Verbs Explained!

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The kids stood absolutely still with their lemons and spoons. As soon as the whistle blew, they started racing ahead. A few lemons fell off the spoons. These were met by groans of disappointment from the participants and the crowd alike.

Mittu was nearing the finish line when Tatha cheered "Go on, Mittu." Mittu turned to look at Tatha, and PLOP! His lemon rolled off his spoon. Mittu was out.

On the way home, Tatha and Mittu walked for a while in silence. "I shouldn't have called out," said Tatha apologetically.

"I shouldn't have looked." Mittu laughed light-heartedly.

"Ah! Newton's laws." sighed Tatha.

"What?" Mittu looked up inquisitively.

"Newton's Laws of Motion," shrugged Tatha. "Three laws that explain all and any type of movement or motion…," he added after a pause.

"Any type of motion?" asked Mittu.

"Yes."

They had reached the park near home. Mittu looked at the children in the park. "Racing, running, swinging, jumping, falling, skipping, throwing a ball?"

"Yes."

Mittu looked at the road. "Bicycling and driving?"

"Yes."

Looking up at the sky,
Mittu quizzed,
"Birds flying?
The rotation
of the earth?
The moon
orbiting
the earth?
All verbs?"

Tatha nodded.
"Yes."

"Wow!" Mittu looked stumped. "How?"

"After you freshen up," Tatha said, opening the gate to their house.

"See you in five!" Mittu raced inside. Tatha was sipping his coffee when Mittu rejoined him. "Now!" he said eagerly.

"In the lemon and spoon race," Tatha pointed out, "all of you were standing still at the beginning?"

"Nearly!"

"Let us assume you were all stationary, or at rest. The spoons in your mouths were at rest. And the lemons on those spoons were also at rest. None of these was moving?"

Mittu nodded.

"But when the whistle blew, all of you started moving towards the finish line. Your body changed from a state of rest to a state of motion?"

"Yes."

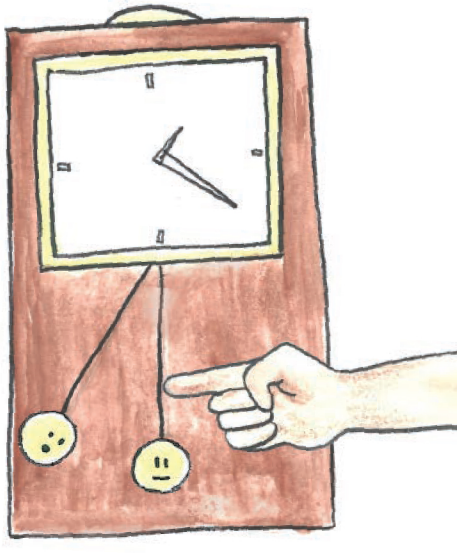
"You were holding the spoon firmly, almost as if it were attached to your body. So when you moved, the spoon moved with you?"

Mittu nodded, "And the lemon on the spoon too."

"And do you think the spoon and the lemon would have moved ahead in the race if you had not moved?"

"Of course not!" said Mittu looking puzzled.

"This is because anything at rest remains at rest, and anything in motion remains in motion unless a force acts on it. This tendency of a body to keep doing what it is doing is called ***inertia****. When you were standing still, you needed some force to move forward. The same force also acted on the spoon and the lemon, and changed their state from rest to motion."*



Mittu still seemed a bit confused.

Tatha continued, "Take swings for example. A swing at rest will continue to be at rest unless you push it. Pushing is the force you are using to change its state of rest. Similarly, a car at rest will remain at rest. When you start a car, the engine provides the force that will put it in motion. Or think of a pendulum clock. It will keep moving back and forth till you forcibly stop it or the clockwork gears break down."

Mittu took a few moments to think about this. Then asked, "But what about the kids who dropped their lemons right at the start?"

"Those kids sprang from a state of rest to a state of motion very quickly. In other words, they gained high speed in a few seconds of time, right?"

"Uh-huh".

"Speed in a particular direction is called ***velocity****. The rate of change of velocity with respect to time is called* ***acceleration****. Those kids experienced a big and sudden acceleration. Their bodies and the spoons in their mouths moved forward very quickly. Only the small surface of the lemon that was in contact with the spoon moved with the spoon. But the rest of the lemon stayed at rest. This caused the lemon to roll off the spoon."*

"Why didn't this happen to me?" Mittu asked.

"Because you changed your velocity more gradually, giving time for the motion to pass smoothly from your legs to the spoon to the whole lemon on the spoon."

"Then, why did my lemon drop when I turned towards you?" Mittu wondered.

