The role of selective attention processes

in answering the representation question

in evaluative conditioning

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Outline and Summary
of the Present Research

Attitudes are "the most distinctive and indispensable concept in contemporary social psychology" (Allport, 1935, p. 798). This outstanding position of the attitude concept in social cognitive research is not only reflected in the innumerous studies focusing on this concept but also in the huge number of theoretical approaches that have been put forth since then. Yet, it is still an open question, what attitudes actually are. That is, the question of how attitude objects are represented in memory cannot be unequivocally answered until now (e.g., Barsalou, 1999; Gawronski, 2007; Pratkanis, 1989, Chapter 4). In particular, researchers strongly differ with respect to their assumptions on the content, format and structural nature of attitude representations (Ferguson & Fukukura, 2012). This prevailing uncertainty on what actually constitutes our likes and dislikes is strongly dovetailed with the question of which processes result in the formation of these representations. In recent years, this issue has mainly been addressed in evaluative conditioning research (EC). In a standard EC-paradigm a neutral stimulus (conditioned stimulus, CS) is repeatedly paired with an affective stimulus (unconditioned stimulus, US). The pairing of stimuli then typically results in changes in the evaluation of the CS corresponding to the evaluative response of the US (De Houwer, Baeyens, & Field, 2005). This experimental approach on the formation of attitudes has primarily been concerned with the question of how the representations underlying our attitudes are formed. However, which processes operate on the formation of such an attitude representation is not yet understood (Jones, Olson, & Fazio, 2010; Walther, Nagengast, & Trasselli, 2005). Indeed, there are several ideas on how CS-US pairs might be encoded in memory. Notwithstanding the importance of these theoretical ideas, looking at the existing empirical work within the research area of EC (for reviews see Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; De Houwer, Thomas, & Baeyens, 2001) leaves one with the impression that scientists have skipped the basic processes. Basic processes hereby especially refer to the attentional processes being involved in the encoding of CSs and USs as well as the relation between them.

Against the background of this huge gap in current research on attitude formation, the focus of this thesis will be to highlight the contribution of selective attention processes to a better understanding of the representation underlying our likes and dislikes. In particular, the present thesis considers the role of selective attention processes for the solution of the representation issue from three different perspectives. Before illustrating these different perspectives, Chapter 1 is meant to envision the omnipresence of the representation problem in current theoretical as well as empirical work on evaluative conditioning. Likewise, it emphasizes the critical role of selective attention processes for the representation question in classical conditioning and how this knowledge might be used to put forth the uniqueness of evaluative conditioning as compared to classical conditioning. Chapter 2 then considers the differential influence of attentional resources and goal-directed attention on attitude learning. The primary objective of the presented experiment was thereby to investigate whether attentional resources and goal-directed attention exert their influence on EC via changes in the encoding of CS-US relations in memory (i.e., contingency memory). Taking the findings from this experiment into account, Chapter 3 focuses on the selective processing of the US relative to the CS. In particular, the two experiments presented in this chapter were meant to explore the moderating influence of the selective processing of the US in its relation to the CS on EC. In Chapter 4 the important role of the encoding of the US in relation to the CS, as outlined in Chapter 3, is illuminated in the context of different retrieval processes. Against the background of the findings from the two presented experiments, the interplay between the encoding of CS-US contingencies and the moderation of EC via different retrieval processes will be discussed. Finally, a general discussion of the findings, their theoretical implications and future research lines will be outlined in Chapter 5.

Zusammenfassung

Einstellungen stellen womöglich das charakteristischste und unverzichtbarste Konzept in der derzeitigen sozialpsychologischen Forschung dar (Allport, 1935, S. 798). Diese herausragende Stellung des Einstellungskonzeptes in der sozial-kognitiven Forschung schlägt sich nicht nur in den zahlreichen Studien nieder, welche sich mit diesem Konzept befasst haben, sondern auch in der großen Anzahl theoretischer Ansätze, die seitdem entwickelt worden sind. Dennoch ist die Frage, was Einstellungen eigentlich darstellen, immer noch unbeantwortet. Insbesondere ist bisher ungeklärt wie Einstellungen in unserem Gedächtnis repräsentiert sind (z.B., Barsalou, 1999; Gawronski, 2007; Pratkanis, 1989, Chapter 4). Forscher unterscheiden sich hierbei in ihren Ansichten vor allem mit Bezug auf den Inhalt, das Format und die strukturelle Natur der Repräsentationen (Ferguson & Fukukura, 2012). Diese vorherrschende Unsicherheit bezüglich der Repräsentation unserer Einstellungen im Gedächtnis ist natürlich auch eng verzahnt mit der Frage, welche Prozesse der Formation unserer Einstellungen zugrunde liegen. In den vergangen Jahren wurde die Problematik der der Einstellungsbildung zugrunde liegenden Prozesse vor allem im Rahmen der evaluativen Konditionierungsforschung (EC) untersucht. In einem typischen EC-Experiment wird ein neutraler Stimulus (konditionierter Stimulus, CS) wiederholt mit einem affektiven Reiz (unkonditionierter Stimulus, US) gepaart. Das Resultat dieser Paarung ist eine Veränderung der Bewertung des CS in Richtung der US-Bewertung (De Houwer, Baeyens, & Field, 2005). Bis jetzt ist es jedoch unklar, welche Prozesse die Bildung einer solchen Einstellungsrepräsentation bedingen (Jones, Olson, & Fazio, 2010; Walther, Nagengast, & Trasselli, 2005). Natürlich gibt es verschiedene Überlegungen dazu, wie CS-US Paare in unserem Gedächtnis enkodiert werden könnten. Ungeachtet dieser wichtigen theoretischen Beiträge lässt einen jedoch die Durchsicht der bestehenden empirischen Arbeiten im Bereich der evaluativen Konditionierung (für Reviews siehe Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; De Houwer, Thomas, & Baeyens, 2001) mit dem Eindruck zurück, dass Forscher die basalen Prozesse einfach

übersprungen haben. Basale Prozesse meinen hierbei vor allem die Aufmerksamkeitsprozesse, welche bei der Enkodierung von Einstellungsobjekten involviert sind.

Vor dem Hintergrund dieser riesigen Forschungslücke bei der Untersuchung von Einstellungsbildungsprozessen liegt der Fokus der vorliegenden These auf der Herausstellung des Beitrages von selektiven Aufmerksamkeitsprozessen zu einem besseren Verständnis von Einstellungsrepräsentationen. Der Beitrag von Aufmerksamkeitsprozessen zur Lösung des Repräsentationsproblems wird dabei aus drei verschiedenen Blickwinkeln betrachtet. Bevor diese verschiedenen Perspektiven jedoch genauer beschrieben werden, soll Kapitel 1 zunächst die Omnipräsenz des Repräsentationsproblems vor dem Hintergrund bestehender theoretischer und empirischer Arbeiten beleuchten. Gleichsam soll es die Rolle von Aufmerksamkeitsprozessen innerhalb der klassischen Konditionierung herausstellen und wie dieses Wissen genutzt werden kann, um die Sonderstellung von evaluativer Konditionierung gegenüber der klassischen Konditionierung hervorzuheben. In Kapitel 2 wird dann der differentielle Einfluss der Verfügbarkeit von Aufmerksamkeitsressourcen und zielgerichteter Aufmerksamkeitsallokation auf Einstellungslernen untersucht. Das primäre Ziel des in diesem Kapitel beschriebenen Experimentes war es dabei zu untersuchen, inwieweit der Einfluss der Verfügbarkeit von Aufmerksamkeitsressourcen und zielgerichteter Aufmerksamkeitsallokation auf EC vermittelt ist über die Veränderung der Enkodierung von CS-US Relationen im Gedächtnis (d.i., Kontingenzgedächtnis). Auf Grundlage der Ergebnisse dieser Studie wird dann in Kapitel 3 die selektive Verarbeitung des US relativ zum CS untersucht. Die zwei Experimente, welche in diesem Zusammenhang berichtet werden, hatten dabei zum Ziel den moderierenden Einfluss der selektiven Verarbeitung des US in Relation zum CS zu untersuchen. In Kapitel 4 soll schließlich die in Kapitel 3 herausgearbeitete Importanz der Enkodierung des US in Relation zum CS im Kontext verschiedener Abrufprozesse beleuchtet werden. Vor dem Hintergrund der Ergebnisse zweier Experimente soll hierbei das mögliche Wechselspiel zwischen der Enkodierung von CS-US Kontingenzen und der Moderation von

EC durch verschiedene Abrufprozesse diskutiert werden. Schlussendlich werden dann im Kapitel 5 die Ergebnisse der vorliegenden Arbeit nochmals zusammenfassend diskutiert, theoretische Implikationen abgeleitet und zukünftige Forschungslinien skizziert.

Chapter 1

The representation question and how encoding processes might provide an answer

1. Evaluative conditioning – a functional definition and its implications for the representation question

In social psychology the formation of attitudes is often investigated in an evaluative conditioning paradigm (EC-paradigm). In a typical EC-paradigm a neutral conditioned stimulus (CS) is repeatedly paired with a positive or negative unconditioned stimulus (US; De Houwer, 2007; Levey & Martin, 1975). The repeated pairing of the CS with the US generally results in changes of the evaluation of the CS mimicking the evaluative response associated with the US. In other words, EC refers to an effect that is based upon changes in the *functional efficiency* of the CS, i.e. its inherent power to elicit the evaluative response associated with the US. In this regards, EC can be assumed to be the result of processes integrating the evaluative response inherent to the representation of the US with the representation of the CS.

Interestingly, although there has been a plethora of theoretical and empirical work on EC in the last decades (for reviews, see De Houwer et al., 2001; Hofmann et al., 2010; Walther, Weil, & Langer, 2011b) it is still an open question how these representations exert an influence on our likes and dislikes (see Jones et al., 2010). While some empirical results point to the formation of a *stimulus-stimulus representation* during conditioning (e.g., Baeyens, Eelen, Van den Bergh, & Crombez, 1992b; Hammerl & Grabitz, 1996; Walther, 2002; Walther, Gawronski, Blank, & Langer, 2009) other findings suggest the formation of a *stimulus-response representation* (e.g., Baeyens, Vanhouche, Crombez, & Eelen, 1998; Gast & Rothermund, 2011; Jones, Fazio, & Olson, 2009). In the case of stimulus-stimulus representations, it is assumed that a mental link between the stimulus representations of CS and US is formed during conditioning. Taking this representation as a basis for EC, the activation of the CS has no direct effect on the activation of the evaluative response, but only an indirect effect via the activation of the US-representation. On the contrary, presuming that EC is based upon the formation of a

stimulus-response representation, the activation of the stimulus-representation of the CS should result in a direct activation of the evaluative response representation. In this respect, the formation of stimulus-response representations is associated with the evaluative response representation becoming an integral part of the CS representation. One way to empirically test these two types of representations against each other is the US-revaluation paradigm (Rescorla, 1974). In a typical US-revaluation paradigm there are two phases. In the first phase, the conditioning phase, CSs are paired with positive or negative USs. After this conditioning phase, a revaluation phase follows where the initial valence of the USs is changed without further pairing of the CSs. Similar to sensory preconditioning (Walther, 2002) it is presumed that these changes in the valence of the US only result in corresponding changes of the pre-associated CS if there has been formed a stimulus-stimulus representation during conditioning. However, as Walther et al. (2011b) already pointed out providing evidence for the formation of one form of representation and not the other is not conclusive for the process by which the representation was formed. Thus, it has to be investigated under which conditions CS and US or CS and evaluative response, irrespective of US-identity, are integrated into a coherent representation. Unfortunately, the role of encoding processes within the whole attitude formation process is almost unexplored until now (for some exceptions see Gawronski, Balas, & Creighton, 2014; Jones et al., 2009; Le Pelley, Beesley, & Griffiths, 2011). This omission surrounding the encoding processes that are involved in the formation of attitude representations becomes also apparent by reviewing existing EC-accounts.

1.1 Attitude representations as a matter of relational encoding

Regarding the question which mechanisms are involved in the encoding and consolidation of the relationship between co-occurring CSs and USs, i.e. how they are learned, current theorizing distinguishes between two mechanisms. On the one hand, attitudes may be formed on the basis of an associative learning mechanism in which objects and events become

automatically linked by virtue of their mere co-occurrence. On the other hand, they might become consolidated by the operation of a propositional mechanism that involves a conscious validity assessment of propositionally represented statements reflecting the CS-US contingencies (e.g., Gawronski & Bodenhausen, 2006; Rydell & McConnell, 2006). In existing EC accounts these two mechanisms are addressed by the referential (Baeyens, Eelen, Crombez, & Van den Bergh, 1992a) and propositional learning account (Mitchell, De Houwer, & Lovibond, 2009), respectively.

The referential account: In the referential account, proposed by Baeyens and colleagues (1992a), it is presumed that pairing a neutral CS with an affect-laden US results in the automatic formation of a CS-US association (i.e., an S-S representation). The process is assumed to be automatic to the extent that there is no need for the conscious processing of the relation between CS and US representation in order to become associated. The notion of the unconscious formation of an association between CS and US was deduced from the observation that contrary to Pavlovian conditioning, EC requires no true statistical CS-US relationship, but only spatio-temporal contiguity of CS-US pairs (Hermans, Baeyens, & Eelen, 1993). Based on these observations Baeyens and his colleagues (1992a) concluded that EC has to be based on some kind of referential learning stemming from the unconscious encoding of CS-US co-occurrences. Contrary to expectancy learning (i.e., Pavlovian conditioning) it is therefore assumed that the activation of the US representation via the activation of the CS representation results in no conscious expectation of the actual occurrence of the US. Postulating the unconscious encoding of the relation between CS and US, the referential account is consequently well suited to account for the presumed independence between EC and contingency awareness. Moreover, presuming an unconscious S-S representation it can also account for US-revaluation effects, which is one reason why this paradigm can only account for the representation but not for the underlying learning process (cf. Walther et al., 2011b).

The propositional account: According to the propositional account evaluative conditioning effects are due to the operation of a conscious propositional reasoning process that interacts with the unconscious processes of perception and retrieval (Mitchell et al., 2009). Contrary to associative learning accounts, such as the referential account proposed by Baeyens and colleagues (1992a), Mitchell et al. claim that the encoding of CS-US contingencies is dependent on the operation of a conscious propositional reasoning process. Propositions or propositional knowledge resulting from the operation of such a conscious cognitive process can be differentiated from associative mental links in two ways. First, contrary to associative mental links formed between co-occurring CS- and US-representations, propositions also represent the relational structure of these co-occurring CS- and US-representations. That is, they do not only represent the relation between co-occurring CSs and USs but also the direction in which these two stimuli are related to each other. Representing the direction of the relationship between co-occurring CSs and USs, propositions have a truth value which can be tested by assessing the probability of the co-occurrence of a given CS with a certain US. If a CS for instance signals a certain US in only 50% of the cases, the proposition that this CS is always followed by the specific US can be declared as false. This example already illustrates that the assumption of a conscious propositional process is dependent on the premise of contingency awareness. Presuming contingency awareness as a necessary precondition for EC to occur excludes the possibility for intrinsic changes in the evaluation of a CS, i.e. the formation of an S-R representation. Indeed S-R representations are independent of the conscious representation of CS-US contingencies and therefore cannot be subjected to a test of their truth value (cf. Walther et al., 2011b).

1.2 Attitude representations as a matter of stimulus-specific encoding

The EC-accounts described thus far (i.e., the referential and the propositional account) postulate that the representation underlying EC is dependent on the encoding of the relation

between CS and US. Specifically, the referential account (Baeyens et al., 1992a) presumes the formation of an associative link and the propositional account (Mitchell et al., 2009) the formation of a proposition reflecting the relationship between co-occurring CSs and USs. There are two further accounts explaining EC independent of any encoding of the relation between CS and US. Instead, they presume the formation of attitude representations to be only dependent on the stimulus-specific encoding of CS-US co-occurrences.

The holistic account: According to the holistic account (Levey & Martin, 1975; Martin & Levey, 1978, 1994) the integration of the evaluative response with a neutral CS (i.e., EC) forms the basis of classical conditioning (CC). In this regards EC is not different from CC but an integral part of it. In detail, it is postulated by the authors that any stimulus or stimulus complex in our environment elicits an evaluative response (Martin & Levey, 1978). The activation of such an evaluative response is thereby presumed to follow autonomic arousal but to precede actual approach/avoidance behavior (Martin & Levey, 1978). In this regard, it goes beyond mere arousal effects, but has to be differentiated from actual behavior. Due to these characteristics ascribed to the evaluative response, the authors defined it as a "subjective evaluative response". While animals, however, can only recur to a rather small repertoire of evaluative responses, namely those ensuring their survival and the survival of their species, human beings are also able to form evaluative responses towards new objects. Specifically, they are able to acquire new evaluative responses by processing the contingencies of those stimuli in a given environment (Martin & Levey, 1978). By processing the contingencies between a new stimulus (CS) and contingent evaluative events (US) human beings are thus able to adopt their behavior to unknown stimuli. According to Martin and Levey (1994) this encoding process does not result in the formation of a representation reflecting the experienced contingencies (i.e., an S-S representation), but in the formation of a holistic representation. The holistic representation deviates from an S-S representation insofar as it is independent of the formation of a mental link reflecting the CS-US contingency. Instead, it is presumed that the experience

of CS-US contingencies results in the integration of stimulus features of the CS and the US with response features of the evaluative response (Martin & Levey, 1994). Any single element of the holistic representation resulting from the fusion of CS, US, and evaluative response is then able to reactivate the complete representation complex.

The encoding process presumed to result in the formation of these holistic representations is a subjective evaluation mechanism. This mechanism is subjective insofar as it only refers to the subjective experience of the individual regarding the CS-US contingencies while being independent of the conscious encoding and retrieval of CS-US contingencies. The retrieval of the evaluative response is therefore presumed to be unmediated by the activation of any cognitive structures, as for instance, associations or propositions. In this respect the holistic account is more parsimonious than accounts postulating those structures. Due to its independence on any relational structures the account also implies the independence of EC on contingency awareness (Martin & Levey, 1978). However, what remains unclear is whether EC is mediated by the activation of US stimulus features and therefore relies on some kind of S-S representation or whether it only depends on the activation of the evaluative response features.

