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Distributed practice can boost evaluative conditioning by increasing memory for the stimulus pairs☆

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ABSTRACT

When presenting a neutral stimulus (CS) in close temporal and spatial proximity to a positive or negative stimulus (US) the former is often observed to adopt the valence of the latter, a phenomenon named evaluative conditioning (EC). It is already well established that under most conditions, contingency awareness is important for an EC effect to occur. In addition to that, some findings suggest that awareness of the stimulus pairs is not only relevant during the learning phase, but that it is also relevant whether memory for the pairings is still available during the measurement phase. As previous research has shown that memory is better after temporally distributed than after contiguous (massed) repetitions, it seems plausible that also EC effects are moderated by distributed practice manipulations. This was tested in the current studies. In two experiments with successful distributed practice manipulations on memory, we show that also the magnitude of the EC effect was larger for pairs learned under spaced compared to massed conditions. Both effects, on memory and on EC, are found after a within-participant and after a between-participant manipulation. However, we did not find significant differences in the EC effect for different conditions of spaced practice. These findings are in line with the assumption that EC is based on similar processes as memory for the pairings.

1. Introduction

Evaluative conditioning (EC) is a change in liking of an initially neutral stimulus (conditioned stimulus; CS) as a result of pairing this stimulus with another stimulus (unconditioned stimulus; US; De Houwer, 2007). The question of whether contingency awareness, or more precisely, the awareness of the pairs during learning and/or memory of the pairs during the measurement phase, is necessary for an EC effect to occur has been a matter of ongoing discussion. The current state of the debate can be summarized by stating that there is on the one hand, evidence that under some conditions an EC effect can occur without contingency awareness (Hütter & Sweldens, 2013; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012; Walther & Nagengast, 2006). On the other hand, it has repeatedly been shown, also in large-scale studies and in a meta-analysis, that in most cases EC is strongly related to contingency awareness (Bar-Anan, De Houwer, & Nosek, 2010; Gast, De Houwer, & De Schryver, 2012; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Stahl & Unkelbach, 2009; Stahl, Unkelbach, & Corneille, 2009).

Most studies on contingency awareness, however, are based on a correlational design. Therefore, they do not allow conclusions about the *causal* relationship between contingency awareness and EC. In addition, many studies also do not allow a conclusion on whether contingency awareness plays a crucial role during the presentation of the pairings or as memory during the measurement of the EC effect (see conscious encoding vs. recollection-during-measurement hypothesis, Gast et al., 2012). To investigate the causal role of awareness, some studies have manipulated aware perception during learning with different manipulations, such as secondary tasks (Pleyers et al., 2009), foveal vs. parafoveal presentation (Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014), and different stimulus durations (Stahl, Haaf, & Corneille, 2016). These studies showed that EC effects are increased by factors that allow aware perception and are difficult to find without aware perception. These studies focus on the role of conscious encoding in EC and although the results are consistent with the view that not only conscious encoding, but also correct memory is necessary for an EC effect to occur (Dedonder et al., 2014; Pleyers et al., 2009), the latter does not strictly follow.

A few recent studies have tried to disentangle encoding-related factors and the effect of memory. In a first study, Gast et al. (2012) tested memory for pairings right after the conditioning phase and 9 to

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10 days later—when evaluation of the CSs was also assessed. They found that an EC effect was only observable for pairings that participants could still remember after the delay at the time of evaluation. Thus, pairs that were first remembered and later forgotten did not show an effect of US valence on CS evaluation. In another study, Gast and Kattner (2016) manipulated memory by combining an EC procedure with a directed forgetting paradigm. Results revealed that CS-US pairs that participants were instructed to forget after their presentation, showed smaller EC effects than pairs that participants were instructed to remember. Similarly, Molet et al. (2016) recently investigated the importance of declarative memory in the formation of social affective evaluations of neutral faces. Participants viewed neutral faces, each presented with a description of a prosocial or an antisocial behavior, respectively. Afterwards, they were instructed to remember these associations or suppress them via different methods. Results showed that the effect of the described behavior on the evaluations of the face was smaller for suppressed face-sentence pairs than for remembered face-sentence pairs.

While these latter studies focus on the role of memory, they also have to be interpreted with some caution, because their design is either correlational or relies on instructions which might increase the possibility of an influence of demand compliance. As memory cannot be manipulated directly or without the possibility of influencing other factors as well, the best strategy in demonstrating the role of memory in EC is a multi-method strategy that involves testing the influence of different factors that are known to impact explicit memory.

