Universität Trier

Fachbereich I - Psychologie

Evaluative Conditioning at Age 39:

Conceptual Challenges and Future Directions

Dissertationsschrift zur Erlangung des akademischen Grades

Doctor rerum naturalium

Dr. rer. nat.

vorgelegt von

Dipl.-Psych. Georg Halbeisen

Trier, den 03.06.2014

Mein herzlicher Dank gilt Prof. Dr. Eva Walther für die Unterstützung, die Anregungen, das Vertrauen und für die Freiheit zu forschen. Ich war Student und ich bin Doktorand, aber vor allem hatte ich die Möglichkeit, Sozialpsychologe zu werden.

Auch möchte ich mich herzlich bei Prof. Dr. Roland Neumann für die Bereitschaft der Zweitbegutachtung bedanken.

Weiterhin gilt besonderer Dank meinen Kollegen, Katarina Blask, Violetta Schaan und Christa Willems, sowie meinen Freunden und meiner Familie für all ihre Unterstützung in den letzten Jahren und während der Erstellung dieser Arbeit. Ebenso möchte ich mich bei allen wissenschaftlichen Hilfskräften bedanken, die die experimentelle Arbeit unterstützt haben: Felicia Arndt, Sascha Bölsche, Kathrin Böshaar, Oliver Contier, Katrin Hillebrandt, Amelie Horn, Marc Latz, Markus Liebertz, Elena Linden, Sophia Nieberle, Fernand Roos, Sebastian Rouget, Christopher Postzich und Stefanie Weyand.

Für all ihre Unterstützung, Liebe und Geduld, danke ich Jessica!

Abstract

Evaluative conditioning (EC) refers to changes in liking that are due to the pairing of stimuli, and is one of the effects studied in order to understand the processes of attitude formation. Initially, EC had been conceived of as driven by processes that are unique to the formation of attitudes, and that occur independent of whether or not individuals engage in conscious and effortful propositional processes. However, propositional processes have gained considerable popularity as an explanatory concept for the boundary conditions observed in EC studies, with some authors going as far as to suggest that the evidence implies that EC is driven *primarily* by propositional processes. In this monograph I present research which questions the validity of this claim, and I discuss theoretical challenges and avenues for future EC research.

Tables of Content

Table of Figures

List of Tables

1 Introduction

The importance of attitudes for understanding everyday behavior can hardly be overstated. In fact, most social behaviors can be construed as an expression of either liking or disliking of another person, an object, or a situation (Eagly & Chaiken, 1993; 2007). For example, your attitude may be reflected in how far away from another person you seat yourself (e.g., Cesario, Plaks, Hagiwara, Navarrete, & Higgins, 2010), in the foods you consume (e.g., Friese, Hofmann, & Wänke, 2008), in the products you purchase (e.g., Vermeier & Verbeke, 2006), or in the political party that you are voting for (e.g., Friese, Smith, Plischke, Bluemke, & Nosek, 2012). Some preferences might be innate. For example, one might be hard-pressed to find a new-born infant that is fond of bitter tastes. However, even an infant's food preferences depend to some extent on its pregnant mother's diet (Schaal, Marlier, & Soussignan, 2000), and it is little surprising to find that attitudes often differ greatly among individuals. Clearly, many of our attitudes must have been acquired (cf. Rozin & Millman, 1987). Given the importance attitudes for understanding social behavior, it is among the central goals of social psychology to understand the processes by which attitudes can be formed (Walther, Nagengast, & Trasselli, 2005).

One line of research that is concerned with the processes of attitude formation is the research on evaluative conditioning (EC). EC is defined as the observable change in liking that is due to the pairing of stimuli (De Houwer, 2007; De Houwer, Baeyens, & Field, 2005) and thus refers to the observation that likes and dislikes could seemingly "transfer" from one stimulus to another by virtue of their mere co-occurrence. For example, your liking of a celebrity may transfer to the product that she or he endorses, or your disliking of bad medical news may transfer to the physician who is bearing them. In a prototypical EC study, individuals are repeatedly exposed to pairs of stimuli of which one is either liked or disliked (i.e., the unconditioned stimulus, US) whereas the other stimulus is rather neutral (i.e., the conditioned stimulus, CS). EC is demonstrated if CS paired with liked US are evaluated more favorably after conditioning compared to CS paired with disliked US. Laboratory demonstrations of EC include the formation of interpersonal attitudes (Koranyi, Gast, & Rothermund, 2013; Olson & Fazio, 2001; Walther, 2002), food preferences (e.g., Baeyens, Vansteenwegen, De Houwer, & Crombez, 1996; Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2009), brand and product preferences (Baeyens, Wrzesniewski, De Houwer, & Eelen, 1996; Sweldens, van Osselaer, & Janiszewski, 2010; Walther & Grogoriadis, 2004), and attitudes towards political slogans (e.g., Razran, 1940).

Although the laboratory demonstrations of EC provide intuitive examples of how everyday likes and dislikes can be acquired (Rozin, Millman, & Nemeroff, 1986; Walther et al., 2005), understanding by which processes such transfer may occur remains an ongoing challenge. Initially, EC had been conceived of as driven by processes that are unique to the formation of attitudes, and that occur independent of whether or not individuals engage in the formation and testing of conscious hypothesis about the CS-US relationship (e.g., Martin & Levey, 1978; Baeyens, Eelen, & van den Bergh, 1990; Olson & Fazio, 2001). EC was thus theoretically distinguished from the processes involved in human causal and predictive learning (e.g., Brewer, 1974; Lovibond, 2003; Shanks, 2007, 2010). This conception has given major impetus to both theoretical and methodological developments in EC research, and is also the reason for why EC is considered important for the broader conceptualization of human learning and memory (Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012).

However, processes of forming and testing conscious hypothesis, now commonly referred to as propositional (Shanks, 2010), have gained considerable popularity as an explanatory concept for the boundary conditions observed in EC studies. In fact, some authors even go as far as to argue that the evidence suggests that EC is driven *primarily* by propositional processes (e.g., Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014; Gast, De Houwer, & De Schryver, 2012; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Sweldens, Corneille, & Yzerbyt, 2014), which marginalizes the idea of unique learning processes in favor of integrating EC into a larger conceptual framework (De Houwer, 2009; Mitchell, De Houwer, & Lovibond, 2009). Given the importance of EC research for understanding the processes of attitude formation in particular, and learning and memory in general, the research presented in this monograph seeks to address a simple yet fundamental question: To what extend does the available evidence support the conclusion that EC is driven primarily by propositional processes?

To this end, I will first give a brief overview of the central theoretical and methodological developments which have culminated in the conclusion that EC seems to be driven primarily by propositional processes (see Chapter 2). Two lines of evidence are discussed in the following chapters: the moderation of EC by performance in awareness tests, and the sensitivity of EC to dual-task interference. In Chapter 3 it is argued and shown that the moderation of EC by performance in awareness tests can be conceptualized as both the intentional and unintentional use of memory for the CS-US pairing. However, neither are these retrieval processes conclusive for any existing account of EC, nor have the existing accounts adequately distinguished between learning and retrieval processes in the first place. The challenges due to this conceptual neglect are discussed, and avenues for future research are outlined. Chapter 4 then examines the sensitivity of EC to dual-task interference and seeks to reconcile inconsistent findings. Based on the idea of structural constraints of working memory (Baddeley, 2012), it is argued and shown that a boundary condition dual-task interference in EC is the (dis)similarity of verbal and visuospatial demand incurred by processing the CS-US pairs and the secondary task, respectively. The possibility of confusing structural constraints with the boundary conditions of propositional processes is identified as another conceptual challenge for EC research, and alternative approaches are discussed. Given that the research presented in both Chapters 3 and 4 suggest that the conclusion in favor of propositional processes may be premature, I discuss in the final chapter some of the overarching themes of my research and present avenues for future research.

2 A Quest for Uniqueness—A Brief Review of 39 Years of EC Research

A study often cited as the primary source of inspiration for modern EC research was published by authors Levey and Martin in 1975 (cf. De Houwer, Thomas, & Baeyens, 2001). In that study, participants were first asked to sort pictures into the categories of liked, neutral, and disliked stimuli. Neutral pictures were chosen as CS, and paired with perceptually similar liked or disliked pictures as US. Given no further instructions, each pair was presented 20 times for a brief duration. Later evaluations of the CS on a scale ranging from 100 (maximum liking) to -100 (maximum disliking), revealed evidence of EC: CS paired with liked US received more favorable evaluations as compared to CS paired with disliked US. It is important to note, however, that the purpose of the experiment was not revealed to the participants, and that according to a post-experimental interview, none of the participants were aware of a consistent relationship between the CS and US.

Admittedly, the study of Levey and Martin (1975) cannot be considered the first demonstration of EC. For example, Razran (1938) found that exposing pictures of college girls whilst receiving a free lunch (versus not receiving a free lunch) positively influenced the later evaluation of these pictures (see also Razran, 1940; 1954). Similarly, Staats and Staats (1957) found an effect on the evaluation of nonsense syllables that was due to their pairing with nouns of positive or negative connotations (see also Staats & Staats, 1958). However, these previous studies made use of either difficult-to-control or demand-inducing techniques, which may be one of the reasons for why the study of Levey and Martin was more influential. Specifically, Razran's "luncheon technique" may confound the positive evaluation of receiving a free lunch with the satisfying of physiological needs, consistency concerns due to receiving a gift, or other social aspects of the experience of dining. Similarly, and although the design used by Staats and Staats (1957) was highly controlled, it has been criticized that their participants could easily deduce the purpose of the task. Indeed, some experiments suggested that the Staats and Staats findings are an artifact of experimental demand (e.g., Insko & Oakes, 1966; Page, 1969), explaining the need for Levey and Martin (1975) to test for awareness in the first place.

However, it was arguably the very finding that EC could seemingly occur without awareness of the CS-US relationships that is the most important reason for the prominence of the Levey and Martin (1975) study. By the time the study was published, psychologists were emancipating themselves from the behaviorist dogma that human behavior could be reduced to the mechanistic and (in the sense of being unmediated by propositional processes) "automatic" linking of stimuli to responses (e.g., Berlyne, 1975; Brewer, 1974; for review, see Greenwood, 1999; Shanks, 2010; for contemporary uses of the term automaticity, see Bargh, 1994; Moors & De Houwer, 2006). Chomsky's (1959) scathing criticism of Skinner's (1957) attempt to explain "verbal behavior" (i.e., language) acquired instant notoriety, and the approach of treating human participants in much the same way that Behaviorists had studied animal behavior was outright ridiculed. For example, Brewer (1974) argued that human participants will speculate about the purpose of the study in which they are participating in. Hence, subjecting participants to stimulus contingencies without accounting for these processes reveals that "common sense is not a good guide when predicting the behavior of investigators operating in [a behaviorist] framework" (p. 14).

According to the emerging cognitive zeitgeist, neither simple nor complex human behaviors could be adequately described without referring to the formation and testing of conscious hypothesis (i.e., propositional processes). It was argued that effects such as observed in Staats and Staats (1957) stem from the participant's conscious expectation of how stimuli are related, and (in the case of that specific example) from awareness of and compliance with what the experimenter expects the participant to do (cf. Page, 1969). Indeed, in his critical review of the available literature, Brewer (1974) concluded that "there is not and never has been any convincing evidence for unconscious, automatic mechanisms in the conditioning of adult human beings" (p.27; see also Lovibond & Shanks, 2002). It was against this historical backdrop that the finding of unaware EC triggered the proposal of processes unique to the formation of preferences, which were hypothesized to occur independent of propositional processes.

The Holistic Account

Martin and Levey (1978) were not oblivious to the fact that the behaviorist conception of learning was unable to explain (or even define) the meaningful units of complex human behaviors. However, they argued that many human behaviors follow from an individual's evaluation of liking or disliking of other individuals, objects, or situations. This "evaluative response" was considered to be immediate in the sense that it preceded any "cognitive" judgment, and "truly subjective" in the sense that it cannot be reduced to behavioral or physiological changes—although such changes could follow from an evaluative response. In light of their previous findings (Levey & Martin, 1975), Martin and Levey (1978; 1994) proposed that it is the evaluative response that could be acquired in the mechanistic and propositionally unmediated sense that behaviorism had promoted.

In their account[1] it was argued that complex organisms (including humans) possess a learning mechanism by which evaluations towards formerly neutral stimuli are acquired on the basis of their co-occurrence with other liked or disliked stimuli. Upon encountering salient events that elicit an evaluative response, co-occurring stimuli become part of "immediate memory" whose contents are then stored in an undifferentiated fashion (p. 63, Martin & Levey, 1978). The evaluative response towards the US is thereby "fused" into a *holistic representation* that also contains the elements of the co-occurring CS. Due to the nature of the representation, the CS cannot be perceived without redintegratively activating the evaluative response. According to this approach, the only boundary condition of EC is thus that an

[1] The term "evaluative conditioning" was initially introduced as a label of the account of Martin and Levey (1978). However, to avoid confusion between the terms initial theoretical connotation (cf. Baeyens, Crombez, van den Bergh, & Eelen, 1988) and its contemporary definition as an effect (cf. De Houwer, 2007; De Houwer et al., 2005), I have maintained a descriptive use of the term EC throughout the monograph, and refrained from introducing the account by its original label.

evaluative response is triggered, and that both the CS and the response are part of "immediate memory"—which according to several summaries and also later formulations of the account, merely specifies that CS and US have to co-occur in order for EC to be obtained (e.g., De Houwer et al., 2001; Hofmann et al., 2010; Martin & Levey, 1994; Walther, Weil, & Düsing, 2011c). However, neither does the formation of the holistic representation require any propositional knowledge of the CS-US relationship, nor is such knowledge assumed to result from having acquired a holistic representation.

The Referential Account

Support for the independence of EC from propositional processes was also obtained by Baeyens et al. (1990). Specifically, the authors replicated Levey and Martin (1975), but used a more sensitive a posteriori measure of awareness in which participants had to indicate which US had been paired with which specific CS (Dawson & Reardon, 1973). Moreover, they also used a concurrent measure of awareness administered on a trial-by-trial basis such as to preclude the possibility that unaware EC is merely an artifact of forgetting. Although the concurrent measure was found to increase overall levels of awareness, a relationship between EC and performance in the awareness tests was not obtained.

Baeyens and colleagues provided further support for the uniqueness of EC by investigating the sensitivity of EC to being extinguished by CS-alone presentations (cf. Lovibond, 2004). Resistance to extinction is implied both by the notion that the CS is only represented as part of the holistic representation (i.e., CS-alone presentations are self-reinforcing as they always activate the evaluative response, Levey & Martin, 1987) as well as that EC does not rely on having acquired any propositional knowledge of the CS-US relationship that could be invalidated by CS-alone presentations (see also Baeyens, Hermans, & Eelen, 1993). Consistent with these implications, EC was found to be resistant to extinction (Baeyens et al., 1988; Baeyens, Eelen, van den Bergh, & Crombez, 1989; see also Levey & Martin, 1975).

Although the findings obtained by Baeyens and colleagues were consistent with the holistic account, it was assumed that EC results from unconsciously acquiring an association of CS and US representations rather than from a process of fusion (Baeyens, Eelen, Crombez, & van den Bergh, 1992a). Through mechanisms of spreading activation, encountering the CS could therefore activate the US representation. Thus the CS did not acquire the capacity to directly evoke an evaluative response, but to indirectly evoke the response by virtue of its reference to the US representation. However, given that the process was defined as unconscious, EC was not expected to require nor to produce any propositional knowledge of the CS-US relationship. According to this approach then, the only boundary condition of EC is that CS and US co-occur, and that the US maintains its evaluative response. Support for the notion of a referential relationship between CS and US representations came from a study in which the US were revaluated after CS and US had already been paired (Baeyens, Eelen, van den Bergh, & Crombez, 1992b). Consistent with the referential proposal, revaluating the US after conditioning also changed how the previously paired CS were evaluated (but see Martin & Levey, 1994, for an explanation of US revaluation in terms of the holistic account).

