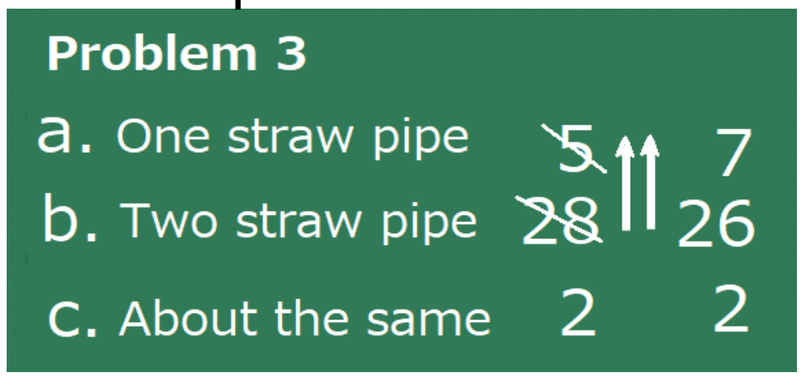
Relax!　Enjoy the class together with your students.

HYPOTHESIS–EXPERIMENT CLASS (HEC)

The teacher proceeds with the lesson by showing the Problems, Readings, and Hands-on on this HEC Classbook flip, one at a time, following the order of the flip:

Problem

1. The teacher reads the problem.
2. Students choose the options for their expectations.
3. Count the number of students who chose each option and show the tally to the pupils.
4. Ask students who wish to speak to give their reasonings or thoughts.
5. Discussion. The teacher should not correct or guide the students to the correct answer.
6. Before the experiment, if a student wishes to change the choice, the teacher records it.
7. Experiment. The teacher declares the result but does not explain it at the stage.



Readings

The teacher reads the reading. In Hypothesis–Experiment Class, the explanations and summaries necessary for the student's understanding are given as Readings at the necessary stages in the sequence of problems in the HEC Classbook.

After Class

At the end of the class, ask the students to rate their enjoyment of the class on a five-point scale and write down their impressions.

Please refer to the attached Instruction documents to ensure that your classes run worry-free and enjoyable.

The subsequent slides can be printed in large print and used as flips for the class.

⇒A3 size or more extensive printing is recommended.

Introducing Dynamics by Blow-Dart Experiment

Hypothesis–Experiment Class

Original Work by

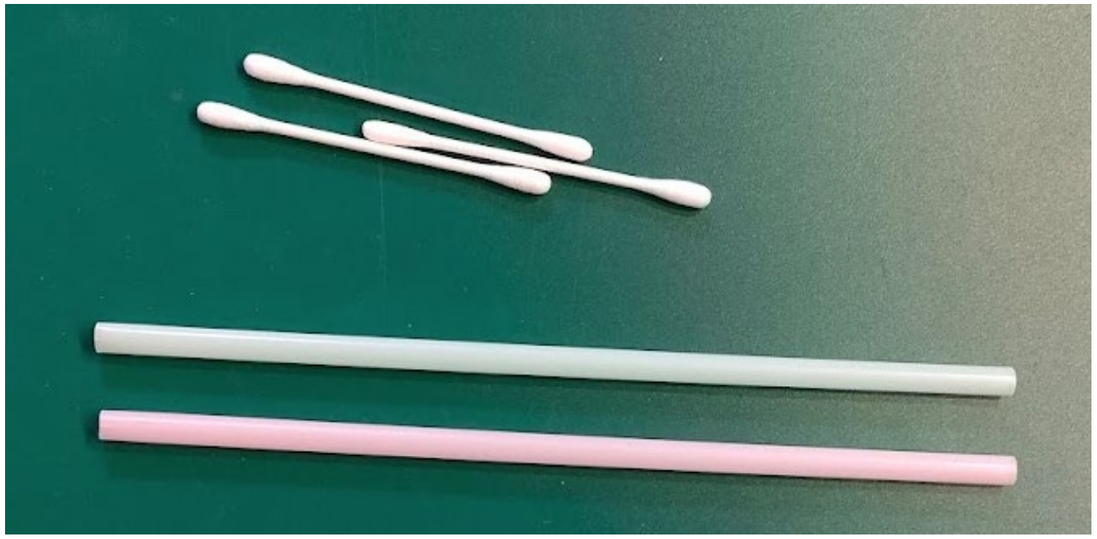
Kiyonobu Itakura

Association for Studies in Hypothesis–Experiment Class

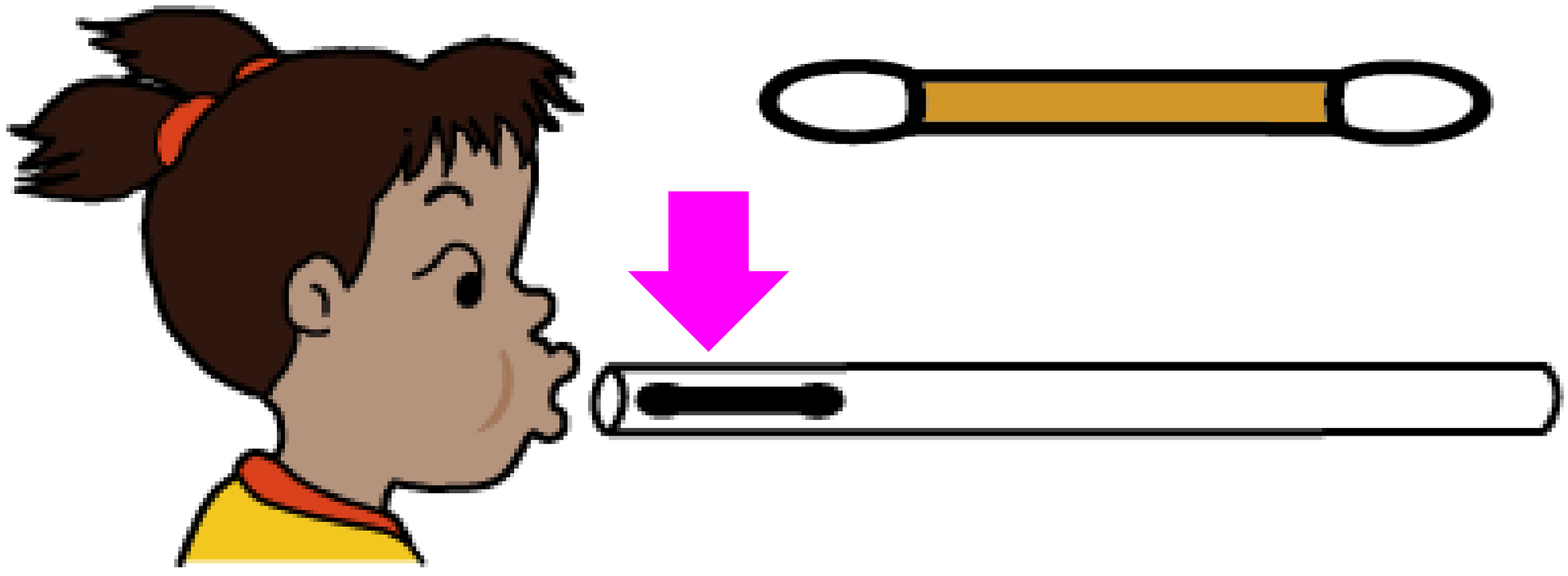
This flip was translated and edited by the Association for Studies in Hypothesis–Experiment Class from the chapter "Blow-Dart and Dynamics" in the HEC Class Book "Introduction to Mechanics," conceived by Itakura, and is published with the copyright holder's consent.

