DOI:10.3819/CCBR.2025.200003 Volume 20, 2025

Comparative Cognition & Behavior Reviews

Occasion Setting in Humans: Norm or Exception?

Jessica C. Lee
University of Sydney
University of New South Wales

Julie Y.-L. Chow
University of New South Wales

Peter F. Lovibond
University of New South Wales

In this commentary, we propose that occasion setting in humans may be even more widespread than Leising and colleagues assume. In contrast to animal work, our research using the feature negative procedure (A+ AX−) reveals substantial individual differences in what people learn about the feature (X). We discuss findings showing that the majority of participants in our experiments learn something akin to occasion setting, and we present reasons for why this may be the case. We conclude that occasion setting may be the norm in humans because it allows existing learning to be preserved and allows for the possibility that the effect of a cue is unique to its accompanying target.

Keywords: occasion setting, feature negative, modulation, conditioned inhibition, prevention learning

Leising, Nerz, Solorzano-Restrepo, and Bond (2025) present a comprehensive review on the theoretical and methodological issues surrounding occasion setting in a number of species. We agree that occasion setting, or modulation, is a potentially widespread phenomenon in human learning and that greater consideration should be paid to the possibility that humans learn hierarchical or higher-order associations in addition to direct or first-order associations. In fact, our findings in causal learning procedures lead us to believe that in humans, modulation may be the norm rather than the exception.

Causal learning often requires individuals to make inferences about cues and their outcomes based on incomplete or ambiguous information. For example, in a feature negative discrimination[1] commonly used in the occasion-setting literature (A+ AX−), it is unclear whether X directly prevents the outcome (i.e., conditioned inhibition or *prevention*) or whether X prevents A from causing the outcome (i.e., negative occasion setting, or what we have termed *modulation*). Situations of high ambiguity are ripe for the observation of individual differences in what people learn. Indeed, we observed this exact result in multiple experiments using self-report (Chow et al., 2022, 2024; Lee & Lovibond, 2021; Lovibond & Lee, 2021; Lovibond et al., 2022). To our surprise, we found that very few participants spontaneously described their learning by using words such as “inhibition” or “prevention” despite prevailing assumptions that learning a direct negative association is dominant under these conditions. Instead, we found that a large proportion of participants reported a modulatory causal structure (i.e., X stopped A from causing an allergic reaction) over a preventative structure (i.e., X prevented allergic reactions) or a configural structure (i.e., A and X together produced no allergic reaction). These findings were surprising because conditioned inhibition (i.e., prevention learning) has been seen as the default mode of learning in feature negative discriminations, with serial presentation of the AX compound assumed to be necessary in order to observe occasion setting (Holland, 1984, 1989, 1991; Holland & Lamarre, 1984; Lamarre & Holland, 1985; see Bonardi et al., 2017, and Fraser & Holland, 2019, for reviews). In contrast, a direct comparison

1. We focus on negative occasion setting in this commentary, as we have investigated negative occasion setting in our research.

of simultaneous and serial presentation of stimuli revealed no significant difference in the kinds of causal structure endorsed by participants, with the majority of participants endorsing a modulatory structure in both conditions (Lovibond & Lee, 2021).

In retrospect, the dominance of modulation learning makes sense. In the presence of ambiguity due to limited information, participants may lean toward modulation, as it is the more conservative inference to make if participants are unable to observe the effects of the feature X with other cues. Modulation also helps to preserve existing learning about the target A, which may be less resource intensive when A is being learned alongside AX. Consistent with this idea, Fraser and Holland (2019) pointed out that one of the hypotheses guiding early animal research was that occasion setting is more likely when the target is learned about faster than the feature. Under this hypothesis, our failure to obtain a difference between serial and simultaneous presentation in feature negative learning in humans (Lovibond & Lee, 2021) may be explained by assuming that learning of the target was rapid in both conditions. Rapid learning may occur because both serial and simultaneous procedures include trials in which the target is presented without any other cues, making its direct relationship with the outcome unambiguous and easy to identify. We generally find rapid learning under these conditions, making it more likely that participants will try to preserve this learning through modulation (a form of theory protection, discussed next).

