COGNITION AND EMOTION
2005, 19 (2), 161–174

Psychology Press
Taylor & Francis Group

Associative learning of likes and dislikes: Some current controversies and possible ways forward

Jan De Houwer
Ghent University, Belgium
Frank Baeyens
University of Leuven, Belgium
Andy P. Field
University of Sussex, UK

Evaluative conditioning (EC) is one of the terms that is used to refer to associatively induced changes in liking. Many controversies have arisen in the literature on EC. Do associatively induced changes in liking actually exist? Does EC depend on awareness of the fact that stimuli are associated? Is EC resistant to extinction? Does attention help or hinder EC? As an introduction to this special issue, we will discuss the extent to which the papers that are published in this issue help to resolve some of the controversies that surround EC. We also speculate about possible boundary conditions of EC and attempt to reconcile conflicting results on the functional properties of EC.

Preferences are assumed to play a crucial role in many phenomena that are studied in learning psychology (e.g., Martin & Levey, 1978), social psychology (e.g., Zajonc, 1980; also see Walther, Nagengast, & Trasseli, this issue), consumer science (e.g., Stuart, Shimp, & Engle, 1987), emotion research (e.g., Sherer, 1993), and clinical psychology (e.g., Hermans, 1998). Given the pervasive impact that preferences have on behaviour, it is important to know where these likes and dislikes come from. Although some preferences are genetically determined, most stem from learning that took place during the lifetime of the individual (e.g., Rozin, 1982). In this special issue, we focus on one such type of

Correspondence concerning this article should be addressed to Jan De Houwer, Department of Psychology, Ghent University, Henri Dunantlaan 2, B-9000 Ghent, Belgium;
e-mail: Jan.DeHouwer@UGent.be

We thank Paul Eelen and the Fund for Scientific Research (Flanders, Belgium) for making possible the special interest meeting on which this special issue was based. We also thank Eva Walther for her critical comments on an earlier draft of this paper.

http://www.tandf.co.uk/journals/pp/02699931.html DOI:10.1080/02699930441000265

learning: Associative learning of likes and dislikes, that is, changes in liking that are due to the pairing of stimuli.[1]

Various terms, such as evaluative conditioning, evaluative learning, and affective learning, have been used to refer to an observed change in the liking of a stimulus that results from pairing this stimulus with another, liked or disliked stimulus. Because the term ''evaluative conditioning'' (EC) is the only of these terms that refers to the fact that the induced changes in liking are due to the pairing of stimuli (rather than to other factors, such as the mere repeated presentation of a stimulus), we prefer to use this term. De Houwer, Thomas, and Baeyens (2001; see also Field, in press) recently reviewed the literature on EC. From this review, it became apparent that there are still many controversies about the conditions under which the pairing of stimuli will lead to changes in liking. In an attempt to stimulate the debate about these issues, we organised a special interest meeting on EC which was attended by most researchers who were at the time actively engaged in EC research. This meeting took place in May of 2002 and was sponsored by the Fund for Scientific Research (Flanders, Belgium) as part of the Scientific Research Network ''Acquisition, Representation, and Activation of Evaluative Judgements and Emotions''. Because many of the papers that were presented during the meeting indeed furthered our knowledge about EC, we decided to put together this special issue on the basis of these papers. As an introduction, we will describe some of the controversies that surrounded research on EC at the time we held the meeting and will discuss to which extent the papers in this special issue help to resolve these controversies. We conclude by discussing possible solutions for the remaining unresolved issues.

CURRENT CONTROVERSIES

Is EC a genuine phenomenon?

Shanks and Dickinson (1990) and Field and Davey (1997, 1998, 1999) convincingly argued and demonstrated that apparent EC effects can be due to an artefact that is related to the stimulus assignment procedure. In several early EC studies (e.g., Baeyens, Crombez, Van den Bergh, & Eelen, 1988), researchers assigned neutral stimuli (conditioned stimuli or CSs) to liked or disliked stimuli (unconditioned stimuli or USs) on the basis of perceptual similarity. If, for

[1] Note that when we talk about ''associative learning'', ''conditioning'', or ''associatively induced changes in behaviour'', we do not want to imply that observed changes in behaviour are due to the formation of associative links between representations. We only want to indicate that the changes in behaviour are due to fact that stimuli have been paired (i.e., presented together) in a certain manner. That is, we use ''associative learning'' to refer to an effect (i.e., a change in behaviour that is due to pairing stimuli) rather than to a theory (i.e., the formation of associations between representations).

instance, a neutral stimulus was perceptually most similar to a liked picture, it was repeatedly presented together with this liked picture during the learning phase. If it was most similar to a disliked picture, it would be paired with that disliked picture. Most often, neutral stimuli that were paired with liked stimuli were afterwards liked more than neutral stimuli that were paired with disliked stimuli. Field and Davey (1999), however, showed that a neutral stimulus that is most similar to a liked stimulus will be liked more during a second rating phase than a neutral stimulus that is most similar to a dislike picture even when the stimuli were not paired or when the stimuli were never presented during the learning phase!

