

September 27, 2013

Garren, M. V., Sexauer, S. B., & Page, T. L. (2013). Effect of Circadian Phase on Memory Acquisition and Recall: Operant Conditioning vs. Classical Conditioning. *Plos ONE*, 8(3), 1-8.
doi:10.1371/journal.pone.0058693

Synopsis

In this study the researchers; Madeleine V. Garren, Stephen B. Sexauer and Terry L. Page begin with a short abstract paragraph detailing the fact that while research has been done on the subject of their study it was previously approached from a different perspective. The research team intended to compare the way the circadian clock regulates memory and learning under classical and operant conditioning methods. The researchers next introduce their article with historical details from previous studies. These studies suggested that memory formation might have been independent of circadian phase. Nonetheless, the ability to recall memories was better with a “contextual cue” after a 24 hour time period in rats and hamsters. (Garren, 2013) They write that disruption of time such as that is experienced when going through “jet-lag” has been proven to impair memory in rats and that it was proven unsettling to the learning process in humans. Hamsters were also tested in which the phase was entirely disrupted and this impaired their abilities to perform a “declarative memory task”. (Garren, 2013) The last study the group examined proved that “ongoing circadian oscillations” in the brain were vital to long term memory development in mice. (Garren, 2013)

The authors summarize that the subject of their research is vital to the development, retention and recall of memories and what has been learned. They believe certain aspects of that process have not been studied nor proven. They go on to theorize that in order to understand the role of the circadian system the researchers need to contrast and compare both classical and operant conditioning and various stimuli in order to reinforce the learning process and/or memory. Due to the multiple variables in previous research studies the authors believe that the previous results simply prove that different methodologies and/or diverse species can create varying results. (Garren, 2013)

The study next reports that the cockroach has the proven ability to learn, retain and recall under both classical and operant conditioning paradigms with identical stimuli. (Garren, 2013) These processes utilized reinforcement. The protocol showed that learning and memory in cockroaches were regulated via the olfactory system which also revealed a preference for certain odors. In a classical conditioning exercise the cockroach exhibited a “strong preference for vanilla at all circadian phases.” (Garren, 2013)

When detailing the results of various tests the researchers reported that they were able to determine that “operant conditioning can establish both short and long-term memories” (Garren, 2013) while utilizing the reinforcing stimuli of what they proved was an “attractant” (vanilla) odor as contrasted with an “aversive” odor (peppermint). They anticipated a number of elements of their trials would result in successful memory acquisition when the animals were provided the vanilla odor and consistent phases as well as poor memory retention when the animals were disrupted and provided aversive stimuli.

The authors further report that “associative memory formation is independent of reward.” (Garren, 2013) They surmise that while the reward was a sucrose solution the subjects end reward which was an apple to eat could have been “independent of the circadian phase.” (Garren, 2013) They detail the vast number of variables in their contrasting research at this point. At this point there is a detailed inclusion of a number of charts indexing the results of the tests performed at different time periods.

The research discusses the various learning theories and the effect of circadian regulation on memory. The researchers determine that despite the use of both classical as well as operant conditioning methods their research proves that the regulation of circadian phases are highly vital to the ability of long-term memory recall. The researchers attempt to adapt their findings to other species and theorize on the significance of their findings.

Finally, Garren, Sexauer and Page detail their materials, methods, training and testing schedules. The authors state that their data was analyzed by a software program and other technical details are provided.

Theory

In the highly technical research of the “Effect of Circadian Phase on Memory Acquisition and Recall: Operant Conditioning vs. Classical Conditioning” the researchers are explicitly utilizing B. F. Skinner’s theories on “operant conditioning” and contrasting these factors and variables with “classical conditioning” of their subjects. They surmise that in previous studies the number of primary and or favorable reinforcers and contrived and negative reinforcers were too numerous to be significant. They also theorize that other factors, such as species could have played a role in previous studies. This question is contrary to B. F. Skinner’s belief that “learning is the same for all organisms”. Skinner has detailed the use of “reinforcement schedules” at fixed and variable intervals and calculated the ratio to the performance outcomes. (Gredler, 2009) These methods were utilized in the tests performed following the training of the animals in the study. Skinner also utilized the “desired” reinforcers as well as the “aversive” reinforcement in his theories examining learning behaviors. The experiment further attempts to elicit responses that are vital to the theory of operant conditioning such as, “is the response a “naturally occurring” response to new stimuli or “contrived”?” (Gredler, 2009)

Analysis

While the research article is quite technical I found it to be interesting nonetheless. The researchers seem to have an intellectual grasp of Skinner’s theories on “operant conditioning” as well as a definitive interest in memory, learning and the circadian phase. The researchers do contradict their own methods and data however at multiple locations along the way. The report seems to follow the process as outlined by the Gredler text of assumptions, reinforcement method, and table of fixed and variable schedules as well as an application to target and shape behavior, all of which is vital to Skinner’s theory of operant conditioning. (Gredler, 2009) While these factors help to bolster the results of the research the authors seem to undermine their own data with numerous self-doubting questions and details that contradict the point of the theory. If you examine the “Results” section of the article where the group details “Operant Conditioning can Establish Both Short and Long-Term Memories” there are numerous

factual details to state that Skinner's theory of operant conditioning is proven by the results documented within the report. The performance of the subjects as detailed in this excerpt, "Following the initial training trial and consumption of the apple slice, animals consistently showed a significantly reduced number of visits to vanilla prior to the visit to peppermint and the receipt of the reward in the 5-minute trial. Little change in performance occurred in subsequent trials indicating that animals were capable of both short-term and long-term memory." reiterates the positive outcome of their testing as well as the documentation in the accompanying (Fig. 1A) chart. The researchers do go on to state that they "found it surprising that memory formation via classical conditioning exhibited a robust circadian rhythm while memory formation following operant conditioning appeared to be completely independent of the circadian system." (Garren, 2013) These and other curious context statements or questions seem to undermine the resulting outcomes.

Evaluation

This is an interesting article detailing a number of highly important areas of concern to educators as well as scientists in any number of fields. While it seems the researchers desired to appear unbiased in their reporting of the results of their numerous training and tests they may have undermined their own data analysis. Initially the article provides background into similar studies that they critique to be ineffective due to the fact that there were numerous variables in species, approach and other factors. When they present their own findings they seem to provide alternative explanations for the outcomes and results thus undermining their own charts and data. I find this disturbing and curious. While I understand that many self-serving articles are presented and prepared by commercial interests or even educational interests that may be subsidized by commercial interests and the researchers may want to refute any appearance of that. I do find it highly disturbing that the blatant method in which the authors seem to question their own outcomes in turn highly curious.

I do appreciate the charts and graphs and the inclusion of the scientific names for certain species, however this seemed a little inconsistent throughout the text of the article. The researchers included highly detailed information at the beginning of their reporting and then simply state, "mice" or the "animal" as opposed to earlier details, such as "*Rhyarobia (Leucophaea) maderae*" with an accompanying table.

Despite the aforementioned shortcomings found within the article I do believe that it does provide a beneficial study of the "effect of circadian phase on memory acquisition and recall" in contrasting the operant versus classical conditioning of various species. The details of the process are interesting as well as the historical outlines of previous studies done. I can appreciate the methodology presented as well as the underlying questions the researchers seem to reveal of their own outcomes and work. Leonard da Vinci said "Art is never finished, only abandoned." So it may be said that these scientists felt similarly.