Problem 1 (Question)

Do you know what Blow-dart is?

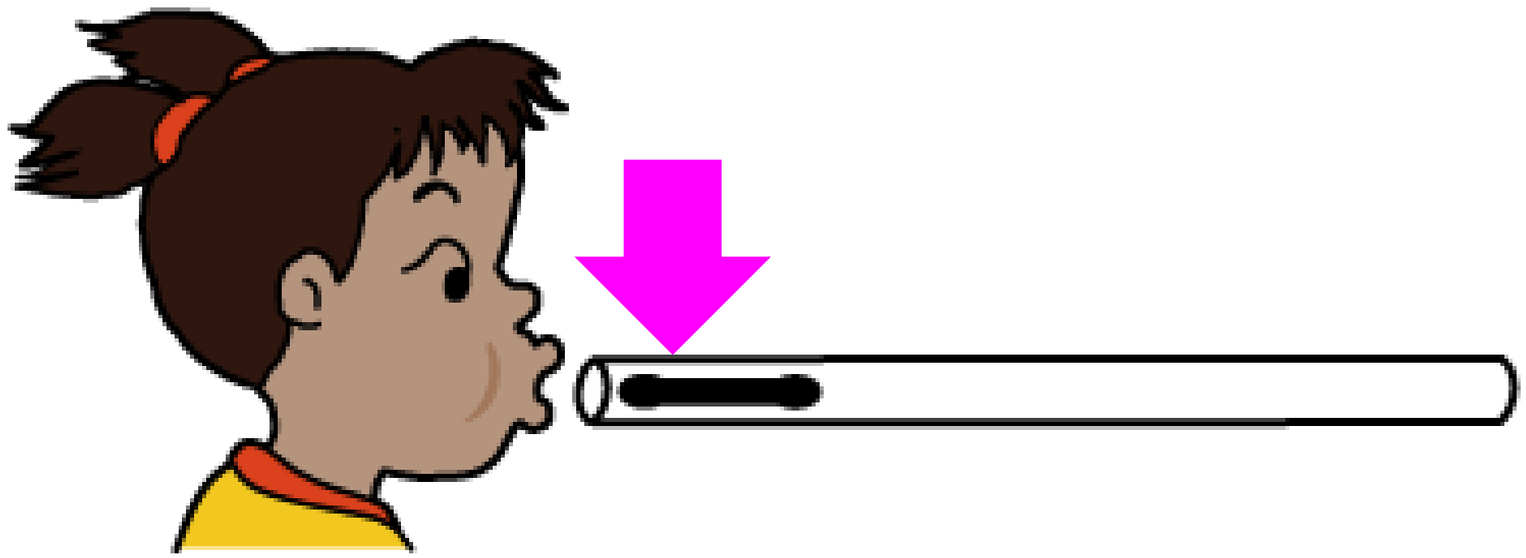


Cotton swabs and Straws

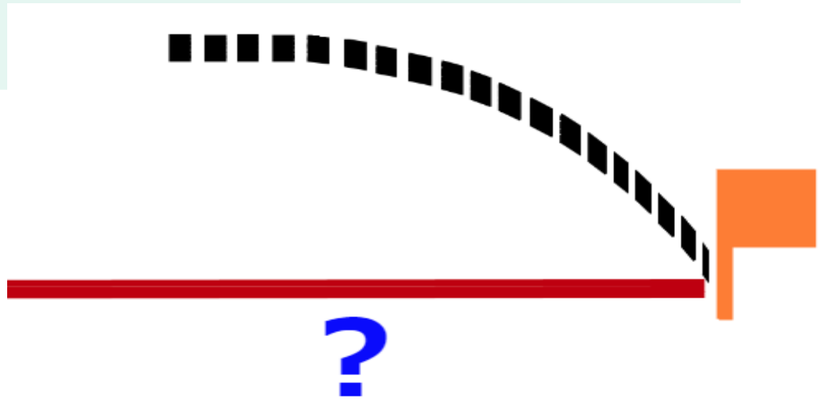


Do you think you can blow a cotton swab through a straw and make it fly?

Insert the cotton swab into the straw from the front and blow vigorously with the straw horizontally, as shown in the image.