Field and Davey (1997, 1998, 1999) therefore argued that to demonstrate that changes in liking are due to associative learning, EC studies should include between-subject control conditions in which stimuli are not paired. Given that few if any studies included such controls, they raised doubts about the very existence of EC as an associative learning phenomenon. Some have argued that there are many within-subjects studies in which the construction of stimulus pairs was counterbalanced across participants or randomised and that therefore do provide strong evidence for the associative nature of EC (e.g., Baeyens, De Houwer, Vansteenwegen, & Eelen, 1998; De Houwer, Baeyens, Vansteenwegen, & Eelen, 2000; De Houwer et al., 2001). Nevertheless, it is good to see that several of the EC experiments that are reported in this special issue did include a between-subjects control condition and still found strong evidence for EC (Díaz, Ruiz, & Baeyens, this issue; Field & Moore, this issue; Hammerl & Fulcher, this issue). This should eliminate all doubts about whether genuine EC effects do exist.

But as is noted by Field and Moore (this issue), EC is certainly not a robust research finding. Field and Davey (1999) and Rozin, Wrzesniewski, and Byrnes (1998) already reported several genuine failures to find EC, that is, failures that were probably not due to a lack of statistical power or to obvious flaws in the design. During our special interest meeting in Belgium, many more reports of unpublished failures to find EC emerged (e.g., Field, Lascelles, & Davey, 2003). Even researchers who were eventually successful in finding replicable EC (e.g., Olson & Fazio, 2001; Walther, 2002) spoke about their lengthy struggle to find the parameters under which EC reliably emerged. It thus appears to be the case that EC is subject to many as yet unidentified boundary conditions.

What are the functional properties of EC?

Given that preferences are such important determinants of behaviour, knowledge about the processes that underlie the formation of preferences can help us understand, control, and predict behavior. Researchers have therefore examined the impact of a number of variables on EC in the hope of gaining insight in the processes that underlie EC. Initial research suggested that, in comparison to

other forms of Pavlovian associative learning, EC appeared to have several unusual functional characteristics (see De Houwer et al., 2001, for a review; also see Lipp & Purkis, this issue). For instance, EC does not seem to depend on whether the participants are aware of which stimulus was paired with which other stimulus (i.e., contingency awareness) and is not reduced when the CSs are presented on their own after the learning phase (i.e., no extinction). However, because some of the studies on which these conclusions were based used a flawed (i.e., similarity-based) stimulus-assignment procedure (see above), there was still strong disagreement about whether EC indeed has unique functional properties and thus about the nature of the processes that underlie EC. Moreover, some studies indicated that EC at least sometimes does show the same functional properties as other forms of Pavlovian learning. This special issue includes several papers that provide new important information about the role of awareness, extinction, and attention in EC. We will thus focus on these three functional properties.

Awareness of the stimulus pairings. Just as there has been an intense debate about the role of awareness in learning in general (e.g., Seger, 1994; Shanks & St. John, 1994; Lovibond & Shanks, 2002), there has been a controversy about whether participants need to be aware of the fact that a stimulus was paired with a positive or negative stimulus to show an associatively induced change in the evaluation of the first stimulus (e.g., Baeyens, De Houwer, & Eelen, 1994; Baeyens, Eelen, & Van den Bergh, 1990; De Houwer, 2001; Field, 2000; Fulcher & Hammerl, 2001; Lovibond & Shanks, 2002). This debate was complicated by the fact that doubts were raised about whether EC is a genuine associative phenomenon: If EC is an artefact of stimulus-assignments rather than based on associative learning, it should come as no surprise that EC does not depend on awareness of the presented associations (e.g., Davey, 1994). The papers of Hammerl and Fulcher (this issue) and Field and Moore (this issue) provide an important additional step toward resolving this controversy. Not only do they provide new evidence for unaware EC, they also included between-subject control conditions that allowed them to conclude that the observed EC effects were based on associative learning.