“Conceptual Conditioning”

The holistic and referential accounts conceived of EC as driven by processes unique to the learning of attitudes that are unconstrained by the boundary conditions of propositional processes. However, this assertion did not remain uncontested. For example, Davey (1994a) not only criticized that the concepts of a holistic representation and an association are empirically indistinguishable, but that they are not necessary to explain the processing features deemed unique to EC. Instead, EC could be explained in terms of a propositional process of conceptual learning. According to Davey’s proposal (see also Field & Davey, 1997) individuals who are confronted with a complex situation consisting of multiple CS-US contingencies try to develop a rule for categorizing CS as liked or disliked. Although the CS may already contain evaluative features, it is unlikely that there are any necessary or sufficient features on the basis of which stimuli could be categorized as liked or disliked. Therefore, the categorization may be based on the similarity of features that the CS shares with other liked or disliked stimuli (such as the US).

The proposal of Davey (1994a) has two important implications: first, EC that was obtained in earlier studies could be an artefact of having selected CS and US on the basis of their similarity (Field & Davey, 1997). This possibility was first raised by Shanks and Dickinson (1990; see also Davey, 1994b), who pointed out that in the studies of Levey and Martin (1975), and Martin and Levey (1978), the CS-US pairs were created based on similarity. If the CS are evaluated according to the evaluation of similar US, EC would occur without requiring any actual pairing of the stimuli. Evidence for this hypothesis was provided by Shanks and Dickinson (1990) and Field and Davey (1999), which emphasizes the importance of using counter-balanced or randomized CS-US assignments (e.g., De Houwer, Baeyens, Vansteenwegen, & Eelen, 2000).

A second implication is that (genuine) EC that occurs without awareness of the CS-US relationship, and that is resistant to extinction, does not preclude the possibility that learning is mediated by propositional processes. As Davey (1994a) argued, pairing a US with a CS could render the CS's features that are congruent with the US's evaluative concept more salient. The participant may thereby learn to categorize the CS as either liked or disliked *because* of the pairing with the US, but EC would neither result from forming a holistic representation nor from acquiring an association. EC would thus be constrained by the propositional processes involved in acquiring and applying a categorization rule, but neither would the occurrence of EC require awareness of the CS-US relationship, nor would EC be sensitive to being extinguished. However, a test of the idea of conceptual conditioning was inconclusive (Field & Davey, 1997).

The Propositional Account

Whereas the proposal of Davey was conceived of as an alternative explanation for the findings usually attributed to the mechanism implied by the holistic and referential accounts, De Houwer et al. (2005) entertained the idea that EC could be driven by multiple processes, including propositional processes that require awareness of the CS-US relationship. This account was mainly inspired by the observation that sometimes, measures of contingency awareness and EC do correlate (e.g., Allen & Janiszewski, 1989; Lipp & Purkis, 2005). De Houwer et al. (2005) criticized that such findings have been neglected, suggesting that researchers were preoccupied with the idea that individuals are rarely able to identify the sources of their preferences (Nisbett & Wilson, 1977). Even if conceding to that premise, however, it does not preclude the possibility that being aware of the CS-US relationship gives sufficient justification for liking or disliking the CS. The hypothesis that EC could also be driven by propositional processes therefore must be entertained.

The notion of a propositional learning mechanism was later refined in De Houwer (2009), and Mitchell et al. (2009) according to which conscious, effortful, and goal-driven processes lead to the formation and evaluation of propositional beliefs about the CS-US relationship. Unlike associations, by which the activation of one representation could spread to another, propositions have semantic structure in that they specify the way in which stimuli are related (e.g., the CS predicts the US). Upon encountering the CS such belief may become active, but encountering the CS does not directly activate the US representation or an evaluation. Although the proposal remains vague about how the formation of a belief would translate into liking or disliking the CS (Baeyens, Vansteenwegen, & Hermans, 2009; Shanks, 2007), it is argued that its generation, which requires awareness of the CS-US relationship, sufficient processing resources, and the intention of doing so, is sufficient for EC to occur.

One of the central reasons for why the propositional account has advanced to becoming a primary explanatory concept of EC is that early demonstrations of the independence of EC from propositional processes were not replicated following methodological improvements. For example, it has often been criticized that rather than showing the independence of EC from propositional processes, the absence of an empirical relationship between EC and awareness of the CS-US relationship is due to a study lacking power (Bar-Anan, De Houwer, & Nosek, 2010), an awareness test being insensitive to the relevant knowledge (Davey, 1994b; Shanks & St. John, 1994; Stahl, Unkelbach, & Corneille, 2009; Walther & Nagengast, 2006), or a method of analysis obscuring any existing relationship (Pleyers, Corneille, Luminet, & Yzerbyt, 2007). To summarize the gist of efforts directed at tackling these issues: an awareness test should consist of a brief recognition test (Dawson & Reardon, 1973) in which each CS is presented, and in which the participants are tasked with either identifying the US that was paired with the specific CS (*identity memory*) or with indicating the valence of the paired US (*valence memory*, Stahl et al., 2009; Walther & Nagengast, 2006). Whether identity memory or valence memory (or both) are measured should depend on the specific research question (Gast et al., 2012) and on whether or not the CS were presented with the same or with different US (Stahl & Unkelbach, 2009; Stahl et al., 2009). Moreover, and instead of comparing EC between groups of more or less aware participants (e.g., Fulcher & Hammerl, 2001; Walther & Nagengast, 2006), an item-based analysis should be conducted such that EC for CS-US pairs of which the participant was aware can be compared with EC for CS-US pairs of which the participant was unaware. Studies in which these improved methods were used have yielded similar findings, but did not replicate the results of earlier studies (e.g., Levey & Martin, 1975; Baeyens et al., 1990): not only does awareness predict the strength of EC, but EC has only been obtained in CS for which the paired US or its valence was correctly indicated (e.g., Dedonder, Corneille, Yzerbyt, & Kuppens, 2010; Gast et al., 2012; Pleyers et al., 2007; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009; but see Hütter et al., 2012).

Further support for the propositional account was obtained in studies in which the boundary conditions of propositional processes were manipulated during encoding. For example, there are several investigations that have examined the effect of performing a demanding secondary task during learning, either as a means of experimentally reducing awareness of the CS-US relationship (e.g., Brunstrom & Higgs, 2002; Fulcher & Hammerl, 2001), or as a means of interfering with the cognitively demanding activity of forming propositional knowledge (e.g., Field & Moore, 2005; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Walther, 2002). In most of these studies, the secondary task interfered with the occurrence of EC (Brunstrom & Higgs, 2002; Davies, El-Deredy, Zandstra, & Blanchette, 2012; Dedonder et al., 2010; Field & Moore, 2005; Kattner, 2012; Pleyers et al., 2009). Other studies have investigated, for example, the effects of goals on the occurrence of EC (Corneille, Yzerbyt, Pleyers, & Mussweiler, 2009; Verwijmeren, Karremans, Stroebe, & Wigboldus, 2012), or the effect of framing the relationship between CS and US (Fiedler & Unkelbach, 2011; Langer, Walther, Gawronski, & Blank, 2009; Walther, Langer, Weil, & Komischke, 2011b; Zanon, De Houwer, Gast, & Smith, 2014). Again, EC was shown sensitive to these manipulations. Although the findings of these studies do not necessarily imply that EC cannot occur under conditions that disfavor propositional processes, they do imply that under such conditions EC is far less likely to occur.

The Misattribution Account

Recently, a theoretical account has been proposes to address the question of how EC may occur under conditions that disfavor propositional processes. Specifically, Jones, Fazio, and Olson (2009) have argued that EC could result from a process of implicit misattribution by which the evaluative response that is elicited by the US would be mistakenly attributed to a co-occurring CS. The idea is to some extent reminiscent of the holistic account in that the CS is assumed to acquire the capacity to directly evoke an evaluative response. However, given that the misattribution account specifies EC as an error in processing, awareness of the CS-US relationship should interfere with the process (rather than having no influence, Martin & Levey, 1978). Moreover, implicit misattribution requires that the CS is seen as a plausible source of evaluation, which can be enhanced by contiguity of the processing of CS and US, or factors that increase the salience of the CS relative to the US (see Experiment 4 in Jones et al., 2009). However, except for the study of Jones et al. (2009), there have only been a few investigations which have explored the predictions of this account (Hütter & Sweldens, 2013; Sweldens et al., 2010).

A Note on Procedures

In introducing modern EC research by describing the study of Levey and Martin (1975), I may have invoked the impression of methodological homogeneity among EC studies. However, there are many parameters that vary between different investigations. For example, some studies make use of an incidental learning procedure (e.g., Olson & Fazio, 2001), whereas others make the learning context explicit (e.g., Kattner & Ellermeier, 2011); in some studies, CS and US are presented simultaneously (e.g., Pleyers et al., 2009), whereas others use a delayed (e.g., Walther, 2002), or trace conditioning procedure (e.g., Fulcher & Hammerl, 2001); some studies present a CS with a single US repeatedly (e.g., Gast et al., 2012), yet others pair a single CS with multiple US (e.g., Jones et al., 2009). Moreover, EC studies can differ in the number of overall learning trials, the number of CS-US pairs, or in the duration of CS-US presentations (cf. Baeyens et al., 1992a). In fact, it may be difficult to find any pair of EC studies from different authors that have used the exact same configuration of procedural parameters.

The heterogeneity of procedural configurations may impose difficulties for evaluating the appropriateness of the theoretical accounts as several authors have proposed that differences in procedures promote differences in learning processes (e.g., Sweldens et al., 2010; Walther, Weil, & Langer, 2011d). For example, Sweldens et al. (2010) showed that repeatedly presenting a CS with the same US in a delayed procedure leads to EC that is sensitive to US revaluation (see referential and propositional accounts), whereas presenting a CS with multiple US simultaneously leads to EC that resembles a direct acquisition of an evaluative response (see holistic and misattribution accounts). What such findings imply is that by setting procedural parameters carefully, one may be able to create an ideal environment for a process to be studied. It is important to note, however, that the existing accounts of EC rarely specify procedural boundary conditions (with the exception of the misattribution account), and that several boundary conditions can be reasonably linked to multiple accounts. Nevertheless, procedural boundary conditions will be discussed when necessary.

Summary

Modern EC research was born out of the tension between a behaviorist and a "cognitive" view of learning, and this tension has remained a major impetus for EC research even until today. To adapt a quote from Shanks (2010), the issue is if one should think of EC as driven by the "formation of a mental link or bond between a cue [the CS] and an outcome [the US or the evaluative response], or instead as [driven by] the acquisition of a propositional belief representing the relationship between them" (p. 275). Although there is no a priori reason to assume that it could not be both (cf. De Houwer, 2007; De Houwer et al., 2005), my brief overview of the literature suggests that favor has shifted gradually from the former explanation to the latter. The initial accounts of EC, i.e., the holistic and the referential account, embody the premise of EC as driven by processes unique to the learning of attitudes that are unconstrained by the boundary conditions of propositional processes. According to these accounts, the CS and US representations are either fused or associatively linked. However, these conceptions were based on experimental designs and empirical findings of questionable validity (cf. Field & Davey, 1997; Pleyers et al., 2007), and many recent findings seem to suggest that EC is driven primarily by propositional processes. For example, a recent meta-analysis by Hofmann et al. (2010) has identified performance in awareness tests as the most important moderator of EC, and the findings of experimental investigations provide further support for propositional processes as an explanation of moderations of EC. Notwithstanding that the recently proposed misattribution account has reinvigorated the theoretical interest in processes unique to the learning of attitudes, the linking of implicit misattribution to both procedural boundary conditions (i.e., simultaneous occurrence, cf. Hütter & Sweldens, 2013) and the absence awareness seem to marginalize the account's relevance for a majority of EC studies. If taken at face value, one may be tempted to argue that the evidence favors propositional processes as the primary explanatory concept of EC (cf. Dedonder et al., 2013; Gast et al., 2012; Hofmann et al., 2010; Sweldens et al., 2014),

However, it is important to note that the propositional approach may also seem appealing on a purely conceptual level. For example, the papers of De Houwer (2009), and Mitchell et al. (2009) address EC as only one of several examples in the wider context of associative learning studies, which also include learning in human Pavlovian conditioning (e.g., Lovibond & Shanks, 2002), and causal learning (e.g., Waldman & Holyoak, 1992). By integrating EC into a propositional framework, it is implied that EC can be explained by principles that apply to learning in general, and not only to attitude formation in particular. The account therefore implies theoretical parsimony. Furthermore, the propositional account is able to predict which factors will moderate EC and, most importantly, under which conditions the pairing of CS and US will not result in EC (i.e., under conditions that disrupt propositional processes). In comparison, it has been criticized that a major weakness of the non-propositional accounts (although not including the recently proposed misattribution account) is that they have failed to specify boundary conditions of EC that go beyond the definitional requirement of pairing CS and US (e.g., De Houwer et al., 2001). This renders most non-propositional accounts descriptive at best and untestable at worst.

Notwithstanding the importance of parsimonious and testable theories, it is crucial to neither confuse the premise of theoretical integration with its success, nor to mistake the weaknesses of one approach for the strength of another. Each account of EC, the propositional approach included, specifies one out of an unknown number of mechanisms by which the occurrence of EC could be explained, and therefore each account must be evaluated according to its own conceptual clarity, and its consistency with the available evidence. For example, the mere presence of boundary conditions for the occurrence of EC, although not predicted by the referential and holistic accounts, does not suffice an interpretation in favor of the propositional approach. The interpretation would only be justified if boundary conditions can be directly linked to propositional processes. Given the prominence of the propositional account, and its widespread implications for attitude research, the simple yet fundamental question asked here is: to what extent does the available evidence support the conclusion that EC is driven primarily by propositional processes? And if the evidence does not, what are the conceptual challenges that have remained unaddressed?

3 The Tricky Nature of Memory Performance Data[2]

Recently, the meta-analysis of Hofmann et al. (2010) has identified performance in awareness tests as the most important moderator of EC. Moreover, studies that have used improved methods for measuring and analyzing the relationship between performance and EC often showed that EC is *only* obtained in CS for which the paired US or its valence was correctly indicated (e.g., Dedonder et al., 2010; Gast et al., 2012; Pleyers et al., 2007; Pleyers et al., 2009; Stahl & Unkelbach, 2009; Stahl et al., 2009; but see Hütter et al., 2012). Given that awareness of the CS-US relationship is a necessary condition for propositional learning (Mitchell et al., 2009), these findings cast some serious doubts on whether theories other than the propositional account can adequately address the processes underlying EC. Adding to that impression is also the fact that findings that favor a conclusion of unaware EC can be easily dismissed based on methodological grounds: the study may have been underpowered (Bar-Anan et al., 2010), the test of awareness may have been insensitive (Stahl et al., 2009), or the method of analysis may have obscured a relationship that is present in the data (Pleyers et al., 2007). In comparison, it seems inherently less problematic to conclude in favor of the propositional account on the basis of observing a relationship between EC and performance in an awareness tests. However, that impression may be deceiving (cf. Gawronski & Walther, 2012; Hütter et al., 2012).