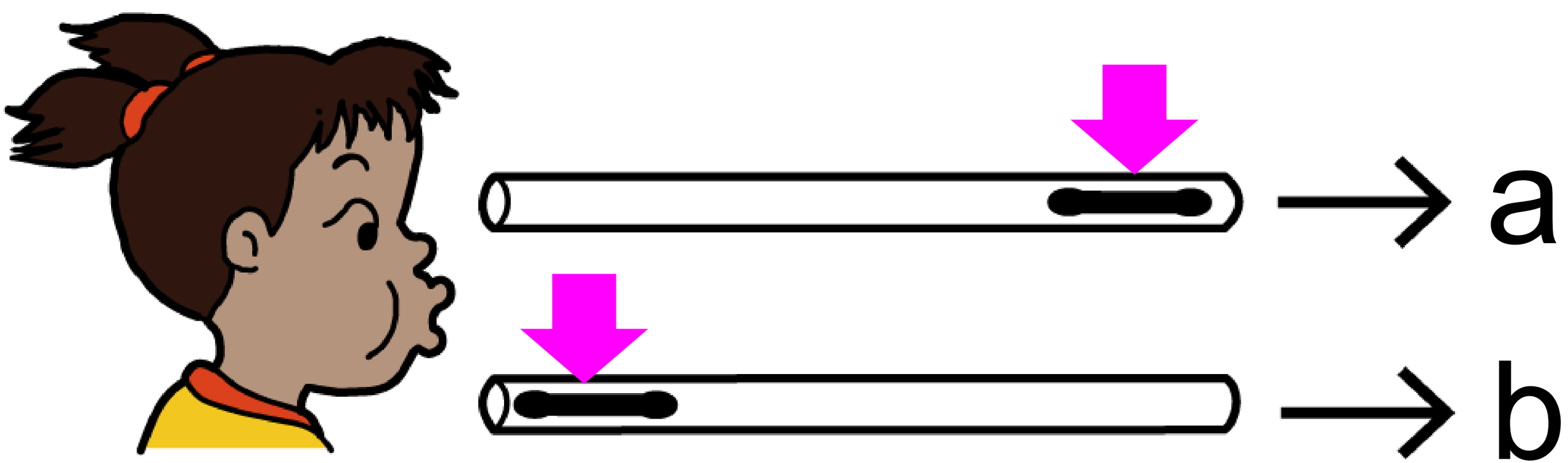
The teacher will show you the experiment three times.
See how far it flies approximately.



Problem 2

Blow a cotton swab through a straw **in the positions in the image below.**

? Which do you think will fly further?



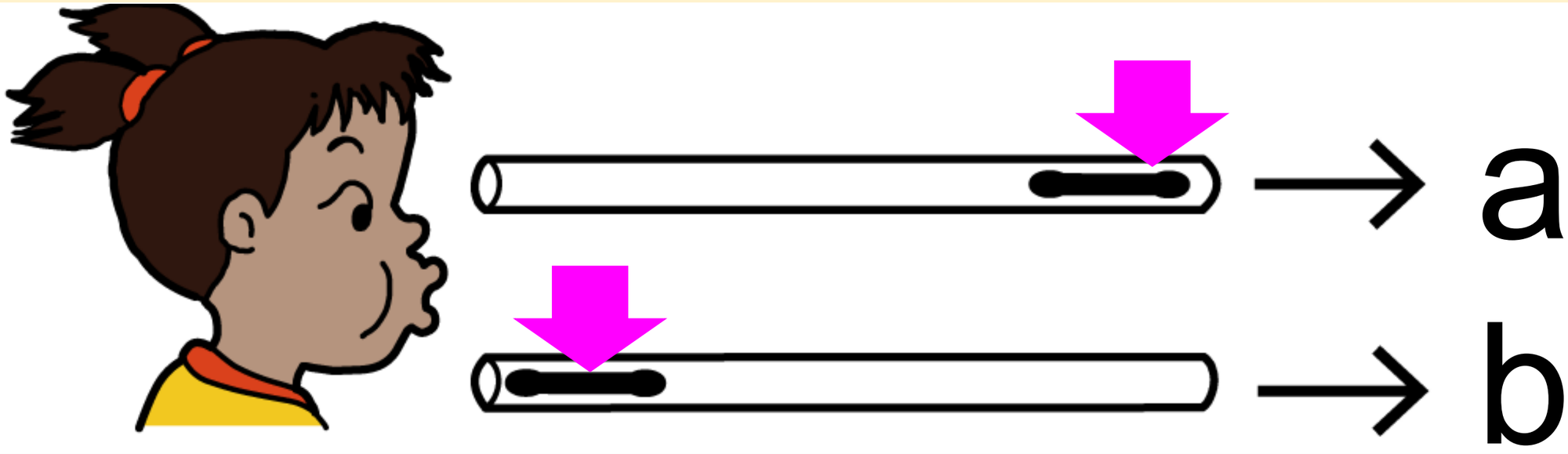
Problem 2

Choose what is closest to your **expectations.**

a. The swab placed **at the "tip" will fly further.**

b. The swab placed **at the "base" will fly further.**

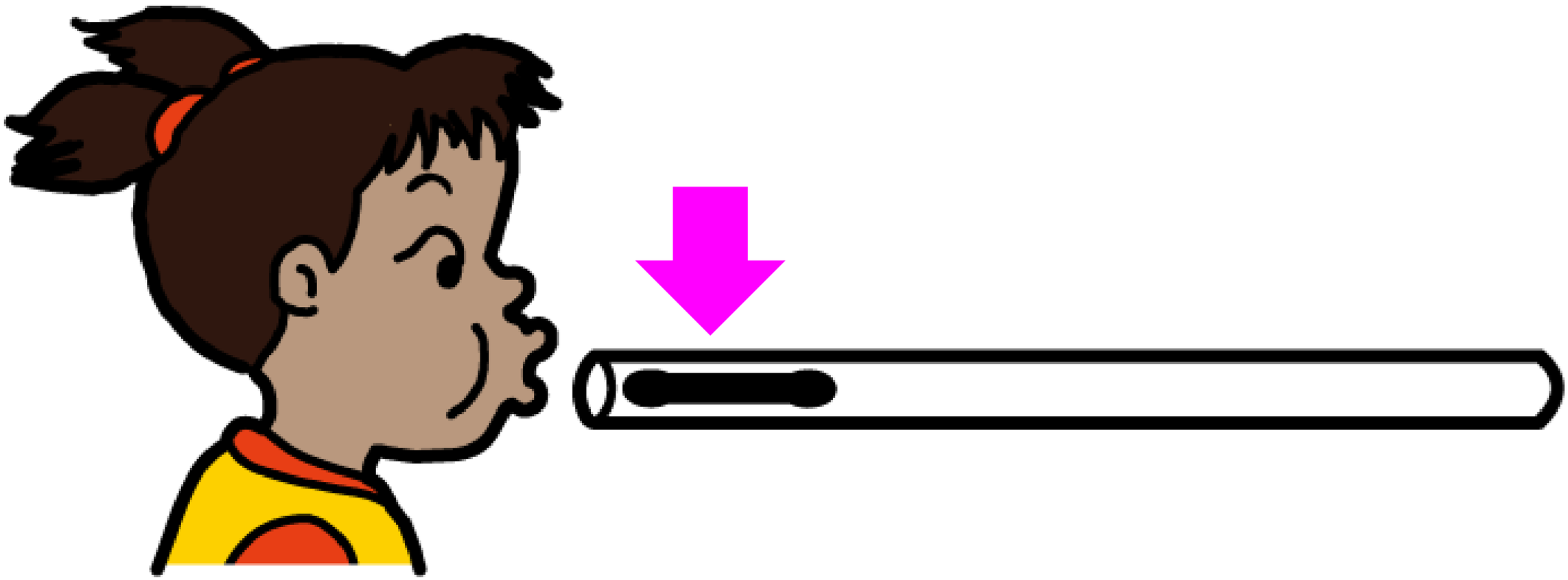
c. Both will fly **about the same** distance.