The implicit misattribution account: The implicit misattribution account (Jones et al., 2009) deviates from the other EC accounts insofar as it does not only incorporate clear assumptions on the structure of the representation being formed but also on the process resulting in the formation of such a representation (i.e., the encoding process). Similar to the holistic account (Martin & Levey, 1978), the authors presume the integration of the CS stimulus features with the evaluative response features of the paired US independent of the encoding of the relation between CS and US. However, in contrast to the holistic account, Jones and colleagues postulate no integration of US stimulus features. Instead, they are assuming the formation of an S-R representation rather than the formation of a holistic representation. The formation of such an S-R representation is presumed to result from the "implicit misattribution" of the evaluative response towards the CS. The authors underpin their assumption of an implicit

misattribution mechanism by the notion that evaluative responses are less inextricably bound to objects than, for instance, stimulus features. In this respect, they are rather diffuse and free-floating features which may be mistakenly integrated with another object occurring in close spatio-temporal proximity. It is evident from the assumption of an implicit misattribution mechanism that the event containing the CS-US pair must include at least a minimal probability for source confusion. Given that the source of the evaluation in an EC procedure is the affect-laden US, EC should increase with a decrease in the conscious processing of the US. In this regard, the implicit misattribution account implies a negative relationship between contingency awareness and EC. Likewise, variables increasing the overlap between CS and US enhance the probability for source confusability and thus EC (e.g., high spatio-temporal contiguity, evaluative response contingency, and ambiguity of the source of evaluation). In one experiment Jones et al. (2009; Experiment 4) varied the perceptual salience of the CS in order to increase the likelihood that the evaluative response automatically activated by the US will be misattributed to the CS. The perceptual salience of the CS was manipulated by varying its size relative to the US, i.e. the CS was either greater in size or smaller than the US. Results of the study indicate that EC is more pronounced for CSs being of greater size than the paired US as compared to CSs being of smaller size than the paired US. The authors interpret their findings as supporting their presumed operation of an implicit misattribution process. Moreover, they claim that their findings cannot be explained by any other existing EC-account. Contrary to their assertion, it can be argued that their findings could also be explained by the referential account (Baeyens et al., 1992a). In particular, it might be argued that the increased salience of the CS relative to the US results in stronger EC, in virtue of the increased attention allocation on the CS relative to the US. To put it concisely, it might be reasoned that increasing the similarity between CS and US with regards to their potency in directing attention results in an increased probability for the unconscious processing of their relation.

1.3 Concluding remarks

The review of the existing EC accounts clearly mirrors the importance of encoding processes in the formation of attitude representations. However, all of them rather concentrate on the question of what has to be encoded instead of when encoding takes place (cf. Gawronski & Bodenhausen, in press). In particular, both the referential (Baeyens et al., 1992a) and the propositional account (Mitchell et al., 2009) presume that the formation of attitude representations is dependent on the encoding of CS-US contingencies. In the referential account, CS-US contingencies are represented by an association between CS and US that is formed upon the unconscious processing of CS-US co-occurrences (i.e., an unconscious S-S representation). On the contrary, the propositional account presupposes the formation of propositions, i.e. "qualified mental links, that is, links that specify how two events are related" (Mitchell et al., 2009, p. 186). In this regard, propositional learning requires the conscious encoding of CS-US contingencies.

Either presuming the conscious or unconscious encoding of CS-US contingencies these models are quite unspecific with respect to the question of when the encoding of CS-US contingencies will take place (see Gawronski & Bodenhausen, in press). That is, they provide no answer on how CS-US contingencies are encoded in memory. Knowing how CS-US contingencies are encoded is however, essential in order to be able to manipulate the CS-US contingencies presumed to underlie EC. The relatively few empirical studies that have tried to manipulate CS-US contingencies may thus be a symptom of the insufficient knowledge on the encoding processes underlying EC (for some exceptions see, Kattner, 2012; Kattner & Ellermeier, 2011; Walther, Blask, and Weil, 2014). The multitude of empirical work concerned with the dependency of EC on either conscious or unconscious representations of CS-US contingencies only measured contingency awareness by assessing contingency memory after conditioning. This is insofar problematic as measuring contingency memory without really knowing which kind of representation of CS-US contingencies underlies EC questions the

interpretability of the memory data with respect to the presumed representation. In this regard, finding EC either in the absence or in the presence of contingency awareness cannot be clearly interpreted with respect to the presumed representation or learning mechanism.

The possible inadequacy of contingency memory measures in order to account for the representation structure becomes even more evident by the assumption of a holistic representation (Levey & Martin, 1975; Martin & Levey, 1978). As already outlined above, this kind of representation is unmediated by any cognitive structures reflecting the experienced CS-US contingencies. Concurrently, it becomes not sufficiently clear from the authors' argumentation whether EC is only dependent on the retrieval of the evaluative response features or whether it is also dependent on the retrieval of some stimulus features from the US. Thus, neither finding EC in the presence of contingency awareness nor in its absence would clearly contradict the assumption of a holistic representation being retrieved from memory. Contrary to the holistic account the implicit misattribution account (Jones et al., 2009) makes rather clear assumptions on what has to be encoded in memory in order to obtain changes in the evaluation of a CS. In particular, Jones and colleagues propose that changes in the evaluation of the CS are due to the mistaken integration of the CS representation with the evaluative response representation. In this respect the implicit misattribution account does not only imply that there is no need for the activation of CS-US contingencies in order to obtain EC but that even the encoding of these contingencies is detrimental to the effect. It becomes apparent from these short reflections that current EC accounts are unable to provide a straight answer to the question of the representation underlying EC because they provide no sufficiently sophisticated ideas on the encoding of CS-US co-occurrences.

2. The representation problem – a new one?

Considering the scarcity of research and theorizing on the role of encoding processes involved in the formation of the representation underlying EC might create the impression that these processes are still not sufficiently understood. However, there is a wealth of research and theorizing on encoding processes in the field of selective attention research (for a review see Fougnie, 2008). Interestingly, selective attention researchers started to think of encoding processes for similar reasons as attitude researchers. In particular, they faced the same core problem as attitude researchers, namely the so-called "binding problem" (von der Malsburg, 1981). The binding problem refers to the problem of how distributed feature representations of several perceived stimuli in a given scene can be bound together to coherent representations reflecting the perceived stimuli. With respect to evaluative conditioning this problem represents the formation of a coherent representation of CS, US, and evaluative response as well as the relation between them. The coherent representation of the relation between CS and US is thereby especially important for the proposed relational encoding accounts, i.e. the referential account and the propositional account in virtue of their dependence on the correct encoding of CS-US contingencies.

According to feature-integration theories (Treisman & Gelade, 1980; Hommel, Müsseler, Aschersleben, & Prinz, 2001) the integration of distributed feature-representations relies on so-called binding processes. The correct operation of these processes is presumed to be critically dependent on selective attention allocation. In particular, selective attention processes determine which information will be integrated and stored in a coherent representation, i.e. which information will be encoded. Investigating the influence of selective attention processes on EC thus seems to be indispensable for a better understanding of the representation underlying EC. This peculiar role of selective attention processes for answering the representation question has already been pointed out in computational models of classical

conditioning (e.g., Kruschke, 2001; Mackintosh, 1975; Rescorla & Wagner, 1972). Yet, selective attention processes have been widely neglected in evaluative conditioning research. The neglect of selective attention processes is particularly surprising if one considers their possible contribution to the dissociation of evaluative conditioning from classical conditioning. This probable contribution of assumptions on the relationship between selective attention processes and classical conditioning to the demonstration of the exceptional position of evaluative conditioning becomes evident when having a closer look at computational models of classical conditioning.

2.1 The Rescorla-Wagner model

In their influential computational model on classical conditioning, Rescorla and Wagner (1972) aimed at predicting classical conditioning effects in a trial-based manner. According to the authors, the presentation of a CS-US pair in a classical conditioning trial may result either in excitatory, inhibitory or in no conditioning. Conditioning is thereby defined as changes in the associative strength of a given CS due to its co-occurrence with a US. Which kind of conditioning, i.e. which changes in the associative strength of the CS, occurs, is assumed to be dependent on the current associative strength of a given CS relative to the maximum level of conditioning supported by the US (i.e., the intensity of the US). Excitatory conditioning is presumed to occur if the intensity of the US exceeds the individual's expectation of US-intensity in the presence of the CS. If actual US-intensity and expected intensity are equal, there will be no conditioning. Inhibitory conditioning effects are presumed to result from the experience of a negative relation between expected and actual US-intensity. Thus, if the actual US-intensity is smaller than the intensity of the expectation of the individual, when presented with the CS, there will be inhibitory conditioning effects. In this regard, the Rescorla-Wagner model (1972) is often stated to reflect the concept of surprise. Surprise thereby results from the discrepancy between the expected and actual US-intensity (see also, Kamin, 1968). While the expected US-

intensity is presumed to be dependent on the amount of associative strength already conditioned to the CS at the beginning of a trial, the actual US-intensity is dependent on the maximum amount of associative strength supported by the US. In a nutshell, changes in the associative strength of the CS on a given trial and in this respect conditioning are highly dependent on the attention devoted to the US in virtue of its unexpectedness. Thus conditioning in this model will mainly depend on the attention paid to the US at the expense of its associative strength relative to the CS.

2.2 Mackintosh's model of classical conditioning

Similar to the Rescorla-Wagner model (1972), three years later Mackintosh (1975) tried to answer the question of how a given CS becomes a signal for the US in an attentional model focusing on the attention paid to the CS. Thus, comparable to the Rescorla-Wagner model it aimed at predicting changes in the associative strength of a CS. However, changes in the associative strength of a CS are not determined by the attention paid to the US in virtue of its surprisingness in the presence of the CS (see Rescorla & Wagner, 1972). Rather, it is presumed that the associative strength of a CS varies with the participant's experience. In particular, it is assumed that, if a CS always co-occurs with a US, the CS will probably attract more attention and therefore will be more likely to become associated with the US than a CS that never co-occurred with the US. Thus, the relevance of a CS in predicting the US and in this regard its associative strength is dependent on the recognition of CS-US co-occurrences. The assumption that conditioning is dependent on the attention paid to the CS in virtue of its predictive validity for the US also allows the model to account for CS pre-exposure effects (Lubow & Moore, 1959). CS pre-exposure refers to the phenomenon that exposing subjects to CS-alone trials before pairing the CS with the US impairs the acquisition of a conditioned response during conditioning. The Rescorla-Wagner model cannot account for this effect insofar as changes in the associative strength of the CS are dependent on an actual/target comparison between the

current associative strength of the CS and the maximum amount of associative strength supported by the US. In this respect, CS-alone presentations should have no impact on the associative strength of a CS. The model proposed by Mackintosh can account for CS pre-exposure by stating that subjects learn about the irrelevance of the CS in predicting a relevant event (i.e., the US) and therefore will ignore it during subsequent pairing.

2.3 Integrating the attention perspective of classical conditioning models with evaluative conditioning

When trying to find a common denominator for these two models of classical conditioning it becomes apparent that both of them imply that changes in associative strength are dependent on the relative attention paid to the CS and the US. In detail, the Rescorla-Wagner model (1972) indicates that changes in the associative strength of the CS and in this respect also its attention-grabbing nature is dependent on the attention paid to the US. The model proposed by Mackintosh (1975) indicates that the attention paid to a CS is mainly determined by the subject's recognition of CS-US co-occurrences. Thus, in essence, both models indicate that conditioning, in terms of encoding and storing the CS as a signal for the US, is driven by the attention paid to the CS in relation to the attention devoted to the US. Transferring this idea to the encoding of CS-US pairs in an evaluative conditioning paradigm, EC in contrast to classical conditioning might be critically dependent on the processing of the US relative to the CS. In particular, EC refers to changes in the evaluation of the CS that are due to its integration with the evaluative response of the US. The primary target in evaluative conditioning is thus the CS and not the US. In this regard, EC should depend on the relation between the selective processing of the US relative to the CS and not the other way around, as presumed in classical conditioning. In terms of selective attention, the integration of CS and US should thus depend on the possibility to process the evaluative response associated with the US while selectively processing the CS.

3. Summary and aims of the present research

From the explanations above, two research questions can be derived. First, it can be deduced from the previous explanations that selective attention mechanism might contribute to a better understanding of the encoding of CS-US contingencies. This probable contribution of selective attention processes in answering the representation question can basically be derived in two ways. On the one hand, research on selective attention provides strong evidence to the notion that selective attention is a necessary precondition for the encoding of information and in this regard should also be essential for the encoding of CS-US contingencies (for a review see Fougnie, 2008). On the other hand, theories on classical conditioning (e.g., Rescorla & Wagner, 1972; Mackintosh, 1975) have long emphasized the critical role of selective attention processes in the encoding of CS-US contingencies. Nonetheless, current research on evaluative conditioning largely ignored selective attention processes when investigating the encoding of CS-US contingencies. Hence, the first goal of the present thesis is to outline the contribution of selective attention processes to a better understanding of the encoding of CS-US contingencies in evaluative conditioning. The suitability of selective attention regarding the encoding of CS-US contingencies in EC as compared to other forms of attention will be outlined in Chapter 2 and 3.

The second research question concerns the structure of CS-US contingencies. In particular it can be derived from the definition of EC that it should be strongly dependent on the processing of the evaluative response associated with the US in relation to the CS. Thus, EC might rely on a CS-US contingency being opposite to that proposed in classical conditioning or expectancy learning. Given that previous research did not critically test for this possibility the second goal of this thesis is to demonstrate that the presumption of such a CS-US contingency may be adequate in the context of evaluative conditioning. In particular, the experiments presented in Chapter 3 will directly test for the moderation of EC via changes in

the selective processing of the US in relation to the CS. In Chapter 4 the contribution of selective attention processes as well as the presumed structure of CS-US contingencies shall then be discussed with respect to the interplay between encoding and retrieval-related processes in EC.

Chapter 2

At the crossroads: Attention, contingency awareness, and evaluative conditioning[1]

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1. Introduction

One reason why the EC paradigm has attracted so much attention is that some researchers have claimed that EC can occur independently of contingency awareness (Baeyens, Eelen, & van den Bergh, 1990; Field & Moore, 2005; Fulcher & Hammerl, 2001; Hammerl & Fulcher, 2005; Walther & Nagengast, 2006). That is, EC is assumed not to depend on the conscious knowledge that a particular CS co-occurs with a particular US (e.g., Baeyens et al., 1990; Field, 2000). It was especially this independence of EC on contingency awareness that made researchers believe that EC is distinct from expectancy learning as proposed in classical conditioning. Other researchers, however, question this claim of unconscious EC and in this regards its uniqueness relative to classical conditioning. Specifically, they assume that EC strictly depends on contingency awareness (Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Stahl, Unkelbach, & Corneille, 2009). This dispute about the relation between EC and awareness manifests itself in the four different EC-accounts which have been described in Chapter 1: Whereas the referential account (Baeyens et al., 1992a), the holistic account (Martin & Levey, 1994) and the implicit misattribution account (Jones et al., 2009) state that contingency awareness should not be required for EC to occur, the propositional account (Mitchell et al., 2009) states that EC is driven by conscious beliefs about the CS-US relationship (see De Houwer, 2009). The theoretical inconsistencies among these accounts are reflected in empirical evidence supporting the notion of EC in the absence of contingency awareness on the one hand (e.g., Baeyens et al., 1990; De Houwer, Baeyens, & Eelen, 1994; De Houwer, Baeyens, & Hendrickx, 1997; Field & Moore, 2005; Fulcher & Hammerl, 2001; Hammerl & Fulcher, 2005; Walther & Nagengast, 2006), and in the presence of contingency awareness on the other hand (e.g., Bar-Anan, De Houwer, & Nosek, 2010; Corneille, Yzerbyt, Pleyers, & Mussweiler, 2009; Dedonder, Corneille, Yzerbyt, & Kuppens,

2010; Kattner, 2012; Kattner & Ellermeier, 2011; Pleyers et al., 2007, 2009; Stahl & Unkelbach, 2009).

Researchers have also examined whether EC depends on attention (Brunstrom & Higgs, 2002; Corneille et al., 2009; Dijksterhuis & Aarts, 2010; Field & Moore, 2005; Jones et al., 2009; Kattner, 2012). However, it is worth noting that attention should not be equated with contingency awareness (Nissen & Bullemer, 1987). Direct evidence for the dissociation of attention and awareness came from Field and Moore (2005, Experiment 2). The authors used backward masked US presentation to reduce awareness of CS-US contingencies and an attention demanding secondary task (i.e., counting backwards from 300 in intervals of three) in order to distract attention from CS-US contingencies. Interestingly, they found that lack of attention, but not lack of awareness, reduced EC. These findings indicate that the relationship between learning and awareness cannot be equated with the attentional requirements of the encoding process underlying learning. Similar results have been obtained by Pleyers and colleagues (Pleyers et al., 2007; 2009), who showed that performing a demanding two-back task effectively reduced EC. In contrast to Field and Moore (2005), however, Pleyers et al. (2009) argued that the attentional effects on EC can be explained by differences in contingency awareness. Taken together, the allocation of attention to CS and US seems to be a critical variable influencing EC. Yet, it is not clear how contingency awareness, attention and EC are interrelated.

1.1 The influence of attentional resources on evaluative conditioning

When considering the interrelation between attention, contingency awareness, and EC, it is important to distinguish between several components of attention. One factor that might contribute to learning in general and EC in particular are the attentional resources available for the processing of stimuli (Field & Moore, 2005; Walther, Ebert, & Meinerling, 2011a). In the present study attentional resources were directly manipulated by presenting USs and CSs in

different modalities in one condition and in the same modality in another condition. Previous research suggests that stimuli share attentional resources if both are processed within the same sensory modality (Arrighi, Lunardi, & Burr, 2011; Kaschak, Zwaan, Aveyard, & Yaxley, 2006). However, attentional resources seem to be independent when stimuli are processed in different modalities (Alais, Morrone, & Burr, 2006; Duncan, Martens, & Ward, 1997). This notion is also in accordance with Sweller's cognitive load theory (Sweller, 1988). The cognitive load theory proposes that working memory capacity is reduced under conditions in which stimuli from the same sensory modality have to be integrated, because the integration process itself reduces capacities available for the processing of the stimuli. Accordingly, presenting stimuli in different modalities (e.g., one stimulus is presented acoustically and another one visually) should release working memory capacity (Sweller, 2002, p. 1506) and should therefore promote learning. Although cross-modal EC paradigms have been used in previous studies (Kellaris & Cox, 1989; Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2009; Todrank, Byrnes, Wrzesniewski, & Rozin, 1995; for a meta-analysis see Hofmann et al., 2010), most of these studies basically aimed at demonstrating that EC can occur independently of a CS-US modality match. However, no previous research has taken into account the possibility that a modality match may be related to attentional resources and might therefore influence EC. In accordance with Sweller's cognitive load theory (Sweller, 1988), it could be speculated that stronger EC occurs in the cross-modal compared to the unimodal condition because CSs as well as USs may attain more relative attention when they are presented in different modalities. However, it is not yet clear whether the influence of attentional resources on EC is dependent upon contingency awareness. In order to clarify this issue, the current study specifically tests whether or not attentional resources exert their effect on EC via contingency awareness.

