For whom Pavlov's bell tolls:

Is there any evidence for associative processes underlying evaluative conditioning?

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1. Introduction

What is an attitude? As with all psychological concepts, the definition of attitudes varies with time and with the implicit theories of how attitudes are formed and changed. Allport (1954), for instance, defined attitudes as "individual mental processes which determine both the actual and potential responses of each person in the social world" (p. 19). Whereas Allport's definition is broad and open to various ways of forming and expressing attitudes, Fishbein and Ajzen (1975) defined attitudes as very specific in this respect, namely as "learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object" (Fishbein & Ajzen, 1975, p. 6). Similarly, Eagly and Chaiken perceived attitudes as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p.1).

In this paper, we will define attitudes (A) as conditioned probabilities that a certain object (O) elicits a specific valenced reaction (V), $A = P(V \mid O)$. This definition has the advantage that it is very broad with respect to the origin as well as to the expression of attitudes. However, the definition also has some implications. For instance, it can be assumed that the accessibility of A increases with P. Thus, the conditions should be addressed under which P is increased or decreased.

2. Attitude formation and change

2. 1 Attitude formation and change through evaluative conditioning

Beyond the question of how attitudes can be properly defined (e.g., Gawronski, 2007), two major topics have been of primary interest in attitude research: (a) the question of how attitudes are formed, and (b) the question of how attitudes can be changed. Traditionally, the question of attitude formation has been addressed by accounts that emphasize the significance of affective processes, whereas research on attitude change has tended to focus on cognitive processes (Eagly & Chaiken, 1993). Research on attitude formation has recently paid special attention to the occurrence of so-called evaluative conditioning (EC) effects (for reviews, see De Houwer, Thomas, & Baeyens, 2001; Walther, Nagengast, & Trasselli, 2005). EC effects refer to changes in liking that are due to the pairing of stimuli (De Houwer, 2007). In a prototypical EC study, a subjectively neutral picture (conditioned stimulus; CS) is repeatedly presented with a subjectively liked or disliked picture (unconditioned stimulus; US). The common result is a shift in the valence of the formerly neutral CS, such that it acquires the evaluative quality of the US. In other words and with respect to our definition, *P* is increased through the repeated pairing of CS and US. This is presumably different from signal or Pavlovian learning, in which the CS acquires a *predictive value*. In an EC paradigm the CS merely attains the *affective quality* of the US, which is usually explained by the formation of an association between the cognitive representation of the CS and the US (De Houwer et al., 2001). As such, subsequent activation of the CS in memory may associatively spread to the US, which in turn activates the evaluation of the US. The result is an evaluative response to the CS that directly corresponds to the one toward the US.

2.2 Examples of EC in Social Psychology

EC is a simple account to alternatively explain many phenomena in social psychology. For instance, EC is involved in illusory correlations in which observers acquire an association between a group of individuals and a certain positive or negative evaluation (Chapman & Chapman, 1967; Fiedler, Russer, & Gramm, 1993; Hamilton, & Gifford, 1976). Even more obvious is the influence of EC in the famous “kill-the-messenger effect.” The “kill-the-messenger effect” describes the phenomenon whereby transmitters are inevitably associated with the valence of the message they have to convey (Manis, Cornell, Moore, & Jeffrey, 1974). Whereas in persuasion a neutral message (CS) usually experiences a revaluation through its co-occurrence with an evaluated communicator (US), the opposite mechanism occurs in the kill-the-messenger effect: the messenger (CS) experiences a revaluation by being associated with bad news (US).

Similar effects were obtained in a series of studies by Skowronski, Carlston, Mae, and Crawford (1998), who demonstrated that communicators become involuntarily associated with their verbal description (i.e., traits) of others. Although descriptions of other people are (psycho)logically independent of the communicator, simple associative processes nevertheless link these two events together and produce such boomerang-like phenomena. Recently, Gawronski and Walther (2008) found that these transference effects are not confined to traits, but that the overall evaluation affects the attitude toward the person who endorsed the evaluation. Gawronski and Walther (2008) called this the TAR effect (*Transfer of Attitudes Recursively*), which refers to the recursive influence of an observed evaluation on the formation of a corresponding attitude toward the source of that evaluation.

