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Loss of salience as a source of latent inhibition in human associative learning

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Abstract

Two experiments made use of a procedure known to generate latent inhibition in human associative learning. Participants received training consisting of exposure to a list of actions performed by a fictitious Mr. X. For most of his actions, an outcome was described, but some were not followed by any outcome. The last action performed by Mr. X was novel for participants in the NOVEL condition. For participants in the EXPOSED condition, Mr. X had performed that target action on repeated occasions, without it producing any outcome. After training, all participants were tested on their ability to retrieve what was the last action performed by Mr. X. In both experiments, retrieval of the target action was poorer in the EXPOSED than in the NOVEL condition. Experiment 2 also included a condition in which the target action was followed by a novel outcome and demonstrated a latent inhibition effect—poorer performance in the EXPOSED condition on a test of the association between the target event and its outcome. These results are interpreted in terms of an attention-reducing mechanism, triggered by the repeated preexposure to the target in the absence of a following event. It is argued that the attentional change involves a reduction in the effective salience of the stimulus of the target event, and thus reduces the processing necessary for encoding in memory and the ability of the event to enter into associations.

Keywords

Attention; latent inhibition; stimulus salience; associability; context

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The aim of the present experiments was to test the hypothesis that a reduction in stimulus salience contributes to the latent inhibition effect seen in human associative learning. Latent inhibition refers to the observation that non-reinforced exposure to a conditioned stimulus (CS), prior to it being paired with an unconditioned stimulus (US), will retard the ability of that CS to elicit the conditioned response (CR) (Lubow & Moore, 1959). This CS-preexposure effect has been found to be a robust phenomenon, occurring over a wide range of training procedures (for reviews, see Lubow, 1989; Lubow & Weiner, 2010)—at least when the subjects are nonhuman animals. However, although the latent inhibition effect is well established for animal subjects, it has been obtained less reliably with humans. Reviewing the phylogenetic distribution of latent inhibition, Lubow (2010) concluded that the effect can be found in simple conditioning in humans when the test involves a measure of autonomic activity (e.g., Lipp, Siddle, & Vaitl, 1992), but that for other procedures, of the sort now commonly used to study human associative learning, the effects are obtained only when the subject is engaged in some masking task during presentation of the target stimulus.

This last observation has led some to hypothesise that the effect seen in humans with these procedures is generated by a process different from that responsible for latent inhibition in animals (see, e.g., Graham & McLaren, 1998; Le Pelley & Schmidt-Hansen, 2010). Some recent published studies, however, have succeeded in demonstrating latent inhibition effects in human learning, without the use

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of a masking task (Evans, Gray, & Snowden, 2007; Forrest, Mather, & Harris, 2018; Granger, Moran, Buckley, & Haselgrove, 2016, Experiment 1; Rodríguez & Hall, 2017). In the procedure of Rodríguez and Hall (2017), a version of which is used in the present experiments, subjects were asked directly about what they knew about the relation between two events that had occurred together in training, and found that preexposure to the first of these reduced the likelihood of a correct answer. Although there was no masking task, the procedure used by Rodríguez and Hall was more complex than one designed to obtain simple conditioning, but the modifications that they introduced with the intention of enhancing the magnitude of the latent inhibition effect were derived from an account derived from experiments in the domain of animal conditioning.

The theory, as proposed by Hall and Rodríguez (2010; see also Hall & Rodríguez, 2011), applied the principle of inhibitory learning espoused by the Pearce-Hall model of conditioning (Pearce & Hall, 1980) to the exposure phase of the latent inhibition procedure. According to Hall and Rodríguez, any novel stimulus will initially evoke the expectation that some event may follow by virtue of a stimulus–event association that has some initial strength. However, nonreinforced stimulus presentations will result in the formation of a stimulus-no event association that opposes activation of the stimulus-event association evoked by a novel stimulus. In accord with the original model, the associability of the stimulus will decline as the discrepancy between what is initially expected and what happens (prediction error) approaches zero. These changes in the properties of the stimulus will retard its ability to function as a CS when subsequently paired with a US. That the learning responsible for the latent inhibition effects depends on prediction error means that acquisition of the stimulus-no-event association (and thus loss of associability) will occur rapidly when the initial expectancy of an event is strong. Rodríguez and Hall (2017) made use of this to enhance the latent inhibition effect in their human associative learning procedure.

