Read this article about brain research and math performance ability. Then answer the questions that follow.

GUT MATH

1 Sight, smell, hearing, taste, touch . . . math?

2 You might love math or hate it. Regardless, scientists say, we are all born with a knack for mathematics.

3 This is not to say that we're all secret computational geniuses. A baby chewing on her toes is not demonstrating in sign language that 12 squared is 144. What does come naturally, though, is the ability to approximate. If our ancestors hadn't been able to judge at a glance whether they were outnumbered by mastodons, or which bush held the most berries, we might not be around today. Every time you leave your algebra class and scan the cafeteria for a table that will fit all of your friends, you're exercising the ancient estimation center in your brain.

4 Stanislas Dehaene was the first researcher to show that this part of the brain exists. In 1989, he met a man called Mr. N who had suffered a serious brain injury. In addition to other problems, Mr. N had acalculia, or an inability to do math. He couldn't recognize the number 5, or add 2 and 2. But Mr. N still knew a few things. For example, he knew that 8 is bigger than 7, and that there are "about 350 days" in a year and "about 50 minutes" in an hour.

5 Dehaene dubbed Mr. N "the Approximate Man" and drew an important conclusion from his case: there must be two separate mathematical areas in our brains. One of these areas is responsible for the math we learn in school; this is what Mr. N damaged. The other area doesn't worry too much about specific numbers, but judges approximate amounts. Since this area was undamaged, Mr. N became the Approximate Man.

6 So what does the brain's estimation center do for the rest of us? In the hopes of answering this question, Harvard University researcher Elizabeth Spelke has spent a lot of time posing math problems to preschoolers. Like the Approximate Man, preschoolers are bad at formal math. When Spelke asks 5-year-olds to solve a problem like 21 + 30, they can't do it—no surprise there. But Spelke has also asked 5-year-olds questions such as, "Sarah has 21 candles and gets 30 more. John has 34 candles. Who has more candles?" It turns out preschoolers are great at solving questions like that. Before they've learned how to do math with numerals and symbols, their brains' approximation centers are already hard at work, making them pros at estimation.

7 After we learn symbolic math, do we still have any use for our inborn math sense? Does it matter? Justin Halberda and his colleagues at Johns Hopkins University think it does. They challenged a group of 14-year-olds with an approximation test: The kids stared at a computer screen and saw groups of yellow and blue dots flash by, too quickly to count. Then they had to say whether there had been more blue dots or yellow dots. The researchers found that kids' math sense varied widely. Most were able to answer correctly when there were, say, 25 yellow dots and 10 blue ones. When the groups were closer in size, say 11 yellow dots and 10 blue ones, fewer kids answered correctly. . . .

8 The big surprise in this study came when the researchers compared the kids' approximation test scores to their scores on standardized math tests throughout their school years. They found that kids who did better on the flashing dot test had better standardized test scores, and vice versa. It seems that, far from being irrelevant, your math sense might predict your ability at formal math.

ANIMAL ARITHMETIC

9 For animals, knowing numbers may be the difference between being full or being hungry, being alive or being, well, not alive. If you can count or estimate quantities, you can figure out which tree has the most fruits, which watering hole has the fewest predators, and even how to find your hideout among all the tunnels in your burrow. Many scientists now think that lots of different animals, from pigeons and monkeys to rats and salamanders, have an innate number sense that helps them tell less from more and maybe even perform some more impressive feats.

10 Rats, for example, can learn to press a lever a certain number of times to get a treat—though they sometimes overshoot, maybe just to play it safe. Birds have been trained to pick up just the fifth seed in a series. Many animals, including pigeons, can tell a smaller pile from a bigger one. Even the humble salamander looked longer (and longingly?) at the test tube that contained more fruit flies.

11 In one of the few number studies with wild animals, rhesus monkeys were shown a pile of lemons. The researchers put the lemons behind a screen, then showed the monkeys another pile of lemons and put that pile behind the screen as well. When they lifted the screen to show the expected number of lemons, the monkeys barely looked, but when the pile had fewer or more lemons than there should have been, the monkeys were seemingly surprised and stared at the lemons for longer.