EC also plays a crucial role when it comes to the evaluation of the self. There are several demonstrations that the (normally positive) evaluation of the self also influences the evaluation of other objects and events. The mere ownership effect (Feys, 1991, 1995), for instance, states that people have a preference for objects belonging to the self. Giving people an object (e.g., a pen) leads to a more favorable attitude towards this object compared to a not-owned object (Beggan, 1992). That people exhibit a preference for aspects associated with the self is also supported by the name letter effect, which describes the phenomenon that people like letters that are part of their own names better than other letters (Nuttin, 1985; see also Koole, Dijksterhuis, & van Knippenberg, 2001). In terms of EC, self-evaluation can be conceptualized as a US and other individuals or objects as CSs. Thus, people can use themselves to evaluate others. According to evaluative learning theory (cf. De Houwer et al., 2001), the mere spatio-temporal CS-US co-occurrence is a sufficient condition for the transfer of valence from the US to the CS (Martin & Levey, 1978). Given that self-evaluation is predominantly positive, associating an object or event with the self may therefore lead to a favorable attitude towards this object or event (Gawronski, Bodenhausen, and Becker, 2007; Walther & Trasselli, 2003). However, self-evaluation can serve not only as a source (US), but also as an object (CS) of attitude formation (Dijksterhuis, 2004).

Effects of EC in social psychology are probably most apparent in the area of persuasion, indicating that EC is not confined to attitude formation, but can also produce attitude change. It is well documented in persuasion research how simple evaluative features of the source, such as attractiveness (Petty & Cacioppo, 1984), credibility, or likeability of the communicator (Petty, Cacioppo, & Goldman, 1981), serve as potent persuasion cues when participants are distracted or low in motivation. In terms of EC, the persuasion message can be considered the CS, and the characteristics of the communicator the US. Similar to EC effects, the transfer of valence from the US to the CS can occur unconsciously, that is, the audience usually does not know why they suddenly like one message better than the other. It is also typical for EC-like phenomena that these communicator effects are not reduced, but, if anything, enhanced when people are distracted or not motivated to deeply process the information. Moreover, research on the US-revaluation effect demonstrates that peripheral persuasion cues, such as source attractiveness, may influence attitudes even when the original message is not available anymore. If an originally likeable source acquires a negative valence, this change in source valence can affect attitudes toward the object without any additional contact to the original message. Thus, contemporary models of persuasion should be expanded by considering the effects of the associative representation of evaluative information in memory.

3. How to explain EC? An unsolved issue

Notwithstanding the significance of EC in many areas of psychology, EC research from on the outset experienced vigorous debates concerning the explanation of the phenomenon. Up to now there is no doubt that EC exists. EC has been demonstrated within the picture-picture paradigm (Baeyens, Eelen, van den Bergh, & Crombez, 1989; Pleyers, Corneille, Luminet, Yzerbyt, 2007; Walther & Grigoriadis, 2004), with haptic stimuli (Hammerl & Grabitz, 2000) and even cross-modally (Todrank, Byrnes, Wrzesniewski, & Rozin, 1995).

However, it is widely debated whether EC is fundamentally different from signal learning or just a much simpler version of the same basic principle. Why is this question important for attitude research? If EC could be identified as a variety of signal learning, this would suggest that attitude formation and change are confined to cognitive processes as suggested by Fishbein and Ajzen (1975) and related models, because signal learning is generally considered a cognitive rule-based process (e.g., De Houwer & Beckers, 2002). Thus, showing that EC is different from signal learning provides a strong argument to doubt the general notion of merely cognitively based attitudes.