Let's express our thoughts. Then check the results with an experiment.

The results
of the experiment showed that

b.

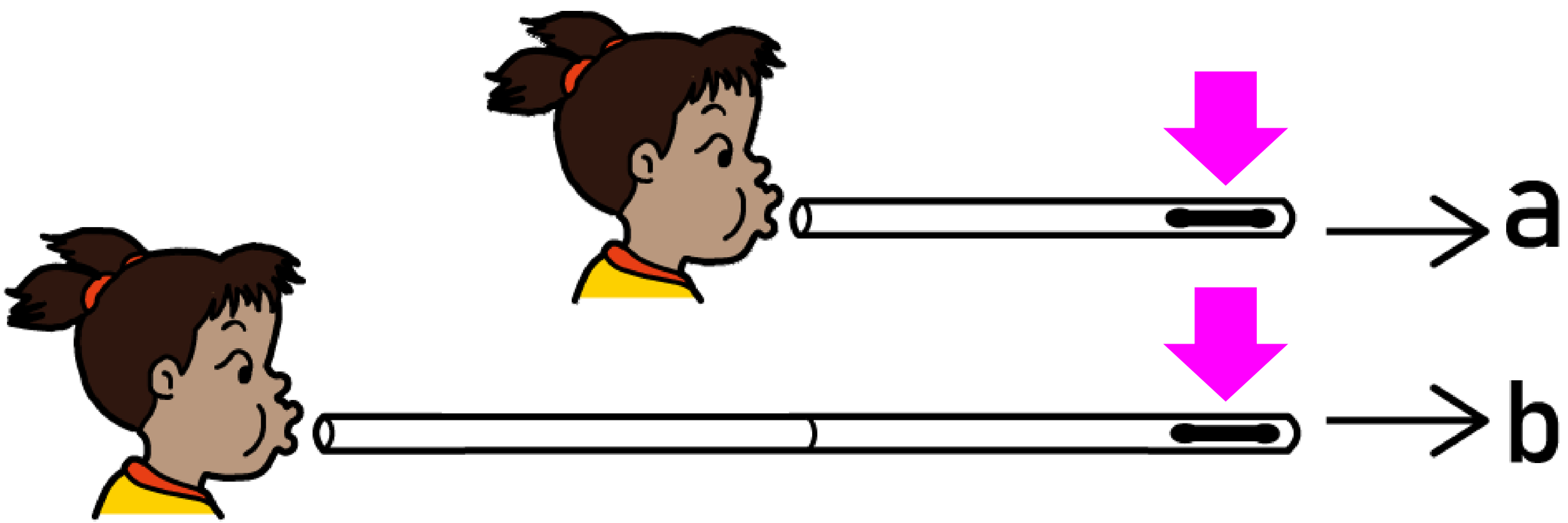


The swab placed **at the “base” flies further.**

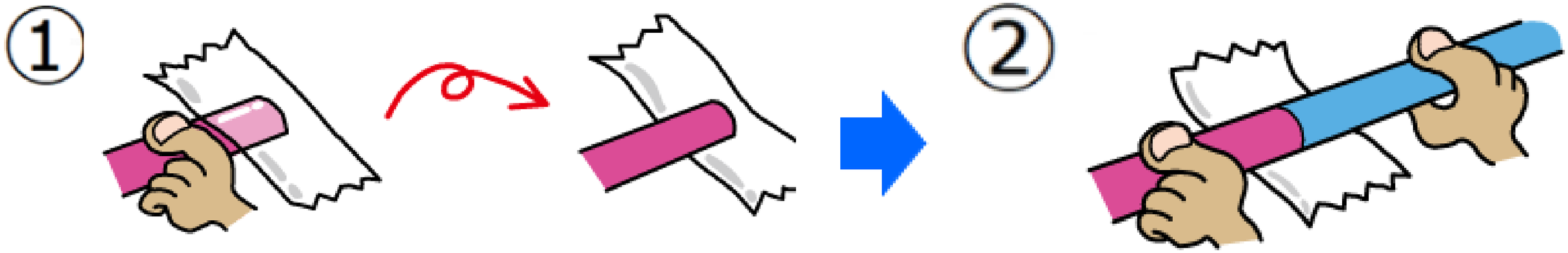
Problem 3

Blow a cotton swab **in the tip** of the **twice-long** straw pipe.

Which do you think the swab will fly further?