In the procedure used by Rodríguez and Hall (2017), participants were simply instructed to observe a series of screens on the computer. These presented a set of statements describing the activities of a fictional Mr. X over 3 days of his everyday life. For most of his actions, a description of its outcome was then presented (e.g., "Mr. X hears his alarm clock . . . and he wakes up"; "Mr. X takes the bus . . . and arrives at work"). These formed a background, intended to ensure, by generalisation, that the subjects would expect some sort of event to follow any of Mr. X's actions. Inhibitory learning should thus be powerful on occasional trials for which an action (e.g., "Mr. X receives a phone call") was not followed by an outcome. At the end of training, all participants received a single critical trial in which the target stimulus (e.g., "Mr. X receives a phone call") was followed by a novel outcome (e.g., "Mr. X feels dizzy"). On a final test trial, intended to assess the strength of the association between the target stimulus and its outcome, the subjects were asked to recall what action Mr. X. had performed prior to the outcome that occurred on the critical trial. Subjects given preexposure to the target action exhibited worse performance than control subjects given no prior exposure, and, in accord with the prediction derived from the account offered by Hall and Rodríguez (2010), the difference was much enhanced when preexposure had been given in the context supplied by the presence of many other action-outcome instances.

According to the Hall and Rodríguez (2010) theory, nonreinforced preexposure will reduce the expectation of an event following the target stimulus and will also reduce the associability of the stimulus. Both these factors could contribute to the observed latent inhibition effect. A reduced associability means that a new association will be formed slowly, and reduced expectation that an event will follow the target stimulus could interfere both with acquisition of the new association and performance on test. Development of the theory to deal with the phenomenon of habituation (Hall & Rodríguez, 2017a, 2017b) has added a third possible source of latent inhibition. Following Pearce and Hall (1980), the Hall and Rodriguez account has two parameters associated with a CS—one is associability (symbolised by α); the other is salience (S), which reflects (at least initially) the physical intensity of the stimulus. One way in which the difference between α and S can be conceptualised is to suppose that, for effective processing, a stimulus representation must enter into a processor of limited capacity. S would reflect the readiness with which the stimulus gains access to the processor and α the ease with which that stimulus may be maintained in the processor. In terms of the notions of automatic and controlled processing (e.g., Shiffrin & Schneider, 1977) that were employed by the original version of the Pearce and Hall (1980) model, easy access to the processor (by virtue of high S) would generate automatic responding to it, but learning about the consequences of the stimulus would require a certain degree of maintained processing (i.e., a relatively high α in addition to a high S). The controlled processing necessary for learning would require high values of both S and α; automatic processing that would ensure responding to a stimulus, but not learning about it, would require only a high value of S.

We have already discussed how α will change with experience. After reviewing evidence from studies of habituation, Hall and Rodríguez (2017b) concluded that S can change too, declining when a stimulus is presented repeatedly, followed by no consequence. Hall and Rodríguez (2017a) have presented a formalisation of this notion, in terms of the process of stimulus-no-event learning described above. The rules determining changes in α and S are different, but for the case of simple nonreinforced exposure, both parameters tend towards zero. This

means that reduction in S can also contribute to the latent inhibition effect (by reducing the ease with which the stimulus will enter into the processor). And, unlike α (associability), which is a parameter reflecting solely attention-for-learning, the loss of S (a reduction in the effective salience of the stimulus) should be evident in measures of other aspects of stimulus effectiveness.

The aim of the present experiments was to test this hypothesis by exploiting a slightly changed version of the procedure used by Rodríguez and Hall (2017). As in the original procedure, participants were exposed to a series of actions performed by Mr. X, the last of which was the target event (the target action). For some subjects, the target action was repeatedly presented before the test, not followed by any outcome; for others, the first and only presentation of the target action was that occurring shortly before the test. The test procedure differed slightly between Experiments 1 and 2, but in both the central feature was that the participants in the condition of primary interest were simply asked to report the last action performed by Mr. X. There is no reason why a change in the value of α, a parameter concerned solely with how well a CS can become associated with its consequences, should have any effect on performance on this test. A stimulus that has lost effective salience, on the other hand, will be less well-processed on the final presentation and thus less likely to be accurately reported in the subsequent test.