3.1 Differences and similarities between EC and signal learning

The procedural similarities between EC and signal learning (i.e., CSs acquire meaning through pairing with USs) suggest that they are both based on similar mechanisms. However, early EC researchers Martin and Levey (1978) inferred from their own findings that evaluative conditioning and signal learning were fundamentally different. This claim was supported by a number of observations that did not fit into the signal learning schema and that could not be explained by signal learning theory (e.g., Rescorla & Wagner, 1972). The first attribute that seems to be different in signal learning and EC is the dependency on contingency. As a logical consequence of defining signal learning as the formation of an expectancy that the US is going to occur when the CS is presented, the contingency (i.e., statistical correlation) between the CS and

US is a crucial determinant of signal learning. Predictions can only be formed when there is a negative or positive correlation between the CS and the US, but not when USs and CSs co-occur on a random basis. Present research, however, indicated that EC appears not to be dependent on the CS-US correlation, which suggests that predictability of the US is not a major ingredient in the EC learning process. This assumption is also supported by the lack of blocking effects in EC (Kamin, 1968). In an intriguing set of studies, Kamin (1968) demonstrated that the association between a CS1 and a US prevents the subsequent association of another CS2 and the same US, although both stimuli perfectly predicted the occurrence of the US. For example, if a person is repeatedly presented with a picture of an icy bridge followed by an accident in an insurance commercial, the individual will form an association between these events. However, if the observer then experiences the icy street along with fog, and both precede the accident, the person will exhibit no reactions towards the fog because the already acquired icy street-accident association appears to 'block' learning about the fog and the accident. The reason the observer does not learn about the fog is that she has already learned that the icy street predicts the car accident. Thus, the fog becomes redundant and no associations are formed. Blocking experiments were highly influential in animal conditioning, but also in human causal learning because they highlight the importance of the “informational value” of one cue (e.g., CS1) relative to another cue (e.g., CS2) in associative learning situations (Rescorla & Wagner, 1972). Although blocking was extensively investigated in classical conditioning as well as in human causal learning (e.g., Baker, Mercier, Vallee-Tourangeau, Frank, & Pan, 1993; Chapman & Robbins, 1990; Dickinson & Shanks, 1985; van Osselaer & Alba, 2000), to our knowledge there is no evidence for blocking in EC.

A further phenomenon that distinguishes signal learning from EC is the resistance to extinction. After an evaluative response is established in the CS, CS-alone presentations do not alter the valence of the stimulus, that is, EC is not impaired by extinction (Baeyens, Crombez, van den Bergh, & Eelen, 1988). In other words, EC is stable over time which means that the affective meaning of an individual or object, once acquired, is not impaired if the person is presented in different settings after conditioning. This is again because EC is not based on an expectancy that the US is going to occur if the CS is presented. In view of its resistance to extinction, EC is more plausibly explained with a transfer of valence such that the CS acquires some affective attributes of the US (De Houwer et al., 2001; Hammerl & Grabitz, 1996).

Beside these two differences, the most debated topic is the question of whether EC is dependent on contingency awareness. As already mentioned above, people in some EC experiments do not know why they started to like a particular CS. Thus, in contrast to signal learning, EC seems to be independent of contingency awareness. However, there are also studies in which only participants aware of the contingencies exhibited EC effects (Allen & Janiszewski, 1989; Fulcher & Cocks, 1997; Ghuman & Bar, 2006; Pleyers et al., 2007; Shimp, Stuart, & Engle, 1991). On the one hand, this contradictory finding may be the result of the fact that there is no standardized EC paradigm and EC studies differ with respect to nearly all learning parameters that are involved. For example, the typical picture-picture study uses rather mild USs (e.g., liked faces). However, some EC studies use highly arousing aversive or appetitive USs, which may increase the organism's need to predict these events in order to approach or avoid them. This evoked need for prediction in turn renders these particular EC studies more similar to the prototypical signal learning paradigm in which almost always strong aversive USs (e.g., electric shock, white noise) are applied.

On the other hand, there is no agreement on how awareness should be assessed (Baeyens, Hermans, & Eelen, 1993; Dawson & Reardon, 1973; Field, 2000, 2001; Field & Moore, 2005; Hammerl, 2000; Lovibond & Shanks, 2002). However, it is clear that the way contingency awareness is measured strongly determines whether an individual is categorized as aware or unaware (see Walther & Nagengast, 2006). The debate over whether likes and dislikes can actually be formed without contingency awareness is important, because a growing body of evidence suggests that conscious awareness of the contingencies between CS and US is a necessary precondition for signal learning to occur (Brewer, 1974; Dawson, 1973; Dawson & Schell, 1987). If EC can be demonstrated without awareness, this would encourage the view of EC as an effect qualitatively different from signal learning.