Lipp and Purkis (this issue), on the other hand, describe one of their earlier studies (Purkis & Lipp, 2001) in which they found EC only in participants who could verbalise the crucial CS-US contingency and only after the moment at which these participants could do so. The results of this study strongly suggest that EC does depend on awareness of the stimulus pairings. Importantly, Purkis and Lipp measured awareness during the learning phase rather than only at the end of the experiment. Their awareness measure was thus probably more sensitive than those that are used in most other studies. This raises doubts about the conclusiveness of other studies in which EC did not appear to depend on contingency awareness. Note, however, that the procedure that is used by Lipp and

Purkis is rather atypical in EC research in that only very few stimuli are presented. We will return to this topic later on.

Is EC sensitive to extinction? Another intriguing finding in the EC literature is that EC appears to be resistant to extinction (e.g., Baeyens et al., 1988; De Houwer et al., 2000). That is, once a stimulus has acquired a valence as the result of being paired with a liked or disliked stimulus, this acquired valence cannot be changed by repeatedly presenting the stimulus on its own. Although there are other forms of learning that also appear to be resistant to extinction (see Field, in press, for a discussion), typically, conditioned responses do decrease rapidly when the CS is repeatedly presented on its own after the learning phase (e.g., Hamm & Vaitl, 1996). If EC is indeed resistant to extinction, this would have many implications (see Walther et al., this issue, for some of the implications for phenomena in social psychology). But because most of the evidence regarding the lack of extinction in EC came from studies that used a similarity-based stimulus-assignment procedure (see above), doubts were raised about this functional property of EC: If changes in liking are not based on associative learning, then it is not surprising that a removal of the association (i.e., presenting one stimulus on its own) has no effect on these changes (e.g., Davey, 1994; Field & Davey, 1997). The paper by Díaz et al. (this issue) tackles this potential problem by including between-subjects controls in extinction studies. Their results confirm that evaluative conditioning is indeed resistant to extinction.

Lipp and Purkis (this issue), however, describe the results of Lipp, Oughton, and LeLievre (2003) who did find extinction in EC if they asked participants to repeatedly rate the valence of the CS at the time it was presented on its own during the extinction phase. Interestingly, they did not find extinction when they looked only at the ratings that participants gave after the extinction phase. They explained this result as an example of renewal, that is, recovery of a conditioned response after removal of the extinction context. Previous failures to find extinction in EC might therefore have been due to the fact that evaluative ratings were only collected after the extinction phase. But as we will discuss later on, there might be other reasons for the discrepancy between the results that were obtained in the studies of Lipp and colleagues and the results that were obtained at other labs.

Does attention help or hamper EC? In contrast to the many reported experiments about the impact of contingency awareness and extinction on EC, very little research has looked at the role of attention in EC. Field and Moore (this issue) report two experiments that suggest that EC is reduced when participants engage in an attention demanding secondary task during the learning phase (i.e., counting backwards from 300). Although this finding is in line with many theories of associative learning in general, other results suggest

that secondary tasks do not always hamper EC. Field and Moore (this issue) themselves point out that Hammerl and Grabitz (2000) did find significant EC when participants solved arithmetical problems during the learning phase, but argue that the divergent results could be due to differences in the nature of the stimuli that were used. Walther (2002, Experiment 5; also see Walther et al., this issue), however, did use stimuli similar to those of Field and Moore and found that, if anything, the presence of a secondary task (remembering an 8 digit number throughout the learning phase) *strengthened* the EC effect. But the secondary task that Walther used was probably less demanding that the secondary task of Field and Moore. Further studies in which the nature of the secondary task is systematically manipulated could thus shed light on these apparently conflicting results.

POSSIBLE WAYS FORWARD

Although the papers that are reported in this special issue will undoubtably help to resolve some of the controversies surrounding EC, they also make clear that many questions remain unanswered. When reading the special issue, one might, for instance, be puzzled by the fact that Lipp and Purkis (this issue) conclude that EC does depend on contingency awareness and does show extinction whereas Hammerl and Fulcher (this issue) and Field and Moore (this issue) present strong evidence that EC does not depend on awareness and Díaz et al. (this issue) demonstrate that EC is resistant to extinction. Likewise, one might be confused by the fact we highlighted that EC effects are not easy to obtain (also see Field & Moore, this issue) whereas the papers in this special issue actually contain several new and well-controlled demonstrations of EC. In the following section, we will present some ideas that might help clarify these two inconsistencies and that could be helpful in guiding future research.