First, it is important to be aware of the fact that most of the evidence for a relationship between EC and awareness is correlation (Gawronksi & Walther, 2012). Indeed, the conclusion of Hofmann et al. (2010) that awareness is the most important moderator of EC is solely based on the observed correlation between an index of EC on the one hand, and performance in a test of awareness on the other hand. However, given its correlational nature, any observed relationship may (nonexclusively) suggest that EC depends on awareness, that

[2] This chapter is based on a manuscript titled "The role of recollection in evaluative conditioning", co-authored by Eva Walther, Katarina Blask, and Rebecca Weil, which is under review at the *Journal of Experimental Social Psychology*.

awareness depends on EC, or that both are spuriously correlated through their dependence on an unknown third variable (cf. Lovibond & Shanks, 2002). Thus the causal status implied by the propositional approach, i.e., that awareness of the CS-US relationship logically precedes the occurrence of EC, cannot be inferred from the presence of a correlation.

Second, it is important to be aware of the inferential leap that is taken by merely stating that EC and awareness are correlated. Awareness of the CS-US relationship is inferred from performance in a recognition test which, prima facie, measures a participant's memory for the CS-US pairings (Gawronski & Walther, 2012). However, awareness, as implied by the propositional approach, concerns a subjective state during learning (i.e., the becoming aware that a CS co-occurs with either liked or disliked US). Although awareness during learning could influence later memory performance, drawing the reverse inference is not logically warranted (i.e., it is the fallacy of *affirming the consequent*, Gawronski & Walther, 2012). Given these issues, Gawronski and Walther (2012) concluded that memory data have little bearing for the question of whether or not awareness during learning is required (or even beneficial) for EC, and that a conclusion in favor of the propositional approach is therefore not justified.

Interpreting the Relationship between EC and Memory Performance

Notwithstanding that memory performance data remain ambiguous about the role of awareness during encoding, several authors have argued that the data are nevertheless informative about the nature of *retrieval* processes that mediate between an acquired representation, and the effect of that representation on liking or disliking of the CS. Specifically, it has been argued that the moderation of EC by memory performance reveals the importance of positional processes at retrieval (e.g., Balas & Gawronski, 2012; Bar-Anan et al., 2010; Gast et al., 2012; Gawronski & Bodenhausen, 2014). For example, Gast et al. (2012) argued that it may not be sufficient for individuals to become aware of the CS-US pairing during encoding, but that awareness has to be maintained in order for the pairing to influence the CS evaluation at a later point in time. The argument that memory performance data reveal the importance of propositional processes at the time of retrieval is therefore based on the assumption that memory performance reveals a conscious form of remembering (cf. Stahl et al., 2009), and that this conscious remembering is used intentionally to evaluate the CS. However, this reasoning again shows a commitment to the fallacy of affirming the consequent, as a specific retrieval process is inferred from the performance of which it may not be the exclusive cause (cf. Hütter et al., 2012). Hence, the extent to which memory performance reflects a conscious form of remembering or any other memory process, and whether or not these processes can account for the moderation of EC, remains an open question. In order to close this theoretical gap, the present research tested different hypotheses about which memory processes underlie the moderation of EC by memory performance.

Intentional and unintentional use of memory in EC. On the one hand, memory can involve the conscious experience of remembering, i.e., recollection (Tulving, 1989). Hence, memory performance in EC studies could indeed 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). On the other hand, however, 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, but that nevertheless show an influence of previous experience on task performance (Schacter, 1987). However, unintended effects also include “informed guessing” which describes accurate responding in explicit tests that occurs without recollection (Jacoby, Toth, & Yonelinas, 1993). So for example, you may be correct in indicating which specific CS and US were paired, although subjectively, you have had the impression that you were merely guessing.

Unintended effects have been explained by an increase in the accessibility of a particular response that is caused by its 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 can increase the accessibility of its associate (Zeelenberg, Pecher, & Raaijmakers, 2003). Accordingly, and assuming that a link between CS and US is somehow represented, presenting the CS may increase the accessibility of the previously paired US as the test's response. The increase in accessibility would lead to the US being indicated without necessitating the US' conscious recollection. Interestingly, there are many studies indicating that such responding can even exceed the influence of intentional uses of memory on performance, denying any a priori justification to the hypothesis that memory performance primarily reflects recollection (cf. Yonelinas, 2002).

In order to distinguish between intended and unintended effects on memory performance, memory 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 can be found in a recent EC study conducted by Hütter et al. (2012). In that study, the authors distinguished between recollecting the valence of the paired US and (strategically) inferring the paired US's valence from CS attitudes (cf. Gawronski & Walther, 2012). 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 valence of paired US, 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. The findings of Hütter et al. (2012) not only corroborate the assumption that memory performance may reflect multiple processes, but also highlight the importance of controlling for strategic uses of CS attitudes when measuring a participants memory for the CS-US pairings. Having discussed which memory processes could be confounded in performance, the question that remains is whether these processes can account for the moderation of EC by memory performance.

Overview of the Experiments

Based on a vast amount of research in cognitive psychology (Jacoby, 1998; Jacoby et al., 1999; Roediger, 1990; Schacter, 1987; Yonelinas & Jacoby, 2012) I 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, Tangen, Cornwell, Quinn, & Murray, 2010). I therefore expected that indices of intentional as well as of unintentional uses of memory are significant predictors of EC. In order to test my hypotheses I designed two experiments in which I 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 I was able to conduct a sensitive item-level analysis of which memory processes moderate EC (cf. Pleyers et al., 2007). However, in the absence of any precedent in EC research, no assumptions were made about the relative importance of one predictor over another.

Experiment 1

In Experiment 1 fictitious water brands (CS) were paired with liked and disliked pictures (US). After assessing CS attitudes, I administered a memory test that manipulated instructions to control performance within participants. On each trial a CS and all US were presented such that I could measure whether the paired US was indicated (henceforth referred to as *identity memory performance*) and also 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), my 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). I then analyzed the effects of recollection and identity memory performance on EC. However, in the analysis I 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 a positive US because they like the CS; Hütter et al., 2012).

Method

Participants and design. Seventy-two students (48 women, 24 men, 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. I used pre-tested materials from Brendl, Nijs, Möller, & Walther (2014). Specifically, fictitious brand names (Blask, Walther, Halbeisen, & Weil, 2012) served as CS and liked and disliked pictures (e.g., a smiling child, a grieving widow) served as US. Half of the CS were paired with liked US while the other half was paired with disliked US, 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. CS 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 CS 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 US (cf. Baeyens et al., 1990). In order to identify recollection within memory performance, each CS was 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 US should be selected on indicate trials, but should not be selected on avoidance trials. Combining the performances under indication and avoidance instructions thus allowed me to infer whether a CS-US pair was recollected or indicated without recollection.

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, I 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, I compared performances on trials that instructed participants to select the paired US (indication trials) with trials on 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) × 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 on avoidance trials compared to indication trials (*M* = .43, *SD* = .22 vs. *M* = .35, *SD* = .20, respectively), $p = .004$. No other effects were significant, all *F*s < 1.80, *p*s > .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), I 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, I 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, I 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, I 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.

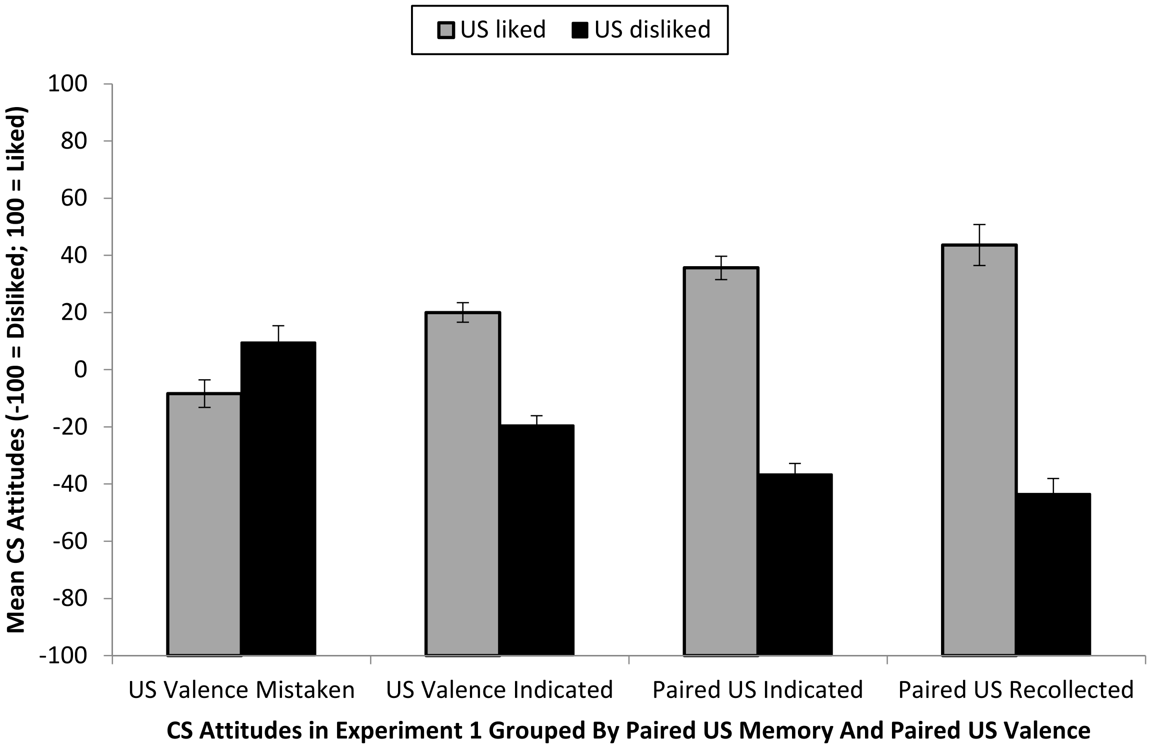

Figure 1. Mean CS attitudes grouped by paired US valence (liked vs. disliked) and paired US memory in Experiment 1 (error bars show standard error of the mean).

Model evaluation. Figure 1 shows the observed mean CS attitudes as a function of the fixed effects incorporated in the final model (see Appendix A for parameter estimates). Descriptively, the strongest conditioning effects were observed for recollected pairs, as CS paired with liked US were evaluated more favorably compared to CS paired with disliked US (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[3], 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, I 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 I also improved upon the technique to identify recollection.

[3] 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).

Experiment 2

Method

Participants and design. Ninety-six students (74 women, 22 men, 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 identify 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 I 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.

Results and Discussion

Memory performance and conscious control. I 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, I proceeded to analyze EC.

Item-based analysis of EC. The item-based analysis of the moderation of EC was similar to Study 1. I 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, I 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. I sought support for any of the possible patterns by evaluating the significance of fixed effects in the final model.

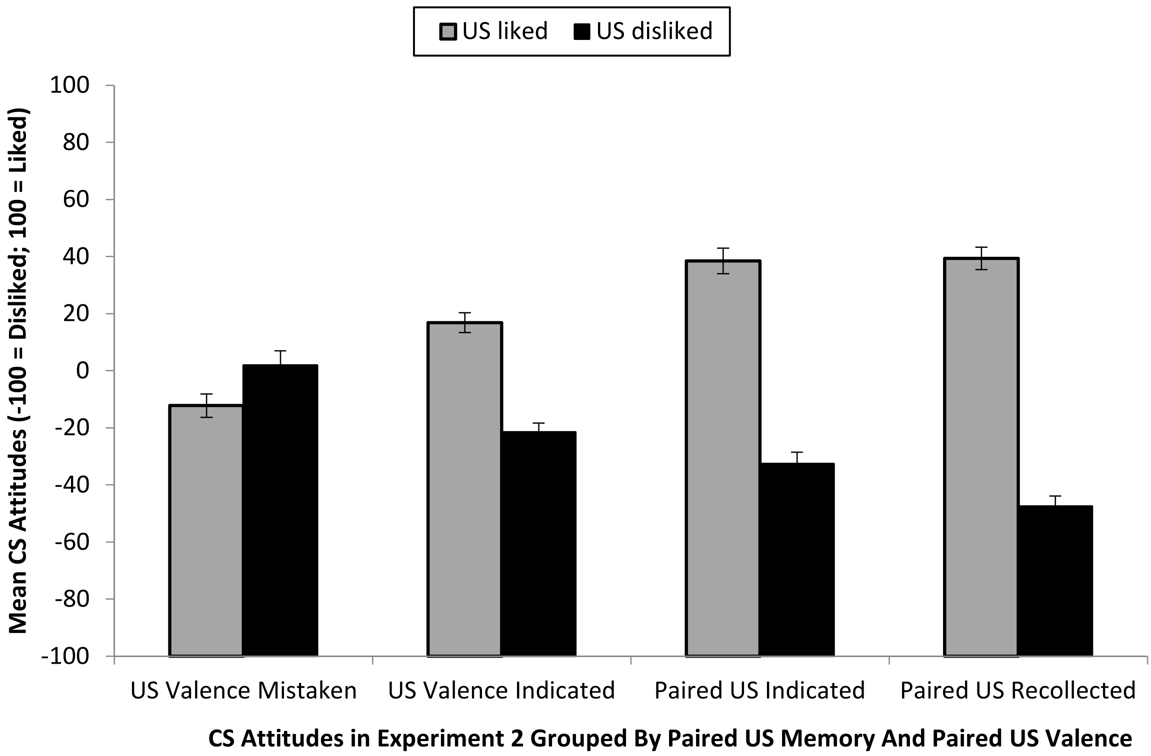

Figure 2. Mean CS attitudes grouped by paired US valence (liked vs. disliked) and paired US memory in Experiment 2 (error bars show standard error of the mean).

Model evaluation. Figure 2 shows the mean CS attitudes as a function of the fixed effects in the final model (see Appendix A 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.

General Discussion

It has been repeatedly shown that EC is moderated by memory for the CS-US pairings (Hofmann et al., 2010), but the question which retrieval 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) I 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 I identified recollection by asking participants to exert control over their memory performance (Jacoby, 1991) and I distinguished recollection from indicating the paired US in the absence of recollection as well as from indicating the valence of paired US. In accordance with previous findings I 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. This reversal could indicate that CS evaluations could be based on false memories for the US (see Bar-Anan et al., 2010, for similar findings), but also that CS evaluations could guide performance in the memory test (cf. Hütter et al., 2010). However, in case of identity memory when participants indicated the paired US correctly, a further increase in EC was observed that was statistically significant (Gast et al., 2012). Because I separated recollection from identity memory performance, I was able to determine to what extent this increase suggested an intended or an unintended effect of memory for the pairings on EC. In fact the findings indicate that EC could be based on both (a) intended and also on (b) unintended uses of memory, as the prediction of EC based on recollection was statistically indistinguishable from the prediction of EC based on identity memory performance. 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.

Limitations

Before discussing the theoretical implications of these findings, it is important to be aware of the constraints on which any interpretations may depend on. For example, despite the fact that I manipulated the test instructions in order to identify recollection within memory performance, the relationship of memory indices to EC remains correlational. Memory indices were defined as predictors in the statistical model, but it may be possible for EC to influence both valence and identity memory indices, although in the latter case such effect would be less plausible (cf. Gast et al., 2012). Suggestions about the causal structure about the relationship between EC and memory indices have thus to be taken with caution.

Moreover, the specific pattern by which memory indices and EC are related may depend on design choices inherent to the experiments. For example, participants were asked to attend to a focal task during learning, rendering the simultaneously presented CS and US task-irrelevant. Drawing the participants' attention to the stimulus pairs or changing the way in which CS and US are presented could alter the nature of encoding operations (cf. Olson & Fazio, 2001; Sweldens et al., 2010), which may translate into a different composition of memory processes and ultimately into different relationships observed between memory indices and EC. Moreover, participants were instructed to evaluate the CS spontaneously. It is not unreasonable to assume that differences in the mindset of participants during evaluation may change the weight by which memory indices are related to EC (cf. Balas & Gawronski, 2012).

