

The Penny Experiment

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(Adapted by ReadWorks)



Paola is 12 years old. She lives in Seville, Spain. The streets of her city are lined with beautiful orange trees. The oranges that grow here are sometimes called *bitter oranges* because of their sharp taste. People often visit the city to see the beauty of Spain. They like to visit a royal palace in the city. They also like to see flamenco, a colorful style of Spanish dancing.

But while all the visitors were coming to Spain, Paola and her family were visiting New York City. They had many things to see while they were there. The Statue of Liberty was on the top of their list of things to see.

The Statue of Liberty is made of copper. But Paola thought the statue didn't look much like copper because it wasn't a reddish-brown color. It was more of a bluish-green color. Once Paola noticed this, she started seeing this same color of copper all over the place. She saw a green copper statue in Central Park and a green copper roof on a famous old building called The Dakota.

There must be two kinds of copper, Paola thought. I guess one kind of copper is green.

When Paola went back home to Spain, she brought some things from New York. One of these things wasn't something you could buy in a store, though. Paola likes to collect coins. So every time she travels, she brings home some money from that part of the world.

On this trip, she brought home about 30 pennies she had saved. She put them in a pouch and packed it in her suitcase. She had never held pennies before. In Spain, they use *euros* to buy things.

Back home, Paola spread all the pennies out on her kitchen table. She saw that they all had different dates on them. Some were old, and some were brand new. One of the pennies was from 1953. That was the year Paola's grandmother was born.

Paola started to sort the pennies by date. That's when she saw something interesting about the pennies. She saw that the pennies were all slightly different colors.

The newer pennies were copper-colored and shiny. But the older pennies were dull and had green spots on them. This was the same kind of green color she had seen on the Statue of Liberty.

Maybe there aren't two different kinds of copper after all, Paola thought. Maybe the copper with green on it is just dirty. Or maybe someone painted it green!

Paola asked her mother why the pennies were green. Her mother told her that the pennies had gone through a process called *oxidation*. This is a chemical reaction that takes place in metal. In copper, it actually changes the color of the metal. When copper turns green, the color is called *verdigris*.

In Spanish, the word for green is *verde*.

"Let's see if we can make *verdigris* on these pennies," Mom said. "We need a glass bowl, some salt, and some vinegar."

They mixed a half-cup of vinegar and two teaspoons of salt together in the bowl. They mixed the vinegar around until the salt dissolved. Then they put 10 of the shiny new pennies into the mixture.

"What are we doing, cooking pennies?" Paola asked.

Mom laughed. "In a way," she said. "I promise I won't make you eat pennies for dinner, though."

After about five minutes, Paola took the bowl of vinegar, salt, and pennies over to the sink, and poured all the liquid out. Then, she spread two paper towels out on the counter.

"Now split the pennies into two groups of five," said Mom. "Wash five of them with water. And leave the other five the way they are."

Paola washed five of the pennies and put them on the right side of the paper towels. She put the rest of the pennies on the other side. That way she would know which group was which.

The next part was the hardest part. It was the part where Paola had to wait for the results. The pennies needed to dry for about an hour while the experiment worked its magic. Paola went for a bike ride to pass the time.

She rode her bike up the street to an old bell tower. As she passed the tower, Paola remembered learning that it used to have a copper ball on the top. She had learned in school that the ball fell off during an earthquake hundreds of years ago. She wondered whether that ball would be green today if it hadn't fallen off.

When she got back home, she ran to the kitchen to check on her pennies. She was so excited she almost forgot to close the front door.

Here's what had happened: The pennies that had been washed off in water looked really shiny. They were not at all green.

But the five pennies that hadn't been washed had started to turn green.

Paola hadn't painted the pennies. The vinegar mixture created a chemical reaction between the copper and the air. This is also known as *redox*. It is what happens whenever atoms change their *oxidation* state. A substance called copper oxide had mixed with the salt and formed on the penny. Copper oxide is green, so now the penny looked green.

"But if this is how you oxidize copper, how did the Statue of Liberty turn green? Did an airplane dump a huge bowl of vinegar on the statue?" Paola asked her mother.

"There is more than one way for a metal to oxidize," Mom said.

She explained that vinegar is a mild acid and that salt is a neutral base. When you mix the two, you can make a chemical called hydrochloric acid. This acid both cleans and oxidizes copper. When you wash it off, the penny looks shiny. When you leave it on, the penny turns green.

There are also other ways of making copper turn green. For example, there could be things in the air that react in different ways when mixed with oxygen. One of these things is sulfur from

coal. It behaves like the vinegar and causes copper to oxidize. And that is why statues and buildings in New York have green-colored copper.

Paola decided to try the experiment again. This time she used some of the bitter oranges from the tree in her backyard. Oranges are acidic, just like vinegar. She followed all the steps from the first experiment. But this time she switched the vinegar with orange juice. And the same thing happened. The unwashed pennies turned green.