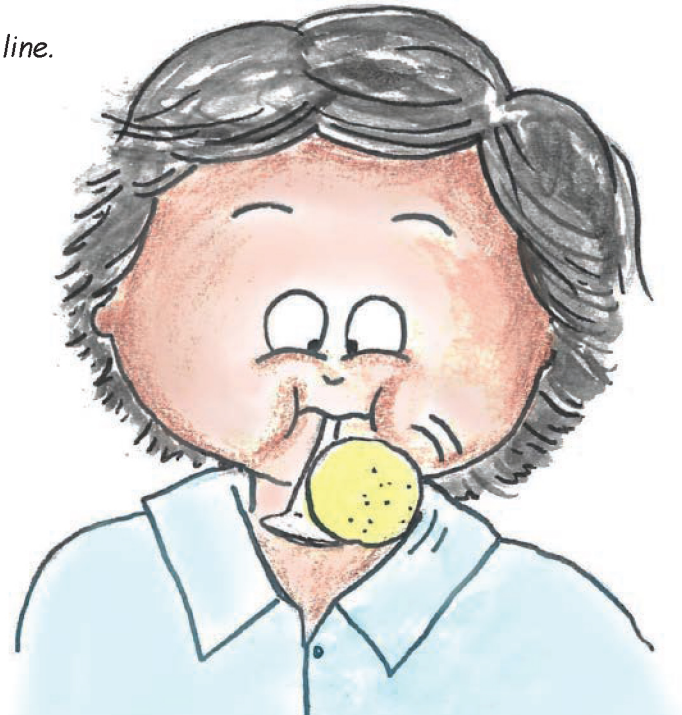
"You tried to change the direction of its motion too suddenly. You, the spoon, and the lemon were all moving in a straight line. When you swerved to look at me, the force you applied to move your head moved the spoon in your mouth, and the lemon on it, sideways. This happened very quickly. Again, the part of the lemon that was not in contact with the spoon could not change its direction as quickly."

"Because of inertia?" Mittu asked.

"Yes. The inertia of moving in a straight line. So it rolled over the edge of the spoon and fell down."

"What about the kids whose lemons fell off their spoons when they stopped at the finish line?"

"The same reason. This time, the kids, the spoons they held in their mouths, and the lemons were all in motion. When their bodies came to a sudden rest at the finish line, the spoons in their mouths came to rest too. But because their velocity changed so quickly, the lemons continued moving forward and rolled off."



Mittu looked a bit puzzled.

"It's very much like swinging. When you jump off a fast-moving swing, your feet come to rest as soon as they touch the ground, but your upper body is still in motion." Tatha continued. "So, you tend to bend forward or take a few steps forward. If you did not do this, wouldn't you too fall like the lemon?"

"Yes!" Mittu exclaimed.

"This is Newton's First Law—everybody and everything continues to be in a state of rest or of uniform motion unless it is compelled by some external force to act otherwise."

*"**Uniform motion?**" Mittu asked.*

"When an object moves in one direction and covers equal distances in equal intervals of time. In other words, the object has constant velocity."

"Understood. What does the second law explain?" Mittu was eager.

"Well, to go back to your lemon and spoon race," Tatha gesticulated in the direction of the sports ground, "did you have great difficulty running with the spoon and lemon in your mouth? Were they heavy? Did you have to use a lot of force or physical strength to run forward with the lemon and spoon? Did you have to push hard to make your way ahead?"

"Don't be silly!" Mittu chuckled.

"What if you were carrying a huge paperweight instead?"

"It would have been a little more difficult," said Mittu thoughtfully.

"What if you were carrying a boulder?" Tatha quizzed.

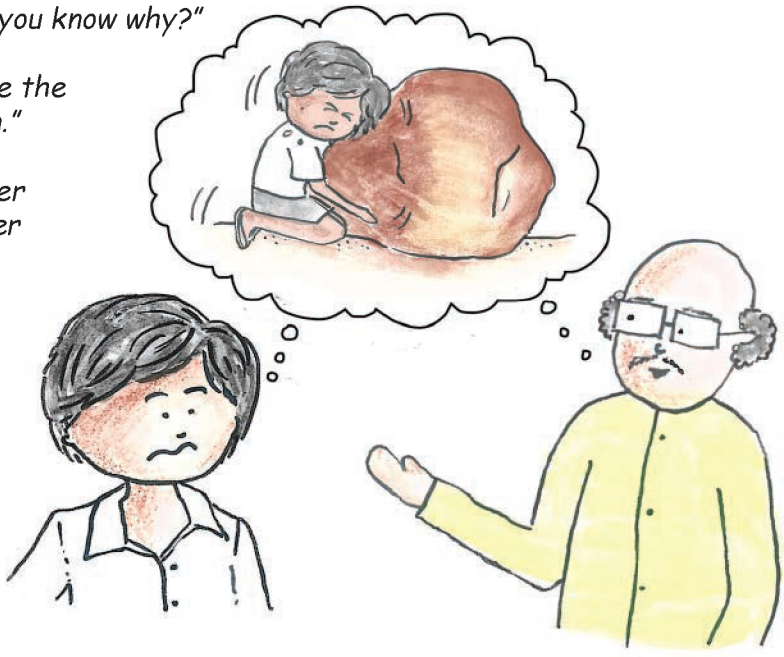
"What are you driving at?" Mittu gazed at Tatha in confusion. "I would not have been able to lift the boulder, forget running with it. You know that."