And finally, it cannot be ruled out that any effect observed for identity memory, for both recollection and performance indices, is contingent on the participants valence memory. For example, identifying the paired US in the absence of recollection does not preclude the possibility that participants were recollecting the valence of the paired US. It is not impossible that without recollecting the US valence, no EC nor any moderation of EC by identity memory would have been observed (Stahl et al., 2009).

Implications

These limitations notwithstanding, the present findings seem to offer some interesting insight into how the relationship between EC and memory performance could be interpreted. In many recent studies it has been argued that the relationship would reveal the importance of propositional processes at the time of retrieval (e.g., Balas & Gawronski, 2012; Bar-Anan et al., 2010; Gast et al., 2012). The correlation, so the argument goes, seems to suggest that participants in EC studies actively consider the contents of their recollective experiences in order to determine the liking or disliking of the CS (see also Bar-Anan et al., 2010, for evidence supportive of this strategy). However, the presence of recollection had only been assumed in previous studies, and in the two experiments reported here recollection was no more or less important for the prediction of EC than unintentional uses of memory. Although there may be different patterns in differently designed studies (cf. Hütter & Sweldens, 2013; Jones et al., 2009), interpreting the correlation between EC and memory performance in purely propositional terms seems unjustified in light of these findings. Instead, it could be argued that the findings reveal the mutual contribution of propositional and associative processes at the time of retrieval (cf. Gawronski & Bodenhausen, 2006).

Assuming that the occurrence of EC is driven by different retrieval processes raises the question on which boundary conditions these processes might depend on? Thus far, EC accounts have remained either silent or vague about this question (cf. Baeyens et al., 2009; Shanks, 2007). For example, the referential account does not conceive of any boundary conditions of the occurrence of EC that are unrelated to either changing the CS-US association (e.g. Baeyens et al., 1989), or changing the valence of the US (e.g., Baeyens et al., 1992b). Conversely, Mitchell et al. (2009) proposed both intentional and unintentional processes by which propositions could influence CS liking, but they left the issue of boundary conditions of these processes unaddressed. However, assumptions about boundary conditions can be readily borrowed from memory research. For example, intentional uses of memory usually suffer from distraction during retrieval (Yonelinas, 2002), which is why under these conditions EC could be primarily influenced by unintended uses of memory. In contrast, unintended uses of memory suffer from changes between learning and retrieval contexts (Yonelinas, 2002; Whittlesea & Price, 2001; see also Humphreys et al., 2010), which is why under these conditions EC could be driven primarily by intentional uses of memory. Manipulating the boundary conditions of retrieval processes could be especially useful if studying the effectiveness of EC in contexts that involve strong motivational or normative concerns, such as when using EC to change attitudes towards minority group members (e.g., Olson & Fazio, 2006).

Side Effects of Neglecting the Processes of Retrieval

Although retrieval processes represent a separate field of EC research, it is important to note that the neglect of retrieval processes in the existing accounts of EC may have unwanted side effects for studying learning processes. Specifically, if conditions manipulated during learning can affect later retrieval processes (cf. Whittlesea & Price, 2001), it may be difficult to unambiguously interpret any finding in terms of an effect incurred at learning. For example, any manipulation of learning conditions that confounds contextual changes between learning and retrieval contexts could moderate EC by affecting unintentional uses of memory. Of course, these issues seem more readily applicable to accounts that assume an indirect rather than direct transfer of evaluation (cf. holistic and misattribution accounts). However, even in the case of a direct transfer of evaluation it might be informative to consider that encoding manipulations could nevertheless affect the retrieval of directly acquired attitudes (cf. Grawonski & Bodenhausen, 2006). Clearly, it will be necessary for future EC research to distinguish, both conceptually and empirically, between encoding and retrieval processes that are involved in EC.

4 Dual-Task Interference: Similarity Matters![4]

It may be little surprising to find that correlational data are of questionable validity when it comes to inferring the causal contribution of propositional processes to the occurrence of EC. However, the suggestion that EC may be primarily based on propositional processes is also based on experimental studies which, while fewer in numbers, are better suited to causal inferences. Such studies have usually manipulated the boundary conditions of propositional processes during encoding, and examined whether EC can occur under conditions that disfavor propositional processing. In the present chapter I examine one prominent line of such experimental research which has investigated the occurrence of EC under dual-task conditions.

In a typical dual-task experiments, learning in a primary task is studied under the influence of a concurrently performed secondary task such as a complex counting or updating task (e.g., De Houwer & Beckers, 2003; Nissen & Bullemer, 1987; Straube, Trippe, Schmidt, Weiss, Hecht, & Miltner, 2011). The use of dual-tasking methodology in EC research has sometimes been motivated by a desire to reduce awareness during learning (e.g., Brunstrom & Higgs, 2002; Fulcher & Hammerl, 2001), although most studies have been based on the assumption that propositional processes incur costs on the limited capacities of the human cognitive system (e.g., Field & Moore, 2005; Pleyers et al., 2009; Walther, 2002). If EC is driven by cognitively demanding processes, then performing the secondary task during learning should interfere with the occurrence of EC (De Houwer, 2009; Mitchell et al., 2009; see also Gawronski & Bodenhausen, 2006; Slomann, 1996; Smith & DeCoster, 2000; Strack & Deutsch, 2004).

However, the empirical evidence on dual-task interference in EC is not entirely consistent. Whereas in some studies EC was obtained under dual-task conditions (Fulcher &

[4] This chapter is based on a manuscript titled „ Dual-Task Interference in Evaluative Conditioning: Similarity Matters!" co-authored by Eva Walther, which is currently under revision for being resubmitted to the *Quarterly Journal of Experimental Psychology*.

Hammerl, 2001; Walther, 2002; Walther & Trasselli, 2003) others found that performing a demanding secondary task interferes and subsequently reduces EC (Brunstrom & Higgs, 2002; Davies et al., 2012; Dedonder et al., 2010; Field & Moore, 2005; Kattner, 2012; Pleyers et al., 2009). How can these inconsistent findings be reconciled? Field and Moore (2005) as well as Pleyers et al. (2009) have endorsed a post hoc explanation in attributing the inconsistent findings to methodological artifacts, such as that different task may influence different processes, or that different tasks are more or less demanding. However, a theoretically more interesting and testable possibility is to assume that the presence or absence of dual-task interference depends on further boundary conditions. Thus far, however, only Kattner (2012) has explored this possibility.

Exploring the Boundary Conditions of Dual Task-Interference in EC

According to the propositional approach, any secondary task that interferes with the propositional encoding of the CS-US relationship should also interfere with the occurrence of EC (Mitchell et al., 2009). However, the findings of a study by Field and Moore (2005) suggest that interference effects occur independent of whether or not the CS-US relationship can be processed. In that study, the occurrence of EC under dual-task conditions was investigated while independently manipulating the speed at which the US were presented (i.e., 17 ms vs. 1000 ms). It was argued that the “subliminal” presentation of the US (i.e., 17 ms) would prevent participants from propositionally encoding the CS-US relationship. However, it was only found that performing a demanding secondary task (i.e., backwards counting) interferes with the occurrence of EC, but no effects were obtained for the speed at which US were presented. Based on these findings Kattner (2012) argued that secondary tasks may differ in the quality of demand, such that some tasks could interfere with the encoding of CS-US relationships, but not with the encoding of individual stimuli. Hence, EC might occur under conditions of a secondary task if that task only interferes with processing the CS-US relationship, In order to test whether these differences in the quality of task demands predict dual-task interference in EC, Kattner (2012) compared the effect of a secondary task designed to interfere with processing stimulus relationships (i.e., additional learning involving CS and US independently) with a secondary task designed to interfere with the processing of CS and US themselves (i.e., solving math problems). However, his findings showed no evidence of EC under either dual-task condition. Notwithstanding that these findings could suggest that encoding the CS-US relationship is crucial to EC after all (see also Dedonder et al., 2010; Pleyers et al., 2009), the inability to predict the occurrence of EC shows that a theoretical framework on the basis of which inconsistent findings could be reconciled has yet to be found.

A Theoretical Framework for Reconciling the Inconsistent Findings

Going beyond the research of Kattner (2012) I suggest that both the learning task and the secondary task can differ in the quality of demand that they impose, and that the similarity of demands might be a source of interference. For example, a closer inspection of the studies that found EC under dual-task conditions revealed that verbally demanding secondary tasks were combined with learning tasks that imposed visuospatial demands, and vice versa. Specifically, the participants in Fulcher and Hammerl’s study (2001) explored the surfaces of haptic CS and US while solving math problems; the participants in Walther’s study (2002, Experiment 5) watched faces while rehearsing an 8-digit number; and finally, the participants in Walther and Trasselli’s study (2003, Experiment 2) listened to instructions that linked CS and US while navigating their path through a haptic miniature maze. Conversely, several previous interference effects could be attributed to the similarity of (verbal) demands imposed by the learning and the secondary tasks. For example, the participants in the study of Pleyers et al. (2009) rehearsed numbers in an n-back working memory task while learning to associate labelled products with positive or negative valences; in the study of Dedonder et al. (2010) participants worked the same n-back task while (mostly) foreign letters were conditioned; and finally, the participants in Field and Moore's study (2005) were counting backwards while instructed to define how CS and US made them feel.

That verbal and visuospatial processing play a central role in dual-task interference can also be derived from the Baddeley model of working memory (Baddeley, 2012; Baddeley & Hitch, 1974). In the Baddeley model, a system of articulatory processes, i.e., the "phonological loop", handles the encoding and maintenance of verbal information, whereas another system, i.e., the "visuospatial sketchpad", handles similar activities for both visual and spatial information. While the independent systems are believed to have unique functional characteristics, both are limited in the amount of information that they can process. Therefore, to the extent that two tasks incur demands in the same rather than in independent systems, interference should occur (for similar predictions, see also the models of Arrighi, Lunardi, & Burr, 2011; Hazeltine, Ruthruff, & Remington, 2006; Wickens, 2002). Consistent with this prediction it has been shown that verbal activities (e.g., repeatedly uttering syllables, verifying sentences), but not visuospatial activities (e.g., tapping, mental rotation), interfere with verbal memory tasks such as retaining a series of letters or words. Conversely, visuospatial activities, but not verbal activities, interfere with memory for visual patterns and locations (e.g., Bayliss, Jarrold, Gunn, & Baddeley, 2003; Cocchini, Logie, Della Sala, MacPherson, & Baddeley, 2002; Logie, 1986; Logie, Zucco, & Baddeley, 1990; Meiser & Klauer, 1999; Shah & Miyake, 1996).

Moreover, Duyck, Szmalec, Kemps, and Vandierendonck (2003; see also Papagno, Valentine, & Baddeley, 1991) found that secondary verbal activities interfere with associative learning of word-like stimuli (i.e., words and nonwords), but that interference is absent if stimuli can be encoded visuospatially. It is important to note that in this study, all word-like stimuli were presented visually rather than acoustically, and that the affordance of nonwords for visuospatial processing was manipulated by assigning the stimuli to abstract line drawings prior to the nonword-word learning task. The findings of that study thus not only suggest that learning to associate two stimuli may depend on the similarity of the encoding activities in the learning and the secondary task, but that it is indeed the encoding activity afforded by a stimulus (i.e., reading versus visualizing), and not merely the modality in which the stimulus is presented, that can produce the effect (cf. Topolinski & Strack, 2009).

Taken together, the findings of previous studies suggest that processing the CS-US pairs and the secondary task could be independent if dissimilar verbal and visuospatial demands are incurred. I therefore hypothesized that the occurrence of dual-task interference in EC depends on the tasks' similarity of verbal and visuospatial demands.

Overview of Experiment 3

In order to test this hypothesis, I investigated the occurrence of EC under conditions of a demanding 3-back working memory task (Kirchner, 1958) while manipulating the quality of demands incurred by the learning and the secondary task between participants. Within the tasks I used word-like stimuli to incur verbal demands, and picture-like stimuli to incur visuospatial demands (cf. Amit & Greene, 2012). Except for using these different types of verbally or visuospatially demanding stimuli, all procedural parameters were kept constant across conditions such as to avoid unwanted methodological artefacts. Subsequent to the conditioning procedure I measured participants' attitudes towards the CS as well as their memory for the CS-US relationships (cf. Hütter et al., 2012; Hütter & Sweldens, 2013). I predicted that relative to conditions using dissimilar types of stimuli, the 3-back task would interfere with changes in CS attitudes when both tasks used the same type of stimuli. By further measuring participants' memory for the stimulus relationship, I was also able to follow up on the question of how dual-task interference relates to processing the CS-US relationship. If dual-task interference and processing the CS-US relationship are closely related (cf. Kattner, 2012), one might expect that the effect of using similar or dissimilar types of stimuli extends to participants' memories for the CS-US relationship. However, if dual-task interference and processing the CS-US relationship are unrelated (cf. Field & Moore, 2005), then effects of the similarity of demands on participants' memories for the relationships are not to be expected.

Method

Participants and Design

In exchange for course credit, 56 students (38 female, 18 male, M_{age} = 22.45, age range: 19-37 years) were randomly assigned to the conditions of a 2 (type of CS-US pairs: word-like vs. picture-like) x 2 (type of 3-back symbols: words vs. pictures) x 2 (US valence: positive vs. negative) design with US valence manipulated within participants, and type of CS-US pairs as well as type of 3-back symbols manipulated between participants.

Materials

The 8 CS used for word-like CS-US pairs and the 8 CS used for picture-like CS-US pairs consisted of neutral word-like (i.e., pronounceable) nonwords and neutral picture-like structures, respectively, that were pretested prior to conducting the study (see Figure 3). Specifically, I used WordGen software (Duyck, Desmet, Verbeke, & Brysbaert, 2004) to create a set of 40 word-like nonwords, and I rearranged each nonword's letters to create a matched set of 40 picture-like structures.

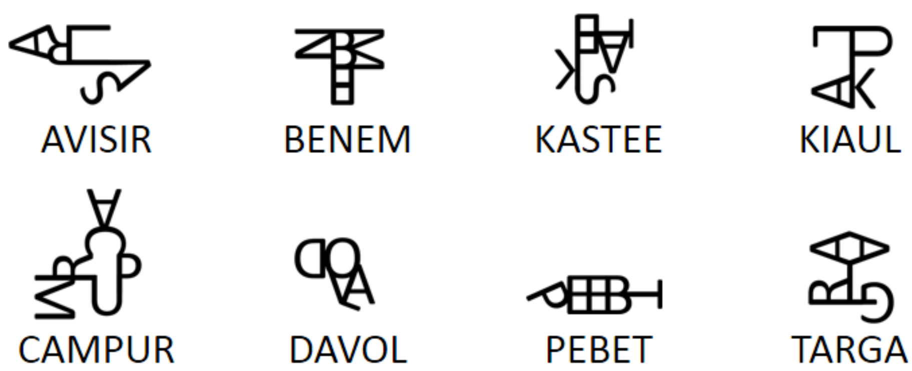

Figure 3. The neutral word-like nonwords and neutral picture-like structures that were used as CS in the experiment.