The majority of participants not only report learning a modulatory causal structure but also seem to behave in ways that are consistent with occasion setting. The first piece of evidence comes from studies examining the degree of transfer observed by modulation and prevention subgroups in a summation test (Leising et al., 2025, Test 2; see Rescorla, 1969). A summation test involves training another cue as a predictor of the outcome (e.g., B+), and then combining the feature X with that predictor (BX), to test its ability to modulate responding to the predictor. Summation is observed if the addition of the negative feature to the separately trained predictor (BX) reduces responding relative to the predictor alone (B). We consistently find strong summation for participants reporting a modulatory causal structure, albeit weaker summation than for those reporting a prevention structure (Chow et al., 2022; Lee & Lovibond, 2021; Lovibond & Lee, 2021). Notably, transfer was determined by the degree of similarity between the training and test targets. Further, we have repeatedly failed to show complete transfer of inhibition in summation tests, even among individuals who report learning a preventive causal structure. We have argued that these results are consistent with "preventors" having also learned a modulatory causal structure but being more willing to generalize the modulatory properties of the feature to new stimuli (Chow et al., 2022). Thus, the summation test may be viewed as more like a generalization test, meaning it is unclear whether the difference between modulation and prevention is actually qualitative or whether there is simply a difference in degree (Chow et al., 2022). The implication of these findings is that Test 2 proposed by Leising et al. may not be very diagnostic in humans. Researchers who wish to use this test should consider the possibility that individual differences may exist in what people learn even among those who have received identical experimental treatment and that the difference between modulators and preventors might be subtle.

The second piece of evidence comes from experiments showing that extinction of a feature is most effective using procedures that nullify the modulatory properties of the feature. After feature negative training (A+ AX−), we found reversal of the inhibitory properties of X after "no-modulation" training (A+ AX+). Reversal also occurred when the no-modulation contingencies included a novel cue (M+ MX+). In contrast to the predictions of the Rescorla-Wagner model (Rescorla & Wagner, 1972), extinction of the feature (X−) did not have the same effect. These results suggest that what is learned in feature negative discriminations is a modulatory causal structure, akin to occasion setting.

A third piece of evidence is that a preventative cue (i.e., a conditioned inhibitor) fails to show greater retardation of subsequent excitatory conditioning compared with a latently inhibited cue (Lovibond et al., 2023). In a series of experiments, we compared the properties of a negative feature X trained in a feature negative discrimination (A+ AX−) with an equivalent cue E presented in compound with a cue (D), which was separately presented with no feedback about the outcome (D DE−; see Lee et al., 2022, for experiments validating this no-feedback procedure). According to the Rescorla-Wagner model (Rescorla & Wagner, 1972), X should become a conditioned inhibitor, whereas E should undergo latent inhibition. Because latent inhibition is assumed to be different to "true" inhibition, X should show stronger inhibition than E in both a summation

***Author Note**: Correspondence concerning this article should be addressed to Jessica Lee at jessica.c.lee@sydney.edu.au*

Jessica Lee, School of Psychology, University of Sydney, Camperdown, 2006, New South Wales, Australia.

and retardation test (Rescorla, 1969). In a retardation test, the degree to which a cue shows impairment in learning when it is subsequently paired with the outcome is used as an index of inhibitory learning. We found that X did indeed show more transfer than E in a summation test, but there was no difference between the speed of acquisition (X+ vs. E+) in a retardation test (Lovibond et al., 2023). The similar levels of retardation observed for the negative feature X and the latently inhibited cue E contradict the intuition that the inhibitor should be slower given that it starts at negative associative strength, but can be explained by assuming that X has become an occasion setter. Occasion setters should show strong transfer, because as mentioned the summation test involves generalization (Chow et al., 2022), and any retardation observed can be attributed to latent inhibition, since the level of retardation observed was equivalent to that of the trained latent inhibitor. We emphasize that this is not the only explanation of our results (see Lovibond et al., 2023); nevertheless, it is worthwhile considering that other processes may be occurring alongside occasion setting.

The final piece of evidence comes from experiments investigating the phenomenon of "protection from extinction." Extinction occurs when a cue that was previously paired with an outcome is no longer paired with that outcome (A+ / A−), and protection from extinction occurs when a stimulus is presented with the extinguished cue and thereby prevents extinction of A from occurring (A+ / AX−). This procedure is similar to the feature negative discrimination, except that the trial types are presented in different phases (A+ and then A−). Traditional models of learning predict that protection of extinction should occur only if the added cue X is inhibitory, because the predictions from X (inhibitory) and A (excitatory) will cancel each other out, resulting in no prediction error and therefore no associative change to A. In contrast to this prediction, protection from extinction seems to occur when the added cue X is neutral (Chow et al., 2024, Experiment 3), excitatory (Lovibond et al., 2000), and even inferred but not physically present (Chow et al., 2024), suggesting that there is more than prediction error at play.

