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Punishment and Reward

The first one to be hungry, on purpose and experimentally, was the cat. The cat was in a wooden box, and around her hung strings and wooden buttons and levers. She could smell fish outside. She hadn't eaten since the previous daylight. Edward Thorndike, who made the box and who held the fish, called the cat's state "utter hunger." Driven by hunger and the smell of fish, the cat swiped and clawed and pushed against the box and all the things around her. She moved impulsively, randomly, reaching at whatever she could grasp. All at once, the box opened and the cat leaped out toward the fish smell. The man offered her a tiny morsel; this was her "reward." The man picked the cat up and returned her to the box. Still driven by utter hunger, the cat began again to move about until the box door gave way, again and again, gaining very small pieces of fish, until the time when she no longer returned to the box. At the end of the day, at last, she and the other cats could eat "abundant food to maintain health, growth and spirits, but commonly some what [*sic*] less than they would of their own accord have taken" (Thorndike 1911, 27).

Dogs came after the cats, but the dogs howled loudly at night when Thorndike left them hungry and their cries awoke William James and his family sleeping upstairs. The dogs, like the cats, lived experimentally in James's basement, which James had lent to his postgraduate student as no suitable space could be found at Harvard University. Because of their howls, the dogs could not live in "utter hunger." They exercised in the wooden boxes at morning-time, when they had not yet eaten, and they "made great effort for a bit of meat," if somewhat irregularly (Thorndike 1911, 59).

I begin this chapter with a piece of what Steven Shaviro has called "speculative extrapolation." Shaviro (2016, 11) suggests that scientists and humanists both practice a form of controlled free imagination, constructing hypothesis and testing them to see whether they work. I do not know whether Thorndike's cat was female. I do not know if she would recognize him as a "man," or if her experience matched his description of it. The anecdote is an attempt to extrapolate the hungry animal's subject position and to test this extrapolation against the known evidence. It matters to me to begin this narrative with a cat and her situation. I prefer to risk an imperfect speculation rather than to reproduce only the voice of a scientist-narrator (whose account of the same events appears below). I seek to pay attention to those who were hungry.

Edward Thorndike made starvation into a tool for the new field of experimental psychology. Within a decade after publication of his thesis, hunger became a standard instrument. Animal behavior labs spread to Harvard, Clark University, Cornell, Johns Hopkins, and the University of Texas, and psychologists in all of these labs adopted hunger as an epistemic tool. Hunger became a standard psychological apparatus, alongside new introductions such as Willard Small's (1900) animal maze and Robert Yerkes's (1907) electric shock apparatus. Psychologists tested hungry turtles, mice, rats, rhesus monkeys, and crows. This setup became standard to the extent that a young psychologist in 1911 could state his method simply and without elaboration, "hunger was used as a motive" (Hicks 1911, 142). Throughout the twentieth century, hunger remained an essential tool for comparative psychology. Hunger (mostly mouse hunger) remains an important model system today, in the fields of behavioral genetics and neurochemistry.

Hunger became a technology to produce behaviors and emotions. Scientists deprived kittens, monkeys, chicks, turtles, children, and soldiers of food for four, eight, twenty-four, or forty-eight hours and observed the effects. Hunger became a standard tool in part because its intensity could be controlled on an objectively measured scale, hours of deprivation. I want to think through the meaning and context of this choice. Why did producing hunger appear to Thorndike and his colleagues at the turn of the twentieth century as a reasonable and generative relation with their animal subjects? What led Thorndike to introduce hunger to these formative experiments in comparative psychology, and why does hunger remain so central to this field? What preexisting relations made hunger an obvious choice? What relations, in the end, did hunger experiments produce?

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Edward Thorndike began his work on animal psychology at the same time that the US government implemented a program of Native American containment and reeducation through hunger (see chapter 1). I suggest that Thorndike's experiments, at the turn of the twentieth century, replicated this same relation in the animal laboratory.