1.2 The influence of goal-directed attention on evaluative conditioning

A second attentional factor that might influence EC is the explicit goal to process the stimuli. Due to its affective nature, the US generally attracts more attention than the affectively neutral CS (e.g., Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Devue, Laloyaux, Feyers, Theeuwes, & Brédart, 2009; Öhman, Flykt, & Esteves, 2001; Vuilleumier, Armony, Driver, & Dolan, 2001). Thus, explicitly directing attention to the CS should lead to stronger EC because it increases the probability that both stimuli, the US *and the CS*, are processed. Guiding attention toward the US, however, should render attending to the CS relatively unlikely, because the CS as a neutral stimulus does not spontaneously catch attention. Accordingly, CS-focus rather than US-focus should result in stronger EC.

However, inducing the goal to attend to the stimuli may also increase the probability that the relation between the stimuli is consciously processed. Evidence for this assumption is provided by studies that explicitly instructed their participants to attend to CS and US (e.g., Corneille et al., 2009; Kattner, 2012). Kattner (2012), for example, either explicitly directed participants' attention towards CS-US contingencies or diverted attention from them. Results indicate stronger EC in the attention-enhanced group relative to the contingency-distraction group. Importantly, the impact of the distraction on the magnitude of EC was mediated by contingency awareness. In the current study I also examined whether the impact of goal-directed attention on EC is mediated by contingency awareness. However, unlike Kattner (2012), participants were not instructed to focus their attention on CS-US contingencies but to focus either on the CSs or the USs.

2. Method

2.1 Participants and design

Forty students (27 female, 1 not reported) were randomly assigned to a 2 (US valence: positive vs. negative) × 2 (attention focus: CS-focus vs. US-focus) × 2 (modality of the US: auditory vs. visual) mixed-factorial design with within-participant variation on the first factor and between-participant variation on the last two factors. Participants received course credit for their participation.

2.2 Procedure

When arriving at the lab, participants were welcomed by an experimenter and seated in front of a computer screen. Participants were introduced to a study on "information processing and concentration" and were asked to follow written instructions on the screen. Specifically, participants were instructed that they would complete a task on information processing that demanded their concentration. The experiment consisted of two consecutive phases that were guided entirely by a computer program: a conditioning phase and a test phase.

Conditioning phase

In the conditioning phase, participants were presented with 16 CS-US pairings. Fictitious water brand names (e.g., Abrizzo, Helvipo) were used as conditioned stimuli (CSs), and valenced words (e.g., love, war, freedom, see Table1 for a complete list) were used as unconditioned stimuli (USs). The stimulus material was pre-tested and successfully applied in previous studies (Brendl, Nijs, Möller, & Walther, 2014). Half of the CSs were paired with a positive US, and half were paired with a negative US. In order to rule out undesirable stimulus-selection effects (Field & Davey, 1999), CS-US assignments were counterbalanced. Each CS-US pair was presented seven times in random order. CS-US pairs were presented simultaneously for 1000 ms, with an inter-trial interval of 2500 ms. All participants were presented with the same words. Depending on the modality condition, however, US words were

presented either acoustically or visually. Thus, attentional resources were manipulated by presenting both stimuli within the same modality (i.e., CS and US visually) or by presenting CS and US in different modalities (i.e., CS visually and US auditory). US words in the unimodal condition were presented on the right side of the screen, whereas US words in the cross-modal condition were presented via headphones. Moreover, in order to manipulate goal-directed attention, participants were explicitly asked to respond either to the CSs (CS-focus) or to the USs (US-focus) by pressing a marked key on the keyboard. In order to prevent participants from pressing the key constantly and to meet the cover story (i.e., that this is a study on information processing and concentration), 16 distracter trials were intermixed with the critical CS-US pairs. These distracter trials consisted of water bottles with arbitrary character strings (e.g., §+##) paired with nonwords (e.g., Kube, Trahot, Refund, see Table 1 for the complete list). Participants in the CS-focus condition were instructed to react only to water bottles with a water brand name, but not to water bottles with arbitrary character strings. In the US-focus condition, participants were instructed to react only to words, but not when a non-word was presented. Specifically, the instruction translates as follows: "Dear participant, the following task measures your information processing and your concentration. Research in neuropsychology has demonstrated that the way in which information is presented has a major influence on human information processing. In the following you will be presented with pictures and words on the screen (unimodal condition) / words via headphone (cross-modal condition). We would like to test how fast you can react to the presented information. In this respect you will be presented with water brand names, water bottles with arbitrary character strings, words and nonwords. Your task is it to react if and only if a water brand name (CS-focus) / word (US-focus) is presented. Please use the red marked key on the keyboard to indicate your response. Important: Try not to be distracted by the words and the water bottles with arbitrary character strings (CS-focus) / the pictures and nonwords (US-focus)." Target and distracter trials were randomized.

Table 1

Overview of the USs and distracter USs used in the current study

USs		Distracter USs	
Positive	Negative		
Liebe (love)	Folter (torture)	Zipat	Ordom
Freiheit (freedom)	Hass (hatred)	Trahot	Suks
Freund (friend)	Krieg (war)	Refund	Enchal
Glück (luck)	Mord (murder)	Kube	Sape
Kuss (kiss)	Terror (terror)	Bluka	Deref
Lachen (laughter)	Gewalt (violence)	Terfo	Rerot
Spaß (fun)	Elend (misery)	Usim	Nedal
Freude (pleasure)	Qual (torture)	Grieka	Lewag

Test phase

The conditioning phase was followed by a test phase in which participants were asked to rate how much they liked the presented stimuli of the conditioning phase in two separate blocks on a graphic rating scale (labeled ''dislike'' on the left and ''like'' on the right) by positioning the cursor on any point of the scale and then pressing the left mouse key. The first block consisted of the sixteen water bottles (i.e., the CSs) and the second block consisted of the words used in the conditioning phase (i.e., the USs). In the unimodal condition, USs were presented visually, whereas in the cross-modal condition USs were presented acoustically. The order of blocks did not vary. To avoid response tendencies, the graphic scale consisted of no additional numbers or other numerical labels. The computer program recorded negative judgments on the left side from -100 to -1, and positive judgments on the right side from +1 to +100. The neutral midpoint of the scale (0) served as the starting position for each judgment.

Awareness measure

Afterwards, participants were asked to complete an awareness assessment task. This task consisted of two blocks. First, participants were asked to indicate for each of the 16 CSs whether it had been paired with a positively or negatively valenced word. Because awareness can be overestimated in this task due to the fact that valence of the US can be inferred from the corresponding evaluation of the CS (Gawronski & Walther, 2012; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012), participants subsequently completed an identity awareness test. In this test, participants were asked to indicate for each of the 16 CSs the correct US it had been paired with during the conditioning phase. The specific CS appeared on the left side of the screen and all 16 US words were presented on the right. Because it is not feasible to present all 16 auditory USs simultaneously and in order to avoid sequence effects when presenting USs sequentially, the presentation mode of the identity awareness assessment was visual in both modality conditions. Participants selected the particular US by pressing the corresponding key on the keyboard.

3. Results

3.1 Manipulation check

To test whether positive USs were evaluated more positively than negative USs across modalities, US ratings were submitted to a 2 (valence of US: positive vs. negative) × 2 (US modality: acoustic vs. visual) ANOVA with repeated measurement on the first factor. The analysis revealed a significant main effect of valence, $F(1, 35) = 1601$, $p < .001$, $\eta_p^2 = .98$, indicating that for both modalities positive words were evaluated more positively ($M_{pos} = 87.76$, $SD = 13.66$) than negative words ($M_{neg} = -86.52$, $SD = 13.73$). No other effects reached statistical significance (Fs < 1, ps $> .35$).

3.2 Impact of attention manipulations on contingency awareness

In order to assess whether or not participants were aware of CS-US contingencies, the relative frequency of CSs for which US valence and US identity had been correctly identified was computed. Thus, participants who correctly classified all 16 CSs received a score of one, and participants who did not identify any CSs received a score of zero. These scores were entered into a 2 (US modality: acoustic vs. visual) × 2 (attention focus: CS-focus vs. US-focus) between-subjects ANOVA (for means and standard deviations see Table 2). For the valence awareness assessment, this analysis revealed a significant main effect for attention focus, $F(1, 35) = 12.53$, $p < .001$, $\eta_p^2 = .26$, indicating that valence awareness was more pronounced in the CS-focus ($M = 0.66$, $SD = 0.17$) compared to the US-focus condition ($M = 0.51$, $SD = 0.11$). Moreover, there was a significant interaction of US modality and attention focus, $F(1, 35) = 4.79$, $p = .04$, $\eta_p^2 = .12$. Further analysis revealed that the focus effect was only apparent in the cross-modal, $F(1, 35) = 16.86$, $p < .001$, $\eta_p^2 = .33$, but not in the unimodal condition, $F(1, 35) = 0.89$, $p = .35$, $\eta_p^2 = .03$. Computing the same ANOVA for the identity awareness scores only revealed a significant main effect for attention focus, $F(1, 35) = 15.71$, $p < .001$, $\eta_p^2 = .31$, indicating that identity awareness was more pronounced in the CS-focus ($M = 0.29$, $SD = 0.17$) compared to the US-focus condition ($M = 0.10$, $SD = 0.12$).

Table 2

Overview of the means and standard deviations in the awareness measurement

| Variable | Cross-modal condition | | | | Unimodal condition | | | |
| | CS-Focus | | US-Focus | | CS-Focus | | US-Focus | |
	M	SD	M	SD	M	SD	M	SD
Valence awareness	0.74	0.16	0.50	0.08	0.58	0.13	0.53	0.13
Identity awareness	0.33	0.19	0.11	0.09	0.25	0.14	0.10	0.15

3.3 Conditioning effects

Evaluative conditioning effects were analyzed by comparing the explicit valence ratings for CSs paired with positive words to those paired with negative words. A 2 (valence of US: positive vs. negative) × 2 (attention focus: CS-focus vs. US-focus) × 2 (US modality: acoustic vs. visual) ANOVA with repeated measurement on the first factor (for means and standard deviations see Table 3) revealed a conditioning effect, $F(1, 35) = 24.44$, $p < .001$, $\eta_p^2 = .41$. Specifically, CSs paired with positive words were evaluated more positively than CSs paired with negative words ($M_{pos} = 14.56$, $SD = 27.87$ vs. $M_{neg} = -12.13$, $SD = 28.44$, respectively).

Table 3

Overview of the means and standard deviations for the CS ratings

	Cross-modal condition				Unimodal condition			
	CS-Focus		US-Focus		CS-Focus		US-Focus	
Variable	M	SD	M	SD	M	SD	M	SD
Positive	35.2	25.04	9.06	36.67	8.53	21.24	5.45	17.07
Negative	-23.38	43.45	-14.04	30.13	-8.21	18.59	-2.9	9.97

There was also a marginally significant interaction of valence and attention focus, $F(1, 35) = 4.13$, $p = .05$, $\eta_p^2 = .11$. Conditioning effects were more pronounced in the CS-focus condition ($M_{pos} = 21.86$, $SD = 26.65$ vs. $M_{neg} = -15.79$, $SD = 33.54$, respectively), $t(35) = 5.01$, $p < .001$, $d = 1.69$, than in the US-focus condition ($M_{pos} = 7.26$, $SD = 27.89$ vs. $M_{neg} = -8.47$, $SD = 22.57$, respectively), $t(35) = 2.08$, $p = .04$, $d = 0.7$. Most importantly, this effect was mediated by both measures of contingency awareness (i.e., valence awareness and identity awareness; *Sobel's* $Z_{valence} = -2.59$, $p = .01$; *Sobel's* $Z_{identity} = -3.18$, $p = .002$; see Figure 1 for the complete path models). That is, increased direct attention to the CS does indeed lead to

stronger EC, because CS attention focus leads to higher contingency awareness which in turn enhances EC.
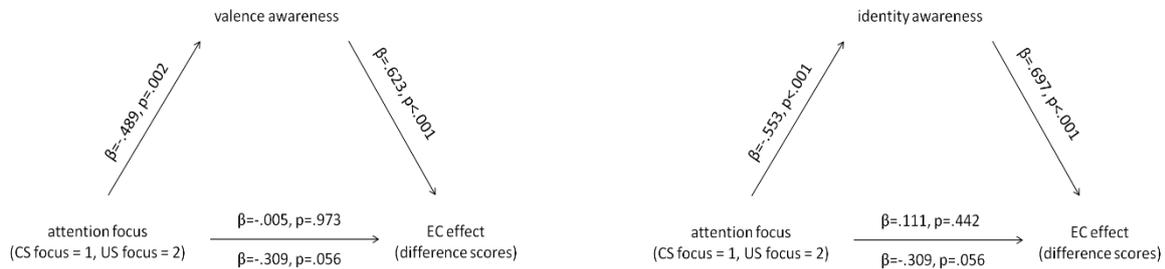
Figure 1. Path models for the indirect effects of attention focus on EC via valence awareness (*Sobel's Z* = -2.5912, *p* = .0096) and via identity awareness (*Sobel's Z* = -3.1832, *p* = .0015).

There was also a significant interaction of valence and modality, $F(1, 35) = 6.87$, $p = .01$, $\eta_p^2 = .16$. Separate simple effect analyses revealed that EC was stronger in the cross-modal condition ($M_{pos} = 22.13$, $SD = 33.37$ vs. $M_{neg} = -18.71$, $SD = 36.70$, respectively), $t(19) = 4.30$, $p < .001$, $d = 1.19$, compared to the unimodal condition ($M_{pos} = 6.99$, $SD = 18.79$ vs. $M_{neg} = -5.55$, $SD = 14.70$, respectively), $t(18) = 2.07$, $p = .03$ (one-tailed), $d = 0.73$. Interestingly, this effect of attentional resources on EC was mediated neither by valence awareness ($p = .20$) nor by identity awareness ($p = .41$, see Figure 2 for the complete path models). The three-way interaction of valence, attention focus and US modality failed to reach statistical significance, $F(1, 35) = 1.57$, $p = .22$.

Figure 2. Path models for the indirect effect of US-modality on EC via valence awareness (*Sobel's Z* = -1.281, *p* = .20) and via identity awareness (*Sobel's Z* = -.829, *p* = .41).

4. General Discussion

4.1 Summary of the results

This study aimed at shedding light on the relationship between EC, attention and contingency awareness. Specifically, the influence of attentional resources and goal-directed attention on EC was examined and whether these effects are mediated by contingency awareness. Confirming the moderating influence of attentional resources on EC, there was stronger EC in the cross-modal compared to the unimodal condition. Learning of CS-US pairs seems to be enhanced if CSs and USs are presented in different modalities. This supports the assumption that there are independent attentional resources for the processing of stimuli from different sensory modalities (Alais et al., 2006; Duncan et al., 1997; Sweller, 1988). In contrast, presenting both CS and US within the same modality resulted in impaired processing of CS-US pairs and therefore in weaker EC. This finding is consistent with the notion that stimuli compete for attentional resources if they are presented within the same modality (Alais et al., 2006; Duncan et al., 1997; Sweller, 1988; Walther et al., 2011a). Moreover, attentional resources exerted their effect on EC independent of contingency awareness. Thus varying the attentional resources seems to have no moderating influence on the encoding of CS-US contingencies.

The results also revealed that the explicit instruction to focus attention on the CS increased EC. This is presumably the case because explicit CS focus enhances the probability that this stimulus receives attention relative to the attention grabbing US (e.g., Anderson et al., 2003; Devue et al., 2009; Öhman et al., 2001; Vuilleumier et al., 2001). This explicit focus on the CS also increases contingency awareness. More importantly, the effect of goal-directed attention on EC was mediated by contingency awareness. This finding is in line with the notion that selective attention influences which information is encoded in working memory (for a review see Fougnie, 2008).

4.2 Limitations and future perspectives

Although the results of the current study provide important new information about the interrelation between attention, contingency awareness and EC, there are several concerns that should be discussed and addressed in future research. One issue regards the manipulation of attentional resources in such a way that a modality match between CS and US occurs in one condition. Thus, one might argue that the manipulation of attentional resources is confounded with CS-US similarity, because there is higher CS-US similarity in the unimodal condition than in the cross-modal condition. According to the misattribution account (Jones et al., 2009), similarity of CS and US critically influences the strength of EC. That is, the more similar CS and US are, the more likely is the misattribution of the US valence on the CS. However, the empirical results clearly point in the opposite direction and thus rule out the possibility that CS-US similarity serves as an alternative explanation for the results of this study. After all, there was stronger EC in the cross-modal than in the unimodal condition. Taking this finding into account, it might be speculated that stronger EC in the cross-modal condition might be due to the auditory modality of the US rather than the increased availability of attentional resources. Specifically, it can be argued that auditory USs are more affect-laden than visual USs, resulting in stronger EC in the cross-modal compared to the unimodal condition. However, the absence of an interaction effect between valence and modality in the US ratings renders this explanation rather unlikely.

