The epidemic of obesity has taken hold in America, contributing to increased rates of cardiovascular disease, stroke, hypertension, type II diabetes, asthma and certain cancers. It is known that humans develop preferences in eating by associated experiences with a certain food. One of the largest factors in developing preferences is taste; thus, this experimentation delves to uncover if linoleic acid, a fatty acid, alters the perception of a taste in rats. Though rats have some dissimilar cues for consumption such as caloric intake, palatability also plays a major role. Given that a large reason for consumption is taste in rats, this project seeks to answer whether fat has an effect on the tastes that can lead to increased consumption. Certainly any effect fat has on taste is intriguing, but for fat to cause an increase in consumption of a certain taste is most interesting, and could take the first step into explaining why obesity rates are high.

Dietary fat is common and is present in items such as corn oil and olive oil. Linoleic acid is represented by the picture above; it is an unsaturated fat that can also be a component of a triglyceride if bound to a glycerol backbone. There are known receptors on the tongue for fatty acids; however it is not yet known how their action may modify the perception of a concurrent tastant. The objective of the project is to determine the effect of linoleic acid on consumption in rats in a naturalistic setting. Previous studies performed by this lab have confirmed that in 20 second brief-access, conditioned aversion trials, linoleic acid increases the perceived intensity of a tastant. This conclusion was reached with data that showed an increase in licking on appetitive tastes and decreased licking on aversive tastes when linoleic acid is present, as compared with the tastant alone. These trials implemented methods that alter rats’ normal behavior, conditioning them to avoid linoleic acid. This experimentation, however, subjects rats to 23 hour trials to gauge the rats’ licking in a natural setting, as well as allowing a choice between a taste alone or a taste mixed with linoleic acid. The tastes include bitter, sour, salty, nutritive sweet, non-nutritive sweet and umami (MSG). The sweet tastes are appetitive and the rest are aversive, although the palatability of umami at different concentrations is still debated. One thing is certain though: the more understanding of fat taste is increased, the closer the human race is to saving themselves from obesity.

Sixteen male Sprague-Dawley rats were subjected to 23 hour trials in which they have a choice between a bottle containing a tastant or a tastant and linoleic acid. Trials were conducted over a nine week period. Except for the control week, every two weeks the fatty acid was switched from linoleic acid to oleic acid, and the tastant was changed every day. A tastant would repeat every week, with a total of six tastants and water on the last day. The solutions were presented to the rats at 2:30PM daily and taken away 23 hours later at 1:30PM the next day. After the solutions were changed, the bottles were replaced at 2:30PM. To assure that the rats did not prefer one side to another, the side which the fatty acid was present was changed every day. Additionally, a preemptive test was performed with a bottle presented on each side, then weighed after 24 hours. This test yielded no data which suggested a significant preference between sides. Once the correct amount of linoleic or oleic acid is measured (0.303 g in 500 mL, 200 µM), it is added to 500 mL of water and mixed with a magnetic stirrer. After the fatty acid is completely in solution, the tastant is then added, as well as to another 500 mL of water. Once the bottles are presented, a device called the AC-108lickometer measures the rats’ licking, which averages 5 licks per second during consumption. The resulting files are filtered and broken down into individual meals, which is a period of licking not broken by a pause of 10 minutes or greater. A meal must be at least 50 licks, though some break 30,000. Many variables are analyzed, some of the most important of which are average licks/23h and average licks/meal. These are the most important variables because they capture a holistic view of how the rats licked over 23 hours.
The total number of licks in 23 hours did not significantly vary between bottles with and without linoleic acid (LA) for all of the taste solutions. The difference between saccharin (non-nutritive sweet) + LA and saccharin alone appears large but is not statistically significant because of large variation. The trend found in saccharin’s data may suggest that the taste is slightly bitter, for the addition of LA tends to lower licking over 23 hours. The concentration of saccharin is 0.005 M, which is on the threshold for a bitter taste to rats, so this may be an underlying cause for this trend in some rats.

In Meals/23h, trends are visible, but the large amount of variation causes for no significant differences in number of meals over 23 hours between bottles with LA and bottles without LA for all of the tastants. Meals/23hr of water alone is significantly greater than meals of water with LA. The average licks per meal tended to be greater with water than water + LA, though this was not significant. The average licks per meal over 23 hours appear to be similar for sucrose and NaCl; however, sucrose is an appetitive stimulus and NaCl is an aversive stimulus. Conversely, the total number of meals over 23 hours for sucrose is around twice as much as that for NaCl, so overall licking was much greater. Because they take fewer meals with NaCl, they have longer pauses between meals and are thus thirstier, which leads them to lick a similar amount of average licks per meal as sucrose. Although the results do not support the hypothesis that linoleic acid increases licking on appetitive stimuli and decreases licking on aversive stimuli compared to the stimuli alone, the trends of licking affirm that nutritive sweet and non-nutritive sweet (sucrose, saccharin) are appetitive, and the rest are aversive.

Curiously, rats tended to lick more on the bitter solution (quinine) without LA compared to the solution with LA. Licking may have been higher due to postigestive cues by the LA. Once they reach the gut they cause for a signal to be sent to increase consumption of the FA because it is highly caloric. It is evolutionarily advantageous to have this feedback response because the higher the calories of the substance the higher the energy, therefore consuming fats is one of the most efficient ways to gain calories. Quinine, the chemical that is perceived as bitter, was at a relatively low concentration (0.01mM). It could be that the postigestive cues from the LA overshadowed the bitter taste and caused for increased licking on the LA solution, albeit not significantly greater than the solution without LA. The bitter chemical could also be changed from quinine to another standard bitter chemical or the saccharin concentration could be raised until it is bitter to see if there is unique interaction between quinine and LA. Further testing with different bitter tastants at varying concentrations is required to confirm the trend seen in the data. In addition, rats had more meals on water in 23hr than water with LA, which indicates the rats took more breaks of 10 minutes or more between licks, however the total licks in 23hr was not significantly greater. Overall the licking pattern resulted in more meals for water alone in 23hr, but not more licks in 23hr or average licks per meal; thus, this does not indicate a preference for water alone or an aversion of water and LA. In data analysis, a separate ANOVA was preformed for each tastant paired with LA and each tastant paired with OA. It compared the independent variables: FA (presence of LA or OA), side preference, and the interaction between side and FA. There were no significant effects of side preference or interactions between side and FA.

Undoubtedly, the results suggest further research is necessary to observe linoleic acid affect rats’ preferences. The concentration of LA could be increased to see a larger difference in licking because this concentration may not increase the intensity of the taste enough to alter licking over 23 hours. Another possibility is to raise the concentration of quinine. If the postigestive cues from LA are strong enough to overwhelm the perception of the bitter from the small quinine concentration, then the data does not pertain to the question of LA affecting taste, but its postigestive effect instead. The results may not be as potent as the 20 second brief-access trials because LA can oxidize over time, lessening its effect as the duration exposed to oxygen increases. Oxidation of LA may also change the perception if it can no longer bind to receptors on the tongue. With only a few significant differences between quinine with LA and quinine without, it is piquing but not definitive that over 23 hours rats prefer quinine with LA, and deserves further testing.