Possible boundary conditions for EC

In many ways, research on EC is still in its early stages. This is evidenced by the fact that little is known about the conditions under which EC effects will emerge and the fact that there are few if any detailed theories of the processes that underlie EC (see De Houwer et al., 2001). Unfortunately, the one weakness strengthens the other. Because it is not easy to find a paradigm that produces reliable EC effects (see Olson & Fazio, 2001, and Walther, 2002, for some promising exceptions), it is difficult to examine the functional properties of EC and thus the processes that underlie EC. Likewise, because there are no detailed theories of EC, it is difficult to make clear predictions about the conditions under which reliable EC effects will be found. Hence, researchers often use a trial-and-error strategy in their attempts to find EC. This also became apparent during the meeting that led to this special issue. There were no reports of studies in which possible boundary conditions were systematically investigated. But several

researchers commented on their failures to obtain EC and speculated about the procedural parameters that need to be in place in order to find EC. The parameter that was mentioned most often was the manner in which participants evaluate the stimuli. Various researchers mentioned that they found EC effects only when participants were strongly encouraged to evaluate the stimuli on the basis of their immediate, spontaneous feelings and were asked not to think too much about their evaluation. In relation to this, it was mentioned that one needs stimuli that participants feel they can evaluate in an intuitive, spontaneous manner.

These suggestions are in line with the idea that EC depends on automatic (i.e., unconscious, unintentional, and/or effortless) processes that produce intuitive, subjectively unjustifiable changes in liking. It is possible that these processes can be immunised by controlled (i.e., conscious, intentional, and/or effortful) processes. Alternatively, the output of the automatic processes might only reveal itself in behavior (e.g., evaluative ratings) when that behavior is not determined by other (controlled) processes. Similar suggestions about the importance of intuitive judgements for measuring automatic processes have been made in the context of implicit learning (e.g., Lewicki, Hill, & Czyzewska, 1997; but see Hendrickx, De Houwer, Baeyens, Eelen, & Van Avermaet, 1997) and automatic affective processing (e.g., Fazio, 1986; Koole, Dijksterhuis, & van Knippenberg, 2001). There is also some evidence that deliberative thought is capable of inhibiting automatic affective responding (see Koole et al., 2001, p. 673). It would thus be worthwhile to test whether EC effects are stronger and more reliable when participants rely on intuition. Note, however, that some researchers have failed to find EC even when participants were encouraged to rely on their intuition and when stimuli were used that should allow for an intuitive evaluation (e.g., Field et al., 2003). It is therefore likely that these factors are not the only ones that determine whether EC will be found. There is thus a clear need for studies that investigate possible boundary conditions of EC in a systematic manner.

EC could be due to different processes

One of the most puzzling aspects of the literature on EC is that there are diametrically opposed results about the functional properties of EC. Whereas some researchers found that EC does not depend on contingency awareness and is not resistant to extinction (see De Houwer et al., 2001, for a review, and Field & Moore, this issue, Hammerl & Fulcher, this issue, and Díaz et al., this issue, for new evidence), Lipp and colleagues found strong evidence that EC does depend on awareness and is resistant to extinction (see Lipp & Purkis, this issue). In our opinion, these conflicting data suggest the EC effects that were observed in the studies of Lipp and colleagues were due to processes different from those that produced EC effects in other studies. If this is true, it should

come as no surprise that the EC effects of Lipp and colleagues show different functional properties that other EC effects. In this section, we will first give a conceptual analysis of the term ''conditioning'' that clarifies that EC and other forms of conditioning can indeed be based on a variety of processes. Next, we will present an hypothesis about the processes that might have operated in the studies of Lipp and colleagues.