Referring to the manipulation of attentional resources, it is also noteworthy to discuss the role of stimulus onset asynchrony (SOA) of CS and US. In order to direct attention towards the CSs and the USs in the current study, CSs and USs were presented simultaneously (SOA = 0). Enhanced attention towards both stimuli can only be expected if CS and US are presented simultaneously, but in different modalities. According to Burr, Silva, Cicchini, Banks, and Morrone (2009), "simultaneity of signals from different senses—such as vision and audition— is a useful cue for determining whether those signals arose from one environmental source or

from more than one" (p. 1761). If CS and US are presented simultaneously within the same sensory modality, CS and US will compete for attentional resources, leading to less attention for each individual stimulus (Alais et al., 2006; Walther et al., 2011a). The latter effect, however, may decrease if CS and US of the same modality are presented in a trace or delayed conditioning procedure (SOA > 0). This is because presenting the CS and US in the same modality with an SOA > 0 overrides the effect of stimuli competing for attentional resources. Thus, CS-US contingencies should be equally likely to be encoded in a unimodal and a cross-modal condition. Future research is needed in order to define the role of SOA with respect to the applicability of modality for manipulating attentional resources.

In addition, one might object that the indirect effect of cross-modality on EC via contingency awareness failed to reach statistical significance due to the differential presentation of acoustic USs during encoding and retrieval. That is, identity awareness in the cross-modal condition might have been underestimated due to the visual presentation of the USs in the awareness assessment. However, there was no effect of modality-match on identity awareness ($F_{identity}$ (1, 35) = 0.85, p =.36). Specifically, in the unimodal as well as in the cross-modal condition, identity awareness rates were above chance level. If anything, cross-modal conditioning produced higher rates of identity awareness on a descriptive level (see Table 2). Notably, the identity awareness measure did not reveal an interaction between modality match and attention focus, whereas the measure of valence awareness did. The discrepancy might suggest that the identity awareness measure underestimated awareness in the cross-modal condition because the pattern observed in the valence awareness measure was not reproduced. However, it is more likely that the valence awareness measure has been contaminated with conditioning effects such as that the difference in valence awareness is most likely to reflect differences in CS evaluations instead of differences in awareness (Hütter et al., 2012). It has been argued that this contamination results because of the fact that participants might infer the valence of the US based on the evaluative response evoked by the CS (Gawronski & Walther,

2012; Stahl et al., 2009). Taking this consideration into account it seems quite implausible that the lack of mediation is due to an underestimation of identity awareness in the cross-modal condition.

A further possible criticism might be directed to the lack of manipulation checks for goal-directed attention and attentional resources in the present study. Admittedly, reaction times to the stimuli could provide a viable manipulation check for attentional resources in the current study (i.e., faster reaction times in the cross-modal compared to the unimodal condition). Unfortunately, reaction times were not assessed in all conditions. Further research should address this flaw by assessing reaction times constantly. Regarding goal-directed attention, its crucial influence on EC might be checked by investigating the differential processing of CSs and USs under conditions where the stimuli have to be selected against each other. Although in the present study, participants were instructed either to respond to the CS or the US, the response on the respective target stimulus was completely independent of the other stimulus of the CS-US pair. Therefore, the current study allows for no conclusions on the contribution of the processing of the non-targeted stimuli on the effect. However, it is this relative processing effect, which is essential for a better understanding of the encoding of CS-US contingencies in EC. To be more precise, investigating the relative contribution of the selective processing of the CS and the US to EC might provide deeper insights to the structure of the contingency representation underlying EC.

Chapter 3

When ignorance breeds preference:

The influence of selective attention on evaluative conditioning[2]

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[2] This chapter is based on the manuscript titled *When Ignorance Breeds Preference: The Influence of Selective Attention Processes on Evaluative Conditioning* co-authored by Eva Walther and Cristian Frings, currently being under revision for resubmission in the *Journal of Experimental Psychology: Learning, Memory, and Cognition*

1. Introduction

Theorists of human and animal learning have emphasized for a long time that attention plays a central role in learning (Kruschke, 2001; Lawrence, 1949; Mackintosh, 1975; Rescorla & Wagner, 1972). As already described in a more detailed way in Chapter 1, the Rescorla-Wagner (1972) model of associative learning assumes, for instance, that stimuli possess different attention-grabbing characteristics, resulting in different rates of learning. Moreover, the Rescorla-Wagner model (1972) states that the rate of learning is driven by the surprisingness of the US, thereby assuming that conditioning is dependent on the attention paid to the US at the expense of its associative strength relative to the CS. In contrast to this notion, Mackintosh (1975) assumes changes in the processing of the CS. Specifically his theory suggests that the salience of the CS increases with its predictive validity for the US. This means that the organism pays little attention to and will hence learn very little from stimuli that are poor predictors. Although Hall and Pearce (1979) later questioned this general notion, there is considerable empirical evidence that both, changes in processing of the US and changes in the amount of attention paid toward the CS, contribute to conditioning.

1.1 The role of attention in evaluative conditioning

Given this core role attributed to attention in learning and the sophisticated theorizing concerning the role of the CS and the US, respectively, it is surprising that the role of attention is still not yet well understood in attitude learning, that is, in the acquisition of preferences (Le Pelley, Calvini & Spears, 2013). The relative inattention to attention processes in preference learning research is also surprising, given that attention is considered a key principle in the effectiveness of advertisements that are clearly aimed at forming and changing our preferences (Tiffin & Winick, 1954). There are several studies showing that the processing of advertisements, and thus their representation in memory, is critically dependent on the degree of attention paid to them (e.g., Burke, Hornof, Nilsen, & Gorman, 2005; Simola, Kuisma, Öörni,

Uusitalo, & Hyönä, 2011; Zhang, 2000). The lack of attention research in EC is also puzzling because this area has experienced a vigorous debate concerning the role of contingency awareness (i.e., awareness of the statistical correlation between the CS and the US) in evaluative learning. Whereas some researchers claim that EC occurs in the absence of awareness (e.g., Baeyens et al., 1990; Field & Moore, 2005; Fulcher & Hammerl, 2001; Jones, Fazio, & Olson, 2009; Olson & Fazio, 2001, 2002; Walther & Nagengast, 2006), others assume that only people who are aware exhibit EC effects (e.g., Bar-Anan et al., 2010; Dawson, Rissling, Schell, & Wilcox, 2007; Dedonder et al., 2010; Pleyers et al., 2007, 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009). As already mentioned in Chapter 1 and 2, the awareness debate refers to the theoretically important question of whether EC is different or similar to other basic forms of learning, such as Pavlovian conditioning or signal learning (see De Houwer et al., 2001; Walther et al., 2005). In addition, it raises the potentially disturbing question of whether people can consciously control the acquisition of their likes and dislikes (see Gawronski & Walther, 2012).

1.2 Attention and contingency awareness

Although some researchers have been interested in the relation between attention processes and EC (Brunstrom & Higgs, 2002; Corneille et al., 2009; Dijksterhuis & Aarts, 2010; Field & Moore, 2005; Jones et al., 2009; Kattner, 2012; Le Pelley, et al., 2013), attention and contingency awareness are often not differentiated. In fact, many studies have used a dual task paradigm that clearly influences both attention and awareness. However, while some researchers postulate a direct influence of increased attentional resources on EC (e.g., Field & Moore, 2005), others presume that attention exerts its effect on EC via contingency awareness (Pleyers et al., 2007, 2009). One reason why there exists such wide room for interpretation is that all these previous studies manipulated attention by manipulating mental load. Moreover, no distinction is made between "attention to the task, to the stimuli or to the information carried

by the task" (Nissen & Bullemer, 1987, p. 29). Although recent studies made progress on this issue by investigating the predictiveness of the CS as a means to address attention (Le Pelley, et al., 2013), the role of *selective* attention in EC remains unaddressed.

1.3 Addressing the role of selective attention in evaluative conditioning

The present experiments aimed at overcoming these shortcomings by adopting a paradigm very well established in selective attention research. From this more fine-grained analysis of the attention processes involved in evaluative learning, I expect deeper insights into how attentional processes modulate evaluative conditioning. In fact, given that USs automatically attract attention due to their affective nature (e.g., Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Hermans, De Houwer, & Eelen, 1994; Klauer, Roßnagel, & Musch, 1997; Pratto & John, 1991; Roskos-Ewoldsen & Fazio, 1992; Wentura, Rothermund, & Bak, 2000), EC is generally assumed to depend on the degree of attention devoted to the CS, and this assumption is supported by a study from Jones et al. (2009, Experiment 4). In manipulating the relative salience of CS and US, the authors found that EC increases if the CS within a given CS-US pair is perceptually more salient (has larger size) than the US. Taken together, these results indicate that allocating more attention to the CS results in stronger EC (see also Blask, Walther, Halbeisen, & Weil, 2012, for similar findings).

However, the picture may be more complex than this. Given the attention-grabbing affective nature of the US (e.g., Anderson et al., 2003; Devue et al., 2009; Öhman et al., 2001; Vuilleumier et al., 2001), it is not only the amount of attention towards the CS, but rather the amount of attention allocated to both stimuli, the CS and the US, that presumably drives EC effects. In particular, if the US is selectively ignored (e.g., because it hampers the processing of the CS), this selective ignoring may decrease evaluative learning. Specifically, it might be argued that selective ignoring of the US impairs the integration of the CS and the US, which may result in diminished EC. This hypothesis is based on research on the instance theory

(Logan, 1988, 1990) indicating that selective attention does play a role at encoding stimuli (and their relations). For instance, Logan and Etherton (1994) showed that participants encoded (and later on retrieved) relations between words if they attended to both stimuli, while they did not encode the relation between the words if they selectively ignored one of the words (see also Boronat & Logan, 1997). Thus, I assume that selective attention can possibly influence the encoding and integration of CS and US and thereby influence evaluative learning.

To this end, I incorporate a selection task from the field of selective attention into an EC paradigm. Cognitive scientists investigate selective attention with filtering tasks or selection tasks (see Luck & Vecera, 2002, for a review). The basic structure of these tasks is to present participants with a relevant stimulus (target) and an irrelevant stimulus (distracter) and instruct participants to selectively respond to the target. It is typically assumed that the relevant and irrelevant information will both get some initial bottom-up activation (for example, because participants allocate their attention to the location of the relevant and irrelevant information). As a consequence, performance in these tasks would benefit if selective attention could amplify the processing of relevant stimulus attributes and suppress the processing of irrelevant stimulus attributes.

In many models of cognitive control, the selective ignoring of distracters is assumed to be a core ability (e.g., Friedman & Miyake, 2004; Frings, Wentura, & Wühr, 2012; Gorfein & MacLeod, 2007; Wühr & Frings, 2008). Because the typical stimuli in an EC paradigm involve an affect-laden US and a rather neutral CS, I assume that learning might depend in part upon the selective processing of the US relative to the CS. For example, what if the task or situation in which the CS-US pair is presented forces participants to selectively attend to the CS while ignoring the US. Will EC still take place under conditions in which the US and its evaluative response are actively suppressed (i.e., selectively ignored)?

In order to answer this question I used an EC paradigm including a variant of the Eriksen flanker task. In a typical Eriksen flanker task, participants perform a choice response to the

central item in a string of letters (e.g., BAB). The adjacent letters, which are irrelevant for the participants' task, are called "flankers" or "distracters". In compatible conditions, the flankers and the target are mapped onto the same response; in incompatible conditions the flankers and the target are mapped onto different responses. Faster responses in compatible conditions than in incompatible conditions represent the Eriksen (or flanker) effect (Eriksen & Eriksen, 1974; see Eriksen, 1995, for a review). It is assumed that flanker stimuli will be processed up to the level of response generation and in the case of incompatible flankers will thereafter be controlled by suppressing the interfering response (Friedman & Miyake, 2004). Yet, the cognitive control of the interference at the level of response selection requires time, resulting in slower RTs in incompatible trials as compared with compatible trials. In addition, cognitive control is not perfect as reflected in a higher amount of errors typically observed in incompatible trials; the higher error rate can be interpreted as failures of control processes to suppress the response generated by the flankers (e.g., Frings et al., 2012; Wesslein, Spence, & Frings, 2014).

1.4 The present research

To investigate the moderating influence of selective attention processes on EC two experiments were designed in which CS-US pairs were presented within an adapted Flanker paradigm. Similar to the original Flanker paradigm (Eriksen & Eriksen, 1974), a target-distracter logic was implemented by introducing the CS as the task-relevant stimulus (i.e., the target) and the US as a task-irrelevant distracter. If EC is considered through the lens of selective attention processes the integration of CS and US should critically depend upon whether the US would be ignored or not. In particular, in Experiment 1, CSs and USs were framed with a colored line and participants had to classify the color of the CS's frame, or not respond at all. The colored frames of CS and US could be compatible or incompatible. Concerning the idea of selection as outlined above, I hypothesized that in incompatible trials, selective ignoring of the US would impair the internal representation of the US, thereby weakening the impact of the US

on the CS. In contrast, in compatible trials, the US does not have to be selectively ignored. Insofar as processing of the USs in compatible trials does not interfere with the target-response, standard EC effects are expected under this condition. In the control condition, in which participants are required not to respond to the stimuli, compatibility of the stimuli's frames should be irrelevant, as the CS does not have to be selected against the US.

To put it concisely, I expected a negative impact of incompatible USs on EC in conditions in which the US was selectively ignored. Given that attention to the CS is guaranteed because people were always required to attend to the CS, selectively ignoring incompatible USs should result in a decrease of evaluative learning. In Experiment 2, I conceptually replicate my findings. Participants either were asked again to select the CS against the US or were required to process both stimuli for responding.

2. Experiment 1

2.1 Method

Participants and Design

A total of 31 participants (15 women) participated in a study on "colors and perception". Participants were assigned to a 2 (US-valence: positive vs. negative) × 2 (selection of the CS: selection vs. no selection) × 2 (compatibility of the CS and US frame: compatible vs. incompatible) within-subjects design. All participants received course credit for their participation. Data from one participant who rated all USs in the opposite direction of the actual US-valence were not included in the analyses.

Procedure

Upon entering the laboratory, participants were welcomed by the experimenter and seated in front of a 19-inch LCD-screen at a distance of 60 cm. Before beginning the experiment participants were administered a consent form to sign. The experiment was conducted using

MediaLab (v.2008) and directRT (v.2008) and consisted of two consecutive phases: a conditioning phase and a test phase.

Conditioning phase. In the conditioning phase, participants were presented with 16 CS-US pairs comprising sixteen fictitious water brands (e.g., Abrizzo, Helvipo, Insente, Ustia, Lurent) as CSs (Blask et al., 2012) and eight positive and eight negative pictures from the EmoPics database (Wessa, Kanske, Neumeister, Bode, Heissler, & Schönfelder, 2010) as USs. Positive USs were characterized by mean valence ratings of 7.41 and mean arousal ratings of 4.71. Negative USs had mean valence ratings of 2.74 and mean arousal ratings of 5.65. One half of the USs of each valence was characterized by a frame color compatible with that of the paired CS, whereas the other half was incompatible with the frame color of the paired CS. In the selection condition, participants were asked to classify the CS with respect to its frame color if it was preceded by a grey dot. Specifically, participants were asked to press the green marked key in response to water brands with a green frame and the yellow marked key for water brands with a yellow frame. In the no selection condition participants were instructed not to respond at all. In order to increase participants' commitment to the task, each correct response was followed by a "correct" feedback and each incorrect response was followed by an "incorrect" feedback remaining on the screen for 1000 ms. CS-US pairs were presented simultaneously for 1000 ms, then being followed by a blank screen for 500 ms. These 1500 ms constituted the response time window during which responses in the selection condition were recorded. In order to keep the timing constant across both selection conditions this time window was also applied to the no selection condition. The response time window was then followed by the response feedback screen for 1000 ms, and an ITI of 500 ms. In the selection condition, the grey dot was presented during the ITI of 500 ms, in the no selection condition only a blank screen appeared. Prompting selection-trials by the grey dot allowed for intermixing selection and no selection trials. CS and US pictures subtended visual angles of 12.0 degrees horizontally by 9.6 degrees vertically. Because previous research has shown that backward conditioning

(i.e., the US spatially precedes the CS) results in reduced EC (Hofmann et al., 2010), CS-US pairs were presented in the centre of the screen with CSs being always presented on the left side and USs on the right side. The stimuli's center-to-center difference was 16.06 degrees. Each of the 16 CS-US pairs was repeated 12 times resulting in a total of 192 trials.

Test phase. The conditioning phase was followed by a test phase. Participants were asked to rate how much they liked the presented stimuli in two separate blocks on a graphic rating scale (labeled ''dislike'' on the left and ''like'' on the right). Participants assigned their ratings to each stimulus by positioning the cursor on any point of the scale and then pressing the left mouse key. The first block consisted of the sixteen CSs, the second block of the USs. To avoid response tendencies, the graphic scale consisted of no additional numbers or other numerical labels. The computer program recorded negative judgments on the left side from -100 to -1, and positive judgments on the right side from +1 to +100. The neutral midpoint of the scale (0) served as the starting position for each judgment.

2.2 Results and Discussion

Manipulation checks - response interference. In order to test whether, in the selection condition, incompatible CS-US pairs actually resulted in more response interference than compatible CS-US pairs, participants' reaction times for compatible and incompatible CS-US pairs were submitted to a one-way repeated measures ANOVA. Only reaction times for correct responses were submitted to the analysis. The analysis revealed a significant Flanker effect, $F(1, 29) = 7.53$, $p = .011$, $MSE = 976.38$, $\eta_p^2 = .21$, indicating that reactions on compatible CS-US pairs were significantly faster than on incompatible CS-US pairs ($M_{compatible} = 588$ ms, $SD = 81$ ms, and $M_{incompatible} = 610$ ms, $SD = 98$ ms, respectively).

In order to analyze response accuracy data, compatible and incompatible CS-US pairs in the selection condition were submitted to a one-way repeated measures ANOVA. This analysis revealed a significant main effect of compatibility of the CS and US frame, $F(1, 29) =$

11.85, $MSE = 0.004$, $p = .002$, $\eta_p{}^2 = .29$. This effect indicates that participants were less accurate (i.e., made more errors) in CS-response selection for incompatible CS-US pairs ($M_{accuracy} = 0.83$, $SD = 0.22$) compared to compatible CS-US pairs ($M_{accuracy} = 0.88$, $SD = 0.17$).

Conditioning Effect. In order to test for an overall EC effect, ratings of CSs paired with positive USs and ratings of CSs paired with negative USs were submitted to a one-way repeated measures ANOVA. The analysis revealed a significant conditioning effect, $F(1, 29) = 16.48$, $MSE = 687.40$, $p < .001$, $\eta_p{}^2 = .36$, indicating that CSs paired with positive USs were evaluated more positively ($M_{pos} = 16.86$, $SD = 32.96$) than CSs paired with negative USs ($M_{neg} = -10.62$, $SD = 34.67$; for means and standard deviations in all conditions see Table 4).

