awareness (Stahl et al., 2009), but traditional memory-based measures of US valence awareness may be contaminated at retrieval. Specifically, participants may infer that a CS was paired with a positive (negative) US if they feel positive (negative) about it, although they forgot the actual US valence or perhaps did not even encode it in explicit memory. This evaluative contamination may bias conclusions against C1 (Bar-Anan, De Houwer, & Nosek, 2010; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012).

Hütter and colleagues (2012) developed a process-dissociation (PD) procedure (Jacoby, 1991) aimed at overcoming this problem by separating the contribution of explicit US valence memory from unconscious evaluative learning in EC. PD studies present participants with the CSs used in the learning phase and have them report the associated US' valence under two possible instruction conditions: First, under the *inclusion* condition, memory and evaluative contributions lead to the same response—participants are asked to report the US valence based on their memory of it or, if they do not remember, to report a response consistent with their feelings toward the CS. Under the second *exclusion* condition, memory and evaluative influences lead to opposite responses: participants are asked to report the US valence based on their memory of it or, if they do not remember it, to report a response that is *opposite* to their feelings toward the CS. Comparisons of response frequencies between the two instruction conditions by way of multinomial processing-tree models (for recent reviews, see Erdfelder et al., 2009; Hütter & Klauer, 2016) allow estimating parameters that quantify the unique contribution of explicit memory (i.e., CS–US memory), implicit memory (i.e., an EC effect in the absence of CS–US memory), and response bias in participants' responses.

Several studies using this approach were conducted by Hütter and colleagues (e.g., Hütter & Sweldens, 2013; Hütter et al., 2012) and support the existence of CS evaluations consistent with US valence (i.e., EC effects) in the absence of explicit memory for the US valence (for meta-analytical evidence, see Mierop, Hütter, Stahl, & Corneille, 2018). Such results are deemed relevant for concluding in the existence of associative attitude learning. As the authors conclude,

> The MPT model, thus, supports the dual-process conceptualization by demonstrating qualitatively distinct associative and propositional learning mechanisms in EC. (Hütter & Sweldens, 2013, p. 642)

Consistent with C1, these findings could indicate that EC is partly acquired in the absence of explicit encoding of the CS–US pairings. They are, however, amenable to alternative interpretations, which will be discussed in P2. For now, we briefly note here that Hütter and De Houwer (2017) recently found a significant implicit-memory parameter in an instructed-EC paradigm. That is, merely informing participants that CSs and USs will co-occur (without having participants experience them) results in both significant explicit *and* implicit-memory parameters. Perhaps, even more concerning, the implicit parameter in that research depended on instructions delivered at recollection time (i.e., focusing on feelings vs. memory). This suggests that the measure of consciousness-independent EC obtained in the PD paradigm may not purely reflect associative processes occurring at learning. Accordingly, the authors noted,

> These findings raise caution towards the interpretation of the memory-independent MPT parameter as an indicator of association formation. (Hütter & De Houwer, 2017, p. 57)

This conclusion is important, considering that PD evidence was until recently considered one of the strongest support to C1:

> . . . 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. (Sweldens et al., 2014, p. 196)

A simple PD approach does not allow teasing apart conflicting—or complementary—learning-based versus memory-based interpretations. To shed light on this issue, it is helpful to cross the PD approach with experimental manipulations operating at encoding. The idea is that stronger support may be provided for the encoding interpretation of PD findings if manipulating factors that operate at encoding results in theoretically meaningful variations in the implicit-memory parameter. We will discuss this rationale when addressing C2 and P2. For now, it is important to note that the best of the correlational approach—that represented in PD studies—ultimately deals with how sustainable EC effects are in the absence of CS–US memory, rather than addressing whether people may acquire an attitude in the absence of explicit CS–US encoding (i.e., C1). Experimental studies that manipulated CS–US encoding, which we discuss now, are closer to the latter, associative learning, question.

Experimental approach to unconscious EC. Together with Gawronski and Walther (2012), we agree that experimental evidence is more informative for drawing conclusions about C1 than evidence carried out in correlational designs relating EC effects to postlearning memory measures of contingency awareness. As these authors nicely put it,

> Specifically, the ambiguous nature of the relation between memory performance and evaluation data implies the quest for experimental approaches to manipulate contingency awareness during encoding instead of studying correlations between EC effects and memory performance. (Gawronski & Walther, 2012, p. 621)

Such experimental investigation has been undertaken in studies that manipulated the spatial location or the suppression of the stimuli (i.e., parafoveal and continuous flash-suppression studies, respectively) or their exposure time (i.e., subliminal or near-subliminal studies). We discuss this research below.

Parafoveal and continuous flash-suppression studies. Dedonder, Corneille, Bertinchamps, and Yzerbyt (2014) manipulated within participants whether the CS appeared in the foveal or parafoveal field of the participants. Chin-rested participants were presented with simultaneous CS–US pairings for 60 ms on a computer screen. The US was always displayed at the center of the screen, whereas the CS appeared either foveally (i.e., 2.5°, left or right from the fixation point) or parafoveally (i.e., 11.5°, left or right from the fixation point). The CS was entirely covered with a colored visual mask for 150 ms following its disappearance from the screen. After providing their ratings of the CSs, participants were presented with each of the CS along with the two USs and had to identify which of the pairing was presented to them before. Results showed above-chance identification only for the foveal CSs. Likewise, CSs ratings showed successfully EC effects only for the foveal CSs.

Of interest, a separate group of follow-up participants was invited to complete the CS–US presentation task, but this time each presentation was followed by a forced-choice CS identification task. Results on this online awareness probe task showed above-chance performance in the identification of *both* the foveal and parafoveal CSs. Thus, this study supports the view that CS awareness is not just necessary but is also insufficient for obtaining EC effects (see also below). In addition, it reveals the lack of sensitivity of memory-based probes for awareness, even when using an identification task that minimizes verbalization.

Contrary to Dedonder et al. (2014), Rydell, McConnell, and Mackie (2008) reported, in two studies, evidence for large parafoveal EC effects under very brief exposure times. These studies differed from those conducted by Dedonder et al. (2014) on several procedural features. First, the parafoveal EC effect was observed on an indirect evaluative measure (i.e., an affect misattribution procedure; Payne, Cheng, Govorun, & Stewart, 2005). Second, the parafoveal stimulus was a US, not a CS, and it was presented for 30 ms instead of 60 ms. Third, the CS (an image of "Bob") was presented after the parafoveal US and it was accompanied by behavioral information (i.e., explicit US) about Bob, whose valence was opposite to that of the parafoveal US. Conceptually replicating a study by Rydell, McConnell, Mackie, and Strain (2006) that is discussed in the next section, double dissociations were predicted and found: The valence of the parafoveal US influenced the indirect evaluative measure, whereas the (opposite) valence of the behavioral information influenced the direct evaluative measure (in the opposite direction).

Such double-dissociative demonstration, with large effects sizes obtained on an indirect measure for low-strength stimuli—and opposite to that conveyed by an explicit information processed for a much longer time—is very impressive. Unfortunately, a number of procedural features mitigate the interpretation of these findings. First, no information is reported on the visual angles at which the parafoveal USs were presented, which makes it impossible to assess whether the USs were presented foveally or parafoveally to the participants. Second, no chin rest was apparently used, leaving room for variations in visual angles. Third, and critically important, the awareness check apparently consisted in a self-report, and there is even no mention that such probe was used in the second study for which the procedure is also not reported. As just discussed, even a two forced-choice identification task underestimates participants' level of awareness at learning. Overall, it, therefore, seems daring to conclude that participants could not consciously process the primes in Rydell et al. (2008) studies.

In Dedonder et al.'s (2010) study, parafoveal versus foveal presentations were confounded with the spatial proximity and the visual relatedness of the stimuli. Arguably, the too-distant and visually unrelated CS–US parafoveal presentation may have prevented processes conducive to associative attitude learning to operate (as discussed in section P2). A recent series of continuous flash-suppression studies (Högden, Hütter, & Unkelbach, 2017) overcame the former problem, yet reached a similar conclusion. In continuous flash-suppression studies, participants are exposed to conflicting visual information. Specifically, a stationary information typically consisting of a gray stimulus of low complexity is presented in one eye, while the other eye is exposed to a flashing stream of colorful stimuli of higher complexity (e.g., Tsuchiya & Koch, 2005). The visual system cannot coherently merge the conflicting visual inputs into a coherent representation, and the less complex input, although it is encoded and processed, is usually suppressed from awareness. In Högden et al.'s (2017) studies, EC effects were found when the CS was not suppressed, but not found when the CS was suppressed by presenting a high-contrast dynamic pattern to the other eye. This pattern of findings was found using both between- (Study 2) and within-participants (Studies 3 and 4) manipulations of CS suppression. As we now discuss, subliminal studies mostly converged in the same conclusion, again by avoiding a spatial proximity confound.

Subliminal or near-subliminal studies. EC research has repeatedly claimed establishing C1 by using briefly presented stimuli that prevent the explicit encoding of CS–US pairings. In a meta-analysis of EC effects, Hofmann and colleagues (2010) identified 15 studies that relied on subliminal US presentations. They found that the EC effect did not differ from zero on that subset of subliminal US studies. These authors, however, identified a smaller subset of eight studies that reported obtaining successful EC effect using subliminal CS and indirect evaluative measures. Quite surprisingly, the meta-analysis found these subliminal EC effects to have an effect size similar to that observed for supraliminal EC effects.

In a recent article, Stahl, Haaf, and Corneille (2016) explained that none of these studies actually qualifies as a subliminal EC study, either because they lacked a sufficiently sensitive assessment of awareness (and were structurally unlikely to have operated under genuinely subliminal conditions) or because they involved problematic designs, or because they simply did not involve evaluative measures (or any combination of the latter limitations). We refer the reader to that recent article for an extensive treatment of the subliminal studies considered by Hofmann et al. (2010). For our current purpose, we would like to discuss instead the "subliminal EC" evidence collected by Stahl et al. (2016).

These authors conducted a high-powered set of six studies involving 27 experimental conditions that varied a number of procedural parameters (i.e., CS presentation time, presence or absence of a CS identification task, presence or absence of a mask, complexity of the CS, processing goals, CS/US onset). Sensitivity power analyses revealed that the set of studies was overall able to detect a subliminal EC effect as small as $d = 0.16$. Yet, those studies did not support the view that EC effects are obtained in the absence of conscious identification of the CS. To the contrary, CS awareness appeared to be necessary, yet generally insufficient, for EC effects to be observed. Conscious identification of the CS, as combined with attention drawn to the CS–US pairings, produced the largest effects (see also Kattner, 2012). A Bayes factor analysis revealed that, even under the set of assumptions most favorable for the subliminal EC hypothesis, the data observed under subliminal or near-liminal conditions were 10 times more likely to be observed under the hypothesis that subliminal EC is not obtained.

In the studies by Stahl et al. (2016), CS and US stimuli were presented adjacently in the center of the screen, thereby eliminating the potential problem of the parafoveal procedure (i.e., that stimuli may have been too far apart from each other to allow for associative learning; see P2). However, although both CS and US stimuli appeared on screen simultaneously, they were likely processed in a serial manner: Participants were instructed to first focus on the location of the briefly presented and masked CS to identify it, and were, therefore, likely to attend to the US stimulus only after the CS was masked. Some attitude models posit that simultaneous CS–US presentations and low US salience are critical preconditions for unaware associative attitude learning (see P2). As a consequence, the sequential pairing of supraliminal USs with subliminal (or near-liminal) CSs may have interfered with C1.

To address this possibility, Heycke, Aust, and Stahl (2017) used auditory USs and presented them with a slight onset asynchrony ahead of the CSs to ensure that the evaluative response to the USs co-occurred with the CS presentation. In one of the three studies, which used the incidental surveillance learning task (Olson & Fazio, 2001), they found some indication for an EC effect on evaluative ratings (but not choice) for brief (20 ms) and masked CSs (but only if the evaluative rating measure was administered first). This finding suggests that EC may be obtained for brief and masked CSs under specific circumstances (i.e., auditory USs, incidental learning task). Importantly, however, the brief and masked CSs in these studies were not subliminal (i.e., identification was at above-chance levels), the evidence was weak (i.e., not robust against slight variations in exclusion criteria), and a follow-up replication study found evidence for the *absence* of EC under the same presentation conditions (Heycke & Stahl, 2018).