Evaluations of the stimuli were obtained by distributing questionnaires containing either word-like or picture-like stimuli among a sample of non-psychology students at the end of a lecture. N = 39 individuals (35 female, 4 male, $M_{age} = 21.97$, age range: 18-27 years) completed the word-like questionnaire, and N = 40 individuals (34 female, 6 male, $M_{age} = 21.42$, age range: 18-26 years) completed the picture-like questionnaire. Each participant provided evaluations on a 21-point Likert-type scale ranging from -10 (*dislike*) to 10 (*like*) and was also given the opportunity to provide any spontaneous association that certain stimuli would bring to mind. Eight matched pairs which produced no consistent associations, were evaluated neutrally, and for which evaluations did not differ between word-like and picture-like stimuli, were selected as CS (see Appendix B for means obtained in pretesting). A 2 (CS type: word-like vs. picture-like) x 8 (matched pairs) ANOVA with matched pairs as repeated-measures variable confirmed that the average evaluation of CS ($M = 0.31$, $SD = 1.47$) did not differ from the scale's neutral midpoint, $F(1, 77) = 3.38$, $p = .07$, and that there were also no effects of CS type, matched pair, or their interaction on CS evaluations, all Fs < 0.65, all ps > .42.

As US I used four clearly positive and four clearly negative verbs for word-like pairs, i.e., *genießen* (to enjoy), *küssen* (to kiss), *lachen* (to laugh), *freuen* (to cheer), *trauern* (to grieve), *fürchten* (to be afraid), *weinen* (to cry), and *bedrohen* (to threaten), and four clearly positive and four clearly negative pictures of verb-related contents for picture-like pairs that were obtained from previous studies (Brendl et al., 2014).

Procedure

Upon arriving in the laboratory participants were introduced to a computer guided study on "the determinants of concentration". Written instructions were given that asked participants to perform an n-back working memory task in which they were to respond by key press to each of a set of five symbols presented in a sequence (i.e., square, triangle, circle, diamond, and star), but only if a specific symbol had occurred n = 3 trials earlier in the sequence (cf. Pleyers et al., 2009). In order to interfere with either verbal or visuospatial processing, half of the participants were shown the written labels of symbols (n-back words condition) whereas the other half were shown pictures of symbols (n-back pictures condition, cf. Amit & Greene, 2012). Due to the simple nature of the stimuli that needed to be maintained, a trial lag of n = 3 was chosen such as to incur high levels of processing demand.

Participants were also informed about additional trials that were presented intermittent the symbol trials. Although participants were asked to not respond to the ostensible "distractor" trials, the instructions emphasized that distractor trials nevertheless affected the trial lag. Participants would thus need to count both symbol and distractor trials in order to identify the critical response trials (for an illustration of a trial sequence, see Figure 4). For half of the participants these distractor trials consisted of eight pairs of word-like CS and US, whereas the other half was exposed to eight picture-like CS-US pairs. The assignment of specific CS to specific US was determined at random, and was counterbalanced by US valence across participants (cf. Field & Davey, 1999). Overall, the 8 pairs were presented 10 times each, and the 5 symbols were presented 30 times each. The order of presentation was randomized with the restriction of having 5 response trials for each symbol. To familiarize participants with the procedure, I also included a practice block consisting of 3 presentations of 2 additional neutral stimulus pairs as well as 2 presentations of each of the five symbols. There were 2 response trials in the practice block. During the procedure an omission of a response trial triggered the feedback "missed!", whereas a response on non-response trials triggered the feedback "error!". The stimulus onset asynchrony (SOA) was 2000 ms, with symbols being presented 500 ms, and CS-US pairs as well as the feedback slides being presented for 1000 ms.

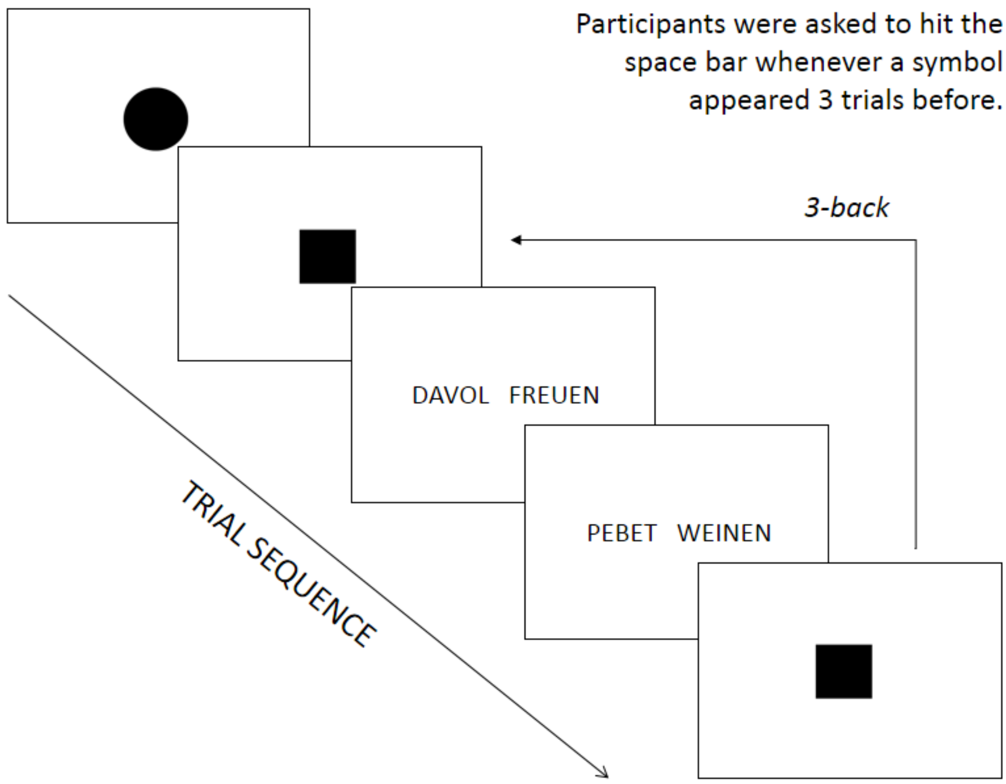

Figure 4. An illustration of a trial sequence combining word-like CS-US pairs and 3-back picture trials.

Upon completion of the task, participants were asked to rate each of the randomly presented CS such as "to rule out artefacts of evaluations on concentration". Each CS was rated 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. Participants also rated the US and were subsequently probed for their memory of the CS-US relationship. Since in the present study I was merely interested in whether or not participants had memory for the CS-US pairs rather than the nature of memory processes (see previous chapter), I assigned participants to one of two conditions of the Hütter et al. (2012) process dissociation procedure (PDP). This PDP is a highly sensitive measure in which participants are asked to recall the valence of paired US (cf. Stahl et al., 2009) while at the same time it provides an additional index of EC to control for artifacts in the measurement of valence memory (cf. Gawronski & Walther, 2012). To achieve the measurement of memory as well as of EC, the PDP compares memory performance under different instructions. Specifically, participants assigned to an "inclusion" condition were presented with the CS and asked to respond with "pleasant" if liked US were remembered whereas participants assigned to an "exclusion" condition were to avoid this response and to use "unpleasant" instead. Likewise, participants assigned to the inclusion condition were asked to respond with "unpleasant" if disliked US were remembered whereas participants in the exclusion condition were to use "pleasant" instead. However, participants of both conditions were asked to respond with "pleasant" to liked CS and "unpleasant" to disliked CS in the absence of memory for the CS-US relationship. Thus participants in the exclusion condition were asked to reverse their evaluative response in case that they remembered the valence of the paired US. The response frequencies obtained under different instructions can then be used to estimate memory, EC that occurs in the absence of memory, and guessing tendencies using multinomial processing trees (MPT; see Hütter et al., 2012, for further procedural details). Concluding the experiment, participants were thanked, debriefed, and awarded their course credit.

Results

Preliminary Analyses

In order to rule out alternative explanations, I first examined whether the use of similar or dissimilar types of stimuli revealed any unexpected effects. Specifically, I wanted to rule out that the similarity of demands influenced US evaluations or that the similarity impacts the difficulty of the 3-back task. I therefore analyzed both the evaluations of US as well as the performance in the 3-back task before I conducted the main analyses.

US evaluations. The evaluations of US were submitted to a 2 (US valence: positive vs. negative) x 2 (US type: word vs. picture) x 2 (type of n-back symbols: words vs. pictures) ANOVA with US valence as repeated-measures variable. As expected, the analyses revealed that positive US received more favorable evaluations than negative US (M_{pos} = 75.42, *SD* = 17.48 vs. M_{neg} = -72.72, *SD* = 17.12), $F(1, 52) = 1510.69$, $p < .001$, $\eta^2 = .967$. In addition, there was a tendency to evaluate words more positively than pictures (M_{words} = 6.5, *SD* = 8.58 vs. $M_{pictures}$ = -3.81, *SD* = 9.03), $F(1, 52) = 18.46$, $p < .001$, $\eta^2 = .262$. However, and most important, no further main effects nor interactions emerged, all *F*s < 0.6, *p*s > .45. Thus there was no evidence that the similarity of demands affected US evaluations in general, or the evaluation of either positive or negative US in particular.

3-back performance. Performance in the 3-back task was indexed as the discriminability *d'* (for means and standard deviations, see Table 1), which is a difference score of z-transformed relative response frequencies on response trials (i.e., hits) and of z-transformed relative response frequencies on non-response trials (i.e., false alarms, see Macmillan & Creelman, 2005; the data of the practice block were not included in the analysis). Overall, *d'* differed significantly from chance level ($M_{d'}$ = 1.69, *SD* = 0.80), $t(55) = 15.74$, $p < .001$, indicating that the responding of participants was sensitive to the difference of response and non-response trials. Submitting *d'* to a 2 (type of CS-US pairs: word-like vs. picture-like) x 2 (type of n-back symbols: words vs. pictures) between-participants ANOVA revealed no main effects or interactions, all *F*s < 1.8, *p*s > .18. Hence, I concluded that similar or dissimilar types of stimuli did not affect the difficulty of the 3-back task.

Table 1

Mean discriminability index d' (standard deviation in parenthesis) of 3-back performance.

	word-like CS-US pairs	*picture-like CS-US pairs*
3-back words	1.97 (0.68)	1.70 (0.82)
3-back pictures	1.46 (0.99)	1.63 (0.69)

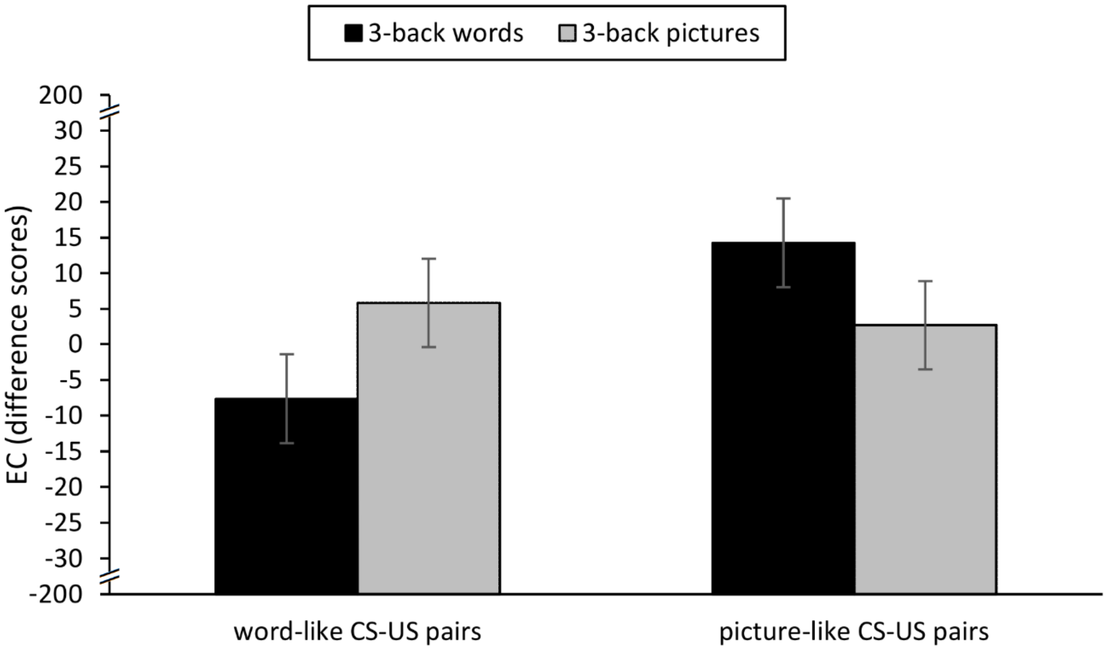

Figure 5. Mean EC (i.e., the difference in evaluations between CS paired with positive US and CS paired with negative US) as a function of the type of stimuli used in the 3-back task and in the evaluative learning task (error bars show standard error of the mean).

EC Effects

I predicted that relative to conditions using dissimilar types of stimuli, the 3-back task would interfere with changes in CS attitudes when both tasks used the same type of stimuli. Thus statistically, I predicted a disordinal interaction of the type of CS-US pairs and type of n-back task on EC. To test this prediction I computed an EC score as the difference between the evaluations of CS paired with positive US and CS paired with negative US such that values larger than 0 indicate the expected change in CS attitudes (for raw means and standard deviations, see Appendix C; for EC scores, see Figure 5). Submitting these EC scores to a 2 (type of CS-US pairs: word-like vs. picture-like) x 2 (type of n-back symbols: words vs. pictures) between-participants ANOVA revealed the significant interaction, $F(1, 52) = 4.05$, $p = .04$, $\eta_p^2 = .07$, but no other effects, all Fs < 2.3, all ps > .13. As predicted EC was larger when combining word-like CS-US pairs with an n-back pictures task (*M* = 5.80, *SD* = 23.26) and picture-like CS-US pairs with an n-back words task (*M* = 14.26, *SD* = 23.26) as compared to combining word-like CS-US pairs with an n-back words task (*M* = -7.64, *SD* = 23.26) and picture-like CS-US pairs with an n-back pictures task (*M* = 2.67, *SD* = 23.26). On average, the EC effect obtained when using dissimilar types of stimuli for the CS-US pairs and the n-back task was significantly different from 0 (*M* = 10.04, *SD* = 18.26), t (27) = 2.91, p = .007, but no EC was obtained when using similar types of stimuli (*M* = -2.48, *SD* = 27.48), t (27) = -0.48, p = .63. Confirming my prediction, these findings provide the first experimental support for the hypothesis that dual-task interference in EC depends on the similarity of verbal and visuospatial demands incurred by the tasks.

Memory for the CS-US Relationship

The response frequency data obtained under inclusion and exclusion conditions of the Hütter et al. (2012) PDP were analyzed to examine the possible impact of using similar and dissimilar types of stimuli on participants' memories for the CS-US relationships. Specifically, I modelled the response frequency data using multiTree (Moshagen, 2010) as a function of memory (*m*), conditioned CS attitudes (*a*), and guessing processes (*g*) while further distinguishing between frequency data obtained from conditions using similar or dissimilar types of stimuli (for parameter estimates, see Table 2).

Table 2

Parameter estimates (standard errors in parenthesis) of the process dissociation procedure.

	m	*a*	*g*
similar types of stimuli	.07 (.06)	.00 (.07)	.50 (.03)
dissimilar types of stimuli	.03 (.06)	.11* (.06)	.53 (.03)

Note. *m* = memory; *a* = conditioned CS attitudes; *g* = guessing; * = $p < .05$ (tested against chance level). P-values are based on a parametric bootstrap in multiTree (N = 500).