Table 4

Overview of the means and standard deviations of CS evaluations and accuracy rates (Experiment 1)

	selection				no selection			
	compatible		incompatible		compatible		incompatible	
US-valence	M	SD	M	SD	M	SD	M	SD
Positive	25.27	33.05	10.72	33.88	10.37	32.11	21.10	32.79
Negative	-12.75	36.76	-9.42	30.50	-8.55	36.68	-11.77	34.75
Accuracy rates	0.88	0.17	0.83	0.22				

Effects of selective attention on EC. In order to simplify analyses, the scores of CSs paired with negative USs were subtracted from CSs paired with positive USs (i.e., I computed EC effects). The EC effects were then submitted to a 2 (selection of the CS: selection vs. no selection) × 2 (compatibility of the CS and US frame: compatible vs. incompatible) ANOVA

with repeated measurement[3]. This analysis revealed the expected two-way interaction between selection of the CS and compatibility of the CS and US frame, $F(1, 29) = 5.22$, $MSE = 1456.14$, $p = .030$, $\eta_p{}^2 = .15$. The main effects of compatibility of the CS and US frame as well as selection of the CS failed to reach statistical significance ($F(1, 29) = 0.08$, $MSE = 1443.39$ and $F(1, 29) = 0.16$, $MSE = 1864.77$, respectively). Consistent with the hypothesized semi-disordinal structure of the interaction, EC effects only differed as a function of the compatibility between CS and US frame if CSs had to be selected against the US, but not if the CS did not have to be selected against the US. Specifically, EC was more pronounced in the compatible selection condition ($M = 38.02$, $SD = 50.31$) as compared with the incompatible selection condition ($M = 20.13$, $SD = 47.10$), $F(1, 29) = 3.72$, $MSE = 1288.08$, $p = .032$ (one-tailed)[4], $\eta_p{}^2 = .11$ (see Figure 3), indicating that in the incompatible selection condition, selectively ignoring the response irrelevant US diminished its influence on EC. Note that EC was significantly different from zero in both compatible and incompatible selection conditions (all $ps < .027$), indicating that, even though selective ignoring of the US had a moderating influence on EC, it did not fully prevent evaluative conditioning. In the condition in which participants did not have to select the CS against the US, compatibility of CS-US pairs did not modulate EC, $F(1, 29) = 1.81$, $MSE = 1611.45$, $p = .189$ ($M_{compatible} = 18.92$, $SD = 54.00$; $M_{incompatible} = 32.87$, $SD = 50.97$).

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[3] Note that the effects reported in the simplified analysis are the same as those resulting from the more complex analysis including US-valence as another within-subjects factor. Effects differ only with respect to the size of the MSE-values, which is due to the varying computation of MSE-values in these analyses.

[4] Note that this F-test corresponds to a t-test for paired samples. Because we expected the EC effect to be larger in compatible as compared to incompatible trials, a one-tailed test appears justified (e.g., Maxwell & Delaney, 1990).

Experiment 1 showed first evidence for the influence of the selective processing of the US on EC. In particular, when participants had to select the CS against an incompatible US, EC was decreased. As outlined above, I argue that flanker interference in incompatible trials is solved by selective ignoring of the flanker (i.e., the US), thereby reducing the processing of the US. This suppression of the US reduces the probability for the integration of the CS with the evaluative response. Before I discuss the implications of this finding in the General Discussion, I will briefly discuss two caveats regarding this experiment and replicate my finding conceptually in Experiment 2. Note that, given that the EC effect was significantly larger in compatible as compared to incompatible trials in the selection condition only at the one-tailed level, a replication is recommended.

3. Experiment 2

One potential shortcoming of Experiment 1 was that participants did not respond at all in the no selection condition. One might argue that the two conditions (selection vs. no selection) tap not only differences in selective attention. For example, it might be argued that differences in compatibility are not a result of differences in selective attention, but of the different response requirements (i.e., responding vs. not responding). In order to rule out this issue, I modified the procedure in Experiment 2 such that participants were always required to respond to the CS-US pairs. Consequently, response requirements were kept constant across selection conditions. In the selection condition, participants again selected the CS against the US by means of the stimulus' frame. In the no selection condition, however, participants were asked to match both stimuli (i.e., they had to decide whether they had the same or different frame colors) and therefore always processed both stimuli without selectively ignoring the US.

In order to keep the compatibility indicating feature (i.e., the colored frame for CSs and USs) constant across both selection conditions, I realized a between subjects design. Realizing this design in a within-subjects manner would require a cue indicating whether participants

have to ignore or not ignore the US in the upcoming trial. I avoided the inclusion of cues by realizing a between-subjects design. In addition, the realization of a between-subjects design allowed for the control of possible task-switching costs, which might have undermined the impact of compatibility of the CS and US frame on EC in the selection condition of Experiment 1. Specifically, that the effect was only marginally significant might depend to some degree on difficulties in switching between responding (i.e., selection condition) and not responding (i.e., no selection condition) on compatible and incompatible CS-US pairs. Based on my hypothesis and the supporting evidence obtained in Experiment 1, I expected that selectively ignoring the US should diminish EC.

3.1 Method

Participants and Design

A total of 96 participants (70 women) participated in a study on the relationship between "colors and perception". Participants were randomly assigned to a 2 (US-valence: positive vs. negative) × 2 (compatibility of the CS and US frame: compatible vs. incompatible) × 2 (selection of the CS: selection vs. no selection) mixed-factorial design with the last factor being manipulated between participants. Participants received either course credit or a monetary compensation of three Euros for their participation. Data from one participant who did not follow the instructions to select the correct CS-response were excluded from further analysis. Another participant participated twice in this experiment and data from the second participation were therefore excluded. Excluding these two participants, a total of 46 participants remained in the selection and 48 participants in the no selection condition.

Procedure

Procedure and stimulus material were the same as in Experiment 1 with the following exceptions. During conditioning, participants in the no selection condition were asked to classify the CS with respect to its similarity to the US. That is, if CS and US had the same frame

color, participants had to press the "similar" key, and if they had different frame colors, they were asked to press the "dissimilar" key.

Insofar as participants' task in the selection condition was to classify the CS with respect to its frame color, the selection of the CS was manipulated between subjects. The between subjects manipulation allowed for the use of the same response keys across both selection conditions. More specifically, the between subjects manipulation allowed for keeping the compatibility indicating feature constant across both selection conditions. In both the selection and the no selection condition, the location of the CS was prompted by a grey dot preceding the presentation of each CS-US pair. By cueing the location of the CS in both conditions, an initial attention focus on the CS was kept constant across conditions.

3.2 Results and Discussion

Manipulation checks - response interference. In order to test whether there is a Flanker effect in the selection condition, but not in the no selection condition, I submitted participants' reaction times to a 2 (compatibility of the CS and US frame: compatible vs. incompatible) $\times$ 2 (selection of the CS: selection vs. no selection) mixed-factorial ANOVA with repeated measurement on the first factor. Similar to Experiment 1 only reaction times for correct responses were analyzed. The results showed no significant main effect of compatibility, $F(1, 92) = 3.05$, $MSE = 585.99$, $p = .084$, as well as no main effect of selection, $F(1, 92) = 1.10$, $MSE = 11531.73$, $p = .298$. However, the expected interaction between selection of the CS and compatibility of the CS and US frame reached statistical significance, $F(1, 92) = 4.72$, $MSE = 585.99$, $p = .032$, $\eta_p^2 = .05$. Testing for the contrast between compatible and incompatible CS-US pairs within the selection condition revealed the expected Flanker effect, $F(1, 45) = 7.10$, $MSE = 620.92$, $p = .011$, $\eta_p^2 = .14$. That is, participants' reactions on compatible CS-US pairs were significantly faster than on incompatible CS-US pairs ($M_{compatible} = 533$ ms, $SD = 76$ ms, and $M_{incompatible} = 547$ ms, $SD = 85$ ms, respectively). Conducting the same test for the no

selection condition revealed no significant difference in reaction times for compatible and incompatible CS-US pairs, $F(1, 47) = 0.09$, $MSE = 552.57$.

Conducting the same analysis on response accuracy revealed no main effect of compatibility of the CS and US frame, $F(1, 92) = 2.63$, $MSE = 0.002$, $p = .108$, no main effect of selection of the CS, $F(1, 92) = 1.27$, $MSE = 0.02$, $p = .263$ as well as no significant interaction effect, $F(1, 92) = 1.73$, $MSE = 0.002$, $p = .191$. However, separately testing for response interference effects within the selection and the no selection condition, respectively, revealed a significant response interference effect within the selection condition, $F(1, 45) = 4.12$, $MSE = 0.002$, $p = .048$, $\eta_p^2 = .08$. Similarly to the results of Experiment 1, participants were less accurate in selecting the correct CS response for incompatible CS-US pairs ($M_{accuracy} = 0.91$, $SD = 0.11$) compared to compatible CS-US pairs ($M_{accuracy} = 0.93$, $SD = 0.10$). As for the RT data, there was no moderating influence of compatibility on response accuracy in the no selection condition, $F(1, 47) = 0.05$, $MSE = 0.002$ (for means and standard deviations in all conditions see Table 5).

Conditioning Effects. In order to test whether CSs paired with positive USs were evaluated more favorably than CSs paired with negative USs, CS ratings were submitted to a one-way repeated measures ANOVA. The analysis revealed a significant conditioning effect, $F(1, 93) = 18.44$, $MSE = 741.37$, $p < .001$, $\eta_p^2 = .17$, indicating that CSs paired with positive USs were evaluated more positively ($M_{pos} = 9.49$, $SD = 22.79$) than CSs paired with negative USs ($M_{neg} = -7.57$, $SD = 23.02$; for means and standard deviations in all conditions see Table 5).

Table 5

Overview of the means and standard deviations of CS evaluations and accuracy rates (Experiment 2)

| | selection | | | | no selection | | | |
| | compatible | | incompatible | | compatible | | incompatible | |
US-valence	M	SD	M	SD	M	SD	M	SD
Positive	12.03	27.28	7.10	29.17	8.71	30.23	10.11	26.64
Negative	-13.20	30.87	-5.74	27.61	-3.05	26.42	-8.45	30.28
Accuracy rates	0.93	0.10	0.91	0.11	0.94	0.07	0.94	0.11

Effects of selective attention on EC. EC effects (i.e., the difference between CSs paired with positive USs and CSs paired with negative USs) were computed and then submitted to a 2 (compatibility of the CS and US frame: compatible vs. incompatible) $\times$ 2 (selection of the CS: selection vs. no selection) mixed-factorial ANOVA with repeated measurement on the first factor[5]. This analysis revealed the expected two-way interaction between compatibility of the CS and US frame and selection of the CS, $F(1, 92) = 4.42$, $MSE = 978.66$, $p = .039$, $\eta_p^2 = .05$, indicating that EC differs as a function of compatibility and selection group. Similar to Experiment 1 there was neither a main effect of compatibility of the CS and US frame, $F(1, 92) = 0.38$, $MSE = 978.66$ nor a main effect of selection of the CS, $F(1, 92) = 0.24$, $MSE = 2990.08$. In order to test whether the two-way interaction reflects the hypothesized semi-disordinal

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[5] Note that the effects reported in the simplified analysis are the same as those resulting from the more complex analysis including US-valence as another within-subjects factor. Effects differ only with respect to the size of the MSE-values, which is due to the varying computation of MSE-values in these analyses.

contrast, I computed compatibility effects within the different selection conditions. As expected, compatibility only modulated EC if the CS had to be selected against the US, $F(1, 45) = 4.62$, $MSE = 765.10$, $p = .038$, $\eta_p^2 = .09$ (see Figure 3). Replicating the results of Experiment 1, EC was more pronounced in compatible trials ($M = 25.23$, $SD = 48.01$) than in incompatible trials ($M = 12.84$, $SD = 49.21$). In contrast, there was no significant impact of compatibility on EC within the no selection condition, $F(1, 47) = 0.94$, $MSE = 1183.13$, $p = .338$ ($M_{compatible} = 11.76$, $SD = 48.01$; $M_{incompatible} = 18.56$, $SD = 41.55$), indicating that compatibility only moderates EC if the CS has to be selected against the US.

Finally, in line with the results of Experiment 1, EC in the compatible selection condition was significantly different from zero ($p < .001$). However, EC in the incompatible selection condition was weaker and differed significantly from zero only in a one-tailed test ($p = .042$, one-tailed). This finding is one more indication that ignoring the US results in a substantial reduction of EC. In sum, the results of the second experiment provided further support for my hypothesis that selectively ignoring incompatible USs has a diminishing impact on EC.
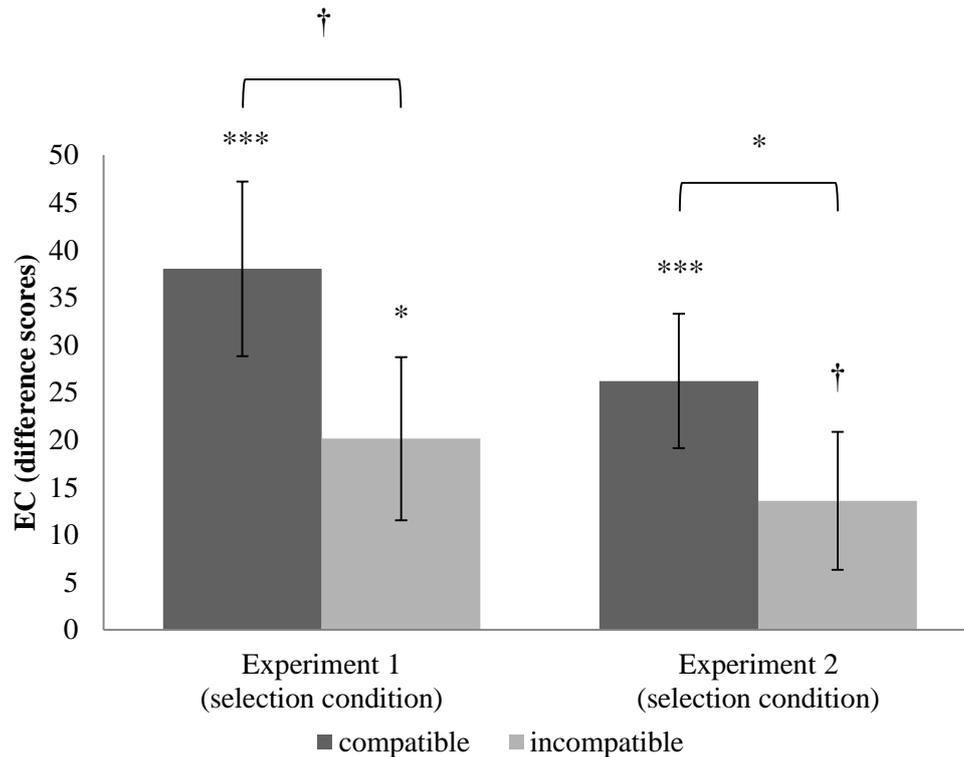
Figure 3. Evaluative Conditioning effects as a function of compatibility in the selection conditions, Experiments 1 and 2. Error bars indicate the standard errors of the means.

However, it might be argued that there was a confounding factor in Experiment 2, namely responding to a single stimulus (i.e., the CS) in the selection condition versus responding to two stimuli (i.e., the CS and the US) in the no selection condition. That is, it might be argued that participants in the no selection condition had fewer resources for processing the CS because they had also to attend to the US. However, as the average RTs in the selection condition did not significantly differ from the average RTs in the no selection condition it seems at least questionable whether comparing two frames really tapped more attentional resources as classifying the color of the target frame.

4. General Discussion

4.1 Summary of the results

Two experiments were designed to investigate the influence of selective attention processes on evaluative learning. Although EC has been intensively investigated in recent years (for a review see, Hofmann et al., 2010), evidence for the (attentional) processes underlying this form of learning is still scarce. In order to address selective attention processes in EC, a variant of the Eriksen flanker task was integrated into a standard EC paradigm. Specifically, I implemented a target-distracter logic by introducing the CS as the target and the US as a task-irrelevant distracter. Selective attention was varied by instructing participants to selectively respond to the CS while ignoring the US, or in the control condition not to respond at all. Results of Experiment 1 provided first evidence that selectively ignoring incompatible USs substantially decreases EC effects. In Experiment 2, I replicated this result and ruled out alternative explanations in terms of differences between the selection and no selection condition on the response level.

Overall, the findings provide compelling evidence for a moderating influence of selective attention processes on EC. In particular, EC was reduced when CSs had to be selected against incompatible USs. Given that EC always refers to the valence transfer from the US to the CS, these findings support the theoretical notion that, in incompatible trials, selectively ignoring the US impairs the internal representation of the US features (Friedman & Miyake, 2004; Frings et al., 2012). According to my hypothesis, limited access to the US's internal representation and thus to its valence reduces the probability for the integration of the CS with the valence feature of the US, and, therefore, EC. In contrast, in compatible trials the US does not interfere with the relevant target response and therefore does not have to be selectively ignored. There was, however, no influence of CS-US compatibility and thus no processing interference for incompatible CS-US pairs if the CS did not have to be selected against the US.

4.2 Limitations and Avenues for Future Research

It should be noted, however, that my variant of the flanker task differed in an important aspect from the original task. In fact, in the standard flanker task, participants select the target object against distracting flanker objects. In my paradigm, participants selected the frame of an object (the CS) against the frame of another object (the US). Thus, one might wonder whether selective attention affected the CS and US or only their frames, respectively. Yet, presenting accurately fitting frames around pictures is typically assumed to lead to the perception of one object (a framed picture) and not to the perception of two objects (a frame and a picture) due to Gestalt mechanisms; for example, it is known that visual elements form perceptual objects on the basis of varying properties like proximity, similarity, closure, or common fate (for a review, see Bruce & Green, 1990). Thus, it is plausible to assume that in my task participants selectively ignored a feature of the US (its frame). Ignoring a feature of an object, however, typically also affects other features of the same object due to object-based attention (see e.g., Wühr & Frings (2008), who showed that an incompatible feature produced less interference when it was presented on an ignored shape as compared to when it was presented on the background). The same logic applies to the processing of the CS; here one can say that responding to one feature of the CS, its frame, will facilitate processing of the whole object (e.g., Duncan, 1984).