Stahl et al. (2016)'s subliminal studies relied on direct evaluative measures. As the authors explained, this choice was made to increase the chance of detecting small EC effect, as direct evaluative measures are generally more sensitive to EC effects than indirect measures are. Some proponents of associative attitude learning, however, hold the view that propositionally learned attitudes are preferably expressed on direct measures whereas associatively learned measures are preferably expressed on indirect measures. For instance, Rydell and colleagues stated,

> . . . implicit attitudes are sensitive to associative information presented below conscious awareness, whereas explicit attitudes [are] sensitive to information amenable to higher order cognition. (Rydell et al., 2006, p. 957)

If this view is correct, then the studies by Stahl et al. (2016), because of their use of direct evaluative measures, may have stacked the odds against detecting a subliminal EC.

A widely cited study by Rydell et al. (2006), conceptually similar to the one we discussed above, speaks to that possibility. In that study, a neutral CS (i.e., the face of an unfamiliar male person named "Bob") was conditioned with supraliminal and subliminal information of opposite valence. For instance, participants were exposed for 25 ms to a negative word (e.g., hate) prior to the presentation of a (positive or negative) behavioral description of Bob. A feedback was communicated, which informed participants that the description was characteristic of Bob when it was positive but uncharacteristic of Bob when it was negative. Hence, subliminal and supraliminal information implied opposite evaluations of Bob. After the learning phase of the experiment, an Implicit Association Test (IAT) was found to reflect the valence of the subliminally presented information, whereas explicit ratings of Bob reflected the valence of the behavioral descriptions characteristic of Bob. Such pattern is highly supportive of the associative view. It is also consistent with the notion that indirect and direct attitude measures are primarily sensitive to associative versus proposition learning, respectively, the first of which operates unconsciously. Unfortunately, this demonstration comes with a number of problems.

First, two studies failed to obtain the dissociation reported in the original study; instead, the supraliminal information similarly affected direct and indirect evaluative measures (Heycke, Gehrmann, Haaf, & Stahl, 2018). Likewise, Rosocha and Balas (2017) found a dominance of explicit information on both direct and indirect (i.e., an IAT) measures, which only differed in strength, *not* in direction. In other words, these authors also failed to replicate double-dissociative evidence and actually reported a positive correlation between direct and indirect measures in one of the learning conditions. The authors concluded that IAT outcomes do not selectively tackle implicit associations, but rather result from the interaction between various processes, some of which the participants were aware of. Finally, these authors also cast doubts on the validity of the awareness check used by Rydell et al. (2006).[3]

Second, it is unclear whether the words briefly flashed on the screen were truly subliminal in Rydell et al. (2006). This is because the awareness check used in that experiment lacked sensitivity (i.e., it was completed only at the end of the study) and the procedure was unlikely to conclusively prevent conscious identification of the USs (i.e., 10 subliminal words were flashed 10 times each for 25 ms, and were only weakly masked, making it likely that participants could have identified the valence of at least some of these repeatedly presented words throughout the learning phase).

Third, and this concern also applies to the "parafoveal" studies by Rydell et al. (2008), a series of high-powered studies by Lähteenmäki, Hyönä, Koivisto, and Nummenmaa (2015) suggests that affective stimuli actually do *not* evoke affective responses in the absence of awareness. The latter authors recently revisited the *affective primacy* hypothesis by discussing neurocognitive, psychophysiological, and behavioral evidence opposing this view. They noted that the "two-pathway" model (e.g., LeDoux, 1998) that suggests a conscious cortical "high road" and a nonconscious subcortical "low road" involved in faster emotional processing of stimuli was recently challenged in an influential study of Pessoa and Adolphs (2010), who found no evidence for a functionally independent subcortical route in primates.

Lähteenmäki et al. (2015) also reported simple behavioral experiments showing that semantic categorization of biologically relevant affective stimuli (such as positive and negative animals or facial expressions) actually precedes their affective categorization. They argued that the latter finding is consistent with recent psychophysiological evidence based on Event-Related Potential recording. Finally, and most relevant to our current discussion of Rydell et al.'s (2006) subliminal US experiment, Lähteenmäki et al.'s (2015) studies revealed that affective stimuli can be consciously processed at short presentation times and systematically fail to elicit an affective response in the absence of awareness.

Another recent study that used indirect measures to address subliminal conditioning avoided this problem by masking the CSs (Greenwald & De Houwer, 2017). In a series of experiments, participants had to learn to quickly press one of two response keys to classify target words as either positive or negative. A response window procedure was used to enforce fast responses, and feedback was given in case of late or erroneous responses. The target words were preceded by one of two sandwich-masked CS primes: One of two four-letter string was always paired with positive targets, the other with negative targets. The learning task, thus, realized a perfect contingency between CS prime and target valence category. This contingency was removed in the test phase, which constituted an evaluative-priming task: Here, each CS prime was presented before positive and negative target words, and it was investigated whether classification performance of valent words was facilitated on congruent trials (i.e., when the response predicted by the CS prime corresponded to the response required by the target's valence category) as compared with incongruent trials (i.e., when the response predicted by the CS prime was incorrect).

Results showed that participants learned to associate the CS letter string with the response it predicted. This finding was obtained even for participants who were not able to identify the CS primes at above-chance levels; it, therefore, constitutes strong evidence for a subliminal conditioning effect. Note that explicit ratings of CSs were not obtained in these studies. In interpreting their findings, the authors are careful to note that it is unclear what exactly is conditioned here (i.e., what is the conditioned response). They consider three possible interpretations: The CSs may have (a) been associated with a manual response (right or left key), (b) facilitated the perceptual identification of the specific target stimuli, or (c) facilitated identification of the target's semantic category. The exact level—motor, perception, semantic—at which these findings occur remains an open question. Importantly (despite their use of what is essentially an indirect evaluative-priming measure), the authors do not suggest that any attitudes were learned at all in their study.

In sum, evidence for the existence of subliminal EC effects remains thin on the ground, for either subliminal CS or US and for either direct or indirect attitude measures. Such effects, however, may be observed under conditions that remain to be identified. For instance, EC may be obtained with subliminal CSs when considering other types of masks or CS–US pairing procedures, or when relying on subjective instead of objective assessments of CS awareness, or perhaps when combining some of these parameters with the use of indirect evaluative measures (for a detailed discussion, see Stahl et al., 2016). Again, we do not claim here that subliminal EC effects do not exist. Rather, we strongly invite considering that they have not been reliably demonstrated yet and, if they have, that such effects are likely to be very weak and to be observed in very limited settings.

As a final comment, we would like to stress that future EC studies interested in briefly presented stimuli should consider several criteria for allowing reliable conclusions about consciousness-independent EC: relevance, sensitivity, and nonreactivity (Lovibond & Shanks, 2002). As explained elsewhere (Pleyers et al., 2007; Stahl et al., 2016), subliminal EC studies often failed to meet these criteria. First, awareness measures should be *relevant* to the learning task, that is, they need to capture all conscious knowledge that may be used to inform attitude measures (e.g., awareness of US valence may be more relevant than awareness of other details of the US stimulus). Second, measures of awareness during learning need to be maximally reliable and *sensitive* for the relevant information. For instance, if the awareness measure is less reliable than the attitude measure (such as when using open-ended awareness questions), the presence of awareness may go undetected and results may artificially suggest learning effects in the absence of awareness. Sensitivity is considered optimal for brief recognition-based awareness checks administered within the learning setting immediately after presentation of the to-be-tested stimulus; in contrast, sensitivity is reduced for delayed, recall-based awareness checks administered in a different context and only after interfering phases of the experiment. Third, these sensitivity demands should be balanced with the requirement that the awareness measure should be *nonreactive* and avoid distorting awareness and/or the learning process itself. The latter is likely to occur if awareness of CS–US co-occurrence is assessed on each trial of an incidental EC study. To avoid this reactivity, researchers have typically risked reducing sensitivity by assessing awareness only after the completion of the learning phase (as discussed above, with the correlational approach).

C2: Is EC Efficient?

Although subliminal EC may be limited to specific sets of conditions, it may, however, be the case that EC effects emerge when little attention is devoted to high-strength (i.e., supraliminal) stimuli. Such demonstration, although perhaps less provocative than one carried out in a subliminal or parafoveal paradigm, would suggest that optimal awareness is not mandatory for an attitude to be formed. Demonstrations of EC under low-attention conditions would also be more ecologically relevant. As Bargh and Morsella (2008) noted,

> 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. (p. 74)

The literature offers mixed support for the existence of EC effects in low-attention conditions. Research that experimentally reduced participants' cognitive resources at encoding generally found no evidence for EC. However, EC research relying on incidental EC paradigms supports the view that EC may emerge under low top-down attention conditions. We mainly discuss cognitive load studies in this section, whereas incidental learning studies are discussed when addressing P2.

EC studies that experimentally taxed participants' cognitive resources at encoding traditionally resulted in inconsistent outcomes, presumably due to the use of questionable designs (see Pleyers, Corneille, Yzerbyt, & Luminet, 2009). In several studies, an attention-reduction condition was contrasted to an attention enhancement instead of a control condition, making it difficult to assess the direction of the effect (Field & Moore, 2005; Fulcher & Hammerl, 2001). In another study, participants were busy rehearsing some irrelevant information delivered before learning (i.e., an eight-digit number), such that interference may have decreased throughout the learning phase (Walther, 2002, Experiment 5).

To overcome these limitations, more recent studies turned to an auditory two-back task that taxed participants' attention throughout the whole learning stage of a picture–picture EC paradigm (Dedonder, Corneille, Yzerbyt, & Kuppens, 2010; Mierop, Hütter, & Corneille, 2017; Pleyers et al., 2009). Specifically, participants in these studies had to press the spacebar of a keyboard each time they heard in their headphone a digit identical to the one they heard two steps before. In a control condition, the headphone aired neutral music. Because the CS–US pairings were presented visually and the concurrent task made use of an auditory modality, top-down attention was low in the load condition.

These studies repeatedly found the load condition to reduce both memory for CS–US contingencies and the EC effect to nonsignificance. This pattern was found when conditioning both complex and familiar stimuli (unfamiliar consumer brands; Pleyers et al., 2009) and simple and unfamiliar Kanjis (Dedonder et al., 2010). This effect of load was generalized to other sensory modalities (i.e., taste) and to indirect evaluative measures (Davies, El-Deredy, Zandstra, & Blanchette, 2012). In addition, studies by Kattner (2012) demonstrated that not only does EC require resources but that it actually emerges only when attention is directed to CS–US contingencies.

Such findings do not accommodate the view of an associative attitude learning system through which attitudes are efficiently acquired. Two pitfalls should be discussed though. First, the load manipulation was implemented between participants. This is potentially problematic because different instructions (i.e., processing numbers vs. neutral music) may have resulted in different goals in these experiments (see Field & Moore, 2005; Gast & Rothermund, 2011b), such that goals, rather than load, may have been the contributing factor. If relevant, however, this interpretation would be inconsistent with C3 (i.e., the goal independence of EC). Second, observing no EC effect under cognitive load may suggest underpowered studies. Conversely, observing an EC effect under load may suggest either the successful operation of an associative system or a lack of strength of the load manipulation.

The use of PD techniques may help to shed light on the latter question. In a recent adversarial research collaboration, Mierop et al. (2017) reasoned that only the explicit-memory parameter should be sensitive to a shortage of attentional resources at encoding. Their prediction was consistent with C2, and also with Jacoby's demonstration of the insensitivity of implicit memory to resource depletion at encoding (Jacoby, Toth, & Yonelinas, 1993). To make sure they would give an associatively driven EC effect a fair chance to emerge, Mierop et al. (2017) relied on the same stimulus materials, pairing procedure and PD analytic strategy as that used by Hütter et al. (2012) in a study that claimed evidence for an associatively driven EC. The three experiments by Mierop et al. (2017) were highly powered and presented procedural variations to allow for generalizability.