In Chow et al. (2024), we found that participants showed protection from extinction when the cover story suggested the presence of a hidden cause that could plausibly explain the absent outcome on the extinction trials. This finding is significant because it demonstrates that an additional cue does not need to be present at the onset of the extinction trials for protection from extinction to occur. The insight also aligns with well-known findings demonstrating the context-specificity of extinction (see Bouton, 1993, 2004). Here, the context can be seen as the hidden cue that serves to modulate (and therefore protect) the preexisting belief that the target cue causes the outcome. If we assume the hypothesis mentioned earlier—occasion setting is more likely to eventuate when learning of the target is faster than the feature—then it makes perfect sense that modulation should occur in extinction, as by definition the target association must be acquired first in order to be extinguished (A+ then AX−, where X is the context).

We concluded from our findings that people have a natural tendency to "protect" existing beliefs, leading them to explain away contradictory information using whatever stimuli or information is available (Chow et al., 2024). If this tendency for *theory protection* is robust (see also Chan et al., 2024; Spicer et al., 2020, 2022), then occasion setting or modulation will be the dominant form of learning. Although theory protection may seem suboptimal when an enduring change has indeed occurred, this tendency helps to maintain stability of learning in a constantly changing environment. In other words, rather than starting from scratch (unlearning or remapping associations), which would lead to erratic behavior, it may be more efficient for a learning system to retain existing knowledge and learn in what specific contexts that knowledge applies. Interestingly, this exact idea is implemented in the Category Abstraction Learning Model (Schlegelmilch et al., 2022).

To summarize, we agree with Leising et al. (2025) that modulation, or occasion setting, is more widespread than assumed. However, we depart in proposing that occasion setting may be the dominant form of learning with procedures such as the feature negative discrimination. We have claimed that discriminations that are ambiguous will produce individual differences in the content of learning, and we have advocated for self-report as an additional test that researchers might want to consider. We reviewed evidence from our lab demonstrating that the majority of participants show behavior consistent with occasion setting, and we presented two explanations for this preference. First, occasion setting, or modulatory learning, may be preferable because it is more conservative when there is limited information regarding the degree to which the properties of the feature generalize. Second, occasion setting allows preservation of existing learning, which may result in more stable and optimal learning over time in comparison to constantly relearning or remapping associations. If we are correct, a challenge for the field will be to identify the enabling conditions that allow occasion setting to occur which will allow occasion setting to be integrated alongside existing mechanisms in formal theories of learning.

References

Bonardi, C., Robinson, J., & Jennings, D. (2017). Can existing associative principles explain occasion setting? Some old ideas and some new data. *Behavioural Processes, 137*, 5–18. https://doi.org/10.1016/j.beproc.2016.07.007

Bouton, M. E. (1993). Context, time, and memory retrieval in the interference paradigms of Pavlovian learning. *Psychological Bulletin, 114*(1), 80–99. https://doi.org/10.1037/0033-2909.114.1.80

Bouton, M. E. (2004). Context and behavioral processes in extinction. *Learning & Memory, 11,* 485–494. https://doi.org/10.1101/lm.78804

Chan, Y. Y., Lee, J. C., Fam, J. P., Westbrook, R. F., & Holmes, N. M. (2024). The role of uncertainty in regulating associative change. *Journal of Experimental Psychology: Animal Learning and Cognition, 50*(2), 77–98. https://doi.org/10.1037/xan0000375

Chow, J. Y. L., Lee, J. C., & Lovibond, P. F. (2022). Inhibitory summation as a form of generalization. *Journal of Experimental Psychology: Animal Learning and Cognition, 48(2)*, 86–104. https://doi.org/10.1037/xan0000320

Chow, J. Y. L., Lee, J. C., & Lovibond, P. F. (2024). Using unobserved causes to explain unexpected outcomes: The effect of existing causal knowledge on protection from extinction by a hidden cause. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 50*(7), 1167–1185. https://doi.org/10.1037/xlm0001306

Fraser, K. M., & Holland, P. C. (2019). Occasion setting. *Behavioral Neuroscience, 133*(2), 145–175. https://doi.org/10.1037/bne0000306