Experiment 1

All the participants received a sequence of trials on each of which an action performed by Mr. X was described. On some of these trials, the action described was followed by the description of an outcome (e.g., "Mr. X reads the paper . . . and he gets sleepy"). For all the participants, a target action, which was not followed by an outcome, occurred as the last trial of training. For participants in group EXPOSED, the target action had been previously presented, not followed by any outcome, during the training phase. For participants in group NOVEL, a different, non-target, action was presented, without outcome, during training. For these subjects, the target action was novel on the last trial of the training. The remaining trials provided the context, in which events similar to the target action were, for the most part, followed by an outcome. For these, we followed the arrangement found to be effective in generating latent inhibition in the study by Rodríguez and Hall (2017). On a minority of trials, the action described was not followed by an outcome, ensuring that the target stimulus would not stand out as the only one not followed by an outcome. The rest of these contextual trials were all followed by the description of an outcome. For half of these, the outcome was the same on every occasion the stimulus action appeared; for the remainder, a different outcome was described on each of the trials on which a particular stimulus action occurred.

The test, in which subjects were asked to specify the last action performed by Mr. X, was given 30 s after the last training trial, on which the target action had been described. We anticipated that this test might be very easy for both groups, potentially obscuring a difference between them. In the hope of avoiding this possible problem, a salient distractor stimulus was presented for all subjects during the 30-s interval.

Method

The participants were 48 students, 12 males (mean age = 20.8 years, standard deviation [SD] = 4.5) and 36 females (mean age = 19.9 years, SD = 1.9), from the University of the Basque Country, who volunteered for the experiment. They were assigned at random to either the EXPOSED group (n = 24) or the NOVEL group (n = 24). They were tested individually, the material being presented on a standard PC. They were informed simply that they would be taking part in an experiment involving cognitive tasks.

Participants received the following on-screen instructions in Spanish: *When you are ready, please press the space-bar of the keyboard to start. The automatic presentation of a sequence of screens will then begin.*

Once the participant had pressed the space-bar, presentation of the trials began. There was a total of 131 trials. There were 119 filler trials that provided the context, 11 presentations of the target (in group EXPOSED) or of a non-target event (in group NOVEL), and a single final trial in which the target stimulus was presented for both groups. Each trial consisted of a 5-s presentation of a text line (font Arial, size 24) describing in one phrase an action performed by Mr. X (e.g., *Mr. X reads the newspaper . . .*). Below this text line, in the middle of the screen, a clip-art illustration of the action was presented simultaneously. On some trials, the action performed by Mr. X was followed by an outcome. On these, 2 s after the beginning of the trial, another text line (Arial font, size 24) describing the outcome appeared below the clip art and remained present for the duration of the trial. A plain white screen, 0.5 s in duration, was presented between trials. (See Figure 1, for screen captures of the different types of trial.)

The trials were organised as three large groups, each of which was presented as being a day in the life of Mr. X. The beginning of each "day" was signalled with a 5-s screen (*Day 1, Day 2*, or *Day 3).*

Day 1 consisted solely of the context trials arranged as 6 blocks of seven. The beginning and the end of a block were not made explicit to the participants. Each block consisted of three trials with actions that were followed by the same outcome on all its occurrences across the days, and three trials with actions that were followed by a different outcome on each. On the remaining trial of each block, no outcome followed the action described. All the specific actions and outcomes that were used as contextual trials,