Overall, the model fits were satisfactory for both similar (p[5] = .69) and dissimilar task comibations (p = .25). In evaluating the parameter for conditioned CS attitudes, I found a significant difference from chance level when using dissimilar types of stimuli (a = .11, SE = .06), p = .04, but no difference was found when using similar types of stimuli (a = .00, SE = .07), p = .57. This suggests that EC was obtained only when using dissimilar types of stimuli. However, the memory parameters were indifferent from chance level in both dissimilar (m = .03, SE = .06) and similar conditions (m = .07, SE = .06), ps = .30 and .14, respectively. Given the chance-level perfomance of participants in both types of task combinations, there was no evidence that the similarity of demands affects participants' memories for the CS-US relationships.

Discussion

The notion that EC is driven by cognitively demanding processes of propositional reasoning has become increasingly popular (Mitchel et al., 2009; De Houwer, 2009). However, uncertainty remains about whether or not performing another demanding task during learning always interferes with the occurrence of EC, as the findings from dual-task experiments are inconsistent. Whereas in some studies EC was obtained under dual-task conditions (Fulcher & Hammerl, 2001; Walther, 2002; Walther & Trasselli, 2003) others found evidence of interference (Brunstrom & Higgs, 2002; Davies et al., 2012; Dedonder et al., 2010; Field & Moore, 2005; Kattner, 2012; Pleyers et al., 2009).

In order to reconcile these inconsistent findings I suggested that learning tasks and secondary tasks may differ in the quality of the demand they impose. Specifically, and based on the Baddeley (2012) model of working memory, I hypothesized that dual-task interference in EC depends on the tasks imposing similar verbal or visuospatial demands (cf. Duyck et al., 2003). In order to test this hypothesis, I investigated the occurrence of EC under conditions of

[5] P-values of parameter estimates are based on a parametric bootstrapping procedure (N = 500) as recommended by Moshagen (2010).

a demanding 3-back working memory task (Kirchner, 1958) while using either word-like or picture-like stimuli to manipulate the tasks' verbal and visuospatial processing demands, respectively. I predicted and found that relative to conditions using dissimilar types of stimuli, the 3-back task interfered with the occurrence of EC when both tasks used the same type of stimuli. EC was significant only in conditions that used dissimilar stimuli. Moreover, participants of either type of task combination were unable to remember whether CS were paired with liked or disliked US. Thus there was no evidence to suggest that the occurrence of EC under dual-task conditions was contingent on participants having encoded the CS-US relationship (cf. Field & Moore, 2005).

Limitations

Before discussing the theoretical implications of these findings, I would like to stress the limitations inherent to the design of this study. First, there are again fixed experimental parameters such as the simultaneous presentation of CS and US, or the incidental nature of the procedure, that could influence the overall nature of the pattern that was obtained. For example, it may be the case that overall EC improves if the participants had been instructed to focus on the CS-US pairs as well as performing the 3-back task. Under such conditions, it might also occur that the type of stimuli used for the CS-US pairs influences the performance in the 3-back task, leading to a trade-off between EC and 3-back performance when tasks impose similar demands.

Second, the importance of verbal and visuospatial demands for predicting dual-task interference does not preclude the possibility that there are other sources of demand. For example, some stimuli may incur neither verbal nor visuospatial demands (e.g., food-related stimuli, cf. Brunstrom & Higgs, 2002; Davies et al., 2012), and thus not every previous finding can be explained in terms of the proposed working memory framework. Also, it is possible for dual-task interference to arise from the need to coordinate several tasks rather than from the tasks incurring similar demands (cf. Schumacher, Seymour, Glass, Fencsik, Lauber, Kieras, & Meyer, 2001; Vergauwe, Barrouillet, & Camos, 2010). Given that the present experiment did not contain a single-task control condition, the magnitude of such effect of coordination cannot be determined.

Implications

The primary motivation for using dual-task methodology in EC studies has been the assumption that propositional processes incur costs on the limited capacities of the human cognitive system. If EC is driven by cognitively demanding processes, then performing a secondary task during learning should interfere with the occurrence of EC (De Houwer, 2009; Mitchell et al., 2009). The observation that dual-task inference can be present or absent, depending on the similarity of demands incurred by both tasks, is thoroughly consistent with the notion of EC as driven by cognitively demanding processes: EC was only obtained under conditions that allowed for independent processing of the CS-US pairs and the secondary task.

However, according to the propositional approach, interference occurs at the level of propositionally encoding the CS-US relationship (Mitchell et al., 2009), and the occurrence of EC should therefore coincide with evidence that the CS-US relationship has been encoded. To investigate this hypothesis, I used the Hütter et al. (2012) PDP to measures the participants' memories for the CS-US relationship. The measure provides an unbiased index of valence recollection as well as an additional measure of EC. Consistent with my analysis of CS evaluations, the EC index was significant only in conditions that used dissimilar stimuli. However, the insignificant memory parameters suggested that the participants were unable to recall the valence of paired US in any of the conditions. Thus the occurrence of EC under dual-task conditions did not coincide with evidence that the CS-US relationship had been encoded. Hence, although my findings support the notion that EC is driven by cognitively demanding processes, they do not necessarily support the hypothesis that EC is driven by the processes specified in the propositional account.

Of course, one must be cautious not to overstate the implications derived from an absence of memory. However, similar implications can be derived from the findings of Field and Moore (2005) as well as from the findings obtained in Blask et al. (2012). Specifically, we investigated EC for visually presented CS that were conditioned using either visual or auditory US. Similar to my study it was argued that processing capacity is constrained by modal working memory systems, and that the increase in processing capacity by presenting CS and US in different (versus the same) modalities could improve learning. Consistent with this prediction, EC was significantly larger when pairing visual CS with auditory US as compared to pairing visual CS with visual US. However, the increase in EC was not mediated by the participants' memory for the CS-US paring. In comparison, such mediating pattern was obtained when participants were given an explicit goal designed to enhance the processing of the CS-US relationship. It seems then that effects that are predicted on basis of assumptions about the structural constraints of working memory do not support the specific prediction made by the propositional approach.

Structural Processing Constraints

Distinguishing between dual-task interference on the basis of structural constraints of working memory, and dual-task interference on the basis of the boundary conditions of propositional processes, may reveal that EC research has yet to face another conceptual challenge. Consider, for example, the assumption that a process incurs costs on the limited capacities of the cognitive system. As pointed out by several authors (Bargh, 1994; Keren & Schul, 2009; Mitchell et al., 2009; Moors & De Houwer, 2006) it is likely that processes differ along a continuum of the costs they incur rather than falling into categories of demanding versus non-demanding processes. Moreover, it is only logical to assume that processes that are confined to the limits of a finite cognitive systems can never occur without incurring any costs at all. Hence, it would be unjustified to assume independence of learning from incurring costs, notwithstanding the difficulties of testing for a null effect that the assumption of independence implies.

At the same time, however, it seems equally problematic to test for a specific process by merely manipulating the availability of processing resources, as the conclusion could be considered either trivial or arbitrary. Trivial, because any process could be interfered with, and arbitrary, should one conclude the presence of a certain process because of the degree of interference that was observed (cf. p. 189 in Mitchell et al., 2009). After all, assuming that one process is more demanding than another only displaces the problem of a trivial conclusion towards the problem of arbitrarily dividing a continuum. There are similar arguments to be made for the dependence of a process on awareness or on processing goals as these are features continuous in nature, too (e.g., Keren & Schul, 2009). The challenge that thus remains for EC research, and the propositional account in particular, is to find ways of distinguishing structural constraints of EC from theoretically relevant boundary conditions of specific learning processes.

5 Conceptual Challenged and Future Directions

The research presented in this monograph has been inspired by a simple yet fundamental question: To what extent does the available evidence support the conclusion that EC is driven primarily by propositional processes? The simple answer to this question is: To a lesser extent than previously assumed. For example, the conclusion in favor of the propositional approach has partly been based on the moderation of EC by performance in memory tests. However, not only does the conclusion involve a confusion of encoding and retrieval processes, but even the retrieval processes that are confounded in memory performance can hardly be described as primarily propositional. Instead, my research showed that both intentional and unintentional uses of memory contribute equally to the moderation of EC by memory performance. Furthermore, I have pointed towards inconsistencies in the experimental evidence of dual-task interference in EC, and suggested as a possible boundary condition the similarity of verbal and visuospatial demands incurred by processing the CS-US pairs and the secondary task, respectively. While my findings suggest that the occurrence of EC under dual-task conditions does indeed depend on cognitively demanding processes, the specific pattern that was obtained was not characteristic of the propositional account. Specifically, EC that occurred under dual-task conditions was not accompanied by evidence that would suggest that the CS-US relationship had been processed. Of course, there are further areas of experimental evidence which have not been examined in this monograph, and that have been argued to support the propositional account (e.g., Corneille et al., 2009; Fiedler & Unkelbach, 2011; Verwijmeren et al., 2012; Walther et al., 2011b; Zanon et al., 2014). However, given that two lines of evidence deemed central to the propositional account are of questionable validity when it comes to arriving at a favorable conclusion, I feel justified in arguing that the empirical support for propositional processes as the primary explanatory concept of EC is yet unimpressive.

Conceptual Challenges

However, there is also a complex answer to the question of whether or not EC is driven primarily by propositional processes, given the unsolved conceptual issues on which a final verdict may depend on. For example, in scrutinizing the processes that underlie the moderation of EC by memory performance, it became apparent that existing accounts of EC have either remained vague about the retrieval processes that produce EC, or simply failed to clearly distinguish between learning and retrieval processes in the first place. Defining the boundary conditions of retrieval processes is not only important as a topic of investigation in its own right, but clearly distinguishing between learning and retrieval could be crucial to studies that are primarily interested in learning processes. For example, without maintaining a clear distinction between learning and retrieval processes, it might be difficult to assess whether a manipulation of encoding conditions has prevented learning, its retrieval, or both. However, in describing the retrieval processes as intentional and unintentional uses of memory, I have argued that boundary conditions studied in memory research may also apply to EC research (Humphreys et al., 2010; Whittlesea & Price, 2001; Yonelinas, 2002).

Another issue that became apparent when interpreting the findings of dual-task interference is that there may be boundary conditions of learning processes related to structural constraints of information processing (e.g., Baddeley, 2012). Given the assumptions of structural constraints, it may be argued that in evaluating the propositional account, more weight should be given to evidence that has focused on what the propositional process does (i.e., the process' operating principle) instead of when the process operates (i.e., the process' operating condition, cf. Gawronski & Bodenhausen, 2014). For example, evidence of the effects of relational framing could be considered uniquely propositional (e.g., Walther et al., 2011b). Hence, if operating conditions are manipulated, the predictions should focus on variations in the sensitivity to relational learning, rather than on learning in general (cf. De Houwer & Beckers, 2003).

At the same time, however, the notion of structural boundary conditions of learning also implies that research that has merely focused on operating conditions, for example, the research on dual-task interference, is not necessarily inconsistent with non-propositional explanations of EC. For example, the holistic account invoked the representation of CS and US in “immediate memory” as a precondition for the process of fusion, and this concept could be conceptualized in the terms of a working memory subsystem. Similarly, the concept of misattribution invoked by Jones et al. (2009) could be linked to the process of simultaneous maintenance of information in working memory, in addition to conceiving as misattribution as the failure to integrate information in early visual processing. It seems than that EC research is still in need of much theoretical and empirical work before concluding either for or against any of the proposed accounts of EC.

In what ways can EC be considered unique?

In calling for more theoretical and empirical development, it is also important to note that the studies presented in this monograph share an overarching theme besides being concerned with the processes related to EC. Specifically, both lines of research have integrated EC research with concepts and methods from memory research such as intentional and unintentional uses of memory, Jacoby’s logic of opposition to distinguish between the two, or Baddeley’s assumptions about the structural constraints of working memory. Of course, “memory research” can hardly be considered a framework for future EC research given its theoretical variety. However, there is a rich literature on problems related to the processes of encoding, storage, and retrieval in memory research whose assumptions may be infused to offer fruitful areas of future EC research.

In pointing towards the overarching theme of integrating EC and memory research, it is noteworthy that my studies share with the propositional approach the motivation to increase theoretical parsimony by explaining the phenomenon of EC by principles common to learning and memory. However, given the methodological and conceptual issues that EC research has to face, it seems unjustified to yet dismiss the possibility that EC is somehow unique. For example, there are still studies that seem to set EC apart from other learning phenomena, like the (relative) insensitivity to extinction (Baeyens et al., 1988; Díaz, Ruiz, & Baeyens, 2005; Dwyer, Jarratt, & Dick, 2007; Stevenson, Boakes, & Wilson, 2000; Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006), the resistance to blocking (Dickinson & Brown, 2007; Walther, Ebert, & Meinerling, 2011a), or the insensitivity to manipulations of CS-US contingency (Baeyens et al., 1993; Kattner, 2014). In the remainder of this chapter I will therefore discuss two approaches to the uniqueness of EC that are inspired by the ideas and research presented thus far.

Quantitative uniqueness. In keeping with the theme of theoretical parsimony, it may be argued that EC behaves different from other effects observed in structurally similar learning paradigms, but that EC can nevertheless be explained by the same underlying principles. A precursor to this idea is the conceptual conditioning account (Davey, 1994a; Field & Davey, 1997), according to which propositional processes of conceptual learning can explain both EC's resistance to extinction as well as the alleged independence of EC from awareness of the CS-US relationship. However, if unique features of EC are to be explained by common principles, than differences between learning effects in structurally similar paradigms are likely due to quantitative confounds (cf. Kruglanski & Thompson, 1999).

A possible sources of such confounds is that EC procedures are inherently concerned with the processing of valenced information. Compared to neutral stimuli, valence has been shown to bias both encoding and retrieval-related processes (e.g., Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Blaney, 1986; Kensigner & Corkin, 2004; Öhman, Flykt, & Esteves, 2001), which could explain differences between studies investigating EC and studies concerned with the learning of neutral materials. At the same time, however, valenced stimuli used in EC studies are usually low in arousal, which may distinguish the effects observed in an EC study from effects observed in human Pavlovian conditioning (cf. Lovibond & Shanks, 2002). Such differences could explain, for example, EC's resistance to extinction. Specifically, it could be argued that in a typical extinction procedure the valenced and confirmatory evidence for the CS-US relationship (i.e., the co-occurrence of CS and US) enjoys an encoding as well as a retrieval advantage over disconfirming evidence, which usually consists of CS-alone presentations. Moreover, if none of the stimuli are particularly arousing, the disconfirming evidence may fail to be noticed because it does not deviate from the baseline of low-arousing events experienced during the initial learning phase. The learning process may thus be biased, but could nevertheless be described as a propositional process concerned with the learning of CS-US relationships.

Qualitative uniqueness. However, I have also invoked the idea of structural constraints of information processing, which fits well with the initial approach of conceptualizing the uniqueness of EC in terms of unique learning processes. Specifically, the holistic account as well as its conceptual successor, the misattribution account, argue that the experience of an evaluative response is a precondition for learning. In this sense, the learning process may be considered *affective* given that learning is triggered by the experience rather than by the semantic concept of liking or disliking the US. Importantly, affective experiences have not only been shown to trigger specific and difficult-to-control facial reactions (e.g., Dimberg, Thunberg, & Grunedal, 2002; Neumann, Hess, Schulz, & Alpers, 2005; Neumann, Lozo, & Kunde, 2014), but the manipulation of facial patterns has been shown to specifically interfere with the experience of affect (Strack, Martin, & Stepper, 1988). Hence, it may be argued that there are structural constrains unique to the learning of affective information which, if interfered with, could provide a direct test of the idea that EC can be driven by unique learning processes (cf. Jones et al., 2009). As an illustration of the feasibility of this new approach to the idea of qualitative uniqueness, I present below a brief summary of a pilot study that I conducted.