My findings are important because they shed light on the stimulus-integration process involved in evaluative learning. In conditioning research it is a widely-shared assumption that USs are automatically processed due to their affective nature (e.g., Fazio et al., 1986; Hermans et al., 1994; Klauer et al., 1997; Pratto & John, 1991; Wentura et al., 2000). This assumption seems difficult to reconcile with my findings indicating that processing of the US can be impaired by selective ignoring of the US as realized through the incompatible trials in the flanker task. Consistent with recent theoretical arguments, however, it can be assumed that automaticity is not an all-or-none process in which all four horsemen of automaticity (Bargh, 1994) are simultaneously at work. Instead, automatic processes may have controlled aspects

that need a thorough analysis of their operating conditions (Gawronski & Bodenhausen, in press). Whereas US processing can be assumed to be unintentional, in that no goal is needed to start the process, it might be controllable to some extent. The imperfection of its controllability is supported by the fact that there was significant EC in the incompatible selection condition of Experiment 1 and at least one-tailed significant EC in the incompatible selection condition of Experiment 2.

Cognitive psychologists have argued for decades that attention may be important in the acquisition of conditioned reactions (Kruschke, 2001; Mackintosh, 1975; Rescorla & Wagner, 1972). Surprisingly, the influence of the selective processing of the US on evaluative conditioning has not yet been addressed. While previous studies have mainly investigated attention as a limited resource in the context of contingency awareness (Field & Moore, 2005; Kattner, 2012; Pleyers et al., 2007, 2009), I went beyond this work by addressing a different variant of attention processes, namely the influence of selective ignoring of the US on EC. If the accessibility of the US valence is experimentally decreased by means of becoming a distracter in a selection task, the integration of the CS with US valence is impaired and therefore EC is reduced. Based on this consideration, it would be an interesting avenue for future research to address other factors that influence the integration processes, such as the emotional salience of the US or the difficulty of the distracter task.

Selective attention is one of the basic mechanisms by which organisms control their sensory input from the environment. Because the sensory input is the basis of what is learned in an environment, investigating selective attention processes and in this respect encoding in the context of evaluative learning would seem to be mandatory. Although EC research has recently elicited increasing interest in social (Hofmann et al., 2010), clinical (Blechert, Michael, Williams, Purkis, & Wilhem, 2008; Hermans, Dirikx, Vansteenwegen, Baeyens, Van den Bergh, & Eelen, 2004; Schienle, Walter, Schäfer, Stark, & Vaitl, 2005), cognitive (Hütter et al., 2012) and consumer psychology (Brendl et al., 2014; Sweldens, van Osselear, & Janiszewski,

2010) comparatively little is known about the encoding and learning processes themselves. Taking into account a recently proposed distinction (Gawronski & Bodenhausen, in press), it is not well known either *what* processes are involved in evaluative learning (e.g., propositional, associative, or attributional) or *when* these processes operate (i.e., under which conditions there is a possibility to inhibit or stop the process). The present research contributes to the *when* question by providing evidence for the impact selective attention has on evaluative learning.

Chapter 4

What can contingency memory data tell us about the encoding of CS-US contingencies?[6]

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[6] The following chapter is based on the manuscript *The role of recollection in evaluative conditioning*, authored by Georg Halbeisen, Eva Walther, Katarina Blask, and Rebecca Weil, currently being under revision in the *Journal of Experimental and Social Psychology*

1. Introduction

The numerous demonstrations of EC notwithstanding, there is considerable disagreement about which processes mediate between exposure to CS-US pairs and the observable changes in CS attitudes (Baeyens, Hermans, & Eelen, 1993; Jones et al., 2009; Field & Davey, 1999; Martin & Levey, 1994; Mitchell et al., 2009). One of the reasons for this ongoing debate is that EC has been considered important for "the broader conceptualization of human learning and memory" (Hütter et al., 2012, p. 539). For example, EC research contributes to the general discussion of whether single or dual-process theories more adequately address the processing of evaluative information. While dual-process accounts indicate that, an associative as well as a propositional learning mechanism might independently account for attitude learning (e.g., Gawronski & Bodenhausen, 2006; Rydell & McConell, 2006), single process theories propose that attitude formation is always mediated by propositional processes (Mitchell et al., 2009).

The discussion about single vs. dual-process theories has predominately focused on the question of whether or not EC requires awareness of CS-US pairing during encoding. In order to test for awareness, memory tests are usually applied that require participants to indicate which out of all presented USs has been paired with a given CS (i.e., US identity memory) or to indicate the valence of the US that was paired with the CS (i.e., US valence memory). Although differences in test performance sometimes failed to moderate EC at the level of participants (e.g., Baeyens et al., 1990; Olson & Fazio, 2001; Walther, 2002; Walther & Nagengast, 2006), studies using item-level analysis found conditioning effects only in CSs for which the paired US or its valence was correctly indicated (e.g., Dedonder et al., 2010; Gast, De Houwer, & De Schryvver, 2012; Pleyers et al., 2007, 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009).

The fact that memory performance in awareness tests is the most important moderator of EC may cast some serious doubts on whether theories other than propositional accounts may adequately address evaluative learning (Hofmann et al., 2010). However, just being able to retrieve CS-US contingencies from memory provides actually no answer on whether encoded CS-US contingencies have been learned in an associative or a propositional way. In essence, finding a moderating influence of contingency memory on EC only provides an answer to whether CS-US contingencies have been encoded and to which extent the US has been processed in relation to the CS. Taking these considerations into account, contingency memory data can account for what was encoded but not for what was learned (i.e., associative or propositional mental links). Thus from just showing that contingency memory has a significant moderating influence on EC, we cannot conclude that CS-US contingencies have been learned in an associative or a propositional way. The only thing we can conclude from these data is to which extent CS-US contingencies have been encoded. To be more precise, contingency memory data are well suited to account for the encoding level of the US in relation to the CS, but not for the presumed learning process. In particular, one can deduce from these data whether a US has only been integrated up to the response level (i.e., valence memory without identity memory) or up to the level of identification (i.e., identity memory). Nonetheless, instead of only assessing what has been encoded, investigating the influence of the conscious controllability of processes involved in the retrieval of CS-US contingencies might further contribute to the *when* question put forth at the end of Chapter 3. Specifically, the differential influence of these processes on EC might provide an indicator for the processing depth regarding the encoding of CS-US contingencies. However, whether or not memory performance confounds different memory processes and to what extent different memory processes account for EC's moderation, has rarely been addressed in previous research (e.g., Bar-Anan et al., 2010; Humphreys, Tangen, Cornwell, Quinn, & Murray, 2010; Hütter et al., 2012). In order to close this theoretical gap the present research investigates which memory processes underlie the moderation of EC.

1.1 Intentional and Unintentional Use of Memory in evaluative conditioning

On the one hand, memory can involve the conscious experience of remembering, i.e., recollection (Tulving, 1989). Hence, memory performance in EC studies may reflect intentional uses of consciously recollecting the CS-US pairings (e.g., Balas & Gawronski, 2012; Bar-Anan et al., 2010; Gast et al., 2012; Pleyers et al., 2007; Stahl et al., 2009). In a prototypical contingency memory assessment as described before conscious recollection is mirroring the idea: "If it is this CS then it has to be this US". Conscious recollection thus implies a high controllability of the retrieval of the US in the presence of the CS, insofar as it also allows for the conscious exclusion of the US if required. On the other hand, cognitive psychologists have long emphasized that memory may also have unintended effects (Jacoby, 1991; Tulving, 1989; Schacter, 1987). Unintended effects typically account for performance in "implicit" memory tests that do not involve instructions to remember (Schacter, 1987). Unintended effects also include "informed guessing" which describes accurate responding in explicit tests that occurs without recollection (Jacoby, Toth, & Yonelinas, 1993). Interestingly, there are many studies indicating that such responding can even exceed the influence of intentional uses of memory on performance (cf. Yonelinas, 2002). Unintended effects have been explained by an increase in the accessibility of a particular response that is caused by recent activation (Berry, Shanks, Speekenbrink, & Henson, 2012; Jacoby, McElree, & Trainham, 1999). For example, studies on associative repetition priming have shown that presenting one of two previously paired stimuli increases the accessibility of its associate (Zeelenberg, Pecher, & Raaijmakers, 2003). Accordingly, presenting the CS may increase the accessibility of the paired US as the test's response and thus lead to its indication even without conscious recollection, but just as a result of spreading activation.

In order to distinguish between intended and unintended effects on memory performance, and in this regard the controllability of encoded CS-US contingencies, tasks may be arranged in such a way that intentional and unintentional uses of memory would lead to

opposite effects (Jacoby, 1991; Jacoby et al., 1993). Specifically, the logic of opposition entails the use of conscious recollection to avoid responding in the way that is facilitated by unintended effects of memory. An intriguing example of this logic is found in a recent EC study of Hütter et al. (2012) in which the authors distinguished between recollecting the valence of the paired US and inferring the paired US's valence from CS attitudes. Whereas participants in one condition were instructed to use the responses "pleasant" and "unpleasant" to indicate either their evaluation of the CS or their recollection of the paired US's valence, participants in another condition were asked to reverse their evaluative responses whenever the valence of the paired US was recollected. The failure to control performance in this test thus reveals an effect that occurs in the absence of recollection. Although Hütter et al. (2012) focused on the distinction between intentional uses of recollection and intentional uses of CS attitudes rather than on the difference between intentional and unintentional uses of memory for the pairings, their findings corroborate the general assumption that multiple retrieval-related processes could underlie memory performance. This raises the question of which processes account for the moderation of EC by memory performance.

1.2 The present research

Based on a vast amount of research in cognitive psychology (Jacoby, 1998; Jacoby et al., 1999; Roediger, 1990; Schacter, 1987; Yonelinas & Jacoby, 2012) we hypothesized that besides intentional uses of memory unintentional uses of memory can also account for the moderation of EC by memory performance. Specifically, the CS may increase the accessibility of the paired US which could not only lead to the US's indication in a test of memory (cf. Zeelenberg et al., 2003), but which may also influence how the CS is evaluated (Fazio & Towles-Schwen, 1999; Greenwald, McGhee, & Schwartz, 1998; see also Humphreys et al., 2010). In order to test these hypotheses we designed two experiments in which we used conscious recollection to distinguish between intentional und unintentional influences on

memory performance. Because recollection was identified by manipulating instructions to control memory performance within participants, we were able to conduct a sensitive item-level analysis of which memory processes moderate EC (cf. Pleyers et al., 2007).

2. Experiment 1

In Experiment 1, fictitious water brands (CS) were conditioned using liked and disliked pictures as US. After assessing CS attitudes, we administered a memory test that manipulated instructions to control performance within participants. On each trial a CS and all US were presented such that we could measure whether the paired US was indicated (*identity memory performance*) and whether participants selected another stimulus of the same valence in case that the paired US was not indicated (*valence memory performance*). Because within-participant manipulations of conscious control have posed difficulties for measures of valence memory (see Hütter et al., 2012, for a discussion), our item-level measure of recollection concerned identity memory performance (cf. Gast et al., 2012). Specifically, each CS was tested twice and participants were instructed to avoid indicating the paired US on one trial, so that recollection would be revealed as the successful avoidance of indicating the paired US (Jacoby, 1991). We then analyzed the effects of recollection and identity memory performance on EC. However, in the analysis we also controlled for effects of valence memory performance because its underlying processes could also affect whether the paired US is indicated (e.g., people may infer that the CS was paired with positive US because they like the CS; Hütter et al., 2012; Stahl et al., 2009).

2.1 Method

Participants and design

Seventy-two students (48 women, $M_{age} = 22.5$, age range: 18–45 years) took part in an experiment for course credit. The experiment consisted of a 2 (US valence: liked vs. disliked) × 2 (trial instructions: indication vs. avoidance) within-participants design.

Materials and procedure

Participants were introduced to a computer-guided study consisting of a conditioning procedure, an assessment of CS attitudes, a memory test, and a socio-demographic questionnaire. In order to avoid demand characteristics, the study was described as concerned with "information processing". Concluding the study, participants were debriefed, thanked, and awarded their course credit.

Conditioning procedure

In the conditioning procedure participants were presented with 16 CS-US pairs among an equal number of filler trials. We used pre-tested materials from Brendl and colleagues (2014). Specifically, fictitious brand names (Blask et al., 2012) served as CSs and liked and disliked pictures (e.g., a smiling child, a grieving widow) served as USs. Half of the CSs were paired with liked USs while the other half was paired with disliked USs, and CS-US assignments were counterbalanced across participants (Field & Davey, 1999). An additional set of 16 brand names was paired with pictures of neutral objects (e.g., a stapler) and served as filler trials. CSs were positioned left to the screen's center and presented simultaneously with right-to-center US. The order of trials was randomized with each trial lasting 2000 ms, and an inter-trial interval of 2250 ms. In order to avoid task demands that promote intentional learning of CS-US pairs, participants were asked to perform a focal task which was embedded in the procedure (cf. Olson & Fazio, 2001). The focal task involved the categorization of composite letters (Navon, 1977). Composite letters were chosen to test whether processing style would affect memory reports (Whittlesea & Price, 2001). Because processing style did not influence

the present findings, this variable will not be further reported. The 16 CS-US pairs and 16 filler trials were repeated 7 times each, while 8 composite letters were repeated 14 times each to make a total of 336 trials.

CS attitudes

Participants were then asked to rate how much they liked or disliked each of 16 randomly presented CSs by positioning a cursor on a 201-point sliding scale ranging from -100 (*dislike*) to 100 (*like*). The scale's midpoint (0) served as the starting point for each judgment. To avoid response tendencies, the scale merely showed the labels *dislike* and *like* and provided no additional numbers or other numerical labels.

Memory test

In the memory test administered afterwards, each CS was presented next to a randomly ordered matrix of all 8 liked and 8 disliked USs (cf. Baeyens et al., 1990). In order to identify recollection within memory performance, each CS was simultaneously presented twice with different instructions. The order of trials was randomized such as to avoid carry-over effects between trials. On indication trials participants received the following instructions: "Please select the picture that was paired with the brand. Please guess if you are uncertain." On avoidance trials, however, participants were required to refrain from indicating the paired US. To assure that avoidance of a paired US was based on its recollection rather than having inferred its valence, avoidance trials further instructed participants to indicate another stimulus of the same valence as the paired US. Specifically, the instructions read: "This brand was paired with a liked or disliked picture. Please select a picture of the same valence (i.e., liked or disliked) which was NOT paired with this specific brand." To avoid confusion of participants, instructions were presented anew for each trial. Given these instructions to control performance, recollected USs should be selected on indicate trials, but should not be selected on avoidance trials. Combining the performances under indication and avoidance instructions thus allowed us to infer whether a CS-US pair was recollected or indicated without recollection.

2.2 Results and Discussion

One aim of the present study was to conduct an item-based analysis of the moderation of EC by recollection as compared to unintended effects of memory. Because identifying recollection critically depends on the participants' ability to consciously control memory performance, we first investigated whether the indication and avoidance instructions produced the expected effects on memory performance. One individual unwittingly participated twice in the experiment and the second data set was thus discarded from all analyses.

Memory performance and conscious control

As identifying recollection depends on participants' ability to control performance, we compared performances on trials that instructed participants to select the paired US (indication trials) with trials in which participants were instructed to select for US valence but to not select the paired US (avoidance trials). A 2 (trial instructions: indication vs. avoidance) $\times$ 2 (selection: paired US vs. US valence) repeated-measures ANOVA on the relative frequencies of different choices revealed a significant interaction, $F(1, 70) = 7.80$, $p = .007$, $\eta_p^2 = .10$. Confirming the intended manipulation, pairwise comparisons showed that participants selected the paired US more frequently on indication trials compared to avoidance trials ($M = .35$, $SD = .28$ vs. $M = .29$, $SD = .26$, respectively), $p = .02$, whereas indicating the US valence was more frequently the case in avoidance trials compared to indication trials ($M = .43$, $SD = .22$ vs. $M = .35$, $SD = .20$, respectively), $p = .004$. No other effects were significant, all Fs < 1.80, ps $> .19$. The pattern clearly shows that participants were able to follow the instructions to indicate or avoid indicating the paired US.

Item-based analysis of EC

Following the methodological advances put forward by Pleyers et al. (2007) and Gast et al. (2012), we conducted an item-based analysis of the moderation of EC using linear mixed

effects models as implemented in R (R Development Core Team, 2012) package lme4 (Bates, Maechler, & Bolker, 2012). In this analysis, we modeled CS attitudes as a function of US valence and its potential moderators (i.e., the model's fixed effects) while controlling for random effects of CS attitudes being nested in both the CS-US pairs and participants (Baayen, Davidson, & Bates, 2008). Because effects are only modeled if they help to explain observed variance, we first tested whether the inclusion of US valence and its moderators was justified by an increase in the model's goodness of fit. Model comparisons were conducted using likelihood ratio tests, and models were fitted using maximum likelihood (ML) estimation for fixed-effects model comparisons whereas restricted maximum likelihood (REML) estimation was used for random-effects model comparisons (Baayen et al., 2008).

Model building. EC was defined as the effect of US valence (USval, liked, disliked, coded 1, -1, respectively) on CS attitudes. It was justified to add USval to a null-model of CS attitudes that comprised only by-participant and by-CS-US-pair random intercepts, $\chi^2 (1) = 40.79$, $p < .001$. The inclusion of USval suggests that the conditioning procedure was effective. Moderations of EC were then modeled as interaction effects of USval with other fixed effects. Here we distinguished between recollection, identity memory performance, and valence memory performance. Recollection referred to the pattern of conscious control in which for a CS-US pair the US was selected on indication trials and not selected on avoidance trials (REC, recollected, not recollected, coded 1, 0, respectively). Identity memory performance (IMP) coded the indication of the paired US on either type of trial, thus comprising both recollection and the indication against the avoidance instructions (paired US indicated, not indicated, coded 1, 0, respectively). And finally, valence memory performance (VMP) coded whether participants were able to indicate the paired US valence, thus comprising both identity memory performance as well as the indication of any stimulus of the same valence as the paired US on either type of trial (US valence indicated, not indicated, coded 1, 0, respectively).