In none of these experiments did a significant memory-independent EC effect emerge. Instead, a large explicit-memory component was found, which was largely reduced in the attention load condition. Extending to yet another procedure and materials the findings observed by Pleyers et al. (2009), Dedonder et al. (2010), Davies et al. (2012) and Kattner (2012), the EC effect was reduced to nonsignificance under cognitive load, but for one of the three experiments, which was also the only one showing a survival of the explicit-memory parameter in the load condition. In sum, PD outcomes suggested that the remaining EC effect observed under the attention load condition should be attributed to an insufficient load manipulation.

Whereas cognitive load studies oppose C1 and C2 (and point to their interdependence), studies involving a more incidental presentation of the CS–US pairings, however, suggest EC effects for unattended CS–US pairings (C2) in the absence of participants' ability to recollect these pairings (C1). This research will be discussed in section P2. For now, we may conclude that little evidence exists that EC effects survive a cognitive load manipulation at encoding, yet that EC effects in the absence of explicit memory may be obtained under incidental learning conditions.

C3: Is EC Goal Independent?

There is not much research that addressed C3 by manipulating processing goals prior to or during learning (but see also P1 section). Corneille, Yzerbyt, Pleyers, and Mussweiler (2009) activated a similarity- or difference-focus mind-set prior to the EC procedure by having participants listing for 2 min either similarities or differences between two drawings (Mussweiler & Damisch, 2008). Carryover effects of this processing goal activation resulted in larger EC effects in the similarity than in the difference condition. These effects were obtained with a similar level of CS–US contingency memory across the two conditions. This experiment anticipated studies on relational processing that will be discussed in P1. Indeed, it suggests that EC effects vary as a function of relational goals (i.e., relate CS and US in terms of similarities vs. differences) that are incidentally activated prior to conditioning. It does not, however, make the case for either the presence or absence of associative learning. This is because an EC effect was always obtained, irrespective of the active processing goal. A more critical question here is whether EC effects may be entirely disrupted in the absence of specific processing goals.

A study by Gast and Rothermund (2011b) provides answers to the latter question. In three experiments, these authors assigned participants to learning conditions in which they were asked to focus either on valence-relevant (i.e., positive/negative) or valence-irrelevant (i.e., North/South German face, old/young face, casual/festive garment) dimensions in the conditioning task. Processing goals were to be applied to conditioning stimuli in Experiments 1 and 2, but to other stimuli interspersed in the conditioning task in Experiment 3. In the three experiments, EC effects were systematically found when the evaluative goal was activated in the task, but not found in the affectively irrelevant goal activation conditions. In the second experiment, this finding was extended to an indirect evaluative measure (an affective priming task). Consistent with Corneille et al. (2009), those effects were not mediated by contingency memory. Based on these findings, the authors concluded,

> Does our research allow the conclusion that EC effects are goal dependent? By manipulating the judgmental task, we also manipulated the judgmental goal. The EC effect depended on this manipulation. Therefore, the obvious answer is, yes, EC effects are goal dependent. (Gast & Rothermund, 2011b, p. 30)

Interestingly, the authors point out that this finding does not necessarily imply that the learning process was goal dependent, because learning *contents* may have differed between conditions. We concur with this assessment. For now, therefore, we may conclude that the learning system involved in EC effects is goal dependent with regard to what content it gets to learn and to evaluative effects it produces or fails to produce, both on direct and indirect measures. A simpler interpretation of these findings is that, considering no

EC effect was observed in valence-irrelevant conditions, the goal independence of the associative learning system in producing attitudes fails to be supported.

Finally, Stahl et al. (2016) also manipulated processing goals in the subliminal and near-subliminal studies discussed in C1 section. Specifically, they activated processing goals related not only to valence judgments (Experiments 2 and 3) and brightness judgment (Experiments 3 and 4) but also to CS/US identification (Experiment 6) and CS identification (Experiments 1 and 5). They noted that processing mode modulated EC, with larger EC effects in orienting tasks promoting an integrative or holistic processing mode. Hence, there is some evidence that the sensitivity of EC effects to goal activation extends to low-strength stimuli settings. Again, however, more research is certainly needed on the role of processing goals in EC effects and on how and when these goals operate. In particular, the incidental EC effects discussed in P2 would rather support the possibility of goal-independent EC effects in incidental paradigms.

C4: Is EC Uncontrollable?

C4 suggests that associatively learned attitudes are impervious to instructions to ignore or reverse CS–US pairing information at encoding. We could identify three EC publications implementing control goals at learning. Gawronski, Balas, and Creighton (2014) motivated their participants, prior to learning, to form affective responses about the CS (i.e., computer drawings) that were consistent with (promotive condition) or immune (preventive conditions) to the CS–US pairings. An explicit evaluative measure showed larger EC effects in the promotive than in the preventive condition. In contrast, an indirect measure (an affective priming task) showed no moderation of EC effects by task instructions. Gawronski, Mitchell, and Balas (2015) reached similar conclusions using control versus emotional-regulation instructions prior to learning (i.e., emotion suppression, stimulus reappraisal, and facial blocking). Here again, the direct evaluative measure reflected the control instruction, but the indirect evaluative measure revealed an EC effect that was unqualified by control instructions.

These findings are consistent with the notion of an uncontrolled associative learning system that passively records co-occurrences and expresses their content in an indirect evaluative task. They raise, however, two questions. First, Gawronski, Mitchell and Balas (2015) pointed out that their finding "does not rule out the possibility that other strategies are more effective in preventing the acquisition of conditioned preferences" (p. 565). Second, the uncontrolled-learning outcomes observed by Gawronski and colleagues were found with instructions that directed participants' attention to the CS–US pairings. As a matter of fact, instructions in these experiments were concerned with the CS–US pairings and the affective implications they should or should not elicit. The latter focus may have contributed to noncontrolled effects on the indirect measure (see also Moran, Bar-Anan, & Nosek, 2015, as discussed in P1 section).

Hütter and Sweldens (2018) recently addressed C4 using a PD procedure. The advantage of a PD procedure is that it teases apart the contribution of controlled and uncontrolled processes while holding constant the nature of the evaluative measure (a direct task, in this case). Their study involved contrasting participants' responses in an inclusion condition (i.e., "use the valence of the images to form an accurate impression of the persons/brands") versus an exclusion condition (i.e., "reverse the valence of the images to form an accurate impression of the persons/brands"). These PD experiments found evidence for contributions of both a controlled-learning and an uncontrolled-learning parameter, which reflected participants' ability and inability to reverse EC effects, respectively. Of importance, they also showed that the controlled parameter only was sensitive to control incentives and to the shortage of cognitive resources at encoding. In another study, the independent contributions of the controlled- and uncontrolled-learning parameters were further validated in the context of a real consumption task.

Taken together, these PD experiments represent a strong support to the view that people may fail to exert control over the evaluative implications of the US for the paired CS, and that when they do so, the CS may acquire, despite instructions and incentives, the US' valence, with downstream behavioral consequences. One should keep in mind, however, that these studies show that, *when* control fails, the CS may be evaluated in line with the US valence. This does not imply that full control is never achieved (Gawronski et al., 2015). It may be (e.g., through extensive training or learning time), in which case uncontrollable processes cannot operate. In other words, EC effects are not unconditionally driven by uncontrollable influences.

Summary assessment on C1 to C4. C1—Limited evidence has been reported for the existence of consciousness-independent attitude learning. We discussed correlational studies and noted that outcomes from studies may speak to whether EC effects are sustained in the presence of memory loss for CS–US pairings, not to the role of contingency awareness at encoding (see also Gawronski & Walther, 2012; Sweldens et al., 2014). As to the experimental studies, there is no evidence today that EC effects are obtained for parafoveal presentations or for CS prevented from entering consciousness by continuous flash suppression. As also discussed, evidence for subliminal and near-subliminal EC effects is very scarce.

C2—Regarding EC efficiency, we noted that evidence appears to be consistently conflicting across two separate strands of research. Specifically, EC studies that taxed participants' cognitive resources at encoding, to the point of preventing the explicit encoding of CS–US pairings in memory, found no evidence for efficient EC. As for C1, this conclusion applied to various sensory modalities and to both direct and indirect evaluative measures. However, an alternative account of the load effects suggests that load manipulations may have distracted participants' attention away from an evaluative processing of the CS–US pairings (therefore, opposing C3). In any case, there seems to be currently no evidence that EC survives the imposition of a large attentional load at encoding. However, incidental EC studies (as will be discussed in P2) support the view that EC may be elicited under low levels of top-down attention.

C3—Turning to the insensitivity of EC effects to processing goals, the current review fails to provide support for this notion. When participants are distracted from processing valence-relevant dimensions of the task (Gast & Rothermund, 2011b), no EC effect is observed, neither on direct nor on indirect measures. The effect of processing goals should not be underestimated. Larger EC effects are found when the task induces a focus on processing the CS–US pair (e.g., Kattner, 2012) and on the valence dimension (Gast & Rothermund, 2011b), smaller effects are found when the focus is on an irrelevant (e.g., brightness) rather than relevant (e.g., valence) dimension of the pair (Stahl et al., 2016), and even smaller effects are found when stimuli are processed individually instead of as pairs (as in the surveillance paradigm by Olson & Fazio, 2001; Stahl et al., 2016).

C4—A recent PD study by Hütter and Sweldens (2018) provides strong evidence for the view that EC effects may be acquired despite incentivized control instructions. The use of a PD approach, because it holds the evaluative measure constant, rules out alternative accounts in terms of different retrieval or expression processes that may be involved when comparing direct versus indirect evaluative measures.

Overall, our discussion suggests that the strongest evidence for automatic attitude formation resides in the existence of EC effects under incidental learning conditions (to be discussed in P2) and in uncontrollable EC effects. Besides this, the literature shows no evidence for EC effects providing a shortage of attentional resources at encoding, shows scarce evidence for the existence of EC effects established in the absence of awareness at encoding, and points to the role of goals in moderating EC effects. Based on what we hope to be a critical but fair integrative review of relevant evidence, the current analysis provides a more nuanced view of how automatic attitude formation may be.

It is important to repeat, however, that "automatic" should not be equated with "associative." Therefore, evidence against automaticity does not imply evidence against associative learning. However, evidence against automatic features of associative attitude learning is problematic for any attitude theory that posits that associative attitude learning is automatic. And, in fact, it questions any theory that assumes a form of automatic attitude learning, even if it does not subscribe to the idea of associative attitude learning. This point is very important as it invites attitude models that do not equate "associative" with "automatic" to refer to a distinct set of evidence for testing their models. Operating principles, which are now discussed, are useful in this regard.

P1: Unqualified Registration of Mere Co-Occurrences Between Stimuli

P1 states that associative learning creates direct associative links in memory between co-occurring stimuli, independently of their validity or relational meaning. This associative learning principle is contrasted to a propositional mode of attitude learning that is assumed to form propositions about stimulus relations (De Houwer, 2007, 2009; Mitchell et al., 2009). Propositions can be understood as statements about the world that can be true or untrue, and that specify how stimuli are conceptually related to each other (e.g., mere co-occurrence, causal antecedence, reversal in meaning). We separately discuss evidence regarding the effects of relational meaning (P1a) and validity (P1b).

P1a: Mere linkage unqualified by relational meaning. Hu, Gawronski, and Balas (2017) hypothesized that P1a may be supported by dissociative effects of relational versus co-occurrence information on direct and indirect evaluative measures, respectively. This point is clearly explained by the authors:

> A central assumption of dual-process accounts is that the effects of relational information require propositional inferences, and therefore are more likely to occur for deliberate judgments that reflect the outcome of such inferences [i.e., explicit evaluations]. However, . . . repeated co-occurrences are claimed to produce unqualified associative links that should influence spontaneous responses resulting from the spread of activation between associated concepts [i.e., implicit evaluations]. Thus, whereas single-process propositional accounts predict a moderating effect of relational information on both explicit and implicit evaluations, dual-process accounts predict a dissociation . . . (Hu et al., 2017a, p. 18)

A recent study by Moran and Bar-Anan (2013), which is considered "the most compelling evidence for the simultaneous operation of associative and propositional learning" (Gawronski, Brannon, & Bodenhausen, 2017, p. 108), examined the latter prediction. Moran and Bar-Anan exposed participants to four families of alien-like characters associated with either the appearance or the disappearance of a positive sound (a melody) or a negative sound (a scream). Participants were instructed to memorize which family performed the four actions for a later memory probe. In this paradigm, the associative system is expected to learn a more negative attitude toward the families associated with the negative sound. In contrast, the propositional system is expected to take into account the meaning of the particular action of the families in relation to the valence of the sound, such that families should be evaluated more negatively when making a negative sound appear or a positive sound disappear. Moran and Bar-Anan (2013) observed the former outcome on an indirect measure and the latter outcome on a direct measure.

