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Abstract

Previous studies using Pavlovian conditioning have shown that the attractiveness of reward cues is associated with drug-taking and other measures of motivation. The purpose of this study was to determine whether nicotine alters the motivational value of a reward associated cue. In the experiment, we trained rats to make lever pressing or nose poking responses presented with a visual cue that predicted the delivery of a food reward. We then measured the average rate of response to the visual cue ("sign tracking") and lever pressing ("cue tracking"). We found that nicotine especially enhanced sign tracking but not cue tracking. These results indicate that nicotine specifically enhances the motivational value of reward cues, and that this may account for some of the effects of smoking.

Methods

• Rates were hand-fed every day for 4 weeks prior to the experiment.

• Pavlovian Conditioning Approach (PCA):

  - Training consisted of one session in which rats were placed into test chambers for the minutes of habituation.
  - Then, three pellets were delivered on an average of one pellet per every 30 seconds to familiarize the rats with the food magazine (location of food reward).

Pavlovian-Conditioning Approach (PCA):

- During the baseline phase, rats were paired with either nicotine or saline depending on the paradigm for each individual rat.
- The rats were placed in the test chambers where there was a red house light (remained lit throughout the experiment). The food magazine was located on one side of the rat's horizontal axis.
- An LED light illuminated the lever when the lever entered the chamber.
- The lever remained extended for 8 seconds and upon completion of the duration, the lever retracted, and a food pellet was delivered to the food cup.
- Engagement in lever pressing had no effect on food reward delivery.
- Lever presses, upon depression of the lever, and nose pokes, upon depression of the light, were counted as the number of the food cup, were recorded.
- Trails were tested using PCA once a day for the consecutive days.

Conditioned Reinforcement Challenge (CRC):

- The test chambers were designed with two behavioral environments: removing the food magazine, placing the lever in the middle, with nose-poke holes on either side.
- The nose poke was designed to be active, in which upon breaking the photo beam, the intrinsic lever was extended for those responses.
- The other nose poke was inactive and breaking the photo beam did not cause any programmed changes.
- The number of lever presses, and nose pokes (both active and inactive) were recorded.

Sign- and Goal-tracking

Introduction

- Motivated behavior is guided by “reward cues,” the people, places, or things associated with food, drug, potential rewards, etc.
- For example, a person who drives a compact while driving may experience an unexpected journey experience (e.g., "road rash") from the roadway. After several hours of driving long distances, the driving cues, "gas," obtain the ability to cue a desire to travel. This ability of a "car" to have an influence on motivational behavior desire to travel is called incentive value.
- One experimental measure of incentive value is the Pavlovian conditioned approach (PCA), which measures the rate of responses to a cue (e.g., “motivation” or "driving desire") after removal of the reward. This is called the "driving desire" (i.e., cue magnitude). Incentive value is the driving desire (e.g., figure or the right).
- Another measure of incentive value is whether the animal will work for the cue (e.g., "combined desire.")
- Previous studies suggest that abused drugs may acquire addictive properties by increasing the incentive value of a “cue.” For example:
  - Cocaine-related cues were found to increase the drug-seeking behavior even when a lower dose of cocaine is administered to the rat.
  - In addition, administration of the drug increased the sign-tracking response (i.e., a cue that the rat is not associated with a cue).
  - The main goal of this experiment was to determine whether nicotine would similarly strengthen the incentive value of the cue as measured by PCA and conditioned reinforcement.

Goal-tracking, approach the associated cue

Sign-tracking, approach the reward location

Conclusions

- Nicotine enhanced sign-tracking behavior whereas no result was seen on goal-tracking behavior.
- Incentive value of the “cue” (lever) increased. This is seen in the each of two measurable properties of incentive value:
  - PCA treatment results indicate presence of nicotine over the five-day period increased the amount of sign-tracking behavior via increased lever presses.
  - Conditioned reinforcement challenge results indicate that nicotine enhanced conditioned reinforcement only in period when reinforcement during PCA.
- These results are not due to a general enhancement of learning or attention.
  - Observed these would be an increase in both sign- and goal-tracking.
  - However, our results show that due to an increase in sign-tracking behavior alone, nicotine enhances only the incentive value of the cue.
- We speculate that nicotine not is a result of the reward induced by nicotine, but rather the increased incentive value of numerous real-life “cues” associated with nicotine intake, such as:
  - Smoking after enjoyable activities (eating, sex, drinking coffee, etc.)
  - Further research can lead to new ways to examine treatment for individuals addicted to not only nicotine, but other abused drugs as well. This approach would focus specifically on treating the ability of cues to control drug-taking behavior, perhaps through the use of cognitive behavioral therapy. In addition, future medications might be able to target the neural underpinnings of cue-reinforcement associations, while able to spare normal learning.

The results showed:

- No significant change in active number of nose pokes in individuals treated with nicotine in PCA treatment followed by either saline or nicotine in CRC.
- No significant change in inactive number of nose pokes in individuals treated with nicotine in PCA treatment followed by either saline or nicotine in CRC.

Active Results

- Individuals given saline during PCA followed by nicotine did not awake substantially more than the other, compared to inactive nose pokes.
- Individuals given nicotine in both PCA treatment and CRC showed increase in number of active nose pokes compared to those given nicotine in PCA followed by saline in CRC.

Inactive Results

- No significant change in active number of nose pokes in individuals treated with nicotine in PCA treatment followed by either saline or nicotine in CRC.
- No significant change in inactive number of nose pokes in individuals treated with nicotine in PCA treatment followed by either saline or nicotine in CRC.

Above: Sign and goal trackers learned different conditioned responses at similar rates over 5 days of training.