A primer of a new qualitative uniqueness of EC. Based on the idea of affective learning processes that are unique to EC I have conducted a pilot study in which participants were conditioned while blocking (vs. not blocking) the experience of positive affect using the Strack et al. (1988) facial blocking technique. The procedure involved the pairing of neutral brand names as CS and multiple positive or neutral pictures as US. Positive and neutral instead of positive and negative pictures were chosen as US because of the difficulty of facially blocking both positive and negative affect simultaneously. While being exposed to the CS-US pairs, participants were either instructed to hold a chopstick in their mouth like a straw (i.e., the blocking condition), or to horizontally hold a chopstick between their relaxed lips (control condition). I also ran a baseline condition in which participants were asked to hold the chopstick with their non-dominant hand, such as to control for effects of the difficulty of the other tasks. CS attitudes were obtained using rating scales, and I also used the Hütter et al. (2012) PDP to measure the participants' valence memory. The findings revealed an interesting dissociation: Whereas the blocking manipulation eliminated the occurrence of EC, significant EC was found in both the control and the baseline conditions. However, the blocking manipulation had no effect on the participants' memory, and in all three conditions participants were able to recall whether CS were paired with positive or neutral US. Thus, the findings suggest that blocking the experience affect does not interfere with learning about CS-US relationship, but with learning to like or dislike the CS. Of course, it will be interesting to see if the pattern replicates even when participants have the intention of acquiring an attitude towards the CS, and what further boundary conditions can constrain the dissociation of learning and liking. In any event, it seems then that there are sufficient challenges and open questions for another 39 years of EC research.

References

Allen, C. T., & Janiszewski, C. A. (1989). Assessing the role of contingency awareness in attitudinal conditioning with implications for advertising research. *Journal of Marketing Research*, *26*, 30-43.

Amit, E., & Greene, J. D. (2012). You see, the ends don't justify the means: Visual imagery and moral judgment. *Psychological Science, 23*, 861-868.

Anderson, A. K., Christoff, K., Panitz, D., De Rosa, E., & Gabrieli, J. D. (2003). Neural correlates of the automatic processing of threat facial signals. *The Journal of Neuroscience*, *23*, 5627-5633.

Arrighi R., Lunardi R., & Burr D. (2011). Vision and audition do not share attentional resources in sustained tasks. *Frontiers in Psychology, 2*, 56.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*, 390–412.

Baeyens, F., Crombez, G., Van den Bergh, O., & Eelen, P. (1988). Once in contact always in contact: Evaluative conditioning is resistant to extinction. *Advances in Behaviour Research and Therapy*, *10*, 179-199.

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1989). Acquired affective-evaluative value: Conservative but not unchangeable. *Behaviour Research and Therapy*, *27*, 279-287.

Baeyens, F., Eelen, P., Crombez, G., & Van den Bergh, O. (1992a). Human evaluative conditioning: Acquisition trials, presentation schedule, evaluative style and contingency awareness. *Behaviour Research and Therapy*, *30*, 133-142.

Baeyens, F., Eelen, P., & Van den Bergh, O. (1990). Contingency awareness in evaluative conditioning: A case for unaware affective–evaluative learning. *Cognition & Emotion, 4*, 3–18.

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1992b). The content of learning in human evaluative conditioning: Acquired valence is sensitive to US-revaluation. *Learning and Motivation*, *23*, 200-224.

Baeyens, F., Hermans, D., & Eelen, P. (1993). The role of CS-US contingency in human evaluative conditioning. *Behavior Research and Therapy, 31*, 731-737.

Baeyens, F., Vansteenwegen, D., De Houwer, J. A. N., & Crombez, G. (1996). Observational conditioning of food valence in humans. *Appetite*, *27*, 235-250.

Baeyens, F., Vansteenwegen, D., & Hermans, D. (2009). Associative learning requires associations, not propositions. *Behavioral and Brain Sciences*, *32*, 198-199.

Baeyens, F., Wrzesniewski, A., De Houwer, J., & Eelen, P. (1996). Toilet rooms, body massages, and smells: Two field studies on human evaluative odor conditioning. *Current Psychology*, *15*, 77-96.

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*, 1-29.

Baddeley, A.D., & Hitch, G. (1974). Working memory. In G.A. Bower (Ed.), *The Psychology of Learning and Motivation* (pp. 48-79), New York, NY: Academic Press.

Balas, R., & Gawronski, B. (2012). On the intentional control of conditioned evaluative responses. *Learning and Motivation, 43*, 89-98.

Bar–Anan, Y., De Houwer, J., & Nosek, B. A. (2010). Evaluative conditioning and conscious knowledge of contingencies: A correlational investigation with large samples. *The Quarterly Journal of Experimental Psychology, 63*, 2313–2335.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R.S. Wyer Jr. & T.K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Bates, D., Maechler, M., & Bolker, B. (2012). *lme4: Linear mixed-effects models using S4 classes*. Retrieved from: http://CRAN.R-project.org/package=lme4

Bayliss, D. M, Jarrold, C., Gunn, D. M., & Baddeley, A. D. (2003). The complexities of complex span: Explaining individual differences in working memory in children and adults. *Journal of Experimental Psychology: General, 132*, 71-92.

Berlyne, D. E. (1975). Behaviourism? Cognitive theory? Humanistic psychology? To Hull with them all. *Canadian Psychological Review*, *16*, 69-80.

Berry, C. J., Shanks, D. R., Speekenbrink, M., & Henson, R. N. A. (2012). Models of recognition, repetition priming, and fluency: Exploring a new framework. *Psychological Review, 119*, 40-79.

Blaney, P. H. (1986). Affect and memory: a review. *Psychological Bulletin*, *99*, 229-246.

Blask, K., Walther, E., Halbeisen, G., & Weil, R. (2012). At the crossroads: Attention, contingency awareness, and evaluative conditioning. *Learning and Motivation, 43*, 99–106.

Brainerd, C. J, Reyna, V. F, Wright, R., & Mojardin, A. H. (2003). Recollection rejection: False–memory editing in children and adults. *Psychological Review, 110,* 762–784.

Brendl, M., Nijs, V., & Möller, J. & Walther (2014). *Emotional counter-conditioning of negative brand attitudes*. Manuscript under revision.

Brewer, W. F. (1974). There is no convincing evidence for operant or classical conditioning in adult humans. In W.B. Weimer & D.S. Palermo (Eds.), *Cognition and the Symbolic Processes* (pp. 1–42). Hillsdale, NJ: Erlbaum.

Brunstrom, J. M., & Higgs, S. (2002). Exploring evaluative conditioning using a working memory task. *Learning and Motivation, 33*, 433-455.

Cesario, J., Plaks, J. E., Hagiwara, N., Navarrete, C. D., & Higgins, E. T. (2010). The Ecology of Automaticity: How Situational Contingencies Shape Action Semantics and Social Behavior. *Psychological Science, 21*, 1311-1317.

Chomsky, N. (1959). A review of BF Skinner's Verbal Behavior. *Language*, *35*, 26-58.

Cocchini, G., Logie, R. H, Della Sala, S., MacPherson, S. E., & Baddeley, A. D. (2002). Concurrent performance of two memory tasks: Evidence for domain-specific working memory systems. *Memory & Cognition, 30*, 1086-1095.

Corneille, O., Yzerbyt, V., Pleyers, G., & Mussweiler, T. (2009). Beyond awareness and resources: Evaluative conditioning may be sensitive to processing goals. *Journal of Experimental Social Psychology, 45,* 279-282.

Davey, G. C. (1994a). Defining the important theoretical questions to ask about evaluative conditioning: A reply to Martin and Levey (1994). *Behaviour Research and Therapy*, *32*, 307-310.

Davey, G. C. (1994b). Is evaluative conditioning a qualitatively distinct form of classical conditioning? *Behaviour Research and Therapy*, *32*, 291-299.

Davies, S. R., El-Deredy, W., Zandstra, E. H., & Blanchette, I. (2012). Evidence for the role of cognitive resources in flavour-flavour evaluative conditioning. *The Quarterly Journal of Experimental Psychology, 65*, 2297-2308.

Dawson, M. E., & Reardon, P. (1973). Construct validity of recall and recognition postconditioning measures of awareness. *Journal of experimental psychology*, *98*, 308-315.

De Houwer, J. (2007). A conceptual and theoretical analysis of evaluative conditioning. *The Spanish Journal of Psychology, 10*, 230-241.

De Houwer, J. (2009). The propositional approach to associative learning as an alternative for association formation models. *Learning & Behavior, 37*, 1-20.

De Houwer, J., Baeyens, F., & Field, A. P. (2005). Associative learning of likes and dislikes: Some current controversies and possible ways forward. *Cognition & Emotion*, *19*, 161-174.

De Houwer, J., Baeyens, F., Vansteenwegen, D., & Eelen, P. (2000). Evaluative conditioning in the picture–picture paradigm with random assignment of conditioned stimuli to unconditioned stimuli. *Journal of Experimental Psychology: Animal Behavior Processes*, *26*, 237-242.

De Houwer, J., & Beckers, T. (2003). Secondary task difficulty modulates forward blocking in human contingency learning. *The Quarterly Journal of Experimental, 56B*, 345-357.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*, 853–869.

Dedonder, J., Corneille, O., Bertinchamps, D., & Yzerbyt, V. (2014). Overcoming Correlational Pitfalls Experimental Evidence Suggests That Evaluative Conditioning Occurs for Explicit But Not Implicit Encoding of CS–US Pairings. *Social Psychological and Personality Science*, *5*, 250-257.

Dedonder, J., Corneille, O., Yzerbyt, V., & Kuppens, T. (2010). Evaluative conditioning of high-novelty stimuli does not seem to be based on an automatic form of associative learning. *Journal of Experimental Social Psychology, 46,* 1118-1121.

Díaz, E., Ruíz, G., & Baeyens, F. (2005). Resistance to extinction of human evaluative conditioning using a between-subjects design. *Cognition & Emotion*, *19*, 245-268.

Dickinson, A., & Brown, K. J. (2007). Flavor-evaluative conditioning is unaffected by contingency knowledge during training with color-flavor compounds. *Animal Learning & Behavior*, *35*, 36-42.

Dimberg, U., Thunberg, M., & Grunedal, S. (2002). Facial reactions to emotional stimuli: Automatically controlled emotional responses. *Cognition & Emotion*, *16*, 449-471.

Duyck, W., Desmet, T., Verbeke, L. P. C., & Brysbaert, M. (2004). WordGen: A tool for word selection and nonword generation in Dutch, English, German, and French. *Behavior Research Methods, Instruments & Computers, 36*, 488-499.

Duyck, W., Szmalec, A., Kemps, E., & Vandierendonck, A. (2003). Verbal working memory is involved in associative word learning unless visual codes are available. *Journal of Memory and Language, 48*, 527-541.

Dwyer, D. M., Jarratt, F., & Dick, K. (2007). Evaluative conditioning with foods as CSs and body shapes as USs: No evidence for sex differences, extinction, or overshadowing. *Cognition and Emotion*, *21*, 281-299.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Harcourt, Brace, Jovanovich.

Eagly, A.H., & Chaiken, S. (2007). The advantages of an inclusive definition of attitude. *Social Cognition, 25*, 582–602.

Fazio, R. H., & Towles-Schwenn, T. (1999). The MODE model of attitude-behavior processes. In S. Chaiken & Y. Trope (Eds.), *Dual-Process Theories in Social Psychology* (pp. 97-116). New York, NY: The Guilford Press.

Fiedler, K., & Unkelbach, C. (2011). Evaluative conditioning depends on higher order encoding processes. *Cognition and Emotion*, *25*, 639-656.

Field, A. P., & Davey, G. C. (1997). Conceptual conditioning: Evidence for an artifactual account of evaluative learning. *Learning and Motivation*, *28*, 446-464.

Field, A. P., & Davey, G. C. L. (1999). Reevaluating evaluative conditioning: A nonassociative explanation of conditioning effects in the visual evaluative conditioning paradigm. *Journal of Experimental Psychology: Animal Behavior Processes, 25*, 211–224.

Field, A. P., & Moore, A. C. (2005). Dissociating the effects of attention and contingency awareness on evaluative conditioning effects in the visual paradigm. *Cognition and Emotion, 19*, 217-243.

Fox, J., & Weisberg, S. (2011). *An {R} Companion to Applied Regression, Second Edition*. Thousand Oaks CA: Sage. Retrieved from: http://socserv.socsci.mcmaster.ca/jfox/Books/Companion

Friese, M., Hofmann, W., & Wänke, M. (2008). When impulses take over: Moderated predictive validity of explicit and implicit attitude measures in predicting food choice and consumption behaviour. *British Journal of Social Psychology*, *47*, 397-419.

Friese, M., Smith, C. T., Plischke, T., Bluemke, M., & Nosek, B. A. (2012). Do implicit attitudes predict actual voting behavior particularly for undecided voters? *PloS one*, *7*, e44130.

Fulcher, E. P., & Hammerl, M. (2001). When all is revealed: A dissociation between evaluative learning and contingency awareness. *Consciousness and Cognition: An International Journal, 10*, 524-549.

Gast, A., De Houwer, J., & De Schryver, M. (2012). Evaluative conditioning can be modulated by memory of the CS-US-pairings at the time of testing. *Learning and Motivation, 43,* 116–126.

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin, 132*, 692–731.

Gawronski, B., & Bodenhausen, G. V. (2014). The associative-propositional evaluation model: Operating principles and operating conditions of evaluation. In J. W. Sherman, B. Gawronski, & Y. Trope (Eds.), *Dual-process theories of the social mind* (pp. 188-203). New York, NY: Guilford Press.

Gawronski, B., & Walther, E. (2012). What do memory data us about the role of contingency awareness in evaluative conditioning? *Journal of Experimental Social Psychology, 48,* 617–623.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*, 1464-1480.

Greenwood, J. D. (1999). Understanding the “cognitive revolution” in psychology. *Journal of the History of the Behavioral Sciences*, *35*, 1-22.

Hazeltine, E., Ruthruff, E., & Remington, R. W. (2006). The role of input and output modality pairings in dual-task performance: Evidence for content-dependent central interference. *Cognitive Psychology, 52*, 291-345.

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136*, 390–421.

Humphreys, M. S., Tangen, J. M., Cornwell, T. B., Quinn, E. A., & Murray, K. L. (2010). Unintended effects of memory on decision making: A breakdown in access control. *Journal of Memory and Language, 63, 400-415.*

Hütter, M., & Sweldens, S. (2013). Implicit Misattribution of Evaluative Responses: Contingency-Unaware Evaluative Conditioning Requires Simultaneous Stimulus Presentations. *Journal of Experimental Psychology: General, 142,* 638-643.

Hütter, M., Sweldens, S., Stahl, C., Unkelbach, C., & Klauer, K. C. (2012). Dissociating contingency awareness and conditioned attitudes: Evidence of contingency–unaware evaluative conditioning. *Journal of Experimental Psychology: General, 141*, 539–557.

Insko, C. A., & Oakes, W. F. (1966). Awareness and the "conditioning" of attitudes. *Journal of Personality and Social Psychology*, *4*, 487-496.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*, 513–541.

Jacoby, L. L. (1998). Invariance in automatic influences of memory: Toward a user’s guide for the process–dissociation procedure. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*, 3–26.

Jacoby, L. L., McElree, B., & Trainham, T. N. (1999). Automatic influences as accessibility bias in memory and Stroop tasks: Toward a formal model. In D. Gopher & A. Koriat (Eds.), *Attention and Performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 461-486). Cambridge, MA: MIT Press.

Jacoby, L. L., Toth, J. P., & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. *Journal of Experimental Psychology: General, 122*, 139-154.

