



Reinstatement after human feature-positive discrimination learning



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ARTICLE INFO

Article history:

Received 30 October 2015

Received in revised form 4 January 2017

Accepted 10 January 2017

Available online 17 January 2017

Keywords:

Modulation

Occasion setting

Feature positive discrimination

Reinstatement

Human

ABSTRACT

In two experiments, using an online conditioned suppression task, we investigated the possibility of reinstatement of extinguished feature-target compound presentations after sequential feature-positive discrimination training in humans. Furthermore, given a hierarchical account of Pavlovian modulation (e.g., Bonardi, 1998; Bonardi and Jennings, 2009), we predicted A-US reinstatement to be stronger than US-only reinstatement. In Experiment 1, participants learned a sequential feature-positive discrimination ($X \rightarrow A^+|A^-$), which was subsequently extinguished ($X \rightarrow A^-$). During the following reinstatement phase, group US-only received US-only presentations (not signalled), group A-US received A-US presentations, and the Control group received exposure to the context, but no CSs or USs, for an equal amount of time. Reinstatement of differential $X \rightarrow A/A$ responding was observed in the US-only group but not in the Control or A-US groups. Although differential $X \rightarrow A/A$ responding was not significant in group A-US, responding to the $X \rightarrow A$ compound was significantly stronger compared to that in group US-only. Hence, it could be the case the group A-US showed stronger reinstatement, but that differential responding was abolished due to excitation gained by A. Experiment 2 was set up to circumvent the acquired excitation of A by testing transfer of the feature after A-US reinstatement to a different target, B. Participants acquired two discriminations, $X \rightarrow A/A$ and $Y \rightarrow B/B$, of which $X \rightarrow A$ was then extinguished. Subsequently, group A-US received reinforced presentations of A during a reinstatement phase while group Control received exposure to the context. Final testing of the novel $X \rightarrow B$ compound was hypothesized to show higher responding in group A-US than in group Control, but findings of this approach were limited due to acquired equivalence and/or perceptual factors causing a secondary extinction effect. We conclude to have obtained clear evidence in favour of reinstatement of differential responding after human Feature-Positive discrimination training and subsequent compound extinction, but no evidence in favour of A-US presentations being a stronger trigger for reinstatement than are US-only presentations.

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Contents

1. Introduction.....	74
2. Experiment 1.....	75
2.1. Method.....	76
2.1.1. Participants.....	76
2.1.2. Apparatus, software and stimuli.....	76
2.2. Procedure.....	76
2.2.1. Barpressing phase.....	76
2.2.2. US-only phase.....	76
2.2.3. Acquisition and acquisition test.....	77

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2.2.4.	Extinction phase and extinction test	77
2.2.5.	Reinstatement phase and reinstatement test	77
2.3.	Results	77
2.3.1.	General remarks	77
2.3.2.	Acquisition test and extinction test	78
2.3.3.	Extinction and reinstatement test	78
2.4.	Discussion	79
3.	Experiment 2	79
3.1.	Method	80
3.1.1.	Participants	80
3.1.2.	Apparatus, software and stimuli	80
3.2.	Procedure	80
3.3.	Results	80
3.3.1.	General remarks	80
3.3.2.	Acquisition test and extinction test	80
3.3.2.	Reinstatement test	81
3.4.	Discussion	81
4.	General discussion	81
	Acknowledgements	82
	References	82

1. Introduction

Research in Pavlovian conditioning focuses on how organisms cope with their environment by learning relations between stimuli. Sometimes, the environment can be fairly simple: the organism learns that there is a direct relation between two stimuli, namely a Conditioned Stimulus (CS) and a biologically relevant stimulus (Unconditioned Stimulus; US). While the latter stimulus unconditionally evokes a certain reaction, a CS will do so only if its occurrence is contingent upon that of a US. More precisely, depending on the contingency, a CS becomes excitatory or inhibitory, respectively. However, there are cases in which stimulus relations are less straightforward. If only on some of the CS presentations the US occurs, the predictive value of the CS becomes ambiguous for the organism. Sometimes this uncertainty can be resolved by taking into account a third stimulus. If this third stimulus (X; feature) predicts that the original CS (A; target) will be reinforced, the situation is referred to as a feature-positive discrimination (XA^+/A^- ; e.g., Sainsbury, 1971).

