



Animal Models of *Human Misbehavior*

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Dr. Pineño in his Hofstra lab.
Photo by Jessica Zilski-Pineno.

In psychology, animal experiments are typically conducted to study general psychological processes, which we, humans, presumably share with the species used in our research. These experiments have provided great insights into the nature of the mechanisms of learning and memory, and have established the basis to study the neurological substrate of such processes (e.g., behavioral neuroscience). Animals are also employed in the psychology laboratory

to understand abnormal or pathological behavioral processes, such as phobic reactions, substance abuse, or addictive behaviors (e.g., gambling). In these cases, animal experiments are said to be models of human behavior: To the extent that we can recreate in the laboratory the conditions linked, in real life, to problematic behaviors, we can use animals to better understand these behaviors as well as devise procedures to eliminate them. But what about those behaviors that are not problematic enough to qualify as “pathological”

and, yet, are a persistent annoyance or a potential health hazard? Can we develop a model in the animal laboratory of typical human “weaknesses” or misbehaviors? In this article, I will describe the research project I recently started in my animal laboratory at Hofstra, in which I am attempting to study an instance of human misbehavior that involves, on the one hand, juicy, tasty, fat (and usually fast) food and, on the other hand, antacid tablets to cope with the aftereffects of enjoying such food.

Antacid and the Glutton Dilemma

It is no secret that, in the United States, we love food. The problem is that we love it a little too much. According to the Web site of the Centers for Disease Control and Prevention, Department of Health and Human Services, "In 2007, only one state (Colorado) had a prevalence of obesity less than 20%. Thirty states had a prevalence equal to or greater than 25%; three of these states (Alabama, Mississippi and Tennessee) had a prevalence of obesity equal to or greater than 30%." Also according to this Web site, the prevalence of obesity among adults has increased from 15.0% (according to a survey conducted in 1976-1980) to 32.9% (according to a survey conducted in 2003-2004).

Although genetic and hormonal differences can account for the predisposition of some individuals to obesity, only environmental factors can explain the rapid increase in the incidence of obesity in our society. Simply put, this pandemic might be due mostly to poor choices in our diet: We eat food of little quality, and we eat too much of it. According to some estimates, "[o]n any given day in the United States about one-quarter of the adult population visits a fast food restaurant" (Schlosser, 2001, p. 3). Because this is mostly a behavioral problem, its solution (at least, one of them) lies in behavior modification: We should teach people how to make healthier choices at the table. But, if we are to help people learn "eating skills," it is essential that we first understand the psychological processes involved in eating behavior, specifically those that might inadvertently result in maladaptive behaviors.

One such psychological process might be related to the use of medicines to relieve pain or other noxious symptoms associated with the ingestion of certain foods. Take, for example, the use of antacids to relieve the symptoms of heartburn caused by eating fatty or spicy food. Let's assume that Mr. X does not particularly enjoy Thai food, but happens to love delicious, yet hot and spicy *tom yum*. As a result of indulging in *tom yum*, Mr. X suffers severe heartburn, only to find relief after he swallows a couple of antacid tablets. When, a few weeks later, Mr. X goes to the same Thai restaurant with a friend, he chooses to order *tom yum* again, only this time taking the antacid tablets before the plate arrives. Common sense says that Mr. X would have been much better off skipping spicy food altogether, but ... how common is common sense when it comes to food? To answer this question, I conducted an online survey in June and July 2008. Fifty-three (53) people, most of them Hofstra undergraduate students, completed this survey. This sample was composed of 10 men (18.9%) and 43 women (81.1%), aged 15-25 years (n = 49, 92.4%), 26-35 years (n = 3, 5.7%), and 46-55 years (n = 1, 1.9%). Among the questions in this survey, two deserve our attention here. In line with Mr. X's example, the first question read: "*Imagine you love spicy food. After eating your favorite spicy dish, 'tom yum,' in a Thai restaurant, your stomach disagrees with you and you experience severe heartburn. But someone tells you there is a 24/7 pharmacy right next door, where you could buy antacid tablets. You would ... (a) get the medicine for quick relief, (b) not get the medicine and deal with the heartburn.*" The answers to this question yielded a strong agreement in