It was justified to model a moderation of USval*REC, χ^2 (2) = 18.24, $p < .001$, but so was the further modeling of USval*IMP, χ^2 (2) = 49.81, $p < .001$, and USval*VMP, χ^2 (2) = 37.52, $p < .001$, as well as the modeling of by-participant random slopes for USval, χ^2 (2) = 55.53, $p < .001$, and USval*REC, χ^2 (2) = 40.42, $p < .001$. The inclusion of USval*REC suggests that recollection moderates EC. However, due to their hierarchical coding (i.e., IMP comprises REC, and VMP comprises IMP), it is important to note that the further inclusion of IMP and VMP after REC may have changed the parameter for USval*REC. Specifically, the further inclusion of an additional moderator changes which specific contrast is captured by the fixed effect's parameter. The stepwise inclusion of all three possible moderations thus may reveal that (a) REC, IMP, and VMP are each associated with a significant increase in EC, (b) that REC does not increase EC and only IMP and VMP do, or (c) that only VMP moderates EC without any increase associated with either REC or IMP. These possibilities were explored by evaluating the significance of fixed effects in the final model.

Model evaluation. Figure 4 shows the observed mean CS attitudes as a function of the fixed effects incorporated in the final model (see Table 6 for parameter estimates). Descriptively, the strongest conditioning effects were observed for recollected pairs, as CSs paired with liked USs were evaluated more favorably compared to CSs paired with disliked USs (M_{liked} = 43.64, SD = 54.58 vs. $M_{disliked}$ = -43.43, SD = 42.08, respectively). EC decreased for pairs for which the paired US was indicated counter to the avoidance instructions (M_{liked} = 35.64, SD = 54.04 vs. $M_{disliked}$ = -36.58, SD = 52.43) as well as for pairs for which participants were only able to correctly indicate the valence of the paired US (M_{liked} = 20.10, SD = 51.46 vs. $M_{disliked}$ = -19.4, SD = 51.81). Moreover, EC was reversed in pairs for which participants failed to correctly indicate the valence of the paired US (M_{liked} = -8.32, SD = 49.92 vs. $M_{disliked}$ = 9.53, SD = 50.33). The final model's estimate for the effect of USval indicated the reverse to be

significant, $B = -8.31$, SE $(B) = 4.21$, $t = -1.98$, $p = .04$[7], and the significant effect of USval*VMP indicated that standard EC was obtained only if participants were able to correctly indicate the US valence, $B = 27.77$, SE $(B) = 4.27$, $t = 6.49$, $p < .001$. The descriptive increase in EC for indicating paired US even counter the avoidance instructions was also significant, USval*IMP, $B = 12.98$, SE $(B) = 5.11$, $t = 2.54$, $p = .01$. However, and despite a descriptive advantage, recollection failed to account for a further improvement in EC, USval*REC, $B = 0.85$, SE (B) $= 6.28$, $t = 0.14$, $p = .89$.

The final model clearly revealed that memory performance moderates EC. Specifically, standard EC was only obtained once the paired US's valence was correctly identified and even reversed if participant mistook the valence of the paired US (Stahl et al., 2009). Moreover, EC increased significantly once the actually paired US was indicated (Gast et al., 2012). However, and despite separating intentional and unintentional uses of memory, we observed that the increase in EC was not limited to recollected pairs but that the increase for recollected pairs was indistinguishable from a similar increase observed for pairs indicated counter the avoidance instructions. Thus the findings not only support the hypothesis that EC can be moderated by recollecting the CS-US pairings, but lend equal support to the hypothesis that EC is moderated by unintentional uses of memory for the pairings. To substantiate the finding that both intentional and unintentional uses of memory moderate EC, a second experiment was conducted to replicate Experiment 1 in which we also improved upon the technique to identify recollection.

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[7] P-values for fixed effects are based on Type III ANOVA using a χ^2- distribution as implemented in R package car (Fox & Weisberg, 2011).

CS Attitudes in Experiment 1 Grouped By Paired US Memory And Paired US Valence
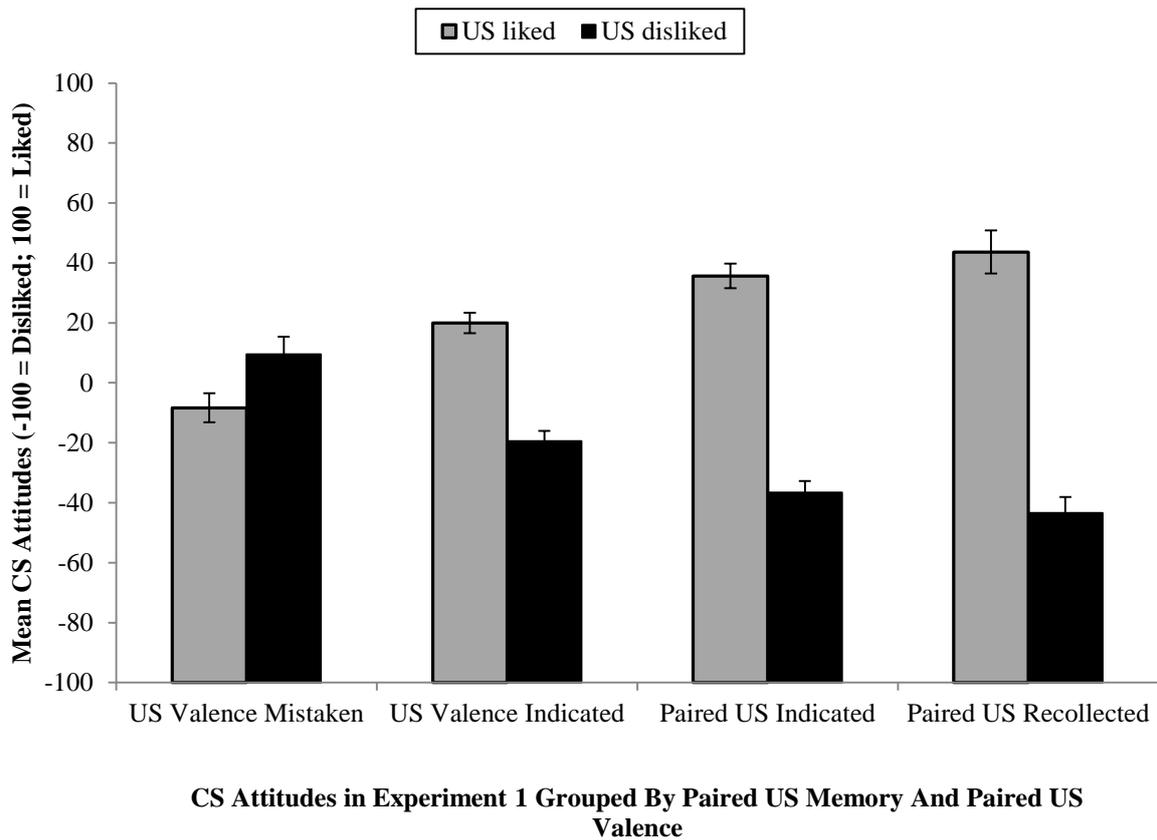
Figure 4. Mean CS attitudes grouped by paired US valence (liked vs. disliked) and paired US memory in Experiment 1 (error bars show standard error of the mean).

3. Experiment 2

3.1 Method

Participants and design

Ninety-six students (74 women, M_{age} = 21.4, age range: 18–29 years) took part in our experiment for course credit. The experiment consisted of a 2 (US valence: positive vs. negative) x 2 (test instructions: indicate vs. avoid) within-subjects design.

Materials and procedure

The materials and the procedure were similar to Experiment 1, except that the focal task asked participants to respond to the presence of a randomly appearing grey circle rather than composite letters. Moreover, Experiment 2 aimed at enhancing the diagnosticity of the memory

test, which was used to distinguish between performance and recollection. After repeated exposure it is likely that participants are sensitive to the difference between old and new stimuli and thus have some form of partial recollection of the US. In order to allow even partial recollection to promote correct responding on avoidance trials, we introduced new stimuli into the test that were not presented during conditioning. Specifically, the 16 pictures used in the test comprised two liked and two disliked pictures, which had not been presented during conditioning. This setup allowed participants to use their partial recollection of US information in order to exclude actually presented pictures as response options (cf. Brainerd, Reyna, Wright, & Mojardin, 2003). As a consequence of this adjustment, the number of overall CS-US pairs as well as the number of distractor trials was reduced to 12. In the conditioning procedure, participants were presented with 12 CS-US pairs, 12 filler trials, and four gray circles each repeated 7 times, accumulating to 196 trials.

Subsequent to the memory test participants were asked to reiterate the indication and avoidance instructions as a test of understanding and compliance with the task. Excluding participants based on partial failures to fully reiterate instructions, did, however, not affect the pattern of results which is why the data of all participants were included in the analysis.

3.2 Results and Discussion

Memory performance and conscious control

We first established whether the indication and avoidance instructions produced the expected effects on memory performance. Submitting the relative frequencies of choices in the memory test to a 2 (trial instructions: indication vs. avoidance) x 2 (selection: paired US vs. US valence) repeated-measures ANOVA, yielded the expected two-way interaction, $F(1, 95) = 53.69$, $p < .001$, $\eta_p^2 = .36$. Pairwise comparisons confirmed that selecting the paired US was more frequently the case on indication trials compared to avoidance trials ($M = .39$, $SD = .26$ vs. $M = .17$, $SD = .21$, respectively), $p < .001$, whereas indicating the US valence was more

frequently the case on avoidance trails compared to indication trials ($M = .52$, $SD = .23$ vs. $M = .31$, $SD = .18$, respectively), $p < .001$. There was also a main effect for selection, $F(1, 95) = 17.49$, $p < .001$, $\eta_p^2 = .16$, showing that selecting the paired US was overall less frequently the case than indicating the US valence ($M = .29$, $SD = .19$ vs. $M = .42$, $SD = .14$, respectively). The main effect of trial instructions was not significant, $F(1, 95) = 1.24$, $p = .26$. Because this pattern confirmed that participants were able to consciously control indicating the paired US, we proceeded to analyze EC.

Item-based analysis of EC

The item-based analysis of the moderation of EC was similar to Study 1. We first tested whether the inclusion of US valence and its moderators was justified as determined by likelihood ratio tests.

Model Building. Starting with a null-model that defined CS attitudes as a function of only by-participant and by-CS-US-pair random intercepts, we first modeled basic conditioning effects by including USval. Its inclusion led to a significant improvement in goodness of fit, χ^2 $(1) = 39.58$, $p < .001$. It was justified to model the moderations of USval*REC, χ^2 $(2) = 49.61$, $p < .001$, USval*IMP, χ^2 $(2) = 52.95$, $p < .001$, and USval*VMP, χ^2 $(2) = 40.84$, $p < .001$, as well as to model by-participants random slopes for the effect of USval, χ^2 $(2) = 52.86$, $p < .001$. While keeping in mind the hierarchical coding of REC, IMP, and VMP, these findings suggest that REC may moderate EC, but also that (a) REC, IMP, and VMP are independent moderators of EC, (b) that only IMP and VMP moderate EC, or (c) that only VMP moderates EC. We sought to support any of the possible patterns by evaluating the significance of fixed effects in the final model.

Model evaluation. Figure 5 shows the mean CS attitudes as a function of the fixed effects in the final model (see Table 6 for parameter estimates). Descriptively, the strongest conditioning effects were observed for recollected pairs ($M_{liked} = 39.35$, $SD = 44.39$ vs. $M_{disliked} = -47.46$, $SD = 41.98$), and EC decreased for pairs for which the paired US was indicated

counter to the avoidance instructions (M_{liked} = 38.41, SD = 49.83 vs. $M_{disliked}$ = -32.53, SD = 47.16) as well as for pairs for which participants were only able to correctly indicate the valence of the paired US (M_{liked} = 16.81, SD = 50.16 vs. $M_{disliked}$ = -21.49, SD = 45.67). Moreover, EC effects were reversed in pairs for which participants failed to correctly indicate the valence of the paired US (M_{liked} = -12.22, SD = 43.23 vs. $M_{disliked}$ = 1.98, SD = 46.31). The final model's estimate for the effect of USval indicated the reverse to be insignificant, B = -4.94, SE (B) = 3.92, t = -1.26, p = .21, but the significant effect of USval*VMP indicated that standard conditioning effects were obtained when participants were able to correctly indicate the paired US valence, B = 25.23, SE (B) = 3.87, t = 6.51, p < .001. The descriptive increase in EC for indicating the paired US counter to the avoidance instructions was also significant, USval*IMP, B = 15.18, SE (B) = 3.74, t = 4.06, p < .001. However, recollection failed to account for a further improvement in EC, USval*REC, B = 4.38, SE (B) = 4.25, t = 1.03, p = .30.

Taken together, the final model revealed that standard EC was only obtained once the paired US's valence was correctly indicated (Stahl et al., 2009), and that EC further increased once the actually paired US was indicated (Gast et al., 2012). However, and despite separating intentional and unintentional uses of memory, the increase in EC by recollecting the paired US was indistinguishable from the increase explained by indicating the paired US counter the avoidance instructions. Thus, the findings lend equal support to the hypotheses that (a) EC is moderated by intentional uses of consciously recollecting the pairings as well as that (b) EC is moderated by unintentional uses of memory for the pairings.
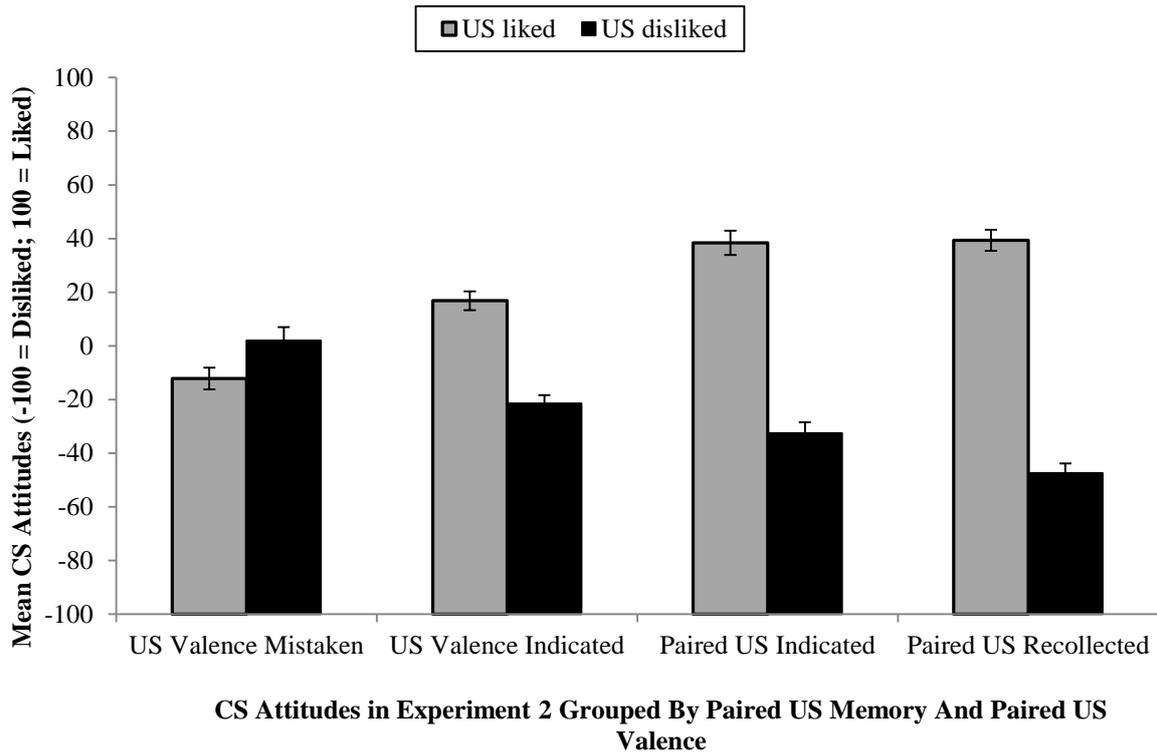
Figure 5. Mean CS attitudes grouped by paired US valence (liked vs. disliked) and paired US

memory in Experiment 2 (error bars show standard error of the mean).

Table 6

Parameter estimates for the linear mixed effects modeling of CS attitudes in Experiments 1 and

2.

Parameter	B	SE (B)	t	p
Experiment 1				
(Intercept)	0.37	4.28	0.09	.93
USval	-8.32	4.21	-1.98	.04
REC	-0.11	5.07	-0.02	.98
IMP	-2.11	3.63	-0.58	.56
VMP	0.62	4.27	0.15	.88
USval*REC	0.85	6.28	0.14	.89
USval*IMP	12.98	5.11	2.54	.01
USval*VMP	27.77	4.27	6.50	<.001
Experiment 2				
(Intercept)	-5.50	3.57	-1.54	.12
USval	-4.94	3.92	-1.26	.21
REC	-5.43	3.96	-1.37	.17
IMP	4.87	3.57	1.36	.17
VMP	3.00	3.84	0.78	.43
USval*REC	4.38	4.25	1.03	.30
USval*IMP	15.18	3.74	4.06	< .001
USval*VMP	25.23	3.87	6.52	< .001

Note. USval = US valence; REC = recollection; IMP = identity memory performance; VMP = valence memory performance. P-values for the fixed effects are based on Type III ANOVA as implemented in R package car (Fox & Weisberg, 2011). Models were fitted using REML estimation.

4．General Discussion

4.1 Summary of the results

Despite an increasing interest in EC as a source of people's likes and dislikes still little is known about the underlying processes. Although it has been repeatedly shown that EC is moderated by memory for the CS-US pairings (Hofmann et al., 2010), the question which retrieval-related processes account for this moderation has not been investigated. Based on previous work showing that different processes are involved in memory performance (Jacoby, 1991; Schacter, 1987; see also Hütter et al., 2012), we hypothesized that EC is moderated by intentional uses of conscious recollection (Balas & Gawronski, 2012; Bar-Anan et al., 2010; Gast et al., 2012; Pleyers et al., 2007; Stahl et al., 2009) as well as by unintended influences of memory (Jacoby, 1991; Jacoby et al., 1993).