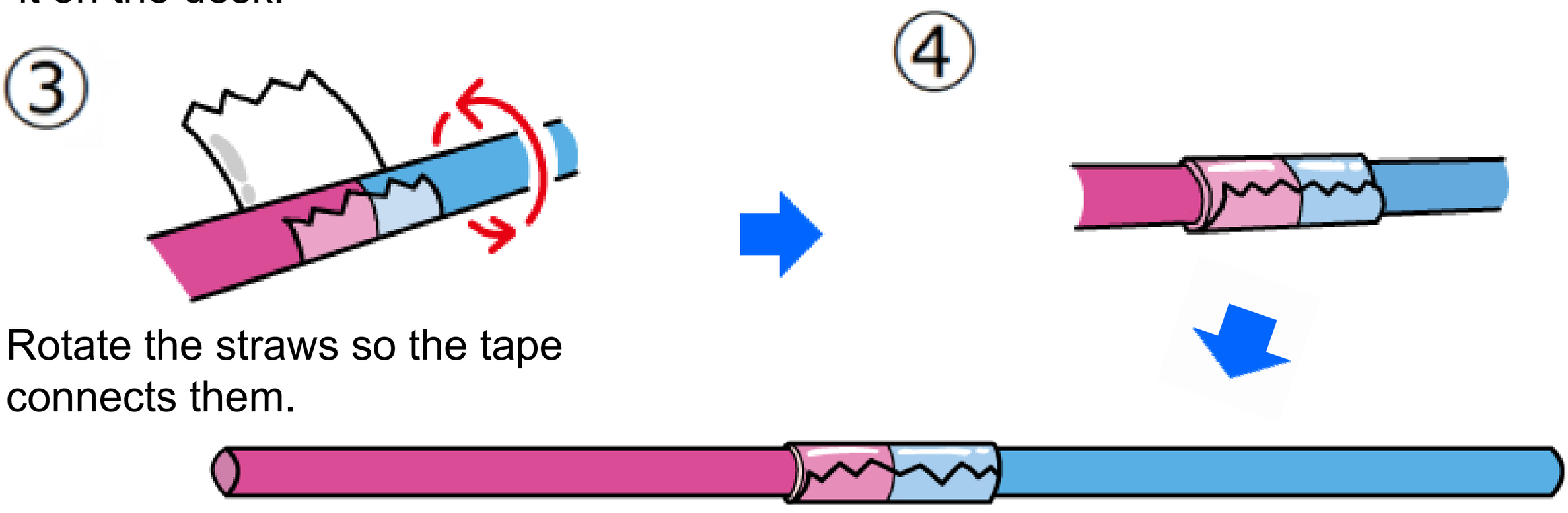


How to Connect the Straws



Place the tape on the tip of the straw so that half of the width of the tape extends out. Then, turn the straw over and place it on the desk.

Attach the tip of the second straw to the tip of the first straw over the sticky part of the tape.



Rotate the straws so the tape connects them.

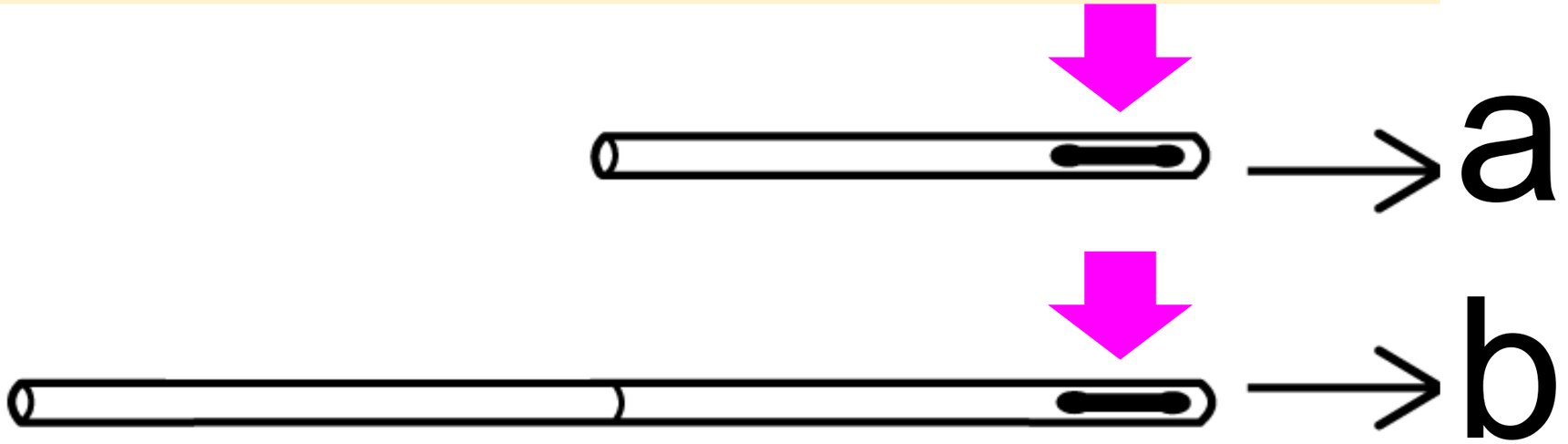
Problem 3

Choose what is closest to your **expectations.**

a. The swab will fly further with **1-straw pipe.**

b. The swab will fly further with **2-straw pipe**.

c. Both are **about the same**.

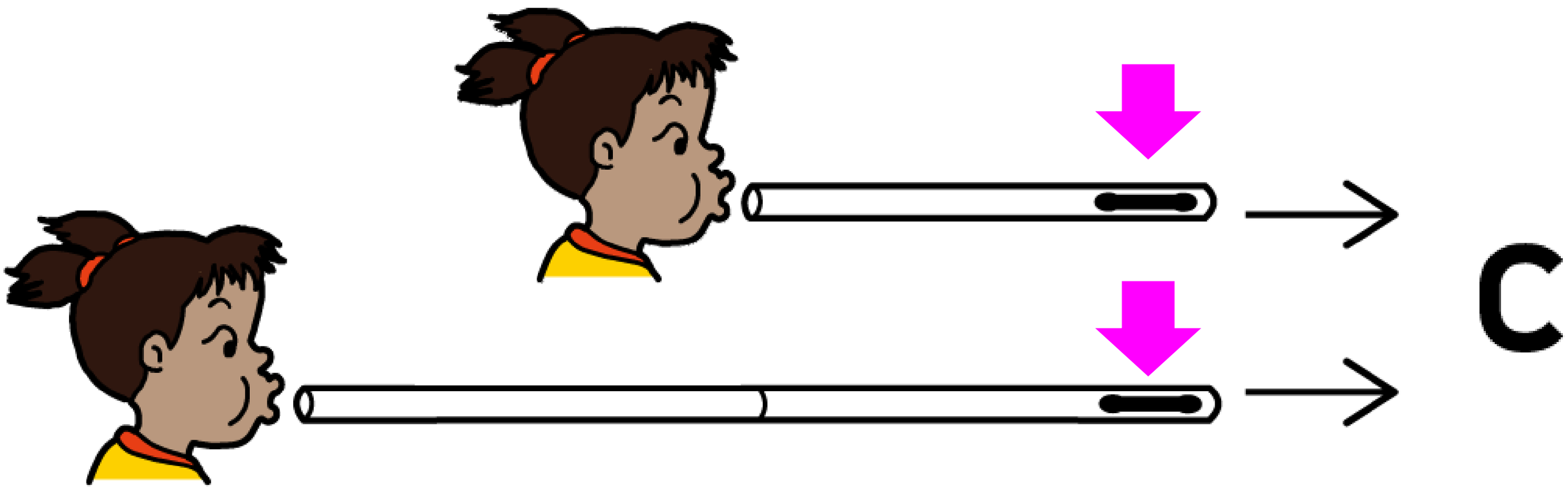


Let's express our thoughts. Then check the results with an experiment.