For many psychologists, the term ''conditioning'' still has theoretical implications. When someone says that a certain change in behaviour is due to conditioning, most psychologists will infer that the associatively induced changes in behaviour were due to simple, unconscious, automatic processes (see Brewer, 1974). Research on human conditioning has clearly demonstrated, however, that associatively induced changes in behaviour (i.e., conditioning) can also be (and are perhaps even most often) due to or mediated by consciously controlled processes (see Dawson & Shell, 1987; De Houwer, Vandorpe, & Beckers, in press; Lovibond & Shanks, 2002, for reviews). Eelen (1980) pointed out that rather than abandoning the term ''conditioning'' on the basis of these findings, it should be used to refer to either a procedure or an effect of this procedure and should be stripped from its theoretical connotations. The term ''classical conditioning'', for instance, should refer to the fact that stimuli are paired in a certain manner (i.e., a procedure) or to the fact that the pairing of stimuli leads to a change in the reaction toward the stimuli (i.e., an effect that is due to the pairing of stimuli).[2] From this perspective, it becomes clear that conditioning effects can result from a variety of processes, automatic or otherwise. This clear separation between conditioning as a procedure, an effect, and a theory allows one to avoid situations in which the term ''conditioning'' constrains theorising about the possible processes that could be responsible for the observed conditioning effects. For instance, from this perspective, there is no paradox in saying that conditioning effects are due to conscious, controlled processes such as the deliberate generation and testing of hypotheses about CS-US relations (see De Houwer et al., in press, for a discussion).

We believe that research on EC could also benefit from Eelen's (1980) distinction between procedure, effect, and theory. As a procedure, evaluative conditioning is similar to a classical conditioning procedure in that stimuli are paired in a certain manner. The only unique procedural feature is that one measures changes in liking. As an effect, evaluative conditioning refers to an observed change in the liking of a stimulus that results from pairing that stimulus with another, liked or disliked stimulus. There is no logical reason why

[2] We want to emphasise that when a conditioning procedure results in changes in behaviour, one needs to be sure that these changes are due to the pairing of the stimuli before one can refer to these changes as a conditioning effect. That is, one always needs to control for nonassociative effects. This definition of conditioning as an effect is, however, neutral with regard to the nature of the processes that are responsible for the fact that the pairing of stimuli results in a change in behaviour.

evaluative conditioning as an effect could be due to simple automatic processes only, nor is there any reason to believe that only associatively induced changes in liking that are based on simple automatic processes should be regarded as ''true'' evaluative conditioning. This perspective is liberating in that it allows one to appreciate the possibility that some of the EC effects that have been reported in the literature could be due to conscious controlled processes rather than simple automatic processes.

These considerations led us to some speculative ideas about the processes that might have been involved in the studies of Lipp and colleagues (see Lipp & Purkis, this issue, for a review). In these studies, typically one CS was followed by an aversive US (CS+, where + stands for the presence of the US) whereas another CS was not followed by the aversive US (CS−, where − stands for the absence of the US). Moreover, the CSs were typically abstract geometrical forms that most participants probably found difficult to evaluate in an intuitive manner. Nevertheless, results consistently showed that the CS+ was afterwards liked less than the CS−. This finding corresponds to evaluative conditioning as an effect. However, EC might have been based on the formation of conscious propositional knowledge about the CS-US relation. Participants might have evaluated the CS+ as being more negative than the CS− not because of an intuitive, unjustifiable feeling, but because they had formed conscious knowledge about the fact that the CS+ and not the CS− always preceded the aversive US. That is, they had the conscious propositional knowledge that the CS+ was always followed by the aversive US, which they saw as sufficient justification for disliking the CS+. In other words, they had a justifiable preference: They justified their dislike for the CS+ by referring to the fact that it was a reliable signal for the aversive US. The assumption that preferences can be based on conscious propositional knowledge could seem implausible at first sight to psychologists who are most often focused on introspectively undefined or incorrectly defined sources of preferences. However, the fact that some (and perhaps even most) preferences are unjustifiable (i.e., not based on conscious propositional knowledge about contingencies or events that actually led to the preference) does not exclude the possibility that at least some preferences are justifiable (i.e., based on conscious propositional knowledge about the contingencies or events that actually form the basis of the preference).

The assumption that the EC effects that were observed in the studies of Lipp and colleagues were based on conscious propositional knowledge about the CS-US relations is compatible with the fact that those EC effects depended on contingency awareness and showed extinction. If EC is based on conscious knowledge of the CS-US relation, contingency awareness is of course required. In addition, during the extinction phase, participants can form the additional proposition that the CS+ is no longer followed by the US. Formulating this new proposition will reduce EC during extinction but EC can resurface when participants no longer consider this additional knowledge as relevant for

evaluating the CS (i.e., renewal). In fact, because human associative learning most often depends on conscious propositional knowledge (see De Houwer et al., in press, and Lovibond & Shanks, 2002, for reviews), one would expect that in those cases where EC is based on conscious propositional knowledge, it will show all the functional properties that are normally found in human associative learning.