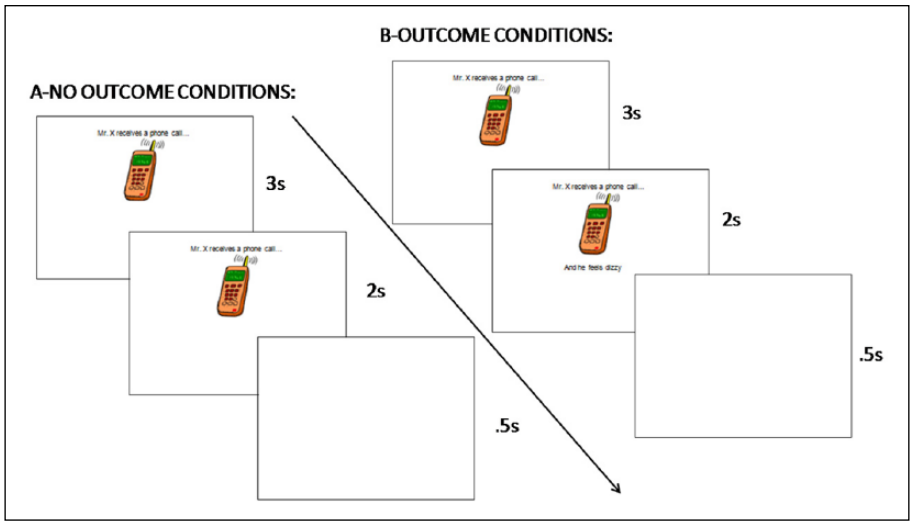

Figure 1. (a) Screenshots and temporal duration of a critical trial with the target action in the NO-OUTOCOME conditions. (b) Screenshots and temporal duration of a critical trial with the target action in the OUTOCOME conditions.

and the order of the trials in each block and on each Day, are presented in Supplementary Material 1.

Day 2 was identical to Day 1 except that presentations of the target (for the EXPOSED group) or the non-target action (for the NOVEL group) were introduced. These were not followed by an outcome. These trials were inserted after the third, the fifth, the second, the sixth, the fourth, and the first contextual trial in blocks 1-6, respectively. Day 3 had the same general structure as Day 2 except that there were only five blocks of trials and the target (or non-target) action was inserted after the seventh, the second, the eighth, the fourth, and the third trial in blocks 1-5, respectively. All subjects then received a final trial in which the target action was presented. For half of the participants, the target action was *Mr. X answers a phone call* and the non-target action was *Mr. X listens to music from his MP3 player*. For the other half of the participants, the arrangement was reversed.

Immediately after the last trial on Day 3, for all the participants, a high definition picture of a lion was presented for 30 s. The image rotated 180° to the right every 10 s. This was followed by a screen with text asking the subject to write down the last action performed by Mr. X. The participants had 30 s to make their response. For the case in which the target action was *Mr. X answers a phone call*, three types of response in which the phone call was the central element were considered correct; they were as follows: *Mr X was answering a phone call, Mr. X was receiving a phone call*, and *Mr. X was chatting by phone.* For the case in which the target action was *Mr. X listens to music from his MP3 player*, these two types of answer were considered correct: *Mr X was listening to music from his MP3 player; Mr X was listening to music.*

Accuracy of the test responses was coded by two independent raters (one of the authors of the study and a research assistant not otherwise involved in the study). Both were blind to the group assignment of the subject. The inter-rater reliability was perfect in both Experiments 1 and 2 (the Cohen's Kappa value was $k = 1.00$, $p < .001$). Chi-square tests and hierarchical log-linear analyses were used to examine categorical data. Kramer's phi coefficient (ϕ) and 95% confidence intervals (CIs) were also calculated to examine effect sizes. The level of statistical significance was defined as an alpha less than .05. All analyses were two-tailed.

Results and discussion

As Figure 2 shows, almost all the participants in the group NOVEL answered the test question correctly, whereas many in the EXPOSED group could not do so. A chi-square analysis (in this and subsequent analyses the alpha level was set at .05) performed on the data shown in the figure confirmed reliability of the difference between the groups: $\chi^2(1) = 12.00$, $p < .001$, $\phi = 0.5$, 95% CI [.20, .66]. Six of the 18 participants in group EXPOSED who failed the test just answered that they did not remember the action in question; the remaining 12 participants who failed in this group did so because they identified some non-target action performed by Mr. X. Interestingly, 8 of these 12 participants failed because they identified "Mr. X goes in a taxi. . ." as the last action performed by Mr. X. This was, in fact, the action performed by Mr. X immediately before the trial in which the target action was presented. For these participants, at least, we may conclude that attention to the general features of the task had been maintained throughout training. The nature of the error is consistent with the proposal that a more novel (and therefore more salient) event is more likely to be encoded and/or recalled than a familiar (and therefore less salient) one.

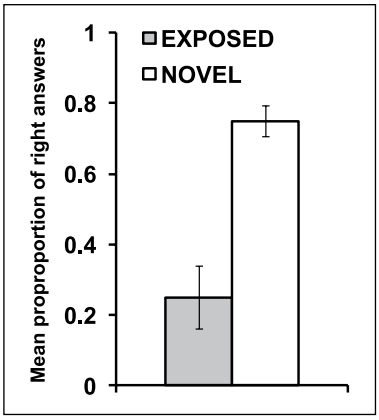

Figure 2. Mean proportion of right answers on the test in Experiment 1 by the EXPOSED and NOVEL groups. Vertical error bars indicate standard error values.