Beside these differences, there are also similarities between EC and signal learning that motivated the assumption in some researchers that both paradigms are based on the same learning mechanisms. These similarities are obvious in the word use and the constituents of the paradigms. In both paradigms, a former neutral CS gains meaning through the co-occurrence with an already meaningful stimulus, the US. Both paradigms are sensitive to sensory preconditioning, which means that the affective value of the CS is transferred to objects or events that are pre-associated with this stimulus due to prior learning (Barnet, Grahame, & Miller, 1991; Hammerl & Grabitz, 1996; Rizley & Rescorla, 1972; Walther, 2002). Furthermore, there is evidence in both paradigms for the US-revaluation effect (see also paragraph 4; Baeyens, Eelen, van den Bergh, & Crombez, 1992; Delamater & Lolordo, 1991; Hosoba, Iwanaga, & Seiwa, 2001; Walther, Gawronski, Blank, & Langer, in press) and second-order conditioning (Barnet et al., 1991; Rizley & Rescorla, 1972; Walther, 2002). Second-order conditioning means that the CS itself attains the power of a US through conditioning. In other words, the CS is first made affectively meaningful through signal learning before it is used as a US in a subsequent phase of the experiment. Evidence for the similarity between EC and signal learning comes also from the signal learning front: Whereas signal learning was traditionally confined mostly to aversive USs, there have been some recent examples of appetitive conditioning in the area of animal learning (Jennings & Kirkpatrick, 2006).

Taken together, there is mixed and controversial evidence for the assumption that EC is a learning mechanism different from signal learning. There are indeed some characteristics of EC that clearly separate EC from signal learning. The most important differences seem to be that EC is not dependent on contingency awareness and is resistant to extinction. On the other hand, phenomena like sensory preconditioning, the US-revaluation effect, and second-order conditioning that appear in EC, as well as in signal learning, cast doubt on the assumption that EC is indeed a learning mechanism distinct from signal learning.

4. Mechanisms underlying EC and signal learning

Although EC has been investigated for almost thirty years now, the processes underlying evaluative learning are still not sufficiently well understood (De Houwer et al., 2001). As already mentioned, it is not clear whether EC can be explained within the same theoretical framework as signal learning, or whether different theoretical assumptions are needed to explain EC. Given the above mentioned empirical differences between EC and signal learning with respect to awareness, extinction, and dependency on contingency, the conclusion suggests itself that two different learning principles may be at work in these paradigms. Within the “dissimilarity approach” group, however, there still many different ideas about which processes may underlie signal learning and EC.

4.1 Dissimilarity approaches

Martin and Levey (1994): Holistic vs. Associative

Early EC theorists Martin and Levy (1987) explained EC’s difference from associative learning as the result of a “holistic representation,” established during conditioning, which comprises elements of the CS as well as the evaluative nature of the US. This fusion process during conditioning is considered an automatic and very basic form of learning. The holistic account implies that perceptual characteristics of the CS are changed during the conditioning procedure in a way that they become more similar to the US. The holistic model accounts for many characteristic of evaluative conditioned attitudes, like the resistance to extinction: Since every presentation of the CS evokes elements of the US, the CS “brings about its own reinforcement” (Martin & Levey, 1994, p. 301). While the holistic account can also explain EC’s independence of the contingency between the CS and the US, it is hard to explain sensory preconditioning within this paradigm (Hammerl & Grabitz, 1996; Walther, 2002).

Field and Davey (1999): Conceptual vs. Associative

An account similar to the holistic account has been proposed by Davey (1994) and Field and Davey (1999), who suggested that EC represents an instance of conceptual categorization. The idea is that during the pairing of CS and US, the common features of the stimuli become more and more salient, which increases the perceived similarity between them. Field and Davey more specifically argued that EC does not reflect “real” associative learning, but is the result of an experimental artifact in which CSs and USs are paired with respect to their pre-experimental similarity. Although this critique was applicable to a particular sub-group of early EC experiments (Baeyens, Eelen, & Van den Bergh, 1990; Baeyens et al., 1989), it has been demonstrated in the meantime that EC effects occur even when CSs and USs are randomly paired, and there are also demonstrations of cross-modal EC (Todrank et al., 1995), which could not be explained by Field and Davey’s account.