"Exactly!" Tatha said calmly. "Do you know why?"

Mittu looked thoughtful. "Because the boulder is heavier than the lemon."

"Exactly!" Tatha said. "The greater the mass of an object, the greater the force needed to move it. When I say mass, I mean the amount of matter, molecules, or atoms present in an object."

"So if I grow taller and fatter, my mass will increase because I will have more cells and molecules in my body, right?" Mittu asked.



"Yes." Tatha agreed.

"And the more mass I have, the greater the force you will need to pull me up from this chair?" Mittu looked at Tatha.

"Yes. Also, the greater the force I will need to make an object move faster or slower," Tatha said. "For example, imagine I were pushing a swing with one child sitting on it. Then imagine that another child of about the same mass joins this one kid on the swing. Now, I would need to apply a much greater force to push the swing. I would also need to apply a much greater force to make a swing with two children reach the same height as a swing with one child on it."

"You will also need more force to slow down or stop a moving swing with more children on it, no?" Mittu added.

"That's right!" Tatha smiled. "This is Newton's second law. Force equals mass times acceleration. F=ma."

"Got it!" Mittu brightened.

"And if you know the mass of an object and the amount of force acting on it, you can say how fast the object will pick up velocity." Tatha added.

"Cool!" Mittu exclaimed.

"Now for the third and last law of Motion," said Tatha.

"Ready!" Mittu was enthusiastic.

"Again, going back to the lemon and the spoon. When you started running, were your feet pushing on the ground backward or forward?" Tatha asked.

"Obviously backward, Tatha. If my feet were pushing on the ground in the forward direction, I would have been running backward," said Mittu rolling his eyes.

"Exactly. So you were pushing the ground backward and the ground was pushing you forward, right? The more force you apply in pushing the ground back, the more force the ground would exert on you to push you in the forward direction," said Tatha smiling.

"OMG! You are right! So for running in the forward direction, I have to push the ground backward. Then it is the ground that will push me forward?"

"Exactly. That is Newton's third law. Every action has an equal and opposite reaction. Let me give you another example. If a car crashed against a pillar, why does the car also get damaged?"

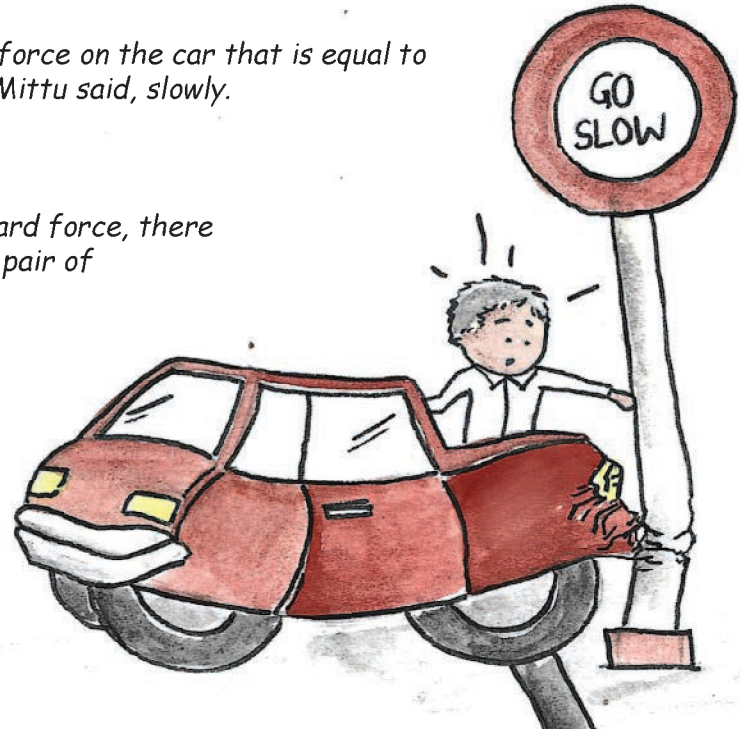
"Because the pillar applies a stopping force on the car that is equal to the force with which the car hit it?" Mittu said, slowly.

Tatha nodded.

"You mean to say that for every forward force, there is a reverse or opposite force? Like a pair of forces?" Mittu asked.

"Bravo!" Tatha exclaimed. "You have understood Newton's third law, Mittu. To every action force, there is an equal and opposite reaction force."

"Thanks for explaining the verbs!" Mittu winked. "Now to practice them," he said running out.



About the Author

Rohini Chintha is an Assistant Professor (C) at the Department of Genetics and Biotechnology, University College for Women, Hyderabad. She is passionate about writing for children, and believes that 'A Happy Childhood builds a Happy Society'. About 110 of her stories for children have been published in various magazines. To view her work, check out her website: www.popscicles.com.

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