Feature-positive discriminations may be resolved by the feature (X) acting as a 'simple' Pavlovian excitor ($X-US$), leaving the target (A) completely irrelevant (e.g., Rescorla and Wagner, 1972). Yet, a more complex hierarchical way of learning feature-positive discriminations has been proposed and confirmed. Namely, X can become a modulator, indicating the validity of the A-US relation. The feature is then referred to as a (positive) occasion setter, and the mechanism as occasion setting (or Pavlovian modulation; for reviews, see Holland, 1992; Swartzentruber, 1995; or Schmajuk et al., 1998). In common-sense terms, this modulatory function may be interpreted as "A predicts the US, if (and only if) X is present". Several accounts deal with explaining which conditions promote the resolution of feature-positive discriminations by either a modulatory or a simple excitatory association. In praxis, these accounts agree on at least one type of manipulation. Namely, a temporal organization in which the feature precedes the target (a sequential feature-positive discrimination; $X \rightarrow A^+/A^-$), is expected to evoke occasion setting while a simultaneous presentation of feature and target (XA^+/A^-) evokes simple excitation (e.g., Holland, 1992).

Treatment of occasion setters as a functionally different class of Pavlovian stimuli is supported by the finding that there are several properties of occasion setters that differ from those of simple Pavlovian excitors. Exemplary is the orthogonality property. This property entails that the modulatory powers of a stimulus are independent of its direct excitatory or inhibitory associations with the

US. In case of feature-positive discrimination learning, this leads to a very straight-forward way of empirically testing for the presence of (positive) occasion setting by way of a feature extinction procedure (X^-) subsequent to sequential feature-positive discrimination learning ($X \rightarrow A^+/A^-$). Although X's simple excitatory powers are reduced, its modulatory powers typically remain intact (e.g., Holland, 1983, 1991).

Previous studies on occasion setting with human participants (e.g., Baeyens et al., 2001; Dibbets et al., 2002; Young et al., 2000) focused mainly on the conditions for evoking occasion setting, contrasting findings from studies with human participants with the mainstream non-human animal results. A different approach to investigating occasion setting lies in validating whether phenomena from the realm of simple Pavlovian conditioning have a counterpart in Pavlovian modulation (for an overview, see Miller and Oberling, 1998). This research strategy does not only give insight in the conditions under which occasion setting occurs, but may also impact our understanding of simple Pavlovian conditioning. A striking example thereof, as Miller and Oberling (1998) argue, is how the former definition of extinction of Pavlovian excitatory conditioning may need to be broadened. For simple Pavlovian conditioning, extinction can be operationally defined as repeated non-reinforced presentations of the CS which result in a decrement in conditioned responding (Miller and Oberling, 1998). This is not the case for occasion setting. The orthogonality property of occasion setters described above, implies that simple non-reinforced presentations of an occasion setter X do not attenuate occasion setting by X (Rescorla, 1986). However, duplication of the training treatment with the reinforcement contingencies reversed from those of training does impact occasion setting (XA^-/A^+ ; e.g., Rescorla 1986). Hence, if extinction is operationalized in a more subtle way as 'exposure to the training conditions with the trial-by-trial reinforcement contingencies reversed', it becomes applicable to both occasion setting as well as Pavlovian excitation.

Establishing the necessary conditions to observe a decrease in conditioned responding, i.e., extinction of sequential feature-positive discriminations, does, however, not address the question of what is learned during the extinction phase. In simple Pavlovian conditioning, there is a growing body of evidence suggesting that an extinction procedure does not simply erase the previously acquired associations. For instance, according to Bouton (1993), especially the extinction information is considered to be context dependent, leading to a return of conditioned responding in accordance with

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