Moran and Bar-Anan's (2013) results support the view that attitudes may be acquired through associative learning. Recently, however, Moran et al. (2015, Experiment 2) demonstrated that these effects are observed only when participants are requested to memorize co-occurrences about stimuli. In the absence of such goal, or when an impression-formation goal is activated, evidence does not conclusively suggest anymore that participants merely record unqualified co-occurrences. In line with research suggesting the role of processing goals (Corneille et al., 2009; Gast & Rothermund, 2011b) and deliberate relational thinking in EC (Fiedler & Unkelbach, 2011; Förderer & Unkelbach, 2012), these authors note in their conclusion,

> The present finding emphasizes that automatic evaluation is not always the reflection of co-variations of stimuli in the environment. Rather, automatic evaluation can reflect inferences from complex information that requires deliberate, propositional processing. (Moran et al., 2015, p. 162)

The sensitivity of indirect evaluative measures to mere co-occurrences or to relational information was also examined by Hu et al. (2017). In their first experiment, the authors observed that, when relational information was provided before the encoding of CS–US pairings, it moderated EC effects on a direct, but not on an indirect evaluative measure. Consistent with an associative learning view, the indirect evaluative measures reflected the US valence irrespective of the CS–US relational content (i.e., they reflected mere co-occurrences). However, the latter was true both under conditions of low and high repetition pairings, therefore opposing the view of a slow-paced associative learning process (e.g., Baeyens, Eelen, Van den Bergh, & Crombez, 1992; Gawronski & Bodenhausen, 2006; Rydell & McConnell, 2006). As a further concern, no reversed evaluation was observed on the explicit measure in conditions where relational information called for such reversal.

A second experiment replicated the finding for a relational effect on a direct and not on an indirect measure, and this time additionally found a significant reversal on the direct measure. Yet, that second experiment also failed to obtain the expected effect of repetition. Finally, a third experiment was conducted, aimed at ruling out ineffective integration of co-occurrence and relational information at encoding, as an explanation for differential effects of relational information at expression on direct versus indirect measures. This was done by switching to a within-participants, per-trial, manipulation of relational information. This time, effects of relational information did not differ anymore between the direct and indirect measures.

Along with Moran et al. (2015), these findings fail to bring clear support for P1a and oppose the view that indirect evaluative measures preferably reflect the operation of a slow-pace associative learning system impervious to high-order cognition. As a matter of fact, the authors note that interpretation of their findings

> . . . does not require any assumptions about two functionally distinct learning mechanisms, [and] reopens the door for single-process propositional accounts as a viable alternative. (Hu et al., 2017, p. 29)

This conclusion is consistent with findings from three experiments conducted by Zanon, De Houwer, and Gast (2012) who also found indirect evaluative measures (an IAT in Experiments 1 and 2, and an affective priming task in Experiment 3) to reflect relational meaning (i.e., assimilative or antagonistic) conveyed by the context of presentation (i.e., in the absence of verbal instructions). These authors, however, found no evidence for an evaluative reversal in the antagonistic condition, which motivated ad hoc hypotheses to allow for a propositional account of the findings: Learned propositions may have encoded both the mere co-occurrences and the relational meaning implied by the context, canceling out their opposite effect on the evaluative measures.

P1b: Mere linkage unqualified by validity. P1b states that associative attitude learning forms direct associative links in memory between co-occurring stimuli, independently of their truth evaluation. This is contrasted to a propositional learning system that is thought to form and assess the truth of mental propositions about co-occurring stimuli. P1b is conceptually close to P1a, and so it comes as little surprise that it resulted in similar conclusions.

In a first experiment, Peters and Gawronski (2011) presented their participants with photographs of men along with positive or negative behavioral descriptions. Participants had to guess the accuracy of each description, and a feedback was delivered right after each guess (i.e., "RIGHT!" or "WRONG!"). Failing to support P1b, the perceived validity of the pairing affected both direct and indirect (i.e., an affect misattribution task) evaluative measures. Experiment 2 replicated this finding, this time using an affective priming task, presumably less sensitive to validity information. Experiment 3 (see also Zanon, De Houwer, Gast, & Smith, 2014) again replicated the outcomes of Experiments 1 and 2 (and so opposed P1b), but additionally found that validity information was less likely to influence indirect evaluations when it was presented *after* learning, which is irrelevant to the current associative attitude *learning* question.

A recent experiment by Moran et al. (2015) suggests that the activation of an impression-formation goal in Peters and Gawronski (2011) may have contributed to their findings. Moran et al. (2015; Experiment 1) examined the effect of information validity under various processing goal conditions (control, memorization of co-occurrences, impression formation). In the control and impression-formation condition, the indirect evaluative measure (a Sorting Paired Features task) showed that participants preferred the targets paired by positive characteristic traits and negative uncharacteristic traits to their counterparts. This contradicts P1b, as it demonstrates a sensitivity of EC to validity information on an indirect measure. That this pattern emerged in the control condition suggests this is the default mode. When participants had to memorize the information, however, the pattern was different. Here, participants formed adequate impressions to a larger extent in the valid than in the invalid condition. At no point, however, was a reversed effect observed that might support unqualified sensitivity to mere co-occurrences in the invalid (i.e., uncharacteristic) condition.

The finding that indirect evaluative measures are sensitive to relational information only under impression-formation but not memorization goals (Moran et al., 2015) is strongly reminiscent of the distinction between online versus memory-based judgment tasks that moderates the memory–judgment relationship (Hastie & Park, 1986). Impression formation is an online task requiring integrating information as it is presented and forming a summary judgment for later retrieval and use. In contrast, under memorization goals, participants merely encode the provided information (without integrating it to form a judgment). As observed by Moran et al., a judgment formed online was readily expressed in both direct and indirect evaluation tasks. In contrast, under memorization goals, the effect of relational information is expected to be stronger on direct (unspeeded) than on indirect (speeded) evaluative measures because of the additional requirements of (a) retrieving both the valence of the associated US and the relational qualifier and (b) integrating these two (potentially conflicting) pieces of information (i.e., modifying the valence of the US in accordance with the relational qualifier). If asked to form an integrative judgment on the basis of information in memory, participants are, therefore, more likely to succeed in unspeeded direct measures and more likely to fail in speeded indirect measures.

In sum, it seems fair to say that, just as for P1a, P1b fails to be conclusively supported by evidence. Rather, this research generally points to the sensitivity of both direct and indirect evaluative measures, to higher order goals, and to relational and truth information about CS–US pairings. In addition, when observed, dissociations may be explained away by an alternative memory-based account. Again, however, the lack of evidence for P1 should not be equated with a demonstration of its falsity. In particular, examining dissociations on direct versus indirect measures may not have been the best option. As explained in the general discussion, this is because there may not be a pure mapping between learning modes (i.e., associative vs. propositional) and measurement modes (i.e., direct vs. indirect). The use of a PD procedure, because it keeps the nature of the evaluative measure constant, may be useful in this regard (i.e., as it avoids inviting alternative explanations in terms of retrieval dissociations; for example, Gawronski & Heycke, 2017).

Complementary observations on P1. Relevant to the discussion of P1 are sensory preconditioning effects, by which an attitude acquired through EC spreads from a conditioned CS to another CS it was preassociated with. This may be considered a special case of EC, in which the affective value of the US spreads across CSs, some of which are never directly paired with it. Walther (2002) provided evidence for the existence of this attitude spreading effect and claimed that it occurs automatically, in the sense of unconsciously and efficiently (i.e., C1 and C2). Support for C1 came from self-reports, which we have seen are insensitive tools for probing CS–US awareness. Support for C2 came from a study (i.e., their Experiment 5) where a mental load procedure consisting in rehearsing an eight-digit number was used. The manipulation check for the load manipulation consisted in verifying that participants had correctly memorized the number. Only two participants could not report the number at the end of the study, making it unclear how much charging the load task was and also when the load taxed resources (i.e., during the entire learning phase or just during the initial encoding of the number).

Consistent with the latter interrogation, EC and attitude spreading effects were found to be marginally and significantly *larger* in the load condition, respectively. The authors speculate that "Too much attention given to the neutral stimuli may presumably block primitive associative learning by triggering higher cognitive processes" (Walther, 2002, p. 930). If this explanation is correct, our understanding is that it would actually support the nonautomaticity of the effect. Walther (2002, Experiment 3) also showed that the spreading attitude effect is unaffected by an extinction procedure. However, no external evidence allows to conclude that this extinction phase was effective in any sense, as EC effects typically do not extinguish (Gawronski, Gast, & De Houwer, 2015; Lipp & Purkis, 2006; Mierop, Molet, & Corneille, 2018) and also did not extinguish in that particular study. Therefore, there seems to be no clear support for the automaticity of sensory preconditioning in that study. Of importance, one should note that, even if there was, such demonstration would speak only to the issue of operating conditions, not operating principles.

Another study by Gawronski, Walther, and Blank (2005, Experiment 2) offers a conceptual replication of this spreading of attitude effect and a generalization of it to indirect evaluative measures. That study, primarily concerned with the role of encoding or retroactive judgments in cognitive balance effects also showed that attitudes toward a source individual (e.g., John, liked vs. disliked) can discount the encoding of this individual's sentiments (e.g., positive vs. negative) about another target (e.g., Aaliyah). This finding, however, speaks to the effect of acquired attitudes, not to attitude acquisition.

In our view, more relevant to P1a is a study combining cognitive balance and revaluation effects by Langer, Walther, Gawronski, and Blank (2009). These authors examined how Heiderian balance effects are sensitive to attitude change in one component of the interpersonal triad. Imagine you are asked how you feel about Adrien, who is unfamiliar to you.

If you like Mary and you learn Mary likes Adrien, then you should get to like Adrien too. The same is true if you dislike Mary and you learn she dislikes Adrien. Conversely, you should dislike Adrien if Mary likes him and you dislike her, or if Mary dislikes him and you like her.

Now, what happens if your attitude about Mary reverses (i.e., if Mary gets reevaluated; see also next section for revaluation effects)? Heiderian balance would predict that your attitude toward Adrien gets adapted to this attitude change, such that your feelings about Adrien flip in the opposite direction. In contrast, unqualified linkage effects would predict that your new attitude toward Mary is directly transferred to Adrien. In this case, your evaluation of Adrien should simply be assimilated to your new evaluation of Mary. This is because P1 assumes effects of mere co-occurrences independent of relational meaning. Evidence supported the latter prediction. One should note, however, that (a) this effect is again concerned with attitude change rather than attitude acquisition and (b) it was observed on direct evaluative measures, showing that the theoretical relation between associative learning (assuming this effect qualifies as such) and attitude expression is not univocal.

P2: S–R Linkage

Whereas associative attitude learning accounts generally posit that people encode mere stimulus co-occurrences in memory (stimulus–stimulus, or S–S learning), attitude research suggests that it may also link the CS with the affective response evoked by the US (S–R learning). This linkage is thought to require no encoding of the CS–US pair in memory (as it assumes an S–R, not an S–S linkage). Jones, Fazio, and Olson (2009) and Sweldens, Van Osselaer, and Janiszewski (2010) independently proposed different sets of learning conditions that promote S–R linkage. According to Jones and colleagues (Jones et al., 2009; Jones, Olson, & Fazio, 2010), CS–US presentations must be incidental, US intensity should be mild, and the CS relatively more salient than the US. In addition, it is also important that the CS and US are visually related to each other (i.e., that participants move their gaze back and forth between the stimuli; this is supported by both eye tracking and experimental manipulations) and are not too spatially distant from each other.