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the use of an antacid when suffering heartburn: 41 respondents (77.4%) said they would get the medicine for quick relief, while only 12 (22.6%) said they would not get the medicine and deal with the heartburn. Even more interesting are the answers to the following question: "*Answer this question ONLY if you decided to take the medicine: One week later you go to the same Thai restaurant with your friend. Your friend asks if you want to share 'tom yum.' You'd really like to, but your last experience wasn't very pleasant. Suddenly, you remember the 24/7 pharmacy right next door. You would ... (a) say 'no' to 'tom yum' as it is too risky, (b) order 'tom yum' and*

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wait to see if you suffer heartburn again, in which case you would get antacid at the pharmacy, (c) go to the pharmacy first and take antacid before the food arrives ... so you can enjoy 'tom yum' with no worries.” Almost half the respondents, 20 people (46.5%), would say “no” to *tom yum* as it is too risky; 14 respondents (32.5%) would go to the pharmacy and take antacid while waiting for *tom yum*, thereby enjoying it without worries; and 9 (21.0%) would wait to see if they would suffer heartburn again before getting antacid at the pharmacy.

Although it is not appropriate to consider the results of this survey as representative of the population (remember that the sample was small and mostly composed of undergraduate students at Hofstra University), it is quite informative in that it tells us that one-third of the people who completed this survey would rely on over-the-counter medication in order to avoid the noxious consequences of the foods they eat. It seems like this tendency might not be news to most antacid brands, given that many of them advertise their products by appealing to potential customers with the possibility of eating all they want, without having to pay the consequences (e.g., slogans of some of their commercials leave no doubt: “Block the burn – Before it hits you” or “Bring it on”). Furthermore, this is not a problem that exclusively concerns our choices involving potentially harmful foods. For example, many of us seem to follow the same “rule of thumb” when it comes to dealing with hangovers after excessive alcohol consumption (i.e., medicines to prevent the hangover caused by excessive alcohol intake, which must be taken along with the first drink).

The Maladaptive Heuristic

Interestingly, this heuristic or “rule of thumb” leading to reckless consumption of foods/drinks (i.e., “now that I am protected, I can eat/drink more of it”) might have its basis in an associative learning process, namely, conditioned inhibition, which in normal circumstances leads to adaptive behavior. Simply put, conditioned inhibition consists of the learning of an “if A, then no B” relationship, a relationship that in our case translates as “if M (medicine), then no E (noxious effect).” Given the causal nature of the M-E relationship, in addition to learning that M signals the nonoccurrence of E, it is also learned that M prevents E’s occurrence. The aforementioned examples can be straightforwardly reinterpreted in terms of conditioned inhibition or preventive relationships: Antacid tablets prevent heartburn, and anti-hangover caplets prevent hangover. In these two instances, M serves to assure us that E will not take place, thereby inducing a feeling of safety that, indirectly, might lead to excessive consumption of a food or drink (the cause, C), which maintains an excitatory or generative relationship with E. These relationships among events M, C and E are depicted in Figure 1.

The above scenario suggests that, paradoxically, a medicine that is effective in yielding immediate relief from noxious effects of certain foods/drinks might also interfere with learning to control the intake of those foods/drinks, with potentially harmful long-term consequences. In other words, a highly adaptive psychological mechanism (i.e., inhibitory learning) might inadvertently lead to a maladaptive behavior.

Modeling Misbehavior in the Animal Laboratory

How can we recreate in the animal laboratory the conditions leading to the previously discussed maladaptive behavior? We can use a conditioned taste aversion preparation, in which rats come to avoid the intake of a taste due to its pairing with gastrointestinal illness (Garcia, Kimeldorf, & Koelling, 1955; Garcia & Koelling, 1966). In this procedure, aversive conditioning is typically induced through the administration of an emetic (for example, an intraperitoneal injection of lithium chloride or, in some studies, exposure to X-rays) after the consumption of a flavored solution, such as salty water. So, in reality the solution is tasty and completely harmless, but it becomes aversive (yucky) and thereby avoided based on its pairing with illness. It is as if the rats “deduced” that their stomach pain was necessarily caused by something they ate.¹ Thus, the conditioned taste aversion preparation provides a good setting to recreate and, hence, study in the laboratory the processes involved in the learning and expression of food-illness relationships (i.e., the C-E link). But, what about the relationship between the medicine and the noxious effect (i.e., the M-E link)? How can we model in the animal laboratory the impact of, say, the intake of antacid tablets on consumption of the tasty, yet potentially harmful food? Based on the discussion of our previous section, all we presumably need is to establish an inhibitory relationship between a second taste and illness or, in other words, a relationship in which a taste signals the nonoccurrence of illness.