Baeyens et al. (1992): Referential vs. Signal learning

In signal learning literature there is consensus that individuals acquire an if-then relationship between the US and the CS during conditioning. Thus, the CS signals the occurrence of the US after successful learning. This is why the correlation between the CS and the US is of critical importance. As several studies indicate, EC, however, is not restricted to a contingency between the CS and the US; rather, it depends on the mere co-occurrence (i.e., contiguity) of these stimuli. To illustrate, consider the conditioning of a neutral individual “Peter” with a liked person “George.” In EC, the acquired positive evaluation of Peter is not diminished when the observer meets Peter in a different context in which George is not present. Baeyens, Eelen, Crombez, and Van den Bergh (1992) hypothesized that this insensitivity of evaluative learning to violations of the contingency rule exists because evaluative conditioning may be a kind of “referential learning” in which the CS acquires the capacity to activate (un)consciously the US representation. They argue that signal learning as well EC present instances of associative learning, but that EC represents a simpler form in which the CS only activates the US without actually generating the expectancy that the US is going to occur in the presence of the CS. Accordingly, social observers would not, for instance, expect George (US) to appear in the presence of Peter (CS). However, this expectancy is exactly what is acquired in signal learning in which the CS elicits the expectancy that the US appears. The referential account can explain many phenomena in the EC literature. However, it should be noted that the referential account only refers to the simple transfer of valence and does not cover the conditioning of attributes different from valence. This is at odds with results from the area of odor conditioning, which have found that attributes like “sour” or “sweet” can be acquired during conditioning (Stevenson, Boakes, & Prescott, 1998). Moreover, the referential account is silent with respect to the exact mechanisms that underlie EC.

Gawronski and Bodenhausen (2006): Associative vs. Propositional Learning

Whereas all accounts reported so far are rooted in basic learning psychology, dual process accounts like Gawronski and Bodenhausen’s (2006) APE approach are much broader and try to explain a wide array of social psychological phenomena such as stereotyping, attitude formation, judgment, and decision making. Similar to other contemporary dual process models, the APE model postulates that two qualitatively distinct processes underlie the attitudinal judgment: associative and propositional processes. According to the authors, associative processes involve the activation of associative networks and are independent of the assignment of truth values. Gawronski and Bodenhausen (2006) consider EC a prototypical example of this kind of learning. According to the APE model, EC can be characterized as an automatic affective reaction that results from the activation and spreading of evaluations associated with the relevant stimulus (e.g., De Houwer et al., 2001; Walther et al., 2005). In contrast to associative processes, propositional processes are defined as validation processes that do depend on the assignment of truth values. Although it should be noted that the APE model is mainly applied to EC, it can be assumed that propositional reasoning is involved in signal learning in which contingency based rules are acquired. This dual-process perspective of conditioning is supported by the finding that EC sometimes decreases under awareness, whereas signal learning apparently benefits from conscious awareness (Dawson & Schell, 1987; Lovibond & Shanks, 2002). Further support for this view comes from Olson and Fazio (2001), who successfully used an implicit learning paradigm to produce evaluative conditioned attitudes. If conditioned attitudes can be acquired implicitly, this speaks to the notion that EC is different from signal learning in which learning occurs on an explicit level.

However, in both domains, EC as well as signal learning, there are studies that contradict this EC = associative = implicit vs. signal learning = propositional = explicit perspective. For instance, Schienle, Schäfer, Walter, Stark, and Vaitl (2005) found that disgust was conditioned in phobic individuals only when people were aware of the contingencies. Likewise, there is evidence in signal learning that conditioning occurs without awareness under certain conditions

(Öhman, Esteves, & Soares, 1995; Öhman & Soares, 1998; Schell, Dawson, & Marinkovic, 1991).