According to Sweldens et al. (2010), heterogeneity of the pairings (i.e., each CS paired with USs of a same valence but of different identities) and the simultaneity of the CS–US pairings should be considered the primary enabling conditions. The latter condition (simultaneity) is also acknowledged to be "the most crucial methodological key to producing implicit misattribution" by Jones et al. (2010, p. 223). The paradigms used by Jones and Sweldens involve very or relatively incidental presentations of the CS–US pairings, respectively.

Evidence for S–R learning in incidental EC studies is usually claimed based on EC effects found in participants showing no CS–US identity memory. That is, when in the context of a postlearning identification task, the CS cannot be retrospectively related to the specific US it was paired with. This absence of US identity memory, in turn, is interpreted as an absence of S–S linkage. This demonstration is problematic because, in addition to the learning or encoding stage, one also has to consider the memory maintenance or retention, and retrieval or performance stages (e.g., Boddez, Haesen, Baeyens, & Beckers, 2014). Instead of being due to S–R learning, findings may be consistent with explicit encoding of (propositions about) CS–US co-occurrences if we consider what is known about memory maintenance: Forgetting occurs at a higher rate for more detailed, low-level (verbatim) information about a stimulus, whereas more abstract high-level (gist) information is retained over a longer time (e.g., Brainerd & Reyna, 2002).

Applied to EC, it follows that perceptual detail of a US stimulus associated with a given CS (i.e., low-level information that allows it to be distinguished from other USs of the same valence) is more likely to be forgotten, whereas its valence (a high-level feature) is retained longer. When asked about their memory for the US paired with a given CS, participants can, therefore, be expected to show higher levels of memory for the US' valence category than for its identity (Stahl et al., 2009). If EC is based on information in memory, this also predicts that a subset of CSs will show EC effects (based on gist memory) despite participants being unable to report specific details about the associated USs, as has been reported in studies using the surveillance paradigm (Olson & Fazio, 2001; Stahl & Heycke, 2016).

The latter, memory-related question, was more precisely tackled in PD studies that experimentally manipulated encoding conditions. One such experiment was conducted by Hütter and Sweldens (2013). Consistent with stated conditions enabling S–R linkage, these authors predicted and found a higher implicit parameter for simultaneous than sequential CS–US pairings. This pairing factor, however, is likely to also affect the formation of explicit memory (e.g., via propositions about CS–US co-occurrences): When both stimuli appear next to each other on the screen, they are more likely to be perceived and encoded as part of a single event; in contrast, when they are presented sequentially one after another, participants are less likely to explicitly encode them as a pair (e.g., Gast, Langer, & Sengewald, 2016). The evidence supports this interpretation: Simultaneous versus sequential presentation affected not only EC but also explicit memory; *both* were increased for simultaneous as compared with sequential pairings (Hütter and Sweldens, 2013; Stahl & Heycke, 2016).

The latter point is a very important one. The PD approach starts by assuming the separate existence of an implicit evaluative learning effect that is distinct from explicit memory for US valence, and it proceeds by asking participants to disentangle their explicit memory for US valence from their subjective evaluations under two different conditions, with the aim of empirically quantifying their separate contributions by estimating separate parameters for each process. Unfortunately, however, the mere finding that the estimate for the implicit process substantially differs from zero does not imply that the assumed second implicit process itself in fact exists; it is well possible that a single-process model may underlie the effects on both parameters (Ratcliff, Van Zandt, & McKoon, 1995). In line with this interpretation, effects of experimental manipulations during encoding (simultaneous vs. sequential pairing, attentional load, US evocativeness) have generally failed to dissociate the explicit and implicit parameters in a manner consistent with dual-process assumptions.

Another line of support for S–R learning comes from evidence for insensitivity of EC to US revaluation. The US revaluation procedure consists of pairing a CS with a US, whose valence is experimentally changed after the learning phase (this time, in the absence of the CS). Whereas S–S learning predicts that the evaluation of the CS reflects the revaluation, S–R learning predicts that it does not (as S–R assumes independence from S–S linkage in memory). Past studies provided conflicting evidence regarding the sensitivity of CS ratings to US revaluation effects (Baeyens et al., 1992; Baeyens, Vanhouche, Crombez, & Eelen, 1998; Walther, Gawronski, Blank, & Langer, 2009). Gast and Rothermund (2011a) reasoned that whether S–R learning operates should depend on the activation of an evaluative response in the learning phase. When such evaluative response is lacking, no S–R learning can take place, as there is basically no response to be linked with the CS.

Consistent with this reasoning, the authors conducted a first experiment in which evaluations were requested in the learning phase. In this case, CS ratings were not sensitive to US revaluation, therefore supporting the creation of S–R linkage. In contrast, CS ratings proved sensitive to US revaluation (i.e., showed evidence for S–S learning) in a second experiment that did not involve evaluation in the learning phase. In their general discussion, the authors note that S–R learning is also consistent with evidence for higher EC effects under evaluative goals conditions (as discussed in C3) and with evaluative effects observed in the Approach-Avoidance (AA) literature (as discussed just after the summary assessment section).

These findings clearly support the role of S–R learning in EC. However, they are not (and were not aimed at being) diagnostic as to whether S–R learning is associative or propositional. In a third study, Gast and Rothermund (2011a) entirely removed the US from the procedure. Instead, the CSs (neutral portraits of individuals) were now paired, block wise, with enforced verbal responses from the participants. Specifically, participants were instructed to speak out loud "Likeable" or "Unlikeable" upon appearance of a gray square on the portrait. The findings showed successful conditioning of the faces on an indirect evaluative measure (i.e., an affective misattribution task). Given the strong verbalization component involved in that study, however, this effect may be interpreted as propositional. As a matter of fact, this procedure shares much in common with instruction-based EC.

Another line of evidence relevant to S–R learning comes from a retroactive interference study. Retroactive interference is observed when the learning of new information makes previously learned information less accessible. Sweldens and colleagues (2010) conditioned beer brands (i.e., the CSs) in a simultaneous or sequential CS–US pairing procedure. In the simultaneous condition, each CS was paired with USs of various identities; in the sequential condition, each CS was paired with a unique US. Next, participants went through an interference task, after which they were asked to report their evaluation of the CSs. A retroactive interference effect, as indicated by a lowering of the EC effect, was observed in the sequential but not in the simultaneous pairing condition. This finding is consistent with the view that simultaneous pairings are conducive to S–R learning. As discussed above, however, simultaneous/different USs pairings versus sequential/same US pairings may affect memory, not just learning. It is, therefore, daring to conclude that the S–R effects found in that study were driven by associative learning effects.

As it appears, S–R learning is usually thought to be supportive of associative attitude learning because it arguably conforms to C1 (i.e., EC without awareness of the CS–US pairs, as measured on memory measures). This points again to a confusion between operative conditions and operating principles. If one does not subscribe to an associative view that maps associative learning with automatic learning, then S–R learning should not suggest per se the operation of an associative learning processes. Just as for S–S pairings, one may argue that an S–R relation is propositionally encoded in memory. An interesting question, therefore, is whether S–R effects are moderated by validity and truth information, or whether they reflect *mere* co-occurrences between a stimulus and the affective response evoked by another one.

Summary assessment of P1 and P2. P1a and P1b—Evidence exists that, in situations when co-occurrence information conflicts with relational or truth information, indirect evaluative measures reflect the mere registration of co-occurrences between stimuli. However, contrasting evidence also exists that direct and indirect evaluative measures are *both* sensitive to relational information. Whether indirect measures reflect mere co-occurrences or relational information seems to depend on high-order processing goals, in a way that is consistent with existing memory models.

P2—PD studies suggest EC effects independent of S–S linkage in conditions predicted to be conducive to S–R learning (i.e., simultaneous but not sequential CS–US pairing, providing USs of several identities but of same valence that are incidentally associated with a CS). However, no PD study found dissociative patterns (i.e., simultaneous and sequential pairings influenced memory and memory-independent EC parameters in the same direction), the absence of which allows for a single-process memory account of the findings.

Research on US revaluation provides evidence consistent with P2: CS evaluation was sensitive to US revaluation only when evaluative responses were elicited at learning. However, we noted that this study also suggests a role for propositional processes in S–R. Finally, we discussed a study in which EC effects were predicted and found to be sensitive to retroactive interference in conditions thought to facilitate S–S learning (sequential/same US pairings) but not in conditions thought to facilitate S–R learning (simultaneous/different USs pairings). We pointed out, however, that these pairing procedures are likely to also affect memory, not just learning, and thereby allow for a single-process account of the finding.

Of critical importance, we also noted that S–R is often interpreted as supportive to associative learning to the extent it is viewed as unconsciously learned (C1), which confuses operative principles and operating conditions.

Associative Learning Evidence in EC-Related Paradigms: AA Training and the Mere-Exposure Effect

Because EC is considered the most suited paradigm for addressing associative attitude learning, so far we have limited our discussion to the EC paradigm. We believe, however, that it is worth discussing other, EC-related, paradigms that may also be relevant to associative attitude learning. One of these paradigms is the AA training paradigm, which shows that repeatedly approaching a stimulus and avoiding another stimulus results in a more positive evaluation of the former stimulus (e.g., Kawakami, Phills, Steele, & Dovidio, 2007; Woud, Maas, Becker, & Rinck, 2013). One may think of the AA paradigm as a form of operant EC (De Houwer, 2007), in which neutral CSs are paired with positive (approach) or negative (avoid) actions, or with the triggering of a positive "approach system" or negative "avoidance system." Jones, Vilensky, Vasey, and Fazio (2013), following Cacioppo, Priester, and Berntson (1993), directly relate this paradigm to a form of conditioning:

> . . . approach and avoidance behaviors, given their conditioned associations respectively with desire and positivity or repellence and negativity, can themselves lead to conditioned positive or negative attitudes towards objects with which they occur (Cacioppo et al., 1993). (Jones et al., 2013, p. 989)

It is assumed that AA training effects reflect the operation of an automatic and consciousness-independent associative learning system (Phills, Kawakami, Tabi, Nadolny, & Inzlicht, 2011). The latter conclusion was supported by evidence for subliminal AA effects (Jones et al., 2013; Kawakami et al., 2007). For instance, Kawakami et al. (2017, Experiment 2) presented pictures of Black and White faces "subliminally" to their participants and paired them with an approach instruction (i.e., joystick pulling) or an avoid instruction (joystick pushing) through a 480-trial-long training task. Participants then completed an IAT that showed reduced anti-Black prejudice in the approach Blacks avoid Whites conditions than in two other (control, or approach Whites avoid Blacks) conditions.

In three recent experiments relying on a variety of stimuli materials, however, Van Dessel, De Houwer, Roets, and Gast (2016) failed to replicate these subliminal AA training effects. This is fully consistent with Stahl et al. (2016), who demonstrated the absence of EC effects when using near-subliminal CS. Of interest, in another line of research, Van Dessel, De Houwer, Gast, and Smith (2015) also found that AA effects are elicited on *both* explicit and implicit measures based on mere AA training instructions; that is, in the absence of any actual approach or avoidance enactment. A similar effect of mere instructions on an indirect evaluative measure was additionally found to be sensitive to relational thinking by Van Dessel, De Houwer, and Smith (in press). As the authors pointed out,

> For reasons of parsimony, a propositional account that can explain these results is to be preferred over an account that additionally postulates the existence of an entirely different second mechanism (i.e., association formation). (Van Dessel et al., in press, p. 18)

Research on AA training, therefore, provides weak support for C1 and may be accounted for by a single-process propositional account.

Another relevant paradigm is the mere-exposure effect. In mere-exposure research, the repeated exposure of a stimulus results in a more positive evaluation of it. Recent accounts attribute mere-exposure effects to the role of processing fluency at judgment, which may not involve learning-related processes. In his late work, however, Zajonc (2001) came to interpret the mere-exposure effect as a special case of classical (in fact, evaluative) conditioning: The merely exposed stimulus (i.e., the CS) is positively conditioned by its contiguous association with the absence of noxious consequences (i.e., the positive US):

> In the mere-repeated-exposure paradigm, the repeatedly exposed stimuli can be viewed as CSs . . . But where is the US? . . . the very absence of a noxious consequence could well act as a US. The absence of aversive consequences constitutes a safety signal that is associated with the CS. As in classical conditioning, after several CS-US occurrences, in which the US is simply the fact that the individual does not suffer any untoward experiences, the CR—an approach tendency—becomes attached to the CS, now communicating that the current environment is safe. (Zajonc, 2001, pp. 225-226)

Such conceptualization, therefore, sees mere exposure as a learning effect. Interestingly, it also sees it as a low-level one. In particular, mere exposure is held to occur for subliminal presentations (Murphy, Monahan, & Zajonc, 1995).