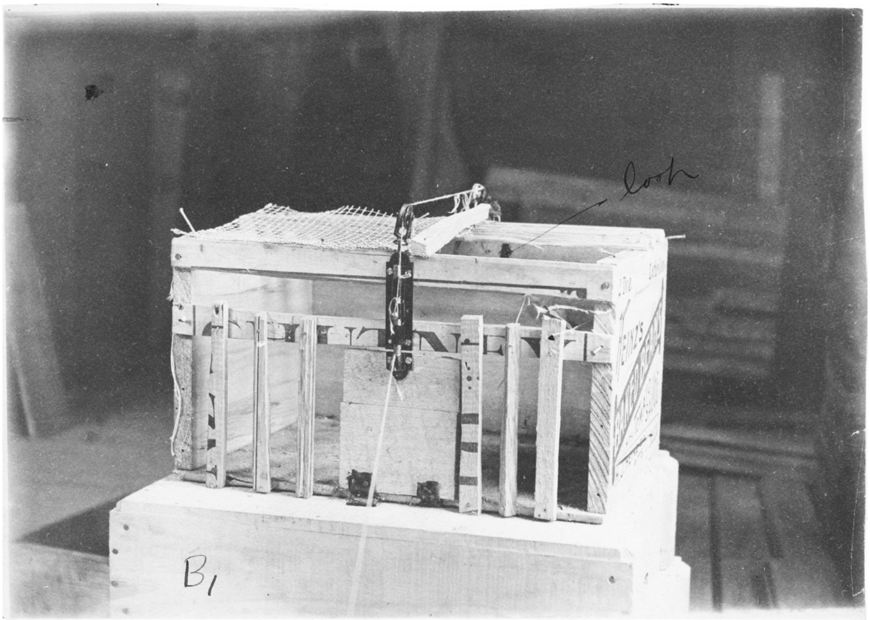

FIGURE 1. Edward L. Thorndike's puzzle-box B1. *Source*: Robert Mearns Yerkes Papers, 1822–1985 (inclusive), Manuscripts & Archives, Yale University Library.

In 1897, Thorndike put a young cat in an uncomfortable situation:

> If we take a box twenty by fifteen by twelve inches, replace its cover and the front side by bars an inch apart . . . we shall have means to observe [a] *simple case of learning*. A kitten, three to six months old, if put in this box when hungry, a bit of fish being left outside, reacts as follows: it tries to squeeze through the bars, and bites at its confining walls. Some one of all these promiscuous clawings, squeezings, and bitings turns round the wooden button, and the kitten gains freedom and food. By repeating the experience again and again, the animal gradually comes to omit all the useless clawing, etc. . . . It has formed an association between the situation, "confinement in a box of a certain appearance," and the impulse to the act of clawing at a certain point of that box in a certain definite way. (Thorndike 1907, 22)

Many questions arise from this experimental description. What elements define this setup as a model of learning? How is it a "simple case"? Why kittens, and why were they hungry? What does it mean to think of this setup, described as "confinement in a box of a certain appearance," as a "situation"? One set of clues can be found in the history of Thorndike's menagerie and his academic trajectory. His model system for learning, hungry kittens in a box, became a paradigm for American educational practice. Learning, Thorndike told his readers, was governed by situations not by culture or personality. Certain situations could become technologies for producing effects in the mind. His experiments also shaped the new discipline of comparative psychology. Hunger became a tool for producing psychological knowledge and a model for how to stimulate learning.

Having carried out animal experiments for a year in William James's basement, Thorndike moved to complete his doctorate at Columbia University, which was more accommodating with a graduate stipend and on-campus laboratory space. He wrote to his future wife, Bess, that he was impatient to install his "menagerie" at Columbia; he was, he wrote, "hungry for work" (Jonçich 1968, 118). Thorndike was ambitious and eager to challenge prevailing assumptions about animal intuition and intellect. As the child of a New England traveling minister, he was raised in a culture of self-control and diligence; his prodigious publication record testifies to his professional discipline. He thought of himself as a disrupter, bringing scientific rigor, laboratory experiment, objective measurement, and statistical analysis to a field dominated by anecdote and speculation. His contemporaries praised his thesis on "Animal Intelligence" as a foundational work in the rising field of experimental comparative psychology (Washburn 1908, 11). Senior scholars in his field, however, did not appreciate Thorndike's brash dismissal of work preceding his own (Mills 1899).

Thorndike saw hunger as a solution to psychologists' lack of scientific objectivity. Hunger offered a controllable and quantifiable experimental variable. This variable could be measured using everyday equipment—scale balances (to weigh food) and clocks (to record duration of fasting and speed of activity). Subjected to a standard rate of food deprivation, animals presumably would respond with consistent behaviors. Animals in a state of "utter hunger" could be run repeatedly through a puzzle box and produce coherent results. Such results required no interpretation or subjective judgment: all an experimenter needed, said Thorndike, was a clock. "Facts . . . may be obtained by any observer who can tell time" (Thorndike 1911, 28). Hunger made objective psychology possible. These experiments turned animal psychology into laboratory work. Thorndike had to create his own experimental setup for animals. Just as he repurposed common technologies (clocks, boxes) as experimental instruments, he repurposed domestic animals as experimental subjects. He first installed his menagerie in his Cambridge, Massachusetts, boardinghouse, whose landlady voiced strong objections. From there the animals moved to James's basement then on to New York, to an attic in the new Columbia University psychology building. At various times Thorndike's attic lab housed chicks, kittens, dogs, a monkey, and even a tank of minnows. All were domesticated animals. Chicks, cats, and dogs depended on human food and care, and were accustomed to human infrastructure. Thorndike's experimental schedule must not have differed too much from that of a household pet, locked indoors and fed once each day according to human rhythms of industry, work, and consumption.