It is also important to realise that justifiable preferences might not only be expressed in direct, explicit measures of valence, such as ratings, but also in implicit measures, such as the affective priming task (e.g., Fazio, Sanbonmatsu, Powell, & Kardess, 1986) and the Implicit Association Test (IAT; e.g., Greenwald, McGee, & Schwartz, 1998). Indeed, there is evidence to support this suggestion. For example, asking people to memorise the (positive or negative) meaning of so-called Turkish words is sufficient to observe affective priming (De Houwer, Hermans, & Eelen, 1998) and IAT effects (Mitchell, Anderson, & Lovibond, 2003) when the Turkish words are used as (prime) stimuli. Likewise, Gregg, Banaji, and Seibt (2004) found that nonsense labels will function as positive or negative concepts in an IAT after merely asking participants to suppose that one label is the name of a group of aggressive people whereas the other label is the name of a group of victims. These findings are reminiscent of earlier findings which showed that merely informing participants that a CS will be followed by a US is sufficient to induce autonomic conditioned responses toward the CS (see Dawson & Shell, 1987, for a review). Although further evidence is needed, it does at least seem plausible that justifiable preferences might indeed be detected also when using implicit measures of valence. Note that this in no way excludes the possibility that implicit measures most often reflect unjustifiable preferences.

If both direct evaluative ratings and implicit measures of valence can reflect either justifiable or unjustifiable preferences, how is one to determine whether a conditioned preference is justifiable? At present, the best option seems to just ask the participant to report the reasons behind his/her evaluation of a particular stimulus. If the participant confidently reports propositional knowledge about the actual CS-US contingency as the reason for his/her preference, one can conclude that the conditioned preference is justified. Note that participants need to be aware of the CS-US contingency before they can use the knowledge of the CS-US contingency as a justification for their preference. However, participants will not necessarily use their conscious knowledge of the contingencies to form an opinion of the CSs. It is thus useful to both examine whether participants are aware of the contingencies and whether participants attribute their preferences to this conscious knowledge. Such an approach will be particularly useful in studies in which contingency awareness is good (e.g., because only few CS-US pairs are presented).

Although we realise that there are problems associated with verbal reports (e.g., Nisbett & Wilson, 1977), one should realise that verbal reports can at least

sometimes provide valuable insights (see Smith & Miller, 1978, for an insightful critique of Nisbett & Wilson, 1977). Also note that researchers do already rely heavily on verbal reports when studying the role of contingency awareness in EC. We believe that research on EC could benefit greatly if participants were asked to justify their preferences. It would, for instance, be interesting to see whether participants in studies, such as those of Lipp and colleagues, will report that their evaluation of the CS+ is based on the CS-US contingency. It would also be interesting to examine whether the functional properties of EC are related to whether participants can justify their preferences in an accurate manner. As Meersmans et al. (this issue) point out, one could also manipulate instructions (e.g., about the nature of the CSs and USs) in such a way that they inhibit or promote the use of conscious knowledge of CS-US contingencies as a basis for ratings. Meersmans et al. also found the distinction between justified and unjustified beliefs helpful to interpret their finding that associative transfer of nonevaluative stimulus properties seems to depend on awareness of the contingencies.

Regardless of the merits of our ideas about the processes that were involved in the studies of Lipp and colleagues, it is important to realise that not all EC effects might be based on the same types of processes. Which processes are involved could depend on procedural parameters, such as the number and nature of the stimuli, the number of times that the CS-US pairs are presented, the intensity of the USs, and instructions. From this perspective, it is interesting to note that researchers use many different paradigms for studying EC. In fact, almost every researcher seems to have his or her own paradigm. Given this state of affairs, it is perhaps not surprising that findings from different labs do not always converge. In any case, an important challenge for future research is to clarify which type of processes can produce EC effects and to identify the procedural elements that determine the nature of the processes that are responsible for the observed effects.

CONCLUSION

Despite the many controversies that have plagued research on EC, it remains a fascinating research topic. Research on EC not only has the potential to lead to important new theoretical insights in the processes that underlie learning and memory, it also has immediate implications for our understanding of numerous phenomena in social psychology, consumer science, emotion theory, and clinical psychology (see Walther et al., this issue, for an inspiring discussion of the possible implications of existing EC research for many topics in social psychology, consumer science, and clinical psychology). Moreover, there is the exciting prospect of many intriguing questions that await an answer. We therefore hope that more researchers will join our battle to gain a better understanding of this important phenomenon.

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