Evidence for subliminal mere-exposure effects has, however, been challenged in experimental studies that failed to observe it, and which found instead a mere-exposure effect only when identification performance was at its highest level (Newell & Shanks, 2007). In line with the findings discussed above, the lack of clear evidence for subliminal mere exposure, thus, fails to support C1.

As mentioned above, the mere-exposure literature generally points to the role of memory processes in the effect (for a demonstration in an ecological setting, see Herrmann, Corneille, Derbaix, Kacha, & Walliser, 2014). Consistent with prior research showing that liking is positively mediated by identification in the mere-exposure paradigm (Brooks & Watkins, 1989), Newell and Shanks (2007) also found liking and recognition to be positively correlated (see also Szpunar, Schellenberg, & Pliner, 2004). Lee (2001) further showed that stimuli reported as "old" in a mere-exposure paradigm are liked better than those reported as "new," irrespective of their objectively old or new status (see also Matlin, 1971; Wang & Chang, 2004). This strongly suggests that the mere-exposure effect reflects the influence of memory (i.e., feelings of familiarity) on liking instead of the influence of learning (i.e., the actual CS presentations) on liking. In line with the latter observation, another study pointed to the role of judgment strategies in the mere-exposure effect and provided evidence that either identification performance or liking can be moved down to chance level or above it depending on the particular judgment strategy (holistic or analytic) used for evaluative and identification judgments (Whittlesea & Price, 2001). Finally, it is worth noting that instruction-based mere exposure effects were recently reported in the literature, on both explicit and implicit measures (Van Dessel, Martens, Smith, & De Houwer, 2017). In sum, just as for AA training research, evidence in the mere-exposure literature does not allow supporting the operation of an associative learning process in attitude formation.

General Discussion

We discussed evidence relevant to four operating conditions and two operating principles commonly associated with associative attitude learning. As it appears, the strength of evidence collected so far varies across specific conditions and principles. As can be seen in Table 1, C4 is best supported, whereas evidence for C1 to C3 stems mainly from incidental paradigms (e.g., Olson & Fazio, 2001; Sweldens et al., 2010), whose effects are amenable to alternative interpretations. This assessment provides a nuanced view on how and when attitude learning may qualify as an automatic process. We noted, however, that these operating conditions are informative to associative attitude learning only to the degree that attitude learning models assume that associative attitude learning qualifies as an automatic process. If not subscribing to the latter assumption, however, one has to turn to a separate set of evidence for testing associative learning, which can be done by addressing operating principles. Operating principles may actually be deemed more relevant to the associative learning *as a process* question, as they directly tackle the "how" instead of the "when" question (Gawronski & Bodenhausen, 2014; Sweldens, 2018).

When discussing operating principles, we noted that S–S and S–R learning are not intrinsically diagnostic of an associative mode of attitude learning. This is because propositions can be established about a CS and either the US it is paired with or with the affective response this US elicits. It is, therefore, critical to specify under which conditions evidence for S–S and S–R learning is adequately interpreted as supportive to associative learning.

Regarding P1a and P1b (unqualified encoding of mere co-occurrences between stimuli), we saw that the latter specification has generally taken the form of predicting dissociations in effects of mere co-occurrences versus relational or validity information on indirect and direct measures, respectively. The evidence collected so far provides mixed support for P1a and P1b. In particular, several studies found indirect evaluative measures to reflect relational or validity information. The question of when direct and indirect measures reflect (or not) relational information, thus, awaits further theorization and empirical investigation.

Regarding P2 (S–R linkage), the models' specification generally implied to relate operating principles (P2) to operating conditions (C1; that is, S–R learning is considered supportive to associative learning because it is viewed as unconsciously learned), which is conceptually problematic. More generally, when discussing both P1 and P2, we noted the scarcity of robust dissociative evidence that would allow supporting the existence of associative attitude learning, as opposed to propositional learning. We also explained throughout this review why such dissociations, when they are observed, can often be accounted for by postlearning processes.

This summary assessment being made, we now discuss specific attitude learning models in light of the operating conditions and principles reviewed here. As it will appear, this analysis stresses that attitude models vary in their endorsement of these conditions and principles. Finally, we address key methodological and theoretical implications of the present review.

Contemporary Attitude Models Endorsing an Associative Learning View, and How They Relate to Conditions and Principles Reviewed Here

An associative attitude learning process is usually acknowledged or even plays a prominent role in current models of attitudes. In particular, many dual-process models assume that distinct learning processes or learning systems underlie the formation of attitudes. These are referred to as propositional versus associative learning (Gawronski & Bodenhausen, 2006, 2011) or rule-based versus associative

Table 1. Summarized Observations for C1 to C4 and P1 and P2, DR, and PE on Indirect Evaluative Measures, and How Contemporary Attitude Models Endorse Them.

Dimension	Summarized observations	SEM	MCM	APE	IAM	PAL
C1: Unconscious	(–) Scarce evidence for EC when CS–US encoding is disrupted (+) EC found in the absence of explicit CS–US memory in PD studies (≈) PD outcomes sensitive to instruction-based EC and postlearning intervention	Yes	/	Yes	Yes	No
C2: Efficient	(–) No EC with load at encoding, even in incidental paradigm (≈) Load confounded with goals (+) EC found in incidental paradigm	Yes	(Yes)	Yes	(Yes)	No
C3: Goal independent	(–) EC is sensitive to goals (≈) Goals may influence learning contents, not learning processes (+) EC found in incidental paradigm	Yes	/	Yes	(Yes)	No
C4: Uncontrolled	(+) Evidence for uncontrolled EC in PD studies	(Yes)	(Yes)	Yes	(Yes)	No
P1: Unqualified linkage	(–) Scarce evidence that EC is sensitive to mere co-occurrences (–) Sensitivity to mere co-occurrences depends on processing goals	Yes	(Yes)	Yes	(Yes)	No
P2: S–R	(+) Support for S–R link in the surveillance paradigm under predicted conditions, also in PD studies (–) Lack of double-dissociative evidence in PD studies (≈) S–R learning, which is an operative principle, is interpreted as associative learning because of its claimed operating conditions	/	/	/	Yes	(Yes)
DR	(–) No evidence	Yes	No	No	/	No
PE	(–) Scarce (P1), and unreplicated (C1) double-dissociative evidence (–) Indirect evaluative measures sensitive to high-order processes (e.g., goals, relational information, verbal instructions) (–) PD evidence found on direct evaluative measures	Yes	No	Yes	No	No

Note. C1 to C4 = operating conditions; P1 and P2 = operating principles; DR = dual representation; PE = preferential expression; SEM = systems of evaluation model; MCM = meta-cognitive model; APE = associative-propositional evaluations; IAM = implicit affect misattribution; PAL = propositional approach to attitude learning; (–) = fails to support or opposes; EC = evaluative conditioning; CS = attitude object; US = attitudinal response; yes = endorses; no = rejects; (yes)/(no) = may be assumed to endorse/to reject; / = agnostic; (+) = supports; PD = process dissociation; (≈) = mitigates interpretation; S–R = stimulus–response.

learning (e.g., Rydell & McConnell, 2006). Other models, however, sometimes refer to explicit versus implicit learning (e.g., Greenwald & Banaji, 1995; Wilson et al., 2000) or, consistent with a long attitude research tradition tracing back to Plato, they oppose affect-based to cognition-based learning (e.g., Edwards, 1990).

Many attitude researchers who contributed to the dual-learning debate did not advance a formal dual-learning model. To illustrate, Wilson et al. (2000) proposed an influential dual model of attitudes that posits the coexistence of dual attitudes in memory. This dual model, however, mainly consists of the idea that when an attitude changes, the newly formed attitude may coexist with the previous one. This is mostly a model of attitude representation and expression, not a dual-learning model. As a matter of fact, Wilson and colleagues remain very vague and cautious about the existence of dual-learning processes; they basically note in the general discussion that

> . . . it might be possible for explicit and implicit attitude to develop simultaneously. Perhaps people learn cultural feeling rules at an explicit level (Hischild, 1979) while simultaneously learning a different implicit attitude from their direct experiences with the attitude object). (Wilson et al., 2000, p. 120)

We consider here four attitude models that more clearly endorse an associative attitude learning process, and we discuss them with regard to their *learning* dimension only. These models are the systems of evaluation model (SEM), the meta-cognitive model (MCM), the APE model, and the implicit affect misattribution (IAM) model. We additionally discuss the propositional approach to attitude learning (PAL), which does not endorse associative learning. Table 1 provides a summary of how these models relate to the operating conditions and principles reviewed here, as well as to two additional dimensions relevant to associative attitude learning: whether the models assume that associative attitude learning creates a distinct evaluative representation in long-term memory (dual representation [DR]) and is preferentially expressed on indirect evaluative measures (PE). Table 1 also provides a summary of the various observations reached in the present review, pointing to evidence supportive to associative attitude learning (+), unsupportive or opposed to it (–), and to a few points that mitigate the interpretation of the evidence collected (≈).

SEM. The SEM (e.g., McConnell & Rydell, 2014; Rydell & McConnell, 2006) is the most radically dual of the dual-learning models. This model proposes that two different learning systems (rule based and associative) are responsible for the formation of dual attitudes (explicit and implicit, respectively; dual representation, or DR) that are simultaneously stored in memory, and are preferentially captured by different evaluative measures (explicit and implicit, respectively; preferential expression, or PE):

> Specifically, we propose that explicit attitudes form and change through the use of fast-learning, rule-based reasoning, whereas implicit attitudes form and change through the use of slow-learning, associative reasoning. (Rydell & McConnell, 2006, p. 995)

> . . . people can hold different implicit and explicit attitudes about the same attitude object at the exact same time, according to how the information they encounter is processed. (Rydell et al., 2006, p. 957)

The SEM acknowledges that "associative" information (understood here as "subliminal" or "associative cues") can affect direct evaluative measures in the absence of propositional information, and it allows propositional information to influence indirect measures in the absence of "associative" information. Yet, this model supports a preferential influence of associatively learned attitudes on indirect measures. This is consistent with predictions drawn in the studies by Rydell et al. (2008, 2006) discussed in the C1 section, where the authors expected subliminal information to influence—through associative attitude learning—indirect evaluations about Bob, but verbal information (of opposite valence) to (oppositely) influence—this time, through propositional attitude learning—the evaluative ratings about Bob:

> . . . the current work experimentally demonstrates that implicit and explicit attitudes are simultaneously formed and changed by different processes that rely on different information. (Rydell et al., 1996, p. 957)

Finally, the SEM subscribes to P1 as the associative system is thought to be impervious to verbal and syllogistic reasoning:

> codes used by the associative system are not verbalizable, not easily used for attributions, not easily converted into propositions, and not easily used for syllogistic reasoning. (McConnell & Rydell, 2014, p. 214)

In our view, virtually all the core SEM assumptions may be questioned. As this will be addressed after the current discussion of attitude models, it is unclear whether indirect versus direct measures preferably reflect the operation of different learning systems. In addition, the existence of a strong subliminal EC, as claimed by this model (C1; see Rydell et al., 2006, 2008) is largely unsubstantiated. Furthermore, the SEM distinguishes between an effortful rule-based system and an efficient associative system (C2), and we saw that efficient EC has received little support so far:

> The rule-based system, however, fits with a conceptualization of explicit attitudes as evaluations based on conscious deliberation or syllogistic reasoning, which can reveal quick changes in expression (Fazio, 1995) but require cognitive resources in their formation and change (Petty & Wegener, 1998). (McConnell, Rydell, Strain, & Mackie, 2008, p. 793)

The same limitation applies to the SEM's endorsement of a goal-independent (C3) associative learning system:

> Implicit measures of attitudes that capture the associative system of evaluation, on the other hand, change more slowly and are unaffected by explicit processing goals . . ., and are strongly influenced . . . by cues that are subliminal in nature. (McConnell & Rydell, 2014, pp. 208-209)

Regarding control, it is not clear how it may be achieved at learning for subliminal stimuli, and so the SEM appears to endorse C4 too.