Thorndike tested his model for learning and intelligence on "simple" minds: kittens, chicks, children. Simple-minded subjects allowed him, he thought, to observe the operation of learning at its most basic. Before building cat puzzle boxes at Harvard, Thorndike traveled to a mental institution to study unconscious cues in young children. He gave pieces of candy to three-year-olds if they guessed correctly a number or letter he was thinking. When the authorities denied him further access to girls and boys (for reasons unclear), Thorndike turned to animals. Instead of candy, the animal subjects who succeeded in their task received a morsel of food to relieve their hunger. What applied to animals, at the most basic level, applied equally well to humans. To learn was not to think or intuit but to respond to "situations," which connect specific feelings, sensations, and bodily movements (Thorndike 1919, 136). Thorndike's model operated at a basic level, directing simple feelings to aggregate along a particular path. The key to learning, in his mind, was the capacity to form mental connections between ideas, actions, and things.

Thorndike made much of the fact that his kittens only gradually became better at opening the puzzle box's trap door. The smooth curve of their improvement suggested, he thought, that they stumbled across the right solution purely by blind and fumbling chance. He found "no sign of abstraction, or inference, or judgment" in kittens' repeated attempts to open the door (Thorndike 1911, 75). "The cat does not look over the situation, much less think it over, and then decide what to do" (Thorndike 1911, 74). He contemptuously dismissed observers who sought proof of animal intellect, memory, or rationality; such attempts, he scoffed, were as ridiculous as a zoologist looking for claws on a fish (Thorndike 1911, 75). Higher-level learning differed from animal learning by quantity not quality. Complex human intellect was "an extended variation from the general animal sort": intelligent people simply were able to form many more connections than animals or simple-minded folk. "[The] intellectual evolution of the race consists in an increase in the number and speed of formation of such associations" (Thorndike 1911, 294). He thought that the human capacity to form connections was inheritable, and he hoped to subject it to eugenic breeding.

Thorndike was a committed eugenicist and insisted on hereditary difference: "in the same way and for the same reason that tall parents have tall children or dark-haired parents dark-haired children, so also stupid parents have stupid children, hot-tempered parents have hot-tempered children, and musical parents, musical children" (Thorndike 1907, 195). One wonders how many families he actually observed. Inherited qualities determined children's capacities to make associations and learn. Thorndike did not hesitate to draw racist conclusions from this premise: he reportedly told a popular audience that psychology's first task following the World War I would be to investigate "the problem of the mental and moral qualities of the different elements of the population of the United States. What does this country get in the million or more Mexican immigrants from the last four years. What has it got from Italy, from Russia, from Scotland and Ireland?" (Jonçich 1968, 375). Late in his career, Thorndike sat on the board of the American Eugenics Association and the Subcommittee on Psychometry of the Eugenics

Research Association ("Sub-Committee on Psychometry" 1928). The kittens' simple minds modeled "feeble-minded" victims of eugenic segregation and violence.

Thorndike's cats left a long-lasting imprint on the American educational system (Tomlinson 1997, 367). In 1899 he was hired to bring his scientific, experimental rigor to the newly affiliated Columbia Teachers College, where he went on to train generations of American educational leaders. His textbooks, dictionaries, teaching, and testing materials extended his influence far wider. His *Thorndike-Barnhardt Junior* and *Intermediate Dictionaries*, containing selections of frequently used words, still remain in publication in the early twenty-first century. Education scholar Ellen Condliffe Lagemann (1989, 185), exaggerating somewhat on purpose, wrote: "One cannot understand the history of education in the United States during the twentieth century unless one realizes that Edward L. Thorndike won and John Dewey lost."

Teaching tools based on this educational model, many designed by Thorndike, spread across the United States. Thorndike "devised rating scales to standardize and measure children's proficiency in hand-writing, spelling, drawing, history and English comprehension, and sold millions of arithmetic textbooks that stressed drill, repetition and the 'overlearning' of basic skills" (Tomlinson 1997, 363). He was deeply involved in designing the Army Alpha and Beta tests for incoming recruits during World War I (Carson 2007, 206). He applied the same analytic zeal to children's education, disaggregating each skill into its smallest component tasks and exercising them one by one. The cat experiment showed, Thorndike claimed, that learning was cumulative not holistic. Teaching must focus exclusively on tasks with future use-value.