In two experiments we identified recollection by asking participants to exert control over their memory performance (Jacoby, 1991) and we distinguished recollection from indicating the paired US in the absence of recollection as well as from indicating the valence of the paired US. In accordance with previous findings we found in both studies that indicating the correct valence was associated with significant EC (e.g., Stahl et al., 2009), and erring in assigning the valence led to a reversal of EC in Experiment 1. Highlighting the importance of retrieval-related processes in EC, this reversal indicates that CS evaluations could even be based on false memories for the US (see Bar-Anan et al., 2010, for similar findings). However, in case of identity memory when participants indicated the paired US correctly, EC increased significantly (Gast et al., 2012). Because we separated recollection from identity memory performance, we were able to determine to what extent this increase suggested an intended or an unintended effect of memory for the pairings on EC. In fact, our findings indicate that EC could be based on both (a) intended and also on (b) unintended uses of memory. Thus, it seems

that the contribution of memory to EC is not limited to an intentional use of recollection, but that EC is also moderated by unintentional uses of memory for the pairings.

This finding corroborates the assumption that conditioned attitudes can be expressed in both a controllable and uncontrollable fashion (De Houwer, 2009; Fazio, 1990; Fazio & Towles-Schwen, 1999). In this respect, it also supports the view that EC results from multiple processes that mediate between exposure to CS-US pairs and CS evaluations (De Houwer, 2007; Jones et al., 2010; Walther et al., 2011b).

4.2 Limitations and Avenues for Future Research

Our discussion has thus far focused on memory processes and on the confounded nature of memory data that does not allow for strong inferences about the associative or propositional nature of learning processes (Gawronski & Walther, 2012). However, which process dominates the retrieval of encoded CS-US contingencies may be assumed to depend on processing or encoding depth regarding the processing of the US in relation to the CS (Craik & Lockhart, 1972). Thus, the moderation of EC via different retrieval related processes might critically depend on whether the US in its relation to the CS is encoded in a rather controlled or uncontrolled way. Thus, while allowing for no strong inferences with respect to the learning processes, memory data might allow for drawing inferences on the differential encoding of CS-US pairs.

Indeed, it is important to note that unintended effects on CS evaluations do by no means preclude the possibility that the encoding of CS-US pairs was intentional (Mitchell et al., 2009). In fact, unintended effects could be caused by errors in source monitoring (e.g., Johnson, Hashtroudi, & Lindsay, 1993) and persist even though both the encoding and evaluation of CS occurred in a controlled manner (see also Humphreys et al., 2010). Moreover, unintended effects have been shown to depend on the similarities between learning and retrieval contexts (cf. Whittlesea & Price, 2001), and thus changes between encoding and retrieval contexts could

facilitate the moderation of EC by recollection as compared to unintentional effects of memory. Clearly, there is still much to learn about the interplay of memory and encoding processes that underlie EC.

Chapter 5

General Discussion

1. Overview

The introductory chapter was meant to outline the importance of encoding processes with respect to the question of what our attitudes actually are. Special attention was thereby paid to the probable contribution of selective attention processes to the solution of the representation issue being reflected in current theorizing and research on EC. Selective attention processes determine which information of a given CS-US pair will be encoded in memory. In this regard they also determine which information is consolidated in memory and may then be retrieved from memory. Despite this essential role of selective attention processes in answering the representation question in EC, they have been widely neglected in attitude research. The present research aimed at closing this gap in current attitude research by discussing and investigating the influence of selective attention processes on EC.

In the first study presented in Chapter 2 the major focus was on dissociating different forms of attention and their influence on EC via changes in contingency memory. In this respect it was aimed at determining which forms of attention exert their influence on EC by moderating the encoding of CS-US contingencies in memory. Previous research concerned with the influence of attention on the relationship between contingency memory and EC did often not differentiate between attentional resources and directed selective attention. The study presented in this chapter dissociated these two forms of attention in order to investigate their differential contribution to the relationship between contingency memory and EC. Attentional resources where manipulated by either presenting CS and US in the same or different modalities. In contrast, goal-directed attention was manipulated by selectively increasing the task-relevance of the CS or the US. Regarding the influence of attentional resources on EC it turned out that more pronounced EC in the cross-modal as compared to the unimodal condition was not mediated by an increase in contingency memory. On the contrary, increased EC in the CS-focus as compared to the US-focus condition was mediated by contingency memory. It can be

concluded from these results that the encoding of CS-US contingencies is best considered in the context of directed selective attention processes. In Chapter 3 these considerations were deepened by investigating the influence of the selective processing of the US relative to the CS in EC. In two experiments it turned out that selectively ignoring the US, because it hampers the selective processing of the CS, results in diminished EC. Contrariwise, EC was not reduced if the US did not hamper the selective processing of the CS or under conditions where the CS had not to be selected against the US. These findings thus provide compelling evidence to the influence of selective attention processes on the encoding of CS-US contingencies. At the same time, the findings indicate that the processing of the US in relation to the CS might be critical for EC. The two experiments presented in Chapter 4 then serve as a basis for discussing whether and to what extent the processing of the US in relation to the CS may be reflected in different retrieval-related processes exerting a moderating influence on EC. The findings of these two studies indicate that both unintended as well as intended retrieval processes exert a moderating influence on EC. Concurrently, these findings indicate that depending on the depth of encoding of the US in relation to the CS, different processes for the retrieval of CS-US contingencies might exert a moderating influence on EC. Thus manipulating the selective encoding of the US in relation to the selective processing of the CS might be used to formulate clear predictions on the processes being involved in the retrieval of CS-US contingencies.

2. Contributions to the body of psychological knowledge

2.1 S-S versus S-R as a matter of US-encoding

When trying to answer the question of whether EC depends on the formation of an S-S or an S-R representation, previous research mainly concentrated on the relation between contingency awareness and EC (for reviews, see Field, 2000; Sweldens, Corneille, & Yzerbyt, 2014). Besides these correlational studies the representation question was also tackled in an

experimental way, namely by investigating the influence of US-revaluation on EC (e.g., Baeyens et al., 1992b; Sweldens et al., 2010; Walther et al., 2009). In a study conducted by Sweldens and colleagues (2010) it turned out that whether there is a moderating influence of US-revaluation on EC or not depends on different boundary conditions. In particular, their findings indicate that S-R learning, as indicated by the absence of a US-revaluation effect, is for instance more probable under conditions of simultaneous CS-US presentation and multiple-US pairings as compared to single US-pairings. What becomes apparent from reviewing these findings is that the occurrence of S-S versus S-R learning seems to be critically dependent on the intensity with which a US is encoded in relation to the CS. For instance, repeatedly presenting a CS with only one US should result in a more intense processing of the US in relation to the CS than presenting a CS with multiple USs. Thus, the question of whether EC relies on an S-R or an S-S representation might be a question of encoding depth with respect to the processing of the US and its evaluative response in relation to the CS. Taking these considerations into account the experimental approach presented in Chapter 3 might essentially contribute to the solution of the representation problem. In particular, implementing a target-distracter logic in an EC-paradigm allows for the manipulation of the selective processing of the US and its evaluative response in relation to the CS. As already discussed in Chapter 4 the influence of these differences in the encoding of CS-US contingencies might then be reflected in the moderation of EC via different retrieval-related processes.

2.2 Associative or propositional – What is learned in evaluative conditioning

In Chapter 1 as well as in Chapter 4 it was already described that there is a rigorous debate on whether evaluative conditioning effects are based upon the formation of an associative or propositional link between CS and US. The formation of associative and propositional mental links thereby mainly differs with respect to their dependency on the conscious processing of CS-US contingencies. Associative learning accounts presume some

kind of automatic link formation mechanism automatically integrating the representation of the CS with the representation of the US (i.e., the formation of an S-S representation) or the evaluative response representation of the US (i.e., an S-R representation). In propositional accounts like that proposed by Mitchell and colleagues (2009) it is generally presumed that learning results in the formation of propositions representing conscious knowledge on the relation between CS and US. Thus, contrary to associative learning accounts, changes in the evaluation of a CS are presumed to be dependent on the conscious encoding of CS-US relations.

The findings of the experiments presented within this thesis contribute to this debate by providing an answer to the question of when the learning process underlying EC is operating. The finding that EC is diminished under conditions of increased attentional load might for instance be interpreted in line with the operation of an associative learning mechanism. Specifically, this finding supports the notion that the formation of associations is dependent on a rather slow learning-memory system (see Smith & DeCoster, 2000). The formation of associations in memory is presumed to be rather slow in virtue of its dependency on a large amount of experience. Thus, if working memory capacity for the maintenance of CS-US co-occurrences in memory is depleted, this should directly influence learning. Importantly, this effect was not mediated by contingency awareness, which might indicate that decreases in EC in virtue of the depletion of attentional resources do not result from an impaired encoding of CS-US contingencies. The finding might be interpreted in favor of the presumed automatic nature of the associative-link formation mechanism. Indeed and as already outlined in the discussion of Chapter 2, it might be questioned inasmuch the contingency awareness measure used in this study was adequate to measure contingency awareness in the cross-modal condition. In this regard, the failure of finding a mediation of this effect via contingency awareness might be due to an underestimation of contingency awareness in the cross-modal condition. Therefore, the results are to be understood as tentative with respect to their explanatory power on which learning mechanisms might be more probable under these conditions.

Besides the findings from this experiment the results from the two experiments presented in Chapter 3 are also rather in line with the assumption of an associative than of a propositional learning mechanism. In particular, finding EC under conditions where the CS has to be selected against the US (i.e., the US is a distracter) contradicts the logic of a propositional learning mechanism. A propositional learning mechanism and in this regard the formation of propositional knowledge on the relation between CS and US is highly dependent on the conscious processing of CS-US co-occurrences. However, taking into account the notion from selective attention theories that incompatible distracters are only processed up to the level of response generation (Friedman & Miyake, 2004), it should be quite unlikely that CS-US contingencies are consciously processed under these conditions. Thus, finding EC to be significantly different from zero in the incompatible selection (Experiment 1. two-tailed; Experiment 2: one-tailed) cannot be very well integrated with the assumption of a propositional learning mechanism.

2.3 The dissociation of evaluative conditioning from Pavlovian conditioning

Grounding EC in Pavlovian conditioning would imply that the effect is dependent on the conscious encoding of the relation that the CS functions as a signal of the US. However, and as has been emphasized throughout this thesis, it seems not to be the encoding of the CS in relation to the US that is important in the process of attitude formation. Instead, it seems to be more important for the formation of attitude representations that the evaluative response of the US is processed in its relation to the CS. Thus, it is rather the predictive value of the US response relative to the CS that is decisive for the occurrence of EC. This notion is especially in line with the findings from the two experiments presented in Chapter 3. Given the logic of the Flanker task used in the two experiments it can be assumed that the attention devoted to the US is dependent on its predictive value for the correct CS response. While in compatible trials the US is a valid predictor for the correct CS response and is therefore also attended, the US is an

invalid predictor on incompatible trials. Hence, on incompatible trials the US will be selectively ignored and not attended to the same extent as the CS. In this respect the attention devoted to the US and thus the depth of its encoding is dependent on its predictive value for the correct CS response. That is, the moderating influence of selective attention processes on EC obtained in the two experiments might depend on the reversed conditional probability as implied by the term contingency awareness. Additionally, finding stronger EC in the CS-focus as compared to the US-focus condition of the experiment presented in Chapter 2 also points in a similar direction. However, given that the direct influence of goal-directed attention on EC was mediated by contingency awareness, i.e. higher contingency awareness in the CS-focus condition, it might be questioned whether these results are actually in favor of the proposed relation. Notwithstanding this seemingly inconsistent finding, the results from the experiments reported in Chapter 4 allow for an interpretation of this finding being consistent with the presumed relationship. In particular, the findings from the two experiments reported in Chapter 4 indicate that the moderating influence of contingency awareness on EC varies as function of US accessibility in the presence of the CS. In particular, it turned out that only having access on the US up to the response level (i.e., having valence memory) is related to less pronounced EC than being able to retrieve the US identity. This pattern completely replicates in the size of the indirect effects of goal-directed attention on EC via valence awareness and identity awareness (*Sobel's* $Z_{valence}$ = -2.5912, p = .0096 and *Sobel's* $Z_{identity}$ = -3.1832, p = .0015). In this respect, contingency awareness measures might be presumed to reflect the intensity to which the US has been encoded in relation to the CS (i.e. processing depth). However, future research should critically test for the relationship between processing depth of CS-US contingencies and the moderation of EC via different retrieval-related processes.

3. Implications and ideas for future research

3.1 Implications for stimulus-stimulus contingency learning

As shown by the results of the reported experiments the CS-US contingency underlying EC seems to differ from that presumed for classical conditioning. While for classical conditioning effects the predictability of the US out of the CS is assumed to be decisive, this predictive relationship seems to be reversed for EC. In particular, the results of all presented experiments rather support the assumption of a CS-US contingency reflecting the predictability of the CS out of the US. This reversal in the contingency underlying EC has important implications with respect to the empirical investigation of contingency learning in an evaluative conditioning paradigm. Previous research on the relationship between contingency learning and EC (e.g., Schmidt & De Houwer, 2012; Stahl & Unkelbach, 2009) generally manipulated CS-US contingencies by varying the predictive validity of one CS for a certain US. Stahl and Unkelbach (2009), for instance, presented a nominal CS either with a single US or multiple USs of the same valence. Their results show a decrease of EC in the multiple as compared to the single-US condition. Additionally, they found decreased contingency memory (valence memory and identity memory) in the multiple US condition as compared to the single US condition. Most importantly and supporting the results from Pleyers and colleagues (2007) conducting an item-based analysis on the relationship between contingency memory and EC, there was only significant EC for CSs classified as aware. These findings can however not be unequivocally interpreted in terms of the presumed CS-US contingency insofar as the manipulation of CS-US contingency is confounded with the frequency of pairing. In particular, CSs in the single US condition were repeated ten times while CSs in the multiple US condition (i.e., one CS with five USs) were only repeated twice. Due to this confounding factor decreased EC in the multiple US condition might also be due to the decreased predictive validity of the US relative to the CS. In order to reconcile the influence of the two possible contingencies on

EC, future research should manipulate the predictive validity of the US or the CS while keeping the predictive validity of the other stimulus constant (i.e., the CS or the US).

3.2 Implications for stimulus-response contingency learning

Considering EC from the perspective of selective attention theories has not only interesting implications with respect to contingency learning in terms of learning S-S contingencies. Concurrently, it provides several interesting future research lines for investigating S-R learning. In particular, selective attention theories, like the *Theory of Event Coding* (TEC; Hommel et al., 2001), propose that the integration of stimulus features and response features relies on a common coding system. The common coding view implies that sensory and motor codes share some common features and therefore can be coded in a common representational structure (Prinz, 1992). The degree to which response and stimulus features are represented in such a common representational structure thereby depends on the amount of selective attention devoted to them. The amount of selective attention devoted to the differential features thereby strongly depends on the task-relevance of these features. In this regard strengthening the task-relevance of the evaluative response features during encoding of CS-US contingencies might strengthen S-R learning. The most important response features with respect to an evaluative response representation are probably its valence, its arousal, and the mental representation of its intended approach/avoidance actions. Increasing the task-relevance of all of these features is thus potentially suitable to increase S-R learning. However, similar to S-S learning one has to keep in mind that the S-R contingency relies on the processing of the evaluative response associated with the US in relation to the CS. Thus increasing the task-relevance of those features has to be associated with a respective manipulation of the task-relevant response directed towards the CS.

One way to manipulate the task-relevance of the valence inherent to the evaluative response representation might be to classify the CS with respect to the valence of the preceding

US. Likewise, arousal might be manipulated by having participants to respond to the CS under time pressure or not. That time pressure effectively influences arousal could for instance be shown in a study by Oliveras et al. (2002). Participants in this study were either instructed to drive under time pressure or not. The findings indicate that participants who were instructed to drive with time restrictions felt more activated, more aroused and more stressed. However, future research will be needed in order to test for the adequacy of such an arousal manipulation in order to increase S-R learning for either high- or low-arousing evaluative responses. Besides manipulating valence and arousal one might also increase S-R learning by integrating the CS either with a mental representation of intended approach or avoidance actions. One possibility to do that would be the integration of the adapted Flanker-paradigm presented in Chapter 3 with a manikin-task (De Houwer, Crombez, Baeyens, & Hermans, 2001). That is, participants are instructed to either move a manikin towards or away from the CS depending on the CS's frame color. If such a manipulation would actually result in learning an S-R contingency that is representative for the mental representation of intended approach or avoidance actions, this would also be highly interesting for more applied areas of psychological research. Just to name one example, consumer research might use these methods to optimize the effectiveness of advertisement campaigns in terms of optimizing the perception-action link.

4. Final conclusions

The present thesis aimed at highlighting the important role of selective attention processes to a better understanding of the representation underlying EC. In sum, the present results indicate that selective attention processes modulate the encoding of CS-US contingencies. Moreover, the results of the experiment in Chapter 2 as well as those from the experiments reported in Chapter 3 provide initial evidence to the assumption that EC relies on the encoding of the evaluative response associated with the US in relation to the CS. In this

regard, the CS-US contingency being inherent to the representation underlying EC might actually differ from that presumed in signal learning. However, future research will be needed to directly test these two kinds of contingencies against each other. Nonetheless, investigating the influence of selective attention processes on EC seems to be a promising way to dissociate these two forms of conditioning. In particular, manipulating the selective processing of CS and US allows for concrete predictions on how CS-US contingencies become encoded in memory and therefore allows for a direct test of the presumed representations. In this regard, investigating the representation underlying EC with the help of selective attention paradigms avoids the reliance on any post hoc explanations. That is, the relationship between encoding and retrieval is not only deduced from a correlation between contingency memory and EC. Instead, the influence of different retrieval processes on EC can be predicted by manipulating the encoding of CS-US contingencies. One might for instance speculate that manipulating the encoding depth of the processing of the CS and the US might predict to which extent different retrieval related processes moderate EC. However, as already outlined in the general discussion of Chapter 4 the interplay between the encoding of CS-US contingencies and the moderation of EC via different retrieval processes has not yet been addressed. In essence, the results of the present thesis may thus be understood as a first step in a new direction to investigate the representation underlying our likes and dislikes.

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Erklärung

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und keine anderen als die angegeben Quellen und Hilfsmittel verwendet habe. Zudem wurde die Arbeit an keiner anderen Universität zur Erlangung eines akademischen Grades eingereicht.

Trier, den 03.06.2014

Katarina Blask