This inhibitory relationship can be established in several ways, following

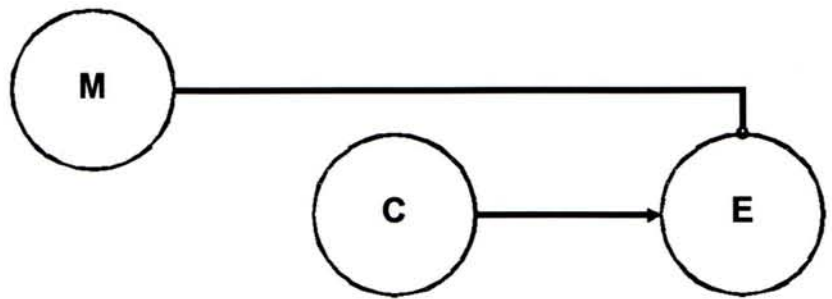


Figure 1. Graphical representation of the causal relationships among a medicine (M), a noxious effect (E), and its cause (C). C produces E, which can be counteracted by M.

different experimental procedures. One such treatment consists of presenting a distinct taste (e.g., citric acid) while the animal is recovering from illness. That is, instead of giving the animal a taste immediately followed by the injection of the emetic, the emetic is given first, followed by the delayed presentation of the taste. This way, the taste is consumed while the animal is recovering from the noxious effects of the previously injected emetic. As a consequence of this treatment, consumption of this taste increases, presumably because the animal learns that it causes relief from illness or, in other words, that it produces a “medicine effect” (e.g., Barker & Weaver, 1991; Hasegawa, 1981; Zahorik & Bean, 1975; also see Garcia, Ervin, Yorke, & Koelling, 1967; Green & Garcia, 1971).

As interesting as all this is on its own, we must remember that our research attempts to study, in the animal laboratory, the excessive or reckless consumption of potentially harmful foods that can be induced by the

previous intake of a medicine. In terms of a conditioned taste aversion preparation with rats, this can be translated as studying if the presence of the taste previously trained as an inhibitor for illness (i.e., the surrogate medicine) enhances the consumption of the taste previously paired with illness (i.e., the surrogate food).

First Steps

Preliminary experimental data seem to meet our expectations: It might be possible to study the previously discussed human feeding misbehavior using rats in a conditioned taste aversion preparation. In a recently conducted study, three groups of rats (i.e., NoMed, Med, and NoAversion) first received a “medicine effect” treatment consisting of several trials on which a solution (citric acid) was presented 75 min after an injection of lithium chloride (i.e., the citric acid solution was presented during recovery from illness caused by the emetic). In a subsequent phase, Groups NoMed and Med were given aversive conditioning with the salt solution,

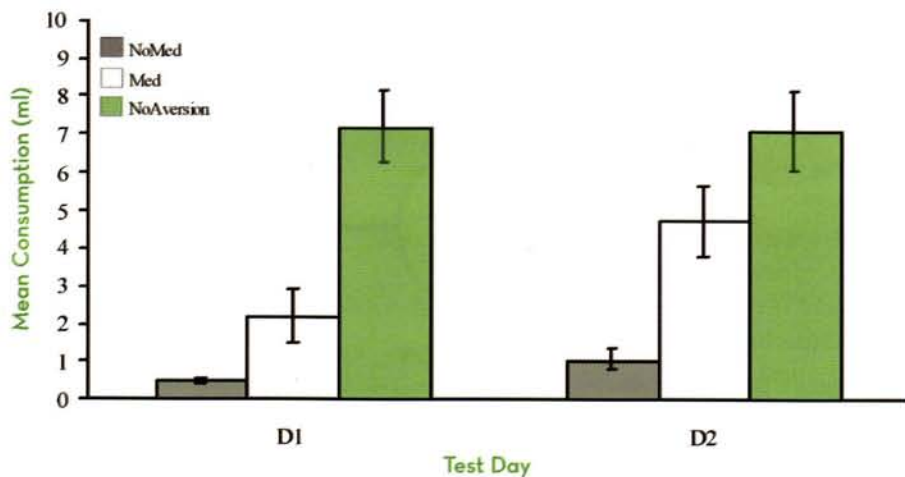


Figure 2. Experimental results: Consumption of the salt solution on two test days by three groups of rats (NoMed, Med, and NoAversion). See text for details.