4.2 Similar process approaches

Although the idea of two different processes underlying EC and signal learning is intuitively plausible and has received some empirical support, there are also arguments that speak against the dual-process assumption. To begin with, there are epistemic arguments. Firstly, how different must phenomena be before they are explained by different processes? Like any science, psychology should be prudent and conservative before new processes are invented just because two effects appear dissimilar. Secondly, what constitutes the differences between phenomena? In other words, how do we know that different processes are at work producing an effect? One heuristic that is often applied to solve this problem is the distinction between implicit and explicit attitude measurements (Greenwald & Banaji, 1995; Petty, Fazio, & Briñol, 2009; Wilson, Lindsey, & Schooler, 2000; Wittenbrink & Schwarz, 2007). Although it is very tempting to use this heuristic, empirical data often contradict the clear cut dissociation between implicit and explicit processes. For instance, there are many cases in which evidence for so called explicit processes can be found in implicit measurements and vice versa (De Houwer, Teige-Mocigemba, Spruyt, & Moors, in press; Gawronski et al., 2005). With respect to signal learning and EC, the question could be raised whether their similarities or their dissimilarities should receive more weight. Thirdly, dual process models are often postulated in order to explain seemingly inconsistent data. For example, approximately 90% of human behavior can be explained by the simple operant learning theory of avoiding pain and approaching pleasure. But what happened before this basic principle was recognized? People may have postulated many different sub-theories in order to explain human behavior. Thus, it could be the case that one theory is simply not broad enough to explain a wide array of human behavior. Fourthly, many dual-process models, such as like the APE model, are merely representational models that do not directly refer to the mechanism underlying phenomena like attitude formation and change. Beside these epistemological arguments, there are also empirical as well as theoretical arguments that speak for a uni-process perspective.

Associative Processes

There is a long tradition in learning theory to explain conditioning effects by means of associative models: The assumption is that during conditioning an association is established between the CS and the US. The popularity of this view has gone so far that signal learning is considered a synonym of associative learning. One of the most prominent associative models designed to explain signal learning is the Rescorla-Wagner Model (RW Model, 1972). According to the RW model, associations are only learned when a surprising event in the environment occurs that goes along with the occurrence of a CS. The RW model expresses the subsequent changes in associative strength between a CS and a US based on conditioning trials. Although the RW model has been criticized from on the beginning because it cannot explain several empirical effects, such as conditioned inhibition and backward blocking, it is nevertheless seen as providing the best explanation of most signal learning phenomena.

Within the group of associative models there are two competing assumptions of how classical conditioning works, referring to the two distinct possible effects of the repeated co-occurrence of CS and US on the representational level. The first is the development of a connection between the CS and the US at the response level. According to this account, the CS acquires its own response that mimics the unconditioned response (UR) elicited by the US (S-R learning). The second possibility is that EC reflects a link between the cognitive representations of the CS and the US. Thus, exposure to the CS after repeated pairings with a US will activate the representation of the US, which in turn activates its corresponding response (S-S learning).

Rescorla suggested an experimental paradigm, the US-revaluation paradigm (Rescorla, 1974), which provides a straightforward test of these two possibilities. If post-conditional changes in the valence of a US lead to corresponding changes in the valence of pre-associated conditioned stimuli (CS), this would support the notion of S-S learning. Evidence for US-revaluation and therefore for the S-S account has been provided by Rescorla (1974) in signal learning as well as by Walther et al. (in press) in the EC area.

Beyond these experimental examples that help to distinguish theoretical accounts on the CS-US representational level, the question remains what exactly is meant by an association within these approaches. An association refers to connections between events in memory (Carr, 1930). However, it is important to note that the term association is merely descriptive in nature and refers neither to the substance of this link, nor to a particular theory of how this link is formed or maintained. What the content of associations is and how they are expressed in the organism's behavior has not been addressed in learning theory so far. Because of this lack of theorizing within associative approaches, a distinction between, for instance, associative vs. propositional learning is misleading. This is because propositional learning (e.g., the learning of an if-then relation) is naturally an instance of associative learning as long as the formation of a connection between stimuli is assumed. Thus, the idea suggests itself that the distinction between associative processes, on the one hand, and other processes (e.g., configural, propositional), on the other hand, is often applied in order to accentuate phenomena (e.g., automatic vs. controlled) without explaining their differences in a theoretically proper way.