Experiment 2

The test performance of the subjects in Experiment 1 was, in our view, surprisingly poor (only six of the EXPOSED group gave the correct response, and six of the NOVEL group failed to do so). This encouraged us to think that it might be possible to replicate the effect without the complication of delaying the test and inserting a distractor before it. Accordingly in this experiment, we gave training like that described for Experiment 1, but there was no distractor and the test was given just 3 s after the last trial of training. Two further groups were included. These (the EXPOSED-OUTCOME group and the NOVEL-OUTCOME group) received the same training and test conditions as the EXPOSED and NOVEL groups, except that for them a novel outcome followed the critical appearance of the target action just before the test. This test should allow us to demonstrate that the difference between groups in their ability to recall the target event can be obtained when, as in the standard latent inhibition procedure, that event is being used to signal an outcome. In addition, by monitoring recall of the outcome on the final test, we should be able to get data consistent with the occurrence of latent inhibition itself in this procedure.

Method

The participants were 128 students, 48 males (mean age = 21.04 years, SD = 4.1) and 80 females (mean age = 20.26 years, SD = 2.8), from the University of the Basque Country, who volunteered for the experiment. They were assigned at random to one of these four experimental groups: EXPOSED group (n = 32), NOVEL group (n = 32), EXPOSED-OUTCOME group (n = 32), and NOVEL-OUTCOME group (n = 32).

Participants received the same instructions and training as in Experiment 1, with the following exceptions. For participants in groups EXPOSED-OUTCOME and NOVEL-OUTCOME, the action performed by Mr. X on the critical trial (the target action: *Mr. X answers a phone call* or *Mr. X listens to music from his MP3 player*, counterbalanced as in Experiment 1) was followed by an outcome that had never occurred before (the target outcome *. . . and he feels dizzy*). For all the participants, immediately after this last trial, a blank screen of 3 s was followed by a screen in which participants were asked to write down what was the last action performed by Mr. X. Although not instructed to do so, they were free to report also the outcome of this action.

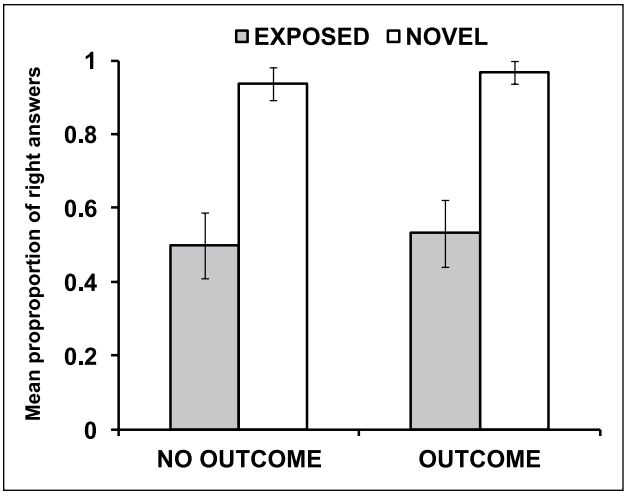

Figure 3. Mean proportion of right answers shown on the test in Experiment 2 by the EXPOSED and the NOVEL groups in the two conditions of density of occurrence of an outcome in the critical trial (NO-OUTCOME AND OUTCOME). Vertical error bars indicate standard error values.

Results and discussion

Figure 3 shows for each group, the mean proportion of correct identifications of the target action. As might be expected, given the changes made to the test, the overall level of performance was superior to that of Experiment 1. Nonetheless, it is clear that the EXPOSED groups showed worse test performance than the NOVEL groups, both when the target action was followed by an outcome and when it was not. A hierarchical log-linear analysis exploring the effects of exposure (EXPOSED vs. NOVEL), presence of an outcome on the critical trial (OUTCOME vs. NO OUTCOME), and accuracy (correct vs. incorrect answers) indicated that the 3-way interaction was not significant, $\chi^2(1) = 0.43$, $p = .83$. Partial associations revealed a nonsignificant association between the presence of an outcome on the critical trial and accuracy, $\chi^2(1) = .180$, $p = .671$, but a significant association between exposure and accuracy, indicating that exposed participants performed on test worse than control participants, $\chi^2(1) = 26.19$, $p < .001$, $\varphi = .44$, 95% CI = [.26, .55]. We have thus