Thorndike excoriated classical humanistic education. He had no time for nebulous claims on behalf of general culture (Tomlinson 1997, 373). He single-handedly scoured word frequencies in a library of core English books, beginning with the Bible, so that his dictionaries would present only words that children were most likely to encounter every day. And encounter they did, through the laborious exercises that many American students today still undergo, as they copy vocabulary words five or ten times in a row. Thorndike's teaching technologies were to education what Frank Gilbreth's (1911) motion studies and the sciences of work were to industrial labor. Use-value guided both content and method: exercise, repetition, and reward. When schoolchildren rewrite their multiplication tables twenty times for a teacher's treat, when policy makers disparage humanist claims for the richness of general education, when education is sold as a set of transferrable skills, we have entered the cat box. We become part of Thorndike's model system.

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Thorndike's cat work stimulated a consequential and long-lasting debate over punishment and reward. Was it better to prevent and punish, or to reinforce and reward? Which made animals (or children) learn best? Which was more efficacious, or more humane? In animal psychology punishment came to mean electric shocks, and reward meant to give some food to the deprived and hungry. Harvard psychologist Robert Yerkes wrote a scathing critique of Thorndike's method, which was by then (1907) the dominant paradigm in animal behavior study. "Usually in experiments with mammals hunger has been the motive depended upon," Yerkes wrote. "The animals have been required to follow a certain devious path, to escape from a box by working a button, a bolt, a lever, or to gain entrance to a box by the use of teeth, claws, hands, or body weight and thus obtain food as a reward." Yerkes objected to this method as both inconsistent and cruel. Experimenters could not be certain that their animals felt as hungry at the beginning of a test run as at its end; nor could they know if one animal's hunger was equivalent to another's. For hunger to function as a consistent motive, it would have to be so strong as to damage the animal and its abilities. For these reasons "the use of the desire for food as a motive in animal behavior experiments . . . [is] almost worthless in the case of many mammals" (Yerkes 1907, 98).

An animal in a state of "utter hunger" (like Thorndike's cat) would be constitutionally unable to perform complex acts. The experiment itself produced an incapable subject. More than this, Yerkes strenuously objected to hunger on moral grounds. It was "inhumane." Hunger only works, he argued, when an experimental animal is so hungry that it exerts its strongest efforts continuously and repeatedly. Yerkes complained that "is not pleasant to think of subjecting [an animal] to extreme hunger in the laboratory for the sake of finding out what it can do to obtain food" (Yerkes 1907, 99). Yerkes proposed that electric shocks were superior to food deprivation on grounds of consistency and humanity. He exercised his animal subjects, dancing mice, in a "discrimination box" designed to test visual ability. In order to escape a narrow, confining corridor, the mouse had to pass through one of two white, gray, or black boxes. When it entered the "wrong" box, the mouse received an electric shock of a voltage "disagreeable but not injurious" to the animal. Over repeated tests, the mouse gradually came to choose the correct box more often than not.

Yerkes (1907, 99) vaunted the reliability of electric punishments as compared to food rewards: "The experimenter cannot force his subject to desire food; he can, however, force it to discriminate between conditions . . . by giving it a disagreeable stimulus every time it makes a mistake." He took pains to justify the "humaneness" of this practice: he regulated the current carefully, so as to prevent injury; the shocks were brief and went off at intervals; his mice remained in perfect health for months (Yerkes 1907, 100). As strange as it may appear to a reader today, Yerkes weighed food deprivation against painful electric shocks and judged the latter best. He translated these experimental methods into the language of utilitarian psychology. Electric shocks were "punishment"; food was a "reward" for hungry animals. These terms became common shorthand in the field. Yerkes (1907, 99) himself considered "the method of punishment . . . more satisfactory than the method of reward, because it can be controlled to a greater extent."

Decades and dozens of papers in the *Journal of Animal Behavior* (which Yerkes edited) tested the relative merits of punishment and reward. Mildred Hoge and Ruth Stocking of Johns Hopkins ran rats through a visual discrimination box. Some rats were hungry, and others were not. Their "punishment was a light electric shock; the reward, milk-soaked bread. The rapidity of learning in the two cases was taken as an indication of the value of the method" (Hoge and Stocking 1912, 42). Rats punished by shocks made correct choices somewhat more quickly than hungry rats incentivized by food. Hoge and Stocking recommended both punishment and reward for rapid learning.