An important and often demonstrated factor in memory is the temporal spacing of repetitions: Spaced repetitions have consistently been found to outperform contiguous (massed) repetitions, an effect known as the distributed practice effect (see Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Donovan & Radosevich, 1999; Janiszewski, Noel, & Sawyer, 2003 for reviews). It comprises two effects: First, the *spacing effect*, which describes an increase in retention of material that is repeated with *some* delay compared to being repeated immediately (e.g., Melton, 1970; Underwood, 1969) and second, the *lag effect*, which describes a memory benefit of material repeated with a longer interval (lag) between study opportunities compared to a shorter lag (Cepeda et al., 2006; Glenberg, 1976; Madigan, 1969). There seems to be an upper limit, however, up to where an increase of lag leads to a better memory performance. Many studies indicated that there is an optimal length of lag between repetitions, with shorter and longer lags leading to a relative decrease in memory performance (Glenberg, 1976; Peterson, Wampler, Kirkpatrick, & Saltzman, 1963; Toppino & Bloom, 2002; Young, 1971). Additionally, Glenberg (1976, 1979) showed that memory performance did not only depend on the length of the lag but was a result of a joint influence of the lag and the length of the time interval between the last study opportunity of an item and the memory measure (retention interval). Precisely, a longer retention interval would require a longer optimal lag to ensure best memory performance (Delaney, Verkoeijen, & Spirgel, 2010), a finding that has recently been supported by a meta-analysis by Cepeda et al. (2006). Note, however, that distributed practice effects—although based on many studies—are not entirely robust to boundary conditions. For a retention interval shorter than a day—a range that we are considering as feasible for the present research—the meta-analysis of Cepeda et al. (2006) produced mixed results for the lag effect, whereas the spacing effect appeared to be quite robust for this period of time. In addition to that, effects of distributed practice studies might under some conditions be partially due to the methodological artefact of *rehearsal borrowing*, which refers to distributing rehearsal time for spaced items towards the presentation time of massed items. This effect decreases study time on massed items in favor of spaced items on mixed learning lists in within-participants design. Some authors have claimed that distributed practice effect is much smaller or even disappears without this confound (Delaney et al., 2010; Hall, 1992).

It has not been tested yet whether also EC effects are moderated by distributed practice manipulations. Although the temporal distance between repetitions of stimulus contingencies both in real live and in experiments varies widely, there is very little knowledge on this factor. In a typical EC experiment, there are usually between two and 48 different CS-US pairs (and sometimes additional filler pairs), each of which is repeated several times in a random or semi-random presentation sequence. Given that also the presentation times per pair vary widely between one and about ten seconds, the typical presentation lag between two presentations of a pair can vary between a couple of seconds and several minutes. Thus, although the degree of distributed practice differs widely between experiments, almost nothing is known about its relevance. It has been shown, however, that increasing the number of repetitions of CS-US pairings up to a certain level increases both memory for CS-US pairings as well as the magnitude of the EC effect (Bar-Anan et al., 2010). Specifically, the authors showed that varying the number of repetitions between 4 and 12 influenced memory and EC while varying it between 12 and 32 did not. This study, however, did not disentangle the effect of total presentation time from the number of repetitions. That is, pairings in each condition had the same duration; Pairs that were shown more often were thus also shown for a longer total presentation time.

The question whether EC effects profit from distributed practice is of practical relevance because it increases our understanding of the situations in which we are likely to acquire a new attitude or change an existing one. As explained above, it is also of theoretical relevance. Based on the hypothesis that EC is based on similar processes as memory acquisition, we hypothesize that also EC effects are influenced by distributed practice manipulations. Finding such an effect would thus not only support the already strong evidence for a relationship between EC and contingency awareness (cf. Hofmann et al., 2010), but would more specifically point to the relevance of memory (rather than awareness during the presentations) and would be additional evidence for a causal role of contingency memory in producing EC.

With the current studies we thus want to test the influence of distributed practice on the size of the EC effect. Based on results of distributed practice on memory and our hypothesis that EC effects are based on similar processes as memory, our primary hypotheses are that EC effects will be more pronounced for pairs learned in a distributed compared to massed way (spacing effect on EC). This means that if repeated pairings are presented contiguously this will lead to smaller EC effects compared to pairings shown for the same total amount of time but distributed over several learning opportunities. Additionally, a shorter lag compared to a more optimal longer lag will show a smaller magnitude of the EC effect (lag effect on EC). So, while keeping the total presentation time of pairings constant, pairs that are repeated with a longer (and optimal) delay between repetitions will show larger EC effects compared to pairs that are repeated with a shorter delay.

Importantly, because it is not entirely certain that distributed practice effects will even influence memory (distributed practice effects on memory are not always found and we had to adjust the procedures to the EC paradigm), these primary hypotheses are conditional on finding substantial distributed practice effects on memory, that is, better memory for stimulus pairs that were presented in a distributed rather than a massed way (spacing effect on memory) and better memory for stimulus pairs that were repeated with a longer (close to optimal) lag compared to a shorter lag (lag effect on memory). As noted above, however, this second effect was less reliably found for the time span investigated here. We only predict an effect of distributed practice on EC under the precondition of a significant effect of distributed practice on memory. Furthermore, because EC effects are influenced by other factors than memory (for example idiosyncratic preferences for some stimuli over others), distributed practice effects are likely to be smaller on EC than on memory and are therefore only expected if the distributed practice effects on memory are substantial.