confirmed the reliability of the effect obtained in Experiment 1, with a simpler test procedure, and in a procedure in which associative learning with the target action as a cue for a subsequent event was possible. It is also worthy of note that, as in Experiment 1, the incorrect alternative most often recalled in both EXPOSED groups was the penultimate action performed by Mr. X: "Mr. X goes in a taxi . . . " Specifically, 10 of the 16 participants in group EXPOSED-OUTCOME, and 11 of the 16 participants in group EXPOSED-NO OUTCOME who answered incorrectly did so because they recalled this penultimate non-target action.

The performance of the OUTCOME groups on the test also demonstrated a result consistent with the occurrence of latent inhibition in that the EXPOSED subjects were less likely to recall the outcome of the target event than were the subjects in the NOVEL condition. For group NOVEL-OUTCOME, 94% of subjects mentioned that Mr. X felt dizzy on the critical trial (giving responses such as: *Mr. X was receiving a phone call and then he felt dizzy; Mr. X felt dizzy when he was listening music on his MP3 player)*. Only 44% of subjects in group EXPOSED-OUTCOME gave responses of this sort. The difference between these percentages was statistically reliable, $\chi^2(1) = 18.62$, $p < .001$, $\varphi = .54$, 95% CI = [.28, .66]. As we have noted, this result does not distinguish between the effects of preexposure on salience and on associability as sources of the latent inhibition effect. Poor recall might arise because the associative link between cue and outcome is weak (as a result of low cue associability); equally, it might reflect the inability of a cue low in salience to evoke a response; or both of these processes might be operating. It does, however, confirm that the basic latent inhibition effect occurs after training that appears to be effective in reducing the effective salience of the target cue.

General discussion

These experiments demonstrated an effect of preexposure on the ability of subjects to report a recently presented event (the test occurring after 30 s in Experiment 1, and after just 3 s in Experiment 2). Repeated previous presentations of the target event impaired performance on the test trial. Experiment 2 also showed that this preexposure effect was observed when, on the critical training trial, the target was followed by a novel outcome. Under these latter conditions, the preexposure not only impaired the recall of the target event but also the recall of its outcome. This result is consistent with the occurrence of a latent inhibition effect of the sort found by Rodríguez and Hall (2017) who, under the same training conditions, showed that preexposure to the target event impaired the ability to report the relationship between the occurrence of that event and the occurrence of the outcome. These results thus support the hypothesis that encouraged the present study: that preexposure to the target event in this procedure will not only impair learning about the relation between that event and an outcome, but it will also modify the ability of this event to command the processing necessary for accurate recall on a memory test. According to the account proposed by Hall and Rodríguez (2010, 2017a), this change in processing is a consequence of a reduction in effective salience. A stimulus low in salience will be less likely to be effectively processed, thus reducing the ease with which its memory trace can be recovered and reported in response to retrieval instructions.

We should acknowledge, however, that an alternative account, that does not assume a loss of stimulus salience, can be derived from consideration of possible proactive interference effects. During exposure (for the EXPOSED groups), the target could have become associated with each of the different sets temporal cues with which it was presented. Participants might then have difficulty on test in picking out the target as the last presented item, if there was concurrent activation of the various other times at which the target had occurred. Although we cannot conclusively disconfirm this account, aspects of our results make us doubt it. In particular, the effect of interest was obtained even when the target event was paired with a novel outcome on the test trial. The proactive interference account requires that the event that presented in the different temporal contexts (the exposed target action) be the same. The introduction of the critical outcome in the paired conditions of Experiment 2 should have helped to the participants to discriminate the last trial from the previous trials in which the target was exposed in the absence of consequences. This might be expected to result in an attenuation of the effect, but, as Figure 3 shows, the effect was as large in the condition with the outcome as in that without an outcome.