Yerkes's student John D. Dodson compared the two tools, hunger and electric current, at various levels of intensity to determine the optimal setup for learning. He ran rats through a discrimination box under varied conditions of duress. As they became hungrier, the animals got faster and more accurate. Past forty-one hours without food, though, their performance declined. They appeared disturbed and "assumed the hump of a starving animal" (Dodson 1917, 265). Likewise, animals improved their performance when subjected to increasingly strong shocks, up to a point of severity beyond which their performance fell off. This curve of optimal drive strength became known as the Yerkes-Dodson Law (Yerkes and Dodson 1908). Dodson (1917, 237) compared "a curve of relative values of different degrees of hunger and a curve of the relative values of different strengths of electrical shock." He found that electric shocks produced the fastest learning times. Dodson wondered whether this had to do with the difference between pleasure and pain, or whether rats simply were primed to flee a dangerous situation more quickly than to seek out food. In any case, punishment trounced reward (Dodson 1917, 276).

As a group, psychologists decided in favor of both punishment and reward. No sooner had Yerkes published *The Dancing Mouse: A Study of Animal Behavior* (1907) than nearly every animal apparatus began to employ both methods.[1] Hunger and electricity, alongside the puzzle maze, became standard equipment for behavioral psychologists from John B. Watson to B. F. Skinner, from the 1910s to the 1950s and still to this day. Punishment and reward. I am stuck considering how the relief of hunger came to represent a reward. Animals deprived of food for one, two, or three days, running and digging and swiping at levers to relieve their discomfort: these were psychological models for pleasure. Even Yerkes, who considered starvation unpleasant and inhumane, called food incentives for deprived animals "the method of reward." Both hunger and electric shocks imposed pain and discomfort. In one case, relief was quick (the shock ceased); in the other, relief (in the form of food) appeared only after animals solved a maze or puzzle. What kind of reward was this? Work hard, driven by hunger, and you will earn a small taste of pleasure—only to be pulled away to work again. Reward, in this utilitarian psychology, meant just a little less suffering, contingent on successful work, lasting only for a short while.

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Thorndike's psychology hung on utilitarian claims about the power of satisfaction, "exercise and reward." The cat's pleasurable feelings, when it opened the door and reached its fishy prize, imprinted upon patterns of movement. The cat, like a child in a classroom, learned by exercise and reward. But thinking with the animals leads me to believe that Thorndike's narrative was misleading. *His cats, in fact, were never satisfied*.[2] When Thorndike reprinted his doctoral dissertation a dozen years after the fact, he added a telling footnote. The original publication had made much of the usefulness of "utter hunger" as an experimental tool. By 1911, however, he felt a need to defend it: "I have been accused of experimenting with starving or half-starved animals" (Thorndike 1911, 27). To demonstrate his probity, Thorndike revealed in that footnote, what the cats ate and when. This is how we know that the same cats repeated multiple iterations of the problem-box experiment. The cats experienced hunger and discomfort, then relief, over and over.

But this seems like a contradiction: if the cat's hunger gets satisfied when it opens the box, how would it still be hungry on the next round? Experimental consistency required that "the animal should be as hungry at the tenth or twentieth trial as at the first." Thorndike explained his solution: "to attain this [consistency,] the animal was given after each 'success' only a very small bit of food as a reward (say, for a young cat, one quarter of a cubic centimeter of fish or meat)" (Thorndike 1911, 27). That quarter-centimeter cube was the reward, the relief, the satisfaction that was meant to produce learning. In fact, it was also a prerequisite for further experimental work. *The "reward" was not one*. Thorndike designed the cat's reward so as to maintain its hunger. What kind of satisfaction was this?

Willard Small picked up this question while elaborating on Thorndike's experiments in 1898–1899 as a graduate student at Clark University. Small built puzzle boxes for hungry rats to break into. Later, he introduced his animals to the Hampton maze. Hunger was their "motive"; food inside the box their reward. An early series of his tests failed catastrophically. One of Small's rats died and the other refused to move. This, he believed, was above all a "pedagogical failure": he had not brought the animals to full satisfaction before starting up the test again. "The quick succession of experiments, followed in each case by deprivation of the fruits of their labor, was bad method," Small concluded. "Nothing could be worse pedagogically, at least from a human standpoint." The failed rats were not able to form strong mental connections between hunger, puzzle solving and pleasure. "To establish an association train of which the motive and first term is hunger, and the end and last term is satisfaction of hunger," he wrote, "the train ought to be fully realized each time" (Small 1900, 139). In other words, for food to truly be a reward, the hungry rats should feed until they are fully satisfied. They had to feel real pleasure at the end of their work.