The Unimodel of EC - an integrative approach

Rather than focusing on the common dual process distinction, the unimodel (Kruglanski & Thompson, 1999) is an integrative approach that “identifies the essential commonalities that all instances of human judgmental reactions share” (Kruglanski). Within the unimodel, it is argued that a single (not dual) cognitive process underlies all types of (rule-based and associative) judgments. However, differences are constituted by several orthogonal parameters that are represented in any judgmental response. “It is the particular constellation of these values that determines whether the information given would impact an individual‘s judgment“(Kruglanski, Erb, Pierro, Mannetti, & Chun, 2006, p.156). Parameters of the unimodel are cognitive resources, task demands, motivation, and relevance. Applying the unimodel to EC research, it could be assumed that relevant parameters of cognitive resources refer to the accessibility of the conditioned evaluation, time pressure or load, and the time the organism has to express the judgement. The number of trials, the inter-trial interval, and the inter-stimulus interval could be considered relevant task demand parameters. The motivation parameters could be given as the salience or surprisingness of the US, and relevance may refer to the valence and the intensity of the US.

Based on the unimodel, it can be suggested that EC and signal learning are not qualitatively different, but that the particular composition of the parameters given in the respective learning context constitutes outcome differences. Thus, differences on the phenomenological level can be presumably explained by differences in parameters and can be considered an epiphenomenon of the same basic (rule-based) process. This process might refer to the acquisition of a primitive if-then rule. For instance, in attitude formation this rule could be: If I feel positively in the context of this stimulus, I like it. On a representational level, however, there are many possibilities of how this rule is represented. One of these possibilities is that if an object O (i.e., the US) is presented with neutral object X (i.e., the CS), then a compound between O and X is formed. Thus, a subsequent presentation of X necessarily activates a presentation of O, which can explain the resistance to extinction and the independence of contingencies in EC. However, depending on the composition of the parameters, other, more sophisticated rules may be acquired. For instance, in the case of strong appetitive or aversive events, the individual's need to control those events may result in the prediction rule: If X occurs then O will happen. According to common learning approaches (Dickinson, 2001), non-expected events result in stronger associations than predicted events. Thus, in the case of a surprising US, a more sophisticated if-then rule, the prediction rule, may be acquired. Depending on parameters like motivation (i.e., surprisingness), the if-then rule therefore graduates from very basic similarity to more sophisticated causal inferences. Applying this logic to the distinction between EC and signal learning, it is not implausible to assume that the relevance (intensity) of the US determines the degree of awareness. Contingency awareness in turn might be necessary in order to predict the US. Thus, with increasing intensity of the US, EC becomes more and more similar to signal learning which could explain why EC can be found in aware as well as in unaware individuals (Pleyers et al., 2007; Walther & Nagengast, 2006).

Evidence for a single rule-based process that underlies all types of conditioning has come from recent animal research. Beckers, Miller, De Houwer and Urishihara (2006) addressed blocking in the conditioning of rats and found that causal inferential reasoning is involved in this learning process. This result not only challenges the view that causal reasoning is the key operation that differentiates humans from other animals, but it also supports the unimodel approach claiming that the same process underlies all kinds of judgments (see also Blaisdell, Sawa, Leising, & Waldmann, 2006). In the area of attitude research, De Houwer and Vandorpe (in press) recently showed that the IAT (Greenwald, McGhee, & Schwartz, 1998), which is usually considered a prototypical test for non-propositional implicit processes, is sensitive to causal learning. Furthermore, there are studies by Deutsch and colleagues indicating that negation processes are much less dependent on controlled processes than hitherto assumed (Deutsch, Kordts-Freudinger, Gawronski, & Strack, in press). More specifically, the authors showed that negations can be processed unintentionally and quickly. Given that negations are assumed to be the constitutional core element of propositional reasoning, and also present the major difference between dual processes, this research questions the validity of the dual-process distinction.

5. Conclusion

The present paper addresses the mechanisms underlying attitude formation and change. While it is stated that EC plays a central role in these attitudinal processes, it should also be noted that mechanisms underlying EC are not well understood yet. For instance, it is not clear whether EC and signal learning refer to similar or different processes. We have discussed similarities and dissimilarities between both learning phenomena and presented theoretical accounts explaining them. An integral unimodel perspective is suggested, in which it is assumed that EC and signal learning both refer to a similar rule-based learning mechanism.

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