The results

of the experiment showed that

C.

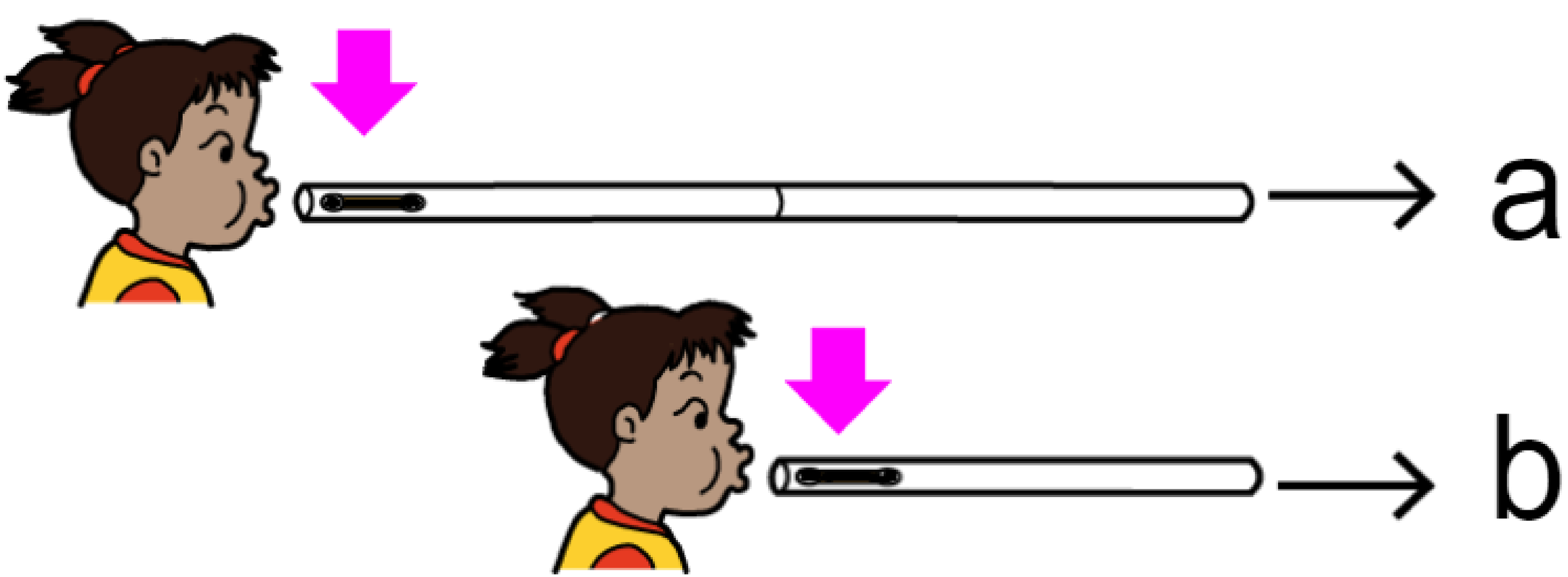


Both are about the same.

Problem 4

Now, **a cotton swab is placed at the base** of the same straw pipes in Problem 3.

? Which do you think will fly further?



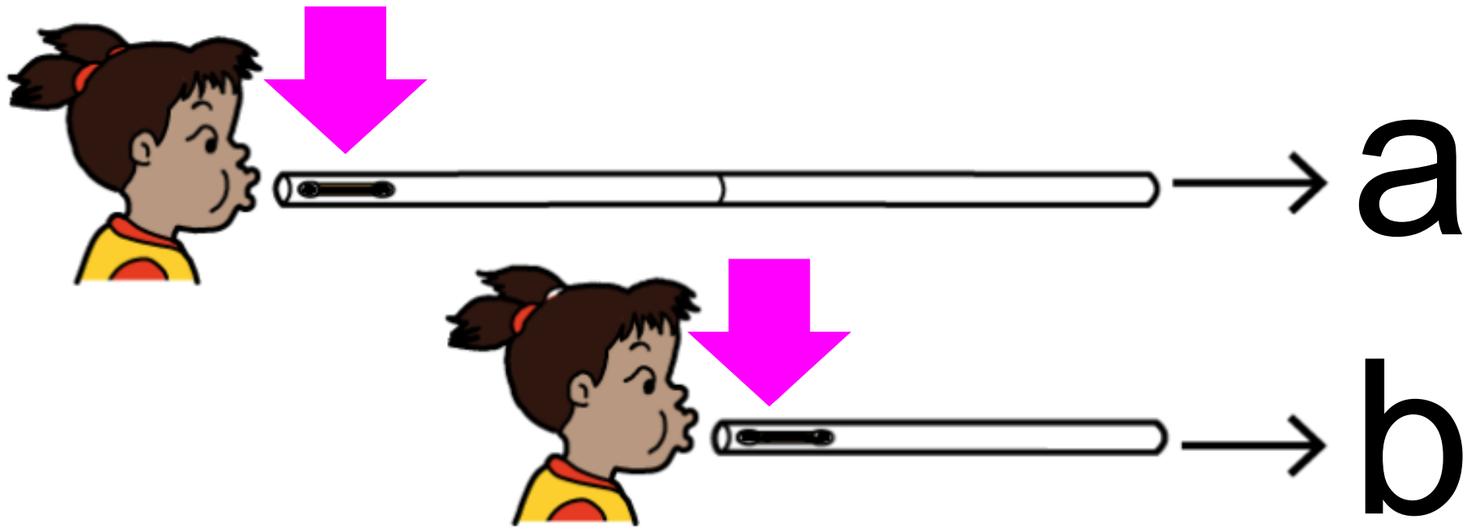
Problem 4

Choose what is closest to your **expectations.**

a. The swab will fly further with **2-straw pipe**.

b. The swab will fly further with **1-straw pipe**.

c. Both are **about the same**.