John B. Watson (1903, 9) disagreed: "The rat does not reason, 'I was not allowed fully to satisfy my hunger when I went to the food just now; therefore I really do not care to make the effort a second time.'" Watson repeated Small's experiments as a graduate student at the University of Chicago. He set test boxes containing bread before hungry rats and observed how quickly they managed to enter. Like Thorndike, Watson allowed successful rats to taste only a small amount of food "for an instant" before immediately starting another test run. He saw no reason to allow the animals to sate their hunger. "Small is possibly applying here somewhat too much of his own conscious processes to the associative powers of the rat," Watson (1903, 9) concluded. "If the rat is successful in overcoming the difficulties keeping it from the food, and is allowed to eat of the food for a short time, both terms of the 'association train' are completed and the rat is instantly ready to repeat the same procedure until his hunger is fully satisfied. Such was certainly the case with my rat." In other words, one could trick the rat into going back to work by giving it the slightest hint of satisfaction. Watson (1914, 58) complained that some psychologists (namely, Yerkes) had maligned the hunger method: "It is not fair to talk of the cruelty and inhumanity of keeping the animal hungry, as has been done by several writers. . . . There is not the slightest difficulty in keeping the animal in perfect condition and at the same time hungry enough to work properly."

Satisfaction and reward therefore did not have to be fulfilled to motivate animals to work. Even a promise, a taste, was enough. It may be worth mentioning that Watson spent most of his subsequent career in advertising, a field dedicated to stimulating desire for delayed gratification (Lemov 2005, 30). B. F. Skinner (1953) eventually would carry delayed gratification to an absurd level. Skinner trained hungry pigeons in the 1950s to press a lever hundreds of times to receive a single small pellet of food (Meehl 1992). The longer the delay, he claimed, the more his animals grew "increasingly compulsive" in their activity (Gere 2017, 174). In this way Skinner made explicit Thorndike's deferral of animals' satisfaction. Skinner conditioned his pigeons to work indefinitely toward a deferred reward. Thorndike's cats, like Watson's rats and Skinner's pigeons, were always hungry. They were meant to feel neither relief nor reward but rather a fleeting promise of future satisfaction: the odor of fish, tiny pieces, incomplete meals.

Even at the close of their workday, the cats were not given what they hungered for. "After the experiments for the day were done, the cats received abundant food to maintain health, growth and spirits, but commonly some what [*sic*] less than they would of their own accord have taken" (Thorndike 1911, 27). Thorndike designed the cat's feeding schedule to replicate the industrial time clock of working hours and meals. (How did Thorndike know what the cats would have eaten of their own accord? Were they his pets before becoming his subjects? Watson later weighed his animals to establish a baseline "maintenance ration.") In any case, Thorndike then left them, still hungry, without food for fourteen hours in preparation for the following day's work.

What does this tell us about the utilitarian promise of hunger and about the parameters of the cats' situation? Thorndike presented the cat's experience as a closed circle of discomfort, movement, and relief. When one of the cat's random clawings and squeezings flipped the latch and the same action led, over repeated trials, to similar success, the cat came to associate that action with the satisfaction of a small piece of fish. The action connected to pleasurable feelings (clawing the latch and eating fish) was strengthened; other actions connected to discomfort or annoyance (like the continuing sensation of hunger) were weakened. Thorndike called this relationship between satisfaction, discomfort, and learning through repeated experiences the Laws of Effect and Exercise. His advice to teachers sums it up: "Exercise and reward desirable connections; prevent or punish undesirable connections" (Thorndike 1919, 142). Yet this narrative was undermined by his own cats' experience. They lived in a constant state of low-level hunger and dissatisfaction, primed to perform experimental work for the future promise of a taste or a smell.

As historian Cathy Gere (2017, 169) has demonstrated, Thorndike established utilitarianism as a founding principle of modern American psychology. Utilitarian philosophers held up hunger as a tool for learning—specifically a tool for impressing laborious and thrifty behaviors upon spendthrift and shiftless people. Hunger was their whip. Ideologies of hunger, learning, and capitalism formed an implicit part of Thorndike's experimental situation. In effect, he turned utilitarianism into an experimental science. Hunger's discomfort was supposed to push one toward civilization. This was the situation: hard work for meager returns, the promise of a reward deferred. Hunger drives people—and animals—to work for food. Hunger appeared as an original, natural, basic feeling, a low entry in the hierarchy of mental functions.[3] Thorndike referred to possessiveness as one of the "original tendencies concerned with food getting," to "pounce," "grab," and "seize" at things (Thorndike 1919, 17). The desire for property appears as a logical, evolutionary outgrowth of hunger. There is no more powerful natural justification for human labor. Hunger models the nature of life under capitalism. But Thorndike's own experimental situation belies this claim.