The detrimental effect of preexposure on performance on the memory test in these experiments might seem to stand in contradiction to a well established finding from studies of list learning—the finding that recall is enhanced for words that have appeared more than once in the list (at least when the presentations are well spaced) (e.g., Madigan, 1969; Melton, 1967). Our EXPOSED groups received total of 12 well-spaced presentations of the target item, but often failed to report it correctly on test. In should be noted, however that standard demonstrations of the repetition effect use the free recall procedure, a test likely to be sensitive to the number of times a stimulus has been presented in the particular context that constitutes list learning. In our cued recall procedure, by contrast, performance depends critically on the effectiveness of the final trial in establishing a strong representation of the event that occurred on that trial. Prior presentations of the stimulus cannot be expected to promote this form of learning; rather, we have argued, they will tend to hinder it.

A closer parallel to our result comes from studies of list learning that have investigated the effects of stimulus novelty or distinctiveness in the context of the von Restorff phenomenon (see Wallace, 1965, for a review of early work on this effect). In these experiments, the test usually involved presentation of a list of items, some new to the subject and some presented in a previously studied list, and the subject's task is to identify the items that were in the original list. Performance has been found to be better for salient or distinctive items (e.g., Rajaram, 1996, 1998). The effect is found most readily when the test simply asks if the item identified is familiar, but it can also be obtained when recollection of details of the original presentation is required (e.g., Kishiyama & Yonelinas, 2003). These results have been presented as demonstrating that recall is better for novel events. It should be acknowledged, however, that in most of these studies, novelty has not been manipulated directly by varying the amount of prior exposure to an item. In the study by Kishiyama and Yonelinas, for example, an item was regarded as "novel" (i.e., distinctive or salient) when it was presented in colour in the original list (most items were black).

Evidence for an effect of novelty (in the literal sense of the extent to which an item has been experienced previously) comes from work on the word-frequency effect on recognition memory. Although common words may be processed in some ways more readily than rare words (e.g., they are more readily identified as words, Whaley, 1978), it is well established that recognition of items presented in a previously studied list is superior for words that are rare in everyday usage (e.g., McCormack & Swenson, 1972; Underwood, 1972). Of course, rare and common words are likely to differ in a range of ways (e.g., in, length, imageability, and so on) in addition to differing in the number of times they have been experienced. In a study by Kinsbourne and George (1974), however, such confounds were avoided by directly manipulating the subjects' experience of the words. Subjects were given a list of words to rate for concreteness (an irrelevant task) prior to receiving a list to be memorised. When required to identify words they had seen before, in a list that contained both studied words and distractors, the subjects showed better performance for words that had been novel at the time of study than for words that had been preexposed. One interpretation of the original demonstrations of the effect of word-frequency on recognition memory holds that rare words are more able to attract attention and thus "memorizing effort" (Kinsbourne & George, 1974) than common words. The result reported by Kinsbourne and George can be accommodated in the same general way, given our hypothesis that exposure to a stimulus will reduce its effective salience, and thus one aspect of its capacity to govern attention.

The notion that latent inhibition is a consequence of attentional change has long been widely promoted (see, for example, Lubow, 1989). It forms the basis for using latent inhibition as a model for the analysis of disorders that are taken to involve an attentional dysfunction, such as schizophrenia (Lubow & Weiner, 2010). The results of the experiments reported here lend support to this approach by suggesting that latent inhibition in human learning has an attentional component similar to that underlying the latent inhibition effects found in the non-human literature. They also make clear the need to analyse closely the exact nature of the processes involved in latent inhibition that go under the general heading of "attention." Most attentional theories of latent inhibition have attributed the attenuation in stimulus processing responsible for the effect in terms of a single factor. For example, this decrease in processing is treated as a reduction in stimulus salience by McLaren and Mackintosh (2000), or as a reduction in stimulus associability by Mackintosh (1975). However, if we accept the distinction proposed in the Pearce and Hall (1980), model more than one factor may be involved. The version proposed by Hall and Rodríguez (2010) developed an account of latent inhibition in which the principle mechanism was a decline in stimulus associability (attention-for-learning). But they also acknowledged (Hall & Rodríguez, 2017a, 2017b) that exposure to a stimulus could also produce a reduction in its effective salience (attention-for-performance). The present experiments show that a change in this latter form of attention may play a role in human latent inhibition. For the future, it will be worthwhile to determine if people with disorders involving attentional problems have dysfunctions of both these forms of attention or of just one, and, if so, which one.

Declaration of conflicting interests

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Supplementary material

Supplementary material is available at: journals.sagepub.com/doi/suppl/10.1177/1747021818777694.

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