Jones, C. R., Fazio, R., & Olson, M. (2009). Implicit misattribution as a mechanism underlying evaluative conditioning. *Journal of Personality and Social Psychology, 96*, 933–948.

Kattner, F. (2012). Revisiting the relation between contingency awareness and attention: Evaluative conditioning relies on a contingency focus. *Cognition and Emotion, 26*, 166-175.

Kattner, F. (2014). Reconsidering the (in) sensitivity of evaluative conditioning to reinforcement density and CS–US contingency. *Learning and Motivation*, *45*, 15-29.

Kattner, F., & Ellermeier, W. (2011). Does evaluative learning rely on the perception of contingency? Manipulating contingency and US density during evaluative conditioning. *Experimental Psychology, 58*, 391-399.

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences of the United States of America*, *101*, 3310-3315.

Keren, G., & Schul, Y. (2009). Two Is Not Always Better Than One A Critical Evaluation of Two-System Theories. *Perspectives on psychological science*, *4*, 533-550.

Kerkhof, I., Vansteenwegen, D., Baeyens, F., & Hermans, D. (2011). Counterconditioning. *Experimental Psychology*, *58*, 31-38.

Kirchner, W. K. (1958). Age differences in short-term retention of rapidly changing information. *Journal of Experimental Psychology, 55*, 352-358.

Koranyi, N., Gast, A., & Rothermund, K. (2013). "Although quite nice, I was somehow not attracted by that person": Attitudes toward romantically committed opposite-sex others are immune to positive evaluative conditioning. *Social Psychological and Personality Science, 4*, 403-410.

Kruglanski, A. W., & Thompson, E. P. (1999). Persuasion by a single route: A view from the unimodel. *Psychological Inquiry*, *10*, 83-109.

Langer, T., Walther, E., Gawronski, B., & Blank, H. (2009). When linking is stronger than thinking: Associative transfer of valence disrupts the emergence of cognitive balance after attitude change. *Journal of Experimental Social Psychology*, *45*, 1232-1237.

Levey, A. B., & Martin, I. (1975). Classical conditioning of human 'evaluative'responses. *Behaviour Research and Therapy*, *13*, 221-226.

Levey, A. B., & Martin, I. (1987). Evaluative conditioning: a case for hedonic transfer. In: H. J. Eysenck and I. Martin (Eds), *Theoretical Foundations of Behavior Therapy* (pp. 113-131). Plenum Press, New York.

Lipp, O. V., & Purkis, H. M. (2005). No support for dual process accounts of human affective learning in simple Pavlovian conditioning. *Cognition & emotion*, *19*, 269-282.

Lovibond, P. F. (2003). Causal beliefs and conditioned responses: retrospective revaluation induced by experience and by instruction. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*, 97-106.

Lovibond, P. F. (2004). Cognitive processes in extinction. *Learning & Memory*, *11*, 495-500.

Lovibond, P. F., & Shanks, D. R. (2002). The role of awareness in Pavlovian conditioning: empirical evidence and theoretical implications. *Journal of Experimental Psychology: Animal Behavior Processes*, *28*, 3-26.

Logie, R. H. (1986). Visuo-spatial processing in working memory. *The Quarterly Journal of Experimental Psychology, 38A*, 229-247.

Logie, R. H., Zucco, G. M., & Baddeley, A. D. (1990). Interference with visual short-term memory. *Acta Psychologica, 75*, 55-74.

Macmillan, N. A., & Creelman, C. D. (2005). *Detection theory: A user's guide (2nd ed.).* Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Martin, I., & Levey, A. (1994). The evaluative response: Primitive but necessary. *Behavior Research and Therapy, 32*, 301-305.

Martin, I., & Levey, A. B. (1978). Evaluative conditioning. *Advances in Behaviour research and Therapy*, *1*, 57-101.

Meiser, T., & Klauer, K. C. (1999). Working memory and changing-state hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*, 1272-1299.

Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). The propositional nature of human associative learning. *Behavioral and Brain Sciences, 32*, 183–198.

Moors, A., & De Houwer, J. (2006). Automaticity: a theoretical and conceptual analysis. *Psychological Bulletin*, *132*, 297-326.

Moshagen, M. (2010). multiTree: A computer program for the analysis of multinomial processing tree models. *Behavior Research Methods, 42*, 42-54.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*, 353–383.

Neumann, R., Hess, M., Schulz, S. M., & Alpers, G. W. (2005). Automatic behavioural responses to valence: Evidence that facial action is facilitated by evaluative processing. *Cognition & Emotion*, *19*, 499-513.

Neumann, R., Lozo, L. & Kunde, W. (2014). Not all behaviors are controlled in the same way: Different mechanisms underlie manual and facial approach and avoidance tendencies. *Journal of Experimental Psychology: General, 143*, 1-8.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological review*, *84*, 231.

Nissen, M. J., & Bullemer, P. (1987). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology, 19*, 1-32.

Olson, M. A., & Fazio, R. H. (2001). Implicit attitude formation through classical conditioning. *Psychological Science, 12*, 413– 417.

Olson, M. A., & Fazio, R. H. (2006). Reducing automatically activated racial prejudice through implicit evaluative conditioning. *Personality and Social Psychology Bulletin, 32*, 421– 433.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: detecting the snake in the grass. *Journal of Experimental Psychology: General*, *130*, 466.

Page, M. M. (1969). Social psychology of a classical conditioning of attitudes experiment. *Journal of Personality and Social Psychology, 11*, 177-186.

Papagno, C., Valentine, T., & Baddeley, A. (1991). Phonological short-term memory and foreign-language vocabulary learning. *Journal of Memory and Language, 30*, 331-347.

Pleyers, G., Corneille, O., Luminet, O., & Yzerbyt, V. (2007). Aware and (dis)liking: Item–based analyses reveal that valence acquisition via evaluative conditioning emerges only when there is contingency awareness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 130–144.

Pleyers, G., Corneille, O., Yzerbyt, V., & Luminet, O. (2009). Evaluative conditioning may incur attentional costs. *Journal of Experimental Psychology: Animal Behavior Processes, 35,* 279–285.

R Development Core Team (2012). *R: A language and environment for statistical computing*. Retrieved from: http://www.R-project.org/

Razran, G. (1938). Conditioning away social bias by the Luncheon technique. *Psychological Bulletin, 35*, 693.

Razran, G. (1940). Conditioned response changes in rating and appraising sociopolitical slogans. *Psychological Bulletin, 37*, 481.

Razran, G. (1954). The conditioned evocation of attitudes (cognitive conditioning?). *Journal of Experimental Psychology*, *48*, 278-282.

Roediger, H. L. (1990). Implicit memory: Retention without remembering. *American Psychologist, 45*, 1043-1056.

Rozin, P., & Millman, L. (1987). Family environment, not heredity, accounts for family resemblances in food preferences and attitudes: a twin study. *Appetite*, *8*, 125-134.

Rozin, P., Millman, L., & Nemeroff, C. (1986). Operation of the laws of sympathetic magic in disgust and other domains. *Journal of Personality and Social Psychology*, *50*, 703-712.

Schaal, B., Marlier, L., & Soussignan, R. (2000). Human foetuses learn odours from their pregnant mother's diet. *Chemical Senses*, *25*, 729-737.

Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 501-518.

Schumacher, E. H., Seymour, T. L., Glass, J. M., Fencsik, D. E., Lauber, E. J., Kieras, D. E., & Meyer, D. E. (2001). Virtually perfect time sharing in dual-task performance: Uncorking the central cognitive bottleneck. *Psychological Science, 12*, 101-108.

Shah, P., & Miyake, A. (1996). The separability of working memory resources for spatial thinking and language processing: An individual differences approach. *Journal of Experimental Psychology: General, 125*, 4-27.

Shanks, D. R. (2007). Associationism and cognition: Human contingency learning at 25. *The Quarterly Journal of Experimental Psychology*, *60*, 291-309.

Shanks, D. R. (2010). Learning: From association to cognition. *Annual Review of Psychology, 61*, 273-301.

Shanks, D. R., & Dickinson, A. (1990). Contingency awareness in evaluative conditioning: A comment on Baeyens, Eelen, and Van den Bergh. *Cognition and Emotion*, *4*, 19-30.

Shanks, D. R., & St John, M. F. (1994). Characteristics of dissociable human learning systems. *Behavioral and brain sciences*, *17*, 367-395.

Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin, 119*, 3–22.

Smith, E. R., & DeCoster, J. (2000). Dual-process models in social and cognitive psychology: Conceptual integration and links to underlying memory systems. *Personality and Social Psychology Review, 4*, 108–131.

Staats, C. K., & Staats, A. W. (1957). Meaning established by classical conditioning. *Journal of Experimental Psychology*, *54*, 74-80.

Staats, A. W., & Staats, C. K. (1958). Attitudes established by classical conditioning. *The Journal of Abnormal and Social Psychology*, *57*, 37-40.

Stahl, C., & Unkelbach, C. (2009). Evaluative learning with single versus multiple USs: The role of contingency awareness. *Journal of Experimental Psychology: Animal Behavior Processes, 35*, 286–291.

Stahl, C., Unkelbach, C., & Corneille, O. (2009). On the respective contributions of awareness of US valence and US Identity in valence acquisition through evaluative conditioning. *Journal of Personality and Social Psychology, 97*, 404–420.

Stevenson, R. J., Boakes, R. A., & Wilson, J. P. (2000). Resistance to extinction of conditioned odor perceptions: evaluative conditioning is not unique. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 423-440.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220–247.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: a nonobtrusive test of the facial feedback hypothesis. *Journal of personality and social psychology*, *54*, 768-777.

Straube, T., Trippe, R., Schmidt, S., Weiss, T., Hecht, H., & Miltner, W. H. R. (2011). Dissociation of acquisition and expression of fear conditioned responses under working memory load. *Emotion, 11*, 209-213.

Sweldens, S., Corneille, O., & Yzerbyt, V. (2014). The role of awareness in attitude formation through evaluative conditioning. *Personality and Social Psychology Review*, *18*, 187-209.

Sweldens, S., van Osselaer, S. M. J., & Janiszewski, C. (2010). Evaluative conditioning procedures and the resilience of conditioned brand attitudes. *Journal of Consumer Research, 37*, 473–489.

Topolinski, S., & Strack, F. (2009). Motormouth: mere exposure depends on stimulus-specific motor simulations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*, 423-433.

Tulving, E. (1989). Memory: Performance, knowledge, and experience. *European Journal of Cognitive Psychology, 1*, 3–26.

Vansteenwegen, D., Francken, G., Vervliet, B., De Clercq, A., & Eelen, P. (2006). Resistance to extinction in evaluative conditioning. *Journal of Experimental Psychology: Animal Behavior Processes*, *32*, 71-79.

Vergauwe, E., Barrouillet, P., & Camos, V. (2010). Do mental processes share a domain-general resource? *Psychological Science, 21*, 384-390.

Vermeir, I., & Verbeke, W. (2006). Sustainable food consumption: Exploring the consumer "attitude–behavioral intention" gap. *Journal of Agricultural and Environmental Ethics*, *19*, 169-194.

Verwijmeren, T., Karremans, J. C., Stroebe, W., & Wigboldus, D. H. (2012). Goal relevance moderates evaluative conditioning effects. *Learning and Motivation*, *43*, 107-115.

Waldmann, M. R., & Holyoak, K. J. (1992). Predictive and diagnostic learning within causal models: asymmetries in cue competition. *Journal of Experimental Psychology: General, 121*, 222-236.

Walther, E. (2002). Guilty by mere association: Evaluative conditioning and the spreading attitude effect. *Journal of Personality and Social Psychology, 82*, 919–934.

Walther, E., Ebert, I., & Meinerling, K. (2011a). Does Cue competition reduce conditioned liking of brands and products? *Psychology & Marketing*, *28*, 520-538.

Walther, E., & Grigoriadis, S. (2004). Why sad people like shoes better: The influence of mood on the evaluative conditioning of consumer attitudes. *Psychology & Marketing, 21,* 755–773.

Walther, E., Langer, T., Weil, R., & Komischke, M. (2011b). Preferences surf on the currents of words: Implicit verb causality influences evaluative conditioning. *European Journal of Social Psychology*, *41*, 17-22.

Walther, E., & Nagengast, B. (2006). Evaluative conditioning and the awareness issue: Assessing contingency awareness with the four–picture recognition test. *Journal of Experimental Psychology: Animal Behavior Processes, 32*, 454–459.

Walther, E., Nagengast, B., & Trasselli, C. (2005). Evaluative conditioning in social psychology: Facts and speculations. *Cognition & Emotion, 19*, 175–196.

Walther, E., & Trasselli, C. (2003). I like her, because I like myself: Self-evaluation as a source of interpersonal attitudes. *Experimental Psychology, 50*, 239-246.

Walther, E., Weil, R., & Düsing, J. (2011c). The role of evaluative conditioning in attitude formation. *Current Directions in Psychological Science*, *20*, 192-196.

Walther, E., Weil, R., & Langer, T. (2011d). Why do we like the iPhone? The role of evaluative conditioning in attitude formation. *Social and Personality Psychology Compass, 5*, 473–486.

Wickens, C. D. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science, 3*, 159-177.

Whittlesea, B. W. A., & Price, J. R. (2001). Implicit/explicit memory versus analytic/nonanalytic processing: Rethinking the mere exposure effect. *Memory & Cognition, 29*, 234–246.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*, 441–517.

Yonelinas, A. P., & Jacoby, L. L. (2012). The process-dissociation approach two decades later: Convergence, boundary conditions, and new directions. *Memory & Cognition, 40*, 663-680.

Zeelenberg, R., Pecher, D., & Raaijmakers, J. G. W. (2003). Associative repetition priming: A selective review and theoretical implications. In J. S. Bowers & C. J. Marsolek (Eds.), *Rethinking implicit memory* (pp. 261-283). New York, NY: Oxford University Press.

Zanon, R., De Houwer, J., Gast, A., & Smith, C. T. (2014). When does relational information influence evaluative conditioning? *The Quarterly Journal of Experimental Psychology*.

Appendix A

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.

Appendix B

Mean evaluative ratings (standard deviation in parenthesis) of word-like and picture-like CS obtained in pretesting.

Stimulus Name	word-like CS	picture-like CS
AVISIR	-0.78 (3.63)	0.69 (3.74)
BENEM	0.78 (3.29)	0.38 (3.80)
CAMPUR	0.60 (3.34)	0.77 (3.09)
DAVOL	0.70 (3.25)	0.62 (3.35)
KASTEE	-0.15 (3.62)	0.69 (4.67)
KIAUL	-0.08 (3.50)	0.03 (3.50)
PEBET	0.80 (4.36)	0.10 (3.24)
TARGA	-0.50 (3.68)	0.23 (3.51)

Note. Ratings are based on a scale ranging from -10 (*dislike*) to 10 (*like*).

Appendix C

Mean CS evaluations (standard deviations in parenthesis) as a function of the type of CS-US pair, the stimuli used in the 3-back task, and the valence of the paired US.

	word-like CS-US pairs		picture-like CS-US pairs	
	positive US	*negative US*	*positive US*	*negative US*
3-back words	-8.39 (20.10)	-0.75 (28.16)	7.95 (12.37)	-6.32 (13.63)
3-back pictures	7.91 (14.14)	2.11 (11.21)	0.13 (18.31)	-2.55 (19.87)

Note. Evaluations were obtained on a 201-point sliding scale ranging from -100 (*dislike*) to 100 (*like*).

Erklärung

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

Trier, den 03.06.2014

Georg Halbeisen