Utilitarian tales about desire, work, and reward were belied by these experimental cats, who were lured to work by false promises of a future satisfaction that never arrived. The cats' experience suggests that to understand this experiment, we need to open that frame. We know that the cats' hunger was not contained within the problem box. Their hunger was perpetuated by the very "reward" that was meant to represent satisfaction due to a job well done. The promise of a reward was always deferred.

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FIGURE 2. "Motivation and Reward in Learning." *Source*: Miller, Hart, and Yale University Institute for Human Relations 1948.

A blocky sans-serif font on a slightly shaky black background announces the genre of a mid-twentieth-century educational film: *Motivation and Reward in Learning*. "Two pale albino rats," intones a tenor voice. "What do you think is the reason for the difference in their behavior?—The one on the left is hungry" (Miller, Hart, and Yale University Institute of Human Relations 1948, 0:18). We see two rats set on a table in cylindrical wire baskets, one empty and one lined with pet food. One rat climbs up the basket wire, pokes his nose through the open mesh, pushes the latch with his head, and climbs out as soon as an opportunity presents itself. The other raises his head in acknowledgment of a human opening his basket and continues eating. (Here I follow the usage of the film, which genders both rats male.) Two human arms enter the frame: a masculine hand with a light-colored sleeve seizes the escaping rat, and a feminine hand with black sleeve picks up the eating one.[4] They place the rats in a wood and Plexiglas box, divided into two chambers labelled "VERY HUNGRY" and "NOT HUNGRY."

Human hands disappear from the frame. On the far wall of each compartment are affixed a metal stirrup and a tin dish. The box's floor appears at first to be striped; closer examination reveals that the stripes are regularly-spaced metal bars, which open to a compartment underneath. The box has more depth than we can see: the rats are balancing on a metal grid above empty air. The slats are wide enough to allow food pellets to fall through. (Later scientists will use a platform suspended in the air like this to produce the rodent equivalent of human stress.)

Noses flaring, the rats case the joint. They sniff each corner and wall, stretching upward toward the open box top and bright bulb. After some minutes, having investigated all possible escape routes, Not-Hungry turns away, presses his back against the Plexiglas barrier and hides his head in the shadow of the suspended tin dish. He remains there, immobile, availing of some privacy. Very-Hungry continues to sniff and climb. His nose flutters rapidly; his eyes, intense and black, reflect the strong light above. What can he see and smell, to his sides and below, that the viewer cannot? Can he smell his neighbor across the wood and Plexiglas divide?

Very-Hungry stands high on two legs, sniffs the air, descends. One such descent activates the metal stirrup, and a food pellet falls into the tin dish. When Very-Hungry discovers it, he crouches, folded over his belly as if he would hide the pellet in a pouch, and eats from his front paws. He leans one paw on the dish and licks the other. The tenor voice tells us: "Food would not be a reward without the drive of hunger." A montage shows Very-Hungry sniffing ever more insistently around the dish and stirrup, moving ever more directly to activate the lever. The voice: "After several more trials, which are not shown, . . . the animal has eliminated irrelevant responses. He has *learned* to press the bar efficiently." The camera pans to the right. Not-Hungry is still hiding, immobile, in a corner beneath the tin dish. "Now, what do you think the satiated animal has learned to do?" (7:21).

A text slide appears: "Will the satiated animal learn if we give him a drive?" At this point the viewer encounters Robert Yerkes's contribution to the hunger-electricity-puzzle apparatus.[5] A feminine hand enters the frame, turning the knob of a potentiometer until, the tenor voice tells us, "the shock is adjusted to be annoying, but not painful." A tone sounds. Not-Hungry bristles like a scared cat and repeatedly leaps off the electrified metal floor, high enough to leave the camera frame. On one landing, he hits the stirrup bar and the shock cuts off. He buries his head under the tin dish, and the voice tells us that he has been "rewarded," although his fur remains visibly stiff and bristled (7:55). And so the experiment repeats. We are told that Not-Hungry "learns even more rapidly than the hungry one, . . . because the drive produced by the electric shock is stronger than hunger" (8:52). To belabor their point well beyond any threshold of cruelty, the producers show us rats biting through rubber tubing, turning exercise wheels, and even fighting other rats in response to repeated electric shocks. "We have demonstrated," intones the tenor voice, "that the satiated animal is neither stupid nor lazy. All he needs is a little motivation" (9:13).