consisting of one pairing of this solution with the injection of lithium chloride, whereas Group NoAversion was given an unpaired presentation of the salt solution and the lithium chloride injection. At test, all groups were given 5-min access to the salt solution. Importantly, the salt solution was preceded by a 5-min presentation of the citric acid solution for Group Med, and of water for Groups NoMed and NoAversion (i.e., with volumes yoked to the consumptions of subjects in Group Med). As can be appreciated in Figure 2, Group NoMed drank less of the salt solution than Group NoAversion on both test days, a result indicative of conditioned aversion to the salt solution in Group NoMed. The critical results are those of Group Med, which show that this group drank more of the salt solution than Group NoMed on both test days (although this difference was only statistically significant on the second test day). Because the only difference between the rats in Groups Med and

NoMed lies in their having received citric acid or water, respectively, prior to being given the salt solution, we can deduce that the presence of citric acid, a taste that was previously learned to have a “medicine effect” (recovery from illness), was responsible for the enhanced consumption of the salt solution in Group Med. One can see the parallel between Mr. X’s use of antacid tablets to indulge himself in *tom yum* and my Wistar rats drinking citric acid (a taste they actually dislike) in order to be able to safely enjoy their salty water.

A Nonconcluding Comment

It is at this point that caution is recommended to the reader. Even though it would be great to end this article with a clear take-home message, the truth is that there are more questions than answers on my desk right now. As a matter of fact, the previously discussed experiment (some additional results of the experiment

that, for the sake of clarity, were not exposed here) and a study in progress have opened new questions that need to be answered. Thus, even when it is tempting to think that we have already found a procedure with rats to effectively model this human misbehavior we call *reckless consumption of potentially harmful foods caused by medicine-induced safety*, it is more appropriate to view these results as our first baby step.

Thus far, we have a promising, yet embryonic, idea in need of much nourishment and, hence, it would be irresponsible to make a claim based on such idea. As Carl Sagan (1987) replied when he was asked whether he believed there was extraterrestrial intelligence: “Really, it’s okay to reserve judgment until evidence is in.”

Footnote

Incidentally, we, humans, also think this way: We attribute our stomach aches to our last meal. Although this inference is normally correct in our daily life (as it would be for a rat falling sick in the wild), think of how our learning system can be “cheated” when the illness is artificially induced by an emetic unrelated to the food we ate. For example, consider how food aversions are established in cancer patients undergoing chemotherapy or radiotherapy treatments.

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After spending one year studying computer science, Dr. Pineño realized that, as much as he loved computers, that career just was not for him. The decision to change his major was made while sneaking into a class on psychology of perception, in which he became fascinated with the topic. In his sophomore year, he joined Dr. Helena Matute's laboratory, where he studied human associative learning for eight years. Although he still conducts experiments in human learning, his passion lies in the animal laboratory. After conducting his first animal experiments with Dr. Mark E. Bouton (University of Vermont) and, later, with Dr. Ralph R. Miller (SUNY-Binghamton), he discovered the tremendous potential of animal research and decided to devote his time to work with rats.

Dr. Pineño's research, both with humans and rats, has always been theoretically driven. However, his current research attempts to model a real-life problematic behavior of potential clinical relevance. He currently teaches Principles of Learning and Behavior, Behavior Modification, and Fundamental Perspectives in Psychology. Amid teaching and research, he is also in the process of writing a nontechnical book for the general public on animal learning. Dr. Pineño is looking for motivated students willing to work in the animal laboratory. For more information about Dr. Pineño and his work, or to contact him, visit his Web site at www.opineno.com.