She called to her mother. Her mother was sitting on the porch and reading a cookbook.

“Look, Mom, I made *verdigris* with oranges, too!”

“That’s great,” Mom said. She pointed to the cookbook. “Because I’m about to make marmalade with the rest of the oranges.”

“Just make sure you leave out the pennies!” said Paola.

Abraham

Abraham, a 12-year-old, 22,000-pound elephant, swam in the Ganges River for five hours before the giant pads of his feet finally touched land. His trainers with the Al-Sindhu All Saints Circus and Touring Exposition would have been amazed and angry at the sight, but they were miles away at the time. During his years with the circus Abraham had learned a total of seven tricks, which included walking on a rubber ball, juggling dull machetes with his trunk, and using his tusks to toss a tiny acrobat 20 feet in the air.

But Abraham refused to swim. This caused the elephant's trainers and owners no small amount of consternation. Da'ud "Sammy" Shabazz, whose great grandfather started the circus with three monkeys and a black Russian bear in 1926, had spent more than 3 million rupees to build, maintain and fill a translucent, 700,000-gallon water tank, which he transported at additional expense to every town and village along the Ganges. Abraham was gentle and a show-off, a rare combination for an elephant, which made him the perennial crowd favorite of the show. It had been Sammy's plan to capitalize on Abraham's popularity by training him to become the first elephant in any circus in India that could juggle while swimming.

The issue was Abraham's pride. Juggling machetes was fine. But there were some things Abraham refused to do for applause or salted treats, and swimming was one of them.

Shabazz did not know his animal was capable of such thoughts, so he assumed the problem was stupidity on the part of the animal, the trainer or both. The fact that his biggest, most popular and most-expensive-to-feed animal refused to go near any tank of water made Shabazz angry.

"Enough!" the Shabazz said to Pawan Mehra, his lead animal trainer, as the two men boarded the river barge that carried the circus up and down the Ganges. "If you cannot get that animal into the tank by the time we dock in Mumbai, you can go back to where I found you—performing on the street with your little monkey!"

Later that night, as the barge pattered down the river, Abraham reached his trunk through the bars of his cage searching for a clutch of hay. To his surprise, the gate opened wide. Never in his dozen years of captivity had any of his cages or pens been left unlocked. As always, Abraham was hungry, so he pushed forward, expecting to step onto the barge's wide wooden deck.

Most nights, his cage faced toward the center of the barge. But tonight the door was aimed not inward toward the boat, but outward, toward the river. When Abraham stepped outside, his right foot touched only air and then water. Abraham trumpeted loudly when he fell, but his head was already below water, muffling the sound.

By the time he rose to the surface, the barge was already floating away down the river. He paddled after it, but the red and yellow heap got smaller and smaller. Abraham stopped

kicking, looked around, and saw a low rise of land far off to his left. He switched directions. Keeping his head underwater, he breathed through his trunk like a snorkel and paddled with his enormous legs.

It took five hours. His legs were tired and his lungs burned when the pad of his foot finally brushed a rock along the bottom. Soon he could walk. He hurried up the bank and over a small hill. In the yellow sunrise light he found before him a broad rice paddy with green bristles poking from the water. Abraham sunk his snout into the water and started sucking up all the rice he could eat.

He grazed for almost an hour before a man appeared on a nearby berm. The man carried a long stick like the ones Abraham's circus trainers used to discipline him. By force of habit, training and fear, the elephant froze. The man was shouting, but he didn't use any commands Abraham could recognize.

The man came closer and raised his stick to his shoulder. From the stick came a flash of light and a booming sound that scared Abraham. The elephant felt something hot hit his shoulder. The man took a few steps forward, raised the stick again, and Abraham felt another hot jolt, this time on his ribs.

Abraham's hind legs jolted to life. He ran through the paddy, away from the man and his strange powerful stick. Abraham ran and ran. He felt slow, his belly sloshing with a heavy load of rice and water. Eventually he came to a clump of trees surrounded by tall grass. Abraham fell asleep before his body even touched the ground.

It was morning again when Abraham woke. He heard the grass around him swishing, felt the ground beneath him quiver. Then he heard an elephant's trumpet. It was loud and close. He heaved himself to his feet and found himself face-to-face with a big male elephant. It stood a foot taller than Abraham.

Abraham walked backwards, taking in the sight of this tall male. He had always been the only male elephant in the circus and had never been challenged like this before. He had to look up at the wizened wild elephant's eyes, but as Abraham looked his challenger up and down, he was surprised by what he saw. The taller elephant looked ancient but, in fact, the old bull was just 10 years old. Repeated stretches of starvation had left his skin wrinkled and loose on his ribs. His left tusk was broken from so many fights for dominance.