Motivation and Reward in Learning was produced in 1948 by psychologist Neal E. Miller and the Yale Institute of Human Relations to illustrate the drive-reduction theory of learning. "Rat learning," writes Rebecca Lemov (2005, 92), "lay at the heart of the [Yale] institute's hopes for a grand theory that would explain the full range of human behavior." Hungry rats, being experimentally available and manipulable, served as laboratory models for the general categories of animal drives and human motivation. Traces of Thorndike's setup appear throughout the film: a problem box, domesticated animals, hunger, learning, reflex-reward, pain and pleasure, stimulus-response, rates of activity over time—all of which constituted a model apparatus for human psychology.

What of Very-Hungry and Not-Hungry? On a first viewing of *Motivation and Reward in Learning*, the rats play the roles that they are assigned by the film's producers. They react predictably to stimulation, and their rates of activity seem to vary in response to different kinds of "drive." As primatologist Harry Harlow (1953, 28) remarked in a blistering critique, the rats seem to respond as though they have no minds of their own: "The kinds of learning problems which can be efficiently measured in these apparatus represent a challenge only to the decorticate animal. It is a constant source of bewilderment to me that the neobehaviorists . . . should choose apparatus which, in effect, experimentally decorticate their subjects." On closer view, however, the film does not show us dumb animals. The rats explore every corner of the box, leading with their very active noses. They offer some support for Harlow's and others' claims that mammals are moved by curiosity and exploration, even more than by hunger. The rats seek shelter and privacy to rest and eat. Their eager noses point us to chemosensory avenues of research that were beginning to develop in the 1940s. While researchers were counting lever presses, the rats' flaring nostrils were mediating a chemosensory encounter with metal, air, wood, lightbulbs, and Plexiglas as well as human and animal scents.

I catch myself here, trying to prove to Harlow that the rats are not as brainless as he thought and that they show signs of intelligence and inner feeling. In so doing, I am replicating the same hierarchy from simple to complex, from brainless to intelligent, that Harlow, Thorndike, and others promoted. Hunger and other "visceral" feelings appear on the lowest rung of the developmental ladder. Higher up on the evolutionary scale, simple feelings become complex emotions. "As we go up the phylogenetic scale," suggested psychologist Abraham Maslow (1943, 90), "appetites become more and more important and hungers less and less important. . . . As we go up the phylogenetic scale and as the instincts drop away there is more and more dependence upon the culture as an adaptive tool." This hierarchy assigns hunger and simple motivations to the "lower" organisms and associates "higher" needs with more developed beings.

Harlow's scales of drive were also social scales. Some people were bound, by nature or society, to pursue simple bodily hungers; others were free to seek complex feeling, culture, and self-actualization. Maslow opined that society ought to provide for everyone's basic needs and allow them to reach for higher ends. Yet, he hedged, some people were bound by circumstance to a simple ("decorticate," in Harlow's terms) state of mind (Maslow 1970; Weidman 2016). Still today, motivation discourse pops up everywhere in discussions of underserved and underrepresented children: how to motivate them to learn? Young people in classrooms circa 1948 must have encountered a doubling or entangling effect in this educational film. The soundtrack, that authoritative tenor voice, narrates the rats' and the viewers' own learning experiences, both at once. The voice tells students what they are learning (the content of their lesson) and how they are learning (like the rats on the screen).

"Now, what do you think the satiated rat has learned to do?" With which rat were students meant to identify? The Very-Hungry rat, driven by hunger and active in pursuit of efficiency? The Not-Hungry rat, who at first appears stupid or lazy but is shocked by low-level pain into rapid learning? How well they learned, young viewers were told, depended on the strength and nature of their motivation (Luissier 2018). The "reward" in *Motivation and Reward* was not much of one. A reward, like a small piece of fish or a pellet of rat food, only temporarily relieved the deprivation of the hungry animal. These so-called rewards did not necessarily bring pleasure—that was not their goal. They only partly alleviated a need, a drive, a lack, that experimenters caused by depriving their subjects of food. Need-drive experiments, as Otniel Dror (2016, 230) put it, reflected an "implied scarcity economy . . . inside the laboratory" and well beyond, in midcentury classrooms and workplaces.

Thorndike's kittens and the other experimental animals were paid for their labor with starvation wages, tiny bits of food. Experimenters kept the animals in a state of insufficiency, driven to complete units of instrumental labor for unsatisfying tokens of reward. The experimental animals shared this condition with many workers in the early twentieth-century. Workers received starvation wages in coal mines, textile mills, plantations, domestic work, charity workplaces, and other sites of labor extraction. Chapter 3 records workers' struggles in the 1930s against starvation wages, labor, debt, and welfare regimes designed to keep them hungry.