Research conducted around the SEM has delivered important insights in attitude research. One of these concerns implicit ambivalence (i.e., attitudes of opposite valences for a same object on direct and indirect measures), which the authors argue is not easily accounted for by the MODE model (i.e., Motivation and Opportunity as DEterminants of attitude-behavior relationship; Fazio, 1990) and the APE model (see McConnell & Rydell, 2014, for a discussion). The SEM is also useful in understanding how attitude change (not acquisition) relates to direct and indirect evaluative measures. Yet, this model, because of its radical stance on associative and propositional learning processes, may be the most problematic dual-learning model to date.

MCM. The MCM (e.g., Petty & Brinol, 2006; Petty, Briñol, & DeMarree, 2007) is first and foremost an attitude structure model, which is interested in dissociations occurring at the expression stage, and in attitude strength and ambivalence questions. This model, however, endorses associative attitude learning:

> . . . the evaluative associations in the MCM are general stored evaluations that can be based on either affect or cognition and can stem from either associative or propositional processes. (Petty & Brinol, 2006, p. 742)

> . . . both positive and negative evaluations can stem from associative or from propositional processes. (Petty et al., 2007, p. 663)

Unlike the SEM, the MCM posits that evaluations stemming from these two learning processes are stored in a unitary representation (i.e., a unique attitude object holding associations with evaluative nodes and validity tags). This unitary view leads to a rejection of dissociative effects on direct and indirect evaluative measures:

> Furthermore, in the MCM, as long as the associative or propositional process leads to an evaluative association, the

> structural consequences are the same. Thus, instead of focusing on whether an evaluative association stems from associative or propositional processes (or affective versus cognitive processes), what matters more in the MCM is the strength of the evaluative association(s) and whether the association(s) are endorsed. (Petty & Brinol, 2006, p. 742)

The MCM does not make unconscious learning claims but seems to allow for influential evaluative associations that cannot be consciously accessed anymore; this assumption represents the basis for a central concept in this model: implicit ambivalence. The MCM also seems to endorse the efficiency claim (C2) as it views associative and propositional processes as "simple" and "reflective," respectively (Petty et al., 2007, p. 663). As to relational information (P1) and controllability (C4), the MCM also leans on an associative view:

> Finally, the MCM concurs with research on cognitive negation that suggests that untagged evaluations are presumed to be true unless evidence against them is or has been generated (e.g., see Gilbert, 1991). Furthermore, research on negation suggests that successful negation is quite difficult (e.g., Deutsch, Gawronski, & Strack, 2006). (Petty et al., 2007, pp. 664-665)

In sum, the MCM proposes that learning processes that differ in levels of elaboration give rise to a single representation in long-term memory. This model makes no claim regarding the possibility of unconscious attitude learning, but it endorses the view of influential attitude representations that cannot be consciously accessed anymore.

APE. The APE model is interested in both learning and expression processes. It predicts dissociations on direct and indirect measures when associative versus propositional processes imply different evaluative outcomes. That the APE model holds a dual-learning view is apparent in recent presentations of the APE model:

> Before an evaluative representation can be activated, it has to be formed on the basis of some kind of learning experience. In the APE model, we distinguish between two conceptually distinct processes of forming evaluative representations depending on whether they are based on associative or propositional principles. (Gawronski & Bodenhausen, 2014, p. 191)

Regarding the operating conditions and principles reviewed here, the APE model acknowledges the existence of unconscious EC effects (C1). Subliminal EC effects are abundantly discussed in APE publications in "implicit attitude change" or "change in associative structure" sections (e.g., Gawronski & Bodenhausen, 2006, pp. 697-698; Gawronski & Bodenhausen, 2011, p. 96). The APE also endorses the control (C4) and relational-qualification claims (P1), and it also endorses the efficiency claim (C2) as it "agrees with the contention that associative processes are highly efficient" (Gawronski & Bodenhausen, 2011, p. 76).

That the APE endorses the four operative conditions of associative learning reviewed here is clearly apparent in Gawronski and Bodenhausen (2014), although it is worth noting that the authors specify the scope and meaning of automaticity (see also Table 13.1 reported on p. 193 in Gawronski and Bodenhausen, 2014):

> **Formation.** Associative learning is commonly assumed to be independent of people's awareness of the relevant contiguities that are responsible for the formation of new associative links. The APE model generally agrees with this contention. (p. 194)

> **Formation.** Associative learning can be described as unintentional in the sense that the learning process itself does not require the goal to form a new association. (p. 196)

> **Formation.** According to the APE model, the formation of mental links through associative learning is resource-independent, although attentional distraction may sometimes disrupt associative learning if it undermines the encoding of the relevant contiguities (e.g., Pleyers et al., 2009). (p. 197)

> **Formation.** In the APE model, we assume that associative learning is uncontrollable in the sense that observed contiguities can create mental links despite the goal of not forming an association between the relevant stimuli (e.g., Gawronski et al., 2012). (p. 198)

In sum, the APE model largely subscribes to the operating principles and conditions of associative attitude learning reviewed here. However, it proposes a more nuanced and dynamic view of associative processes than the SEM does. In particular, the APE model posits a single representation in memory and theorizes in more detail the interdependence of associative and propositional processes:

> Although associative and propositional learning represent distinct mechanisms of forming evaluative representations, their outcomes are assumed to interact in a manner that is similar to the mutual interactions in the expression of evaluative representations. (Gawronski & Bodenhausen, 2014, p. 192)

The latter quote, pointing to interactive effects at two processing stages (i.e., formation of memory traces and evaluative expression), makes it clear that the APE does not unilaterally map indirect and direct evaluations with associative and propositional learning. In general, the APE model assumes that indirect evaluations are the proximal outcome of associative processes (PE). However, it acknowledges that propositional processes can have distal effects on indirect measures via their impact on associative processes. Likewise, the model assumes that direct evaluations are the proximal outcome of propositional processes, but it allows associative processes to have distal effects on direct measures via their impact on propositional processes (for a discussion, see, for example, Gawronski & Bodenhausen, 2006, 2011). Therefore, one way to disentangle associative and propositional learning according to this model is to investigate cases in which a given factor directly influences one process in a manner that conflicts with a potential indirect effect of the other process. In this case, the distal effect should be neutralized, leading to a dissociation between indirect and direct measures. As already discussed, however, current evidence generally fails to support this rationale and, when obtained, such evidence can be accounted for by postlearning accounts.

IAM in S–R learning. In a nutshell, the IAM (Jones et al., 2009) proposes that people may be confused about the source of their affect and may eventually misattribute it to the CS instead of the US it is paired with. The IAM points to several factors that facilitate this process: incidental learning conditions, low US salience, moderate US intensity, and simultaneous CS and US presentations. It also seems important that the two stimuli are visually related to each other (i.e., that participants move their gaze back and forth between the stimuli; this is supported by both eye tracking and experimental manipulations) and not too spatially distant from each other. EC procedures departing from these conditions increase the likelihood that participants figure out that their affective reaction is due to the US, thereby disrupting the implicit misattribution process and the associatively driven attitude acquisition it supposedly entails.

According to the IAM, the CS may acquire the US' valence without connecting CS–US pairs in explicit memory. This qualifies as S–R learning (as opposed to S–S learning). Hence, this account endorses P2 and C1. As just discussed, however, the IAM research implies that CS and US are perceptually connected (i.e., participants shift their gaze between CS and US); it is, therefore, unlikely that this account allows for subliminal EC or EC with visually suppressed stimuli.

As to efficiency (C2), this account leans on the efficiency side as EC effects are expected to be found in low top-down attention paradigms. Finally, our understanding is that this account assumes a lack of control (C4) and a lack of sensitivity to relational information (P1). Indeed, it is unclear in this model how control may operate on implicit processes and how implicit S–R links may be sensitive to relational or truth information at encoding.

Because it clearly rejects a correspondence between attitude learning mode and attitude measurement mode, this model, along with the MCM, may stand the empirical test best. As a further asset, IAM research has specified a precise set of conditions under which implicit EC is more likely to be observed (Jones et al., 2009, 2010). The IAM account, however, is much narrower in scope than the SEM, MCM, and APE models. In light of the evidence reviewed here, it may be a more valid model of associative attitude learning. Yet, it is less comprehensive when it comes to understanding dissociations occurring at the attitude expression (i.e., measurement) stage. Hence, it is important to keep in mind that the question here is not which of these models is most reliable or useful, but which has been best supported with regard to the operating conditions and principles reviewed here. Several of these models, and in particular the MCM and the APE, would remain useful attitude structure and expression models, even if they were to reject or qualify some of their current endorsement of learning principles and conditions.

Finally, it is important to keep in mind that the IAM does not represent the only account for S–R learning, although it is in our view the best theorized one in terms of underlying mechanism. Sweldens et al. (2010) have independently specified a set of conditions conducive to S–R learning. They regularly refer to IAM as an underlying mechanism but allow for other mechanisms in S–R learning (Sweldens, 2018). This is consistent with the lack of evidence for the role of implicit misattribution in S–R paradigms used by these authors. Specifically, Mierop et al. (2018) found evidence for EC effects in the absence of S–S memory. However, contrary to IAM theorization, this effect was unqualified by the evocativeness of the US (i.e., it did not depend on whether the US was highly or mildly valenced).

The propositional approach to attitude learning (PAL). Besides attitude models that endorse associative attitude learning, it may be informative to discuss one that does not. Specifically, the propositional account (e.g., De Houwer, 2009; Mitchell et al., 2009) posits that attitudes are nonautomatically learned. It assumes that attitude acquisition is a result of the same memory and reasoning processes that are involved in other everyday cognitions and behaviors. Learning instances are perceived and stored in memory, and retrieval of the contents of memory serves as the basis for reasoning processes that produce conscious, declarative, propositional knowledge about the relations between events. These propositions are qualified mental links that take into account the type of relations between events (stimuli or responses) as well as their truth value.

The propositional model endorses neither of the automaticity conditions (C1-C4). It does not entirely reject a role for automatic processes, but it restricts them to the memory and perception processes involved in learning; for instance, a consciously formed proposition may be automatically retrieved from memory, and the spontaneous retrieval of stored representations may affect performance on indirect measures such as an affective priming task (and may also trigger emotional and physiological responses).

As it postulates propositional, that is, qualified relational representations (instead of simple and unqualified associations), the PAL does not endorse P1 or dual representations. It might be argued that, by its suggestion that an instance-based memory model serves as the input to a propositional reasoning part, the propositional model as put forward by Mitchell et al. (2009) allows for dual representations—of the instances (that may be interpreted as reflecting mere associations of inputs), plus the (perhaps qualified) propositions that may be formed as an output of reasoning about their relation.

However, instances (i.e., unqualified information about co-occurrence) may also be represented as propositions (e.g., "the CS appeared together with the US").

The PAL does not endorse either preferential expression, as it allows for the influence of propositions on indirect measures (e.g., by automatic retrieval of a consciously formed proposition). At first sight, single-process attitude formation models may have difficulties explaining why implicit evaluations are affected by relational information (e.g., Zanon et al., 2012). Specifically, because relational information contained in the evaluative representation is less likely to be integrated in the evaluative judgment under speeded responses conditions, one may expect CS–US pairings to lead to the same implicit evaluations, regardless of how the CS and US are said to be related. However, single-process attitude formation models may assume that attitude formation is driven not by the actual CS–US pairings but by the mental encoding of those pairings (e.g., Melchers, Lachnit, & Shanks, 2004). For instance, if participants see a CS that co-occurs with the US word UNFRIENDLY while being told the CS is opposite to the US, participants might mentally recode the US as FRIENDLY, thus resulting in a pairing of the CS and the concept "friendly."

Finally, we see no reason why *PAL* would not endorse P2. This is because people may propositionally relate a stimulus to the affective response triggered by another stimulus, as we believe may have been the case in the study by Gast and Rothermund (2011a, Experiment 3) that we discussed in the P2 section.