Holland, P. C. (1984). Differential effects of reinforcement of an inhibitory feature after serial and simultaneous feature negative discrimination training. *Journal of Experimental Psychology: Animal Behavior Processes, 10*(4), 461–475. https://doi.org/10.1037/0097-7403.10.4.461

Holland, P. C. (1989). Transfer of negative occasion setting and conditioned inhibition across conditioned and unconditioned stimuli. *Journal of Experimental Psychology: Animal Behavior Processes, 15*(4), 311–328. https://doi.org/10.1037/0097-7403.15.4.311

Holland, P. C. (1991). Acquisition and transfer of occasion setting in operant feature positive and feature negative discriminations. *Learning and Motivation, 22,* 366–387. https://doi.org/10.1016/0023-9690(91)90002-P

Holland, P. C., & Lamarre, J. (1984). Transfer of inhibition after serial and simultaneous feature negative discrimination training. *Learning and Motivation, 15*, 219–243. https://doi.org/10.1016/0023-9690(84)90020-1

Lamarre, J., & Holland, P. C. (1985). Acquisition and transfer of feature-negative discriminations. *Bulletin of the Psychonomic Society, 23*(1), 71–74. https://doi.org/10.3758/BF03329783

Lee, J. C., Le Pelley, M. E., & Lovibond, P. F. (2022). Nonreactive testing: Evaluating the effect of withholding feedback in predictive learning. J*ournal of Experimental Psychology: Animal Learning and Cognition, 48*(1), 17–28. https://doi.org/10.1037/xan0000311

Lee, J. C., & Lovibond, P. F. (2021). Individual differences in causal structures inferred during feature negative learning. *Quarterly Journal of Experimental Psychology, 74*(1), 150–165. https://doi.org/10.1177/1747021820959286

Leising, K., Nerz, J., Solorzano-Restrepo, J., & Bond S. R. (2025). Are you studying occasion setting? A review for inquiring minds. *Comparative Cognition and Behavior Reviews, 20*, 5-44. https://doi.org/10.3819/CCBR.2025.200002

Lovibond, P. F., Chow, J. Y. L., & Lee, J. C. (2023). Retardation of acquisition after conditioned inhibition and latent inhibition training in human causal learning. *Journal of Experimental Psychology: Animal Learning and Cognition, 49*(2), 75–86. https://doi.org/10.1037/xan0000351

Lovibond, P. F., Chow, J. Y. L., Tobler, C., & Lee, J. C. (2022). Reversal of inhibition by no-modulation training but not extinction in human causal learning. *Journal of Experimental Psychology: Animal Learning and Cognition, 48*(4), 336–348. https://doi.org/10.1037/xan0000328

Lovibond, P. F., Davis, N. R., & O'Flaherty, A. S. (2000). Protection from extinction in human fear conditioning. *Behaviour Research and Therapy, 38*, 967–983. https://doi.org/10.1016/S0005-7967(99)00121-7

Lovibond, P. F., & Lee, J. C. (2021). Inhibitory causal structures inferred through feature negative learning. *Quarterly Journal of Experimental Psychology, 74*(12), 2165–2181. https://doi.org/10.1177/17470218211022252

Rescorla, R. A. (1969). Pavlovian conditioned inhibition. *Psychological Bulletin, 72*(2), 77–84. https://doi.org/10.1037/h0027760

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and non-reinforcement. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II* (pp. 64–99). Appleton-Century-Crofts.

Schlegelmilch, R., Wills, A. J., & von Helversen, B. (2022). A cognitive category-learning model of rule abstraction, attention learning, and contextual modulation. *Psychological Review, 129*(6), 1211–1248. https://doi.org/10.1037/rev0000321

Spicer, S. G., Mitchell, C. J., Wills, A. J., Blake, K. L., & Jones, P. M. (2022). Theory protection: Do humans protect existing associative links? *Journal of Experimental Psychology: Animal Learning and Cognition*, *48*(1), 1–16. https://doi.org/10.1037/xan0000314

Spicer, S. G., Mitchell, C. J., Wills, A. J., & Jones, P. M. (2020). Theory protection in associative learning: Humans maintain certain beliefs in a manner that violates prediction error. *Journal of Experimental Psychology: Animal Learning and Cognition*, *46*, 151–161. https://doi.org/10.1037/xan0000225