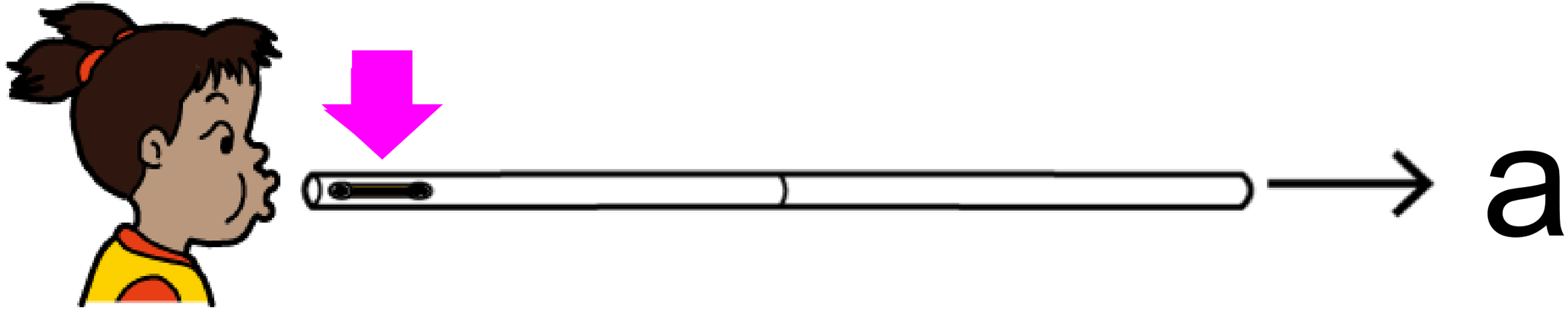


Let's express our thoughts. Then, check the results with an experiment.

The results

of the experiment showed that

a.

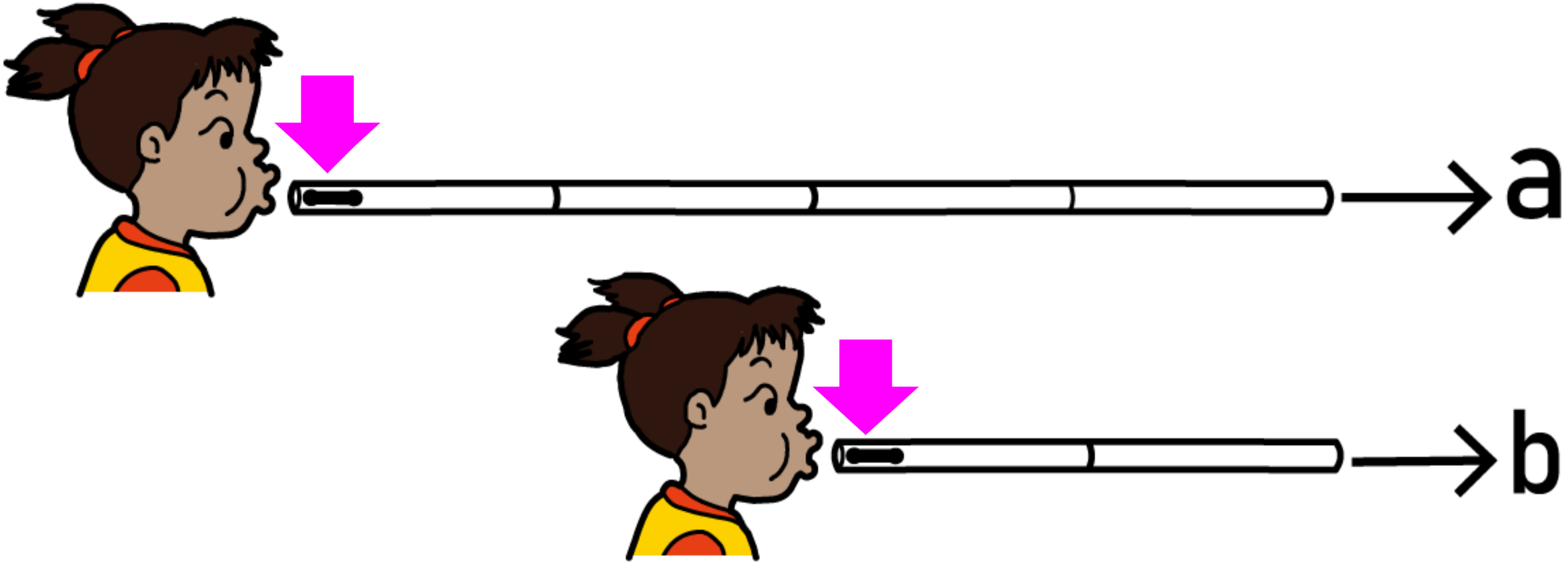


The swab flies further with 2-straw pipe.

Problem 5

Now, experiment with **four** connected straws.

Do you think you can make them fly further this time too?