The propositional account is perhaps best supported by the evidence, as summarized in Table 1. It is challenged by the finding of uncontrolled EC, as well as by the many reports of EC effects acquired under incidental conditions and in the absence of memory for CS–US episodes. However, these findings may be accounted for by the involvement of memory processes involved in learning; and, unless clear double dissociations are found in future research, such evidence can probably be accommodated within a propositional single-process model of attitude acquisition.

Relations Within and Between Conditions and Principles

It should now be clear that the various conditions and principles reviewed here overlap to some degree. A major interdependence concerns C1 and C2: A heavy reduction of participants' resources at encoding largely depletes, often to nonsignificance, CS–US contingency memory. This is consistent with current theorizing in consciousness research, which holds that conscious processing depends on bottom-up stimulus strength and top-down attention amplification (for an overview, see Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006). If both stimulus strength and top-down attention are low, a stimulus cannot be processed consciously. If, however, the contribution of only one of the two factors (stimulus strength or attention) remains below a certain level, a stimulus remains in one of two qualitatively distinct subconscious states. A stimulus remains *subliminal* if top-down attention amplification is high but stimulus strength is very low (e.g., because the stimulus is presented briefly and masked); despite being amplified by attention, the weak stimulus fails to enter consciousness (this state is thought to be associated with substantial neural activity in perceptual areas that is however not accessible to higher order cognition). If, instead, stimulus strength is high but top-down attention is low, the stimulus remains *preconscious*; despite being clearly visible, the stimulus is not consciously processed because it is unattended (in this state, the stimulus is well represented in sensory areas and can become the object of higher order cognition as soon as it is attended). This state of accessibility outside the focus of attention is sometimes referred to (not as lack of consciousness but instead) as a specific—phenomenological—form of consciousness (Block, 1995). The present review found more support for EC effects under conditions of high stimulus strength and low attention (i.e., incidental paradigms) than for EC effects under conditions of low stimulus strength and high attention (i.e., subliminal EC).

We also saw that C2 (efficiency), in the way it has been operationalized, possibly overlapped with C3 (goal independence). That is, completing a two-back task on numeric values may have distracted participants from the evaluative processing of the stimuli. An examination of efficiency that is independent of goal activation would be welcome.[4]

C3 (goal independence) is also involved in C4 (control), as control may be considered a processing goal in and by itself. And, C4 (control) is certainly involved in P1a and P1b as insensitivity to relations and truth is conceptually close to a lack of control over learning.

Finally, P2, especially as embodied by the implicit misattribution process, is inherently related to nearly all other conditions and principles. It certainly relates to C1 as the implicit misattribution process is thought to occur implicitly and is not concerned with CS–US linkage. The implicit affective misattribution process may furthermore be assumed to be efficient (C2), as implied by the incidental nature of the paradigm. And, it is hardly controllable as it is unconscious, which by the way points to the overlap between C1 (awareness) and C4 (control). Whether P2 implies C3 (goal independence) may deserve further attention.

The latter analysis confirms that, although features of automaticity should not be lumped together, they are unlikely to be conceptually uncorrelated (Moors, 2016; Moors & De Houwer, 2006). It also suggests that processing conditions and principles may be more interdependent (not conceptually, but empirically) than attitude research may presume.

Do Indirect Evaluative Measures Preferably Reflect Associative Learning?

A lingering message emerging from this review is that one should not equate evaluative measure modalities (i.e., direct vs. indirect attitude measures) with evaluative learning processes (i.e., propositional vs. associative). The idea that the evaluative outcomes of distinct (propositional vs. associative) learning systems are expressed through different (direct vs. indirect) measures hardly withstands empirical evidence. As we have seen (e.g., with PD studies, but also when discussing P2), direct measures have been used to provide evidence for the operation of an associative learning process. Conversely, indirect measures have been found to reflect nonautomatic learning (see C2 and C3 sections) and relational information (see P1 section). Moreover, recent research has found indirect measures to be sensitive to social judgeability concerns (Loersch, McCaslin, & Petty, 2011) to instruction-based learning (e.g., Gast & De Houwer, 2012; Van Dessel et al., 2015), and to be amenable to conscious introspection (Hahn, Judd, Hirsh, & Blair, 2014).

If indirect evaluative measures reflect neither a distinct learning mechanism nor distinct attitudinal representations, then the question arises how to interpret differential effects found on indirect versus direct measures. One obvious answer to this is that, because indirect measures usually involve speeded responses, they involve different retrieval and expression processes. Different categories of measures, best capturing the operation of a controlled "reflective" versus a more automatic "impulsive" system, may predict different behavioral outcomes, or the same behavior but in different contexts or for different individuals (e.g., Friese, Hofmann, & Schmitt, 2009; Friese, Hofmann, & Wänke, 2008; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008). Hence, the idea of dissociations on evaluative measures should not be rejected as a whole. Rather, we reject one that would suggest distinct learning systems preferably expressing their distinct evaluative outcomes via distinct categories of evaluative tasks. One may readily accept the view that evaluative methods show dissociations in predicting behavior, while rejecting the view that the attitudes they measure originate from different learning processes, or are based on different representations. Various factors contribute to attitude measurement outcomes, and these factors may largely differ between direct and indirect measures (e.g., on controllability) independent of how attitudes are acquired in the first place.

In this sense, indirect evaluative measures do remain interesting when their predictive value operates over and above that of direct evaluative measures. The IAT, for instance, may help to predict future voting behavior among undecided voters (Arcuri, Castelli, Galdi, Zogmaister, & Amadori, 2008), and seems to better predict future suicide attempts in patients admitted in psychiatric emergency units than psychiatrists do on the basis of a clinical interview (Nock et al., 2010). In a recent study, a field-identification IAT measure was shown to better predict academic perseverance in undergraduate students than did a Theory of Planned Behavior Questionnaire (Roland, Mierop, Frenay, & Corneille, 2018). More generally, we believe that dual models of attitudes, such as Petty and Cacioppo's (1986) elaboration likelihood model, Chaiken's (1987) heuristic-systematic model, Fazio (1990)'s MODE model and Strack and Deutsch's (2004) Reflective-Impulsive Model (i.e., RIM) have delivered very useful insights on how evaluations relate to behaviors. Again, however, these insights do not require assuming that indirect and direct attitude measures differentially relate, either purely or preferably, to distinct evaluative acquisition pathways.

Implications for Dual-Learning Models of Attitudes

This review stresses that most operating conditions and principles that have been typically evoked to support the existence of an associative attitude learning process have failed to receive compelling empirical support so far. And, when they did receive such support, the latter was found to be limited to specific procedural conditions, and was regularly amenable to alternative accounts in terms of postlearning processes (e.g., retrieval, or control at expression). Because models and theories are essentially aimed at accounting for evidence (and then also at anticipating new findings), we hope the present review encourages dual attitude theorists to more closely adapt their models to the full scope of extant evidence, and to also more clearly state which evidence they consider critical to their theorization.

As just discussed, attitude models vary in their endorsement of principles and conditions. Of critical importance here is the need for a general clarification in current theories of which principles and conditions they deem critical to their own conceptualization of associative learning, and why. An attitude model may, for instance, consider that some features of automaticity are critical when other features are not. Or, it may clearly reject automaticity but endorse principles. Or, it may actually even endorse all conditions without necessarily considering them critical for a formal test of the model. Without clearly stating this, however, it is not clear how the model can be tested. Consider this characterization of the APE as an illustration:

> Importantly, there is no one-to-one mapping between operating principles and operating conditions, such that associative processes would operate automatically, whereas propositional processes operate in a controlled fashion (Gawronski & Bodenhausen, 2007a, 2009). Instead, both associative and propositional processes have automatic and controlled aspects. (Gawronski & Bodenhausen, 2011, p. 73).

This unmapping statement makes it clear that operating conditions are not diagnostic to associative learning. Yet, the

APE model, which is arguably the most prominent dual model of attitudes to date, clearly endorses an automatic associative learning view (e.g., Gawronski & Bodenhausen, 2014). Such confusion may be avoided by clearly stating that principles are critical to associative and propositional learning, whereas conditions are not.

Another source of confusion here is that, in current theorizations, "associative" and "propositional" or "rule-based" processes tend to cover different stages of the information processing, ranging from learning to actual behaviors. This is problematic because conditions and principles may differentially apply to different stages of the process. In that sense, recent efforts aimed at further clarifying how associative processes apply to attitude learning, representation, and expression are very useful (e.g., Gawronski & Bodenhausen, 2014; Gawronski et al., 2017). In our view, the APE model fares better in its expressive than its learning dimension.

A third source of confusion relates to the fact that, as dual-learning models integrated new evidence, they tended to become more nuanced, but often at the cost of becoming increasingly complex and, ultimately, perhaps also less testable. This is true, for instance, when considering how propositional and associative learning are thought to interact:

> These systems, while potentially interacting, can operate independently and concurrently. (McConnell & Rydell, 2014, p. 212)

Sometimes, the evolution from clear and testable statements to complex and hardly testable ones is apparent within a single publication. Consider this, merely for the sake of illustration:

> The SEM posits that two dissociable systems of knowledge give rise to qualitatively different types of attitude object evaluations. (McConnell & Rydell, 2014, p. 204)

> The associative system is defined in large part as an interrelated group of processes that utilize specified types of codes. (McConnell & Rydell, 2014, p. 214)

> In many cases, processes that are part of the associative system often support the processes involved in the rule-based system . . . Many processes that are part of the rule-based system . . . are likely supplemented and directed in large part by processes that are part of the associative system. (McConnell & Rydell, 2014, p. 215)

Such dynamic, yet underspecified, characterization of the associative and rule-based systems is detrimental to model validation. It seems difficult to test the validity of such statements unless the nature of the processes, their operationalization, and their conditions of occurrence are more clearly specified. This is not to say that this model is unspecified. As we have seen, it states when "associative" and propositional information may end up influencing either direct or indirect measures. However, we believe that statements such as the last one reported above hardly allow for model validation. As a further concern, the dynamic view communicated in the second and third quotations seems rather inconsistent with that communicated in the first. Because the first statement is also much simpler than the other two, however, chance also is that it is the one that gets retained by the reader.

In our view, dual models in general—and the models reviewed here in particular—have delivered strong and insightful outcomes, several of which are definitely worth pursuing. However, just as pruning a tree allows light coming through and its strongest branches to develop, the present analysis suggests that future attitude research may benefit from focusing on the best empirically substantiated dimensions of associative learning, and (perhaps temporarily) set aside others. For instance, the evidence discussed here suggests that research on goals and on controllability is more likely to generate useful insights, whereas there is less compelling support for unaware or efficient attitude learning. Likewise, when and why implicit and explicit measures are or are not influenced by relational information represent stimulating questions for future research.

We also believe that it is important to keep in mind that a single-process learning approach to attitude acquisition may offer a parsimonious alternative to dual conceptualizations. Throughout this article, we repeatedly pointed to alternative accounts of effects based on such approach. Hopefully, the present review will prove helpful in clarifying the support associative attitude learning has received, and in revising dual-learning attitude models accordingly; that is, in a way that makes it possible to demonstrate the predictive advantage or parsimony of these models over single-process learning ones.

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Notes

1. One way to get away from the difficulty above is to define evaluative learning in terms of behavioral outcomes (i.e.,

what evaluative response is learned instead of how it is learned). Our understanding, however, is that not only attitude research but also social cognition research at large are not served best by such approach. This is because the focus of interest in these fields includes investigating underlying mental processes.

2. We use both terms interchangeably in this review, in both cases referring not to an awake and vigilant state but to the state of having conscious access to a certain piece of information (i.e., being aware or conscious of something).
3. Our attention was drawn to Rosocha and Balas's (2017) article upon revising this article. Because this article is published in Polish, we contacted the second author to confirm our correct translation of it (i.e., Robert Balas, personal email communication, January 31, 2018).
4. The current authors have tried to achieve this by manipulating cognitive load on a per-trial basis, but repeatedly failed to successfully achieve this. The difficulty lies in achieving perfect control over the level of resources participants are willing to devote to individual trials.

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