Abraham, fed grain every day of his life and strong from all the balancing tricks, noticed all of this instinctively. His fear turned to anger, and he stopped stepping backwards. He flared his ears and stomped the ground, making his strong leg muscles ripple. Finally he raised his head and trumpeted. It was the loudest sound he had ever made in his life.

The old-looking alpha male stood his ground, but he did not charge. Instantly, Abraham knew he'd won. The wild one stomped and brayed and huffed. Eventually he looked away, and walked off toward the river. Two young females stepped toward Abraham and sniffed.

Abraham's first few months as a lower alpha male in the herd's complex leadership structure were patchy. Whenever he saw a human, he would freeze in place. This annoyed the other elephants, who mostly ignored the humans and bumped into their big new friend every time he stopped suddenly.

But Abraham understood humans in ways the herd did not, and this became a major advantage. His understanding of humans became his biggest contribution to the herd. Abraham was able to find food in places none of the other elephants had ever thought to look. One day, a few dozen elephants tried slurping up the last stalks of rice from a paddy that had already been harvested. Some were growing testy from hunger. The dry season had been especially hot and long, and many of the grasslands the herd traditionally grazed were yellow and barren by the time they arrived.

As the others scrounged for whatever rice they could find, Abraham noticed a few huts rising along the berm. He walked to the closest hut, which smelled of grease and cooked lentils. He reared up on his hind legs and brought his front feet crashing down onto the hut's mud walls, which crumbled. Lifting the corrugated metal roof off with his trunk, he found fat woven sacks of beans, lentils and salt.

Abraham ate for a few minutes, then stepped aside to make room for some babies. One baby ate so quickly she made loud snorts. The mother elephant swung her trunk around and patted Abraham on the head.

The wet season came and then the dry. Abraham never became one of the herd's lead alpha males—he was too strange and his behavior around humans made the other elephants nervous.

Even though he was relatively short, Abraham was strong and fast, and he retained the graceful movements of a practiced dancer. The female elephants liked this, and during confrontations with humans or other herds, the different groups of males all competed to recruit Abraham to their team. Soon Abraham had a mate and baby elephants of his own.

One morning the herd was standing on the banks of the Ganges. Abraham watched his youngest offspring use his trunk to shoot his sister with water when he noticed a red and yellow barge motoring slowly upriver. There were humans on the deck of the barge and they looked at the herd, but did not point. They did not seem to recognize any of the elephants standing there.

Abraham felt the urge to stop grazing and stand motionless. He felt some fear, too, but he could not remember why. Sensing a fresh patch of grass beside him, Abraham turned his back to the barge and ate.

Name: _____ Date: _____

1. Who is Abraham?

- A a trainer
- B an elephant
- C a rice farmer
- D a circus ringmaster

2. How does Abraham change in the story?

- A He was afraid of performing, then overcomes his anxiety.
- B He was afraid to swim, then decides to go into the circus tank.
- C He was unfamiliar with humans, but later learns their ways.
- D He was trained as a performer, then escapes into the wild.

3. Abraham's life in captivity was very different from that of his wild peers, as he learns when he meets the wild elephant male. What evidence supports this?

- A Abraham's fear turns to anger when he meets the wild elephant male.
- B The wild elephant male looked ancient but was just 10 years old.
- C Abraham was healthy and strong, while the wild elephant was starved and injured.
- D Abraham raised his head and trumpeted whereas the wild elephant stood his ground but did not charge.

4. Based on the story, how did Abraham adjust to life in the wild?

- A Abraham adjusted to life in the wild very easily.
- B Abraham found it very difficult to adjust to life in the wild.
- C Abraham was unable to adjust to life in the wild.
- D Abraham adjusted to life in the wild with some difficulty.

5. What is this passage mainly about?

- A The life of an Indian villager.
- B The story of an escaped elephant.
- C The life of an Indian animal trainer.
- D The history of the Al-Sindhu All Saints Circus.

6. Read the following paragraph, written from Abraham’s point of view.

“The man came closer and raised his **stick** to his shoulder. From the **stick** came a flash of light and a booming sound that scared Abraham. The elephant felt something hot hit his shoulder. The man took a few steps forward, raised the **stick** again, and Abraham felt another hot jolt, this time on his ribs.”

Based on the description above, what kind of “**stick**” was the man really holding?

- A a club
- B a sword
- C a spear
- D a gun

7. Choose the answer that best completes the sentences below.

Abraham never became one of the herd’s lead alpha males—he was too strange and his behavior around humans made the other elephants nervous. _____, the different groups of males all competed to recruit Abraham to their team because he understood humans.

- A Consequently
- B However
- C In summary
- D Moreover

8. The wild elephant herd eventually came to accept Abraham as one of their own. What evidence from the text supports this conclusion?

9. Describe how Abraham’s experience as a circus elephant helped him to survive in the wild.

10. How do you think Abraham feels about his new life with the wild elephants at the end of the story? Use evidence from the text to support your answer.