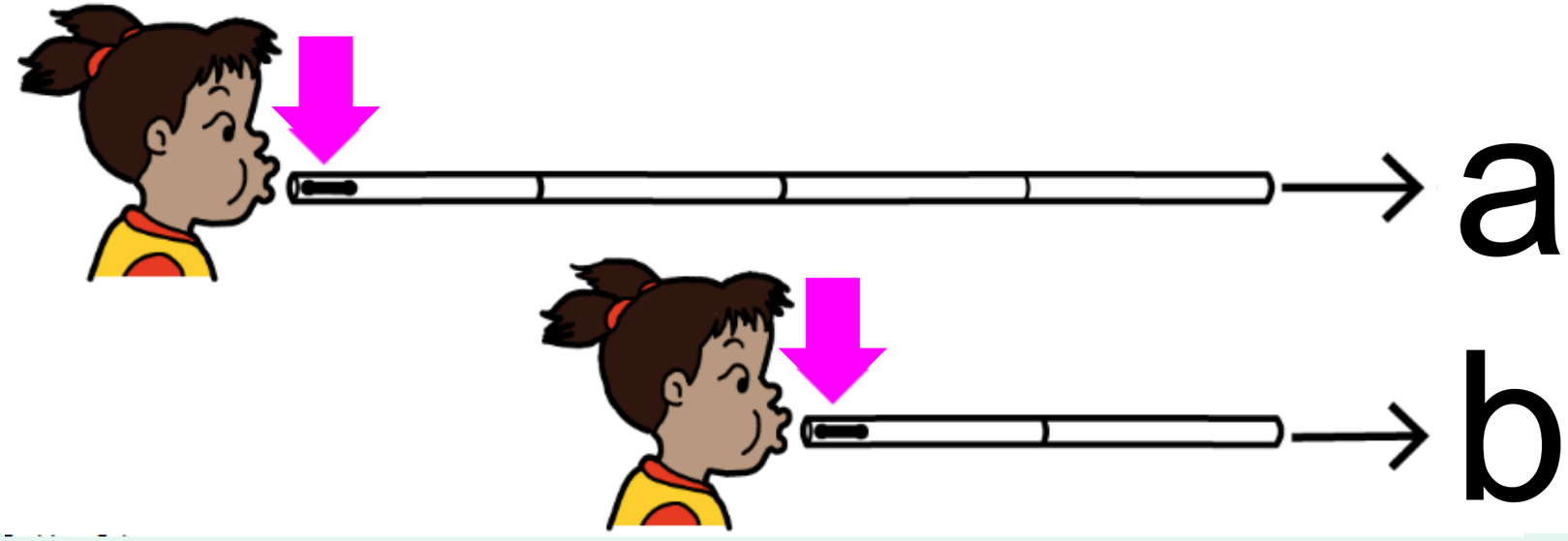
Problem 5

Choose what is closest to your **expectations.**

a. The swab will fly further with **4-straw pipe**.

b. The swab will fly further with **2-straw pipe**.

c. Both are **about the same**.

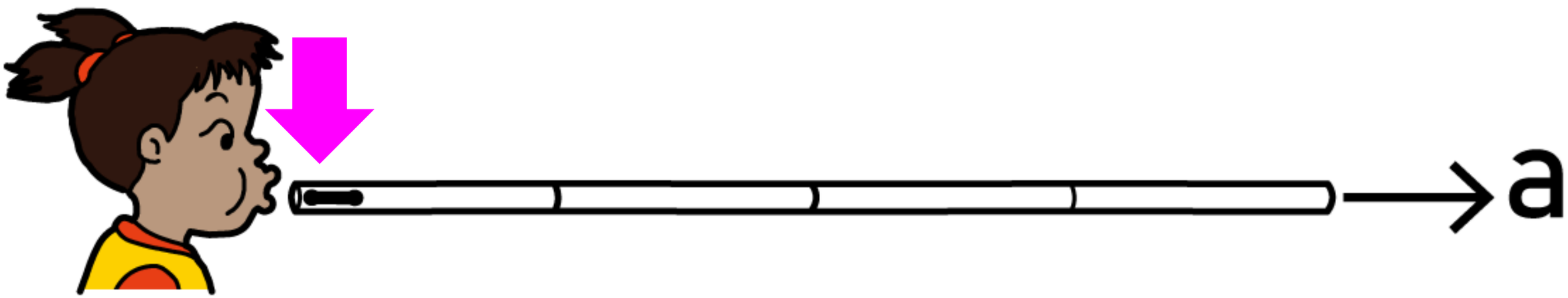


Let's express our thoughts. Then check the results with an experiment.

The results

of the experiment showed that

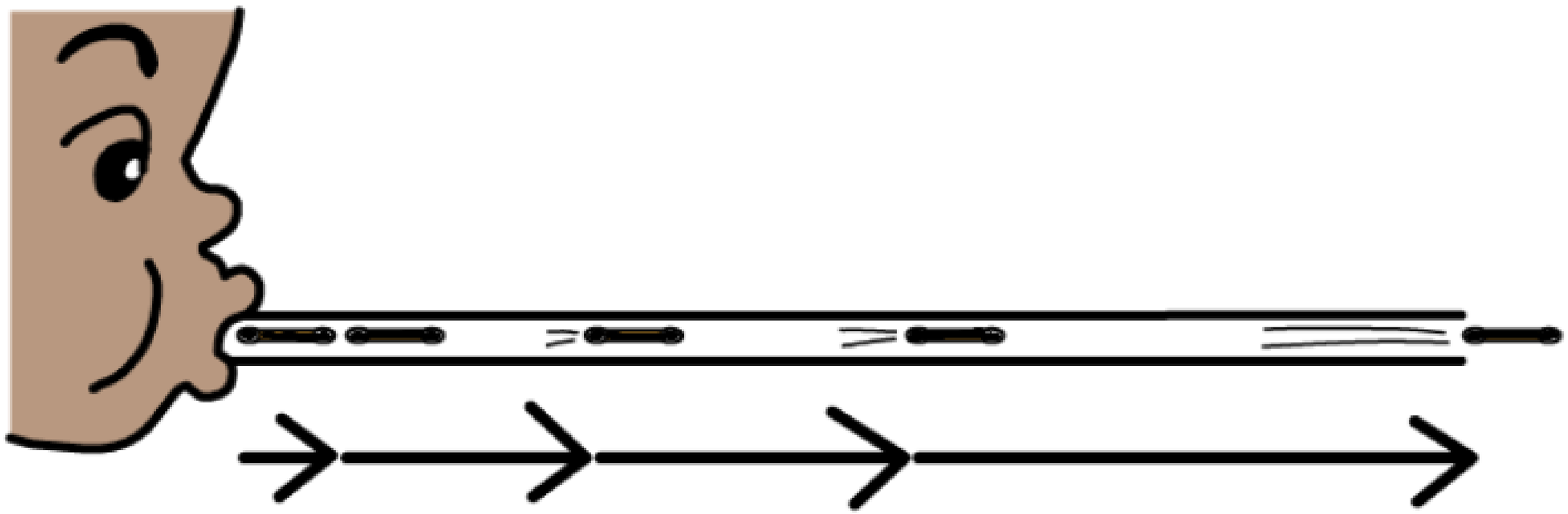
a.



The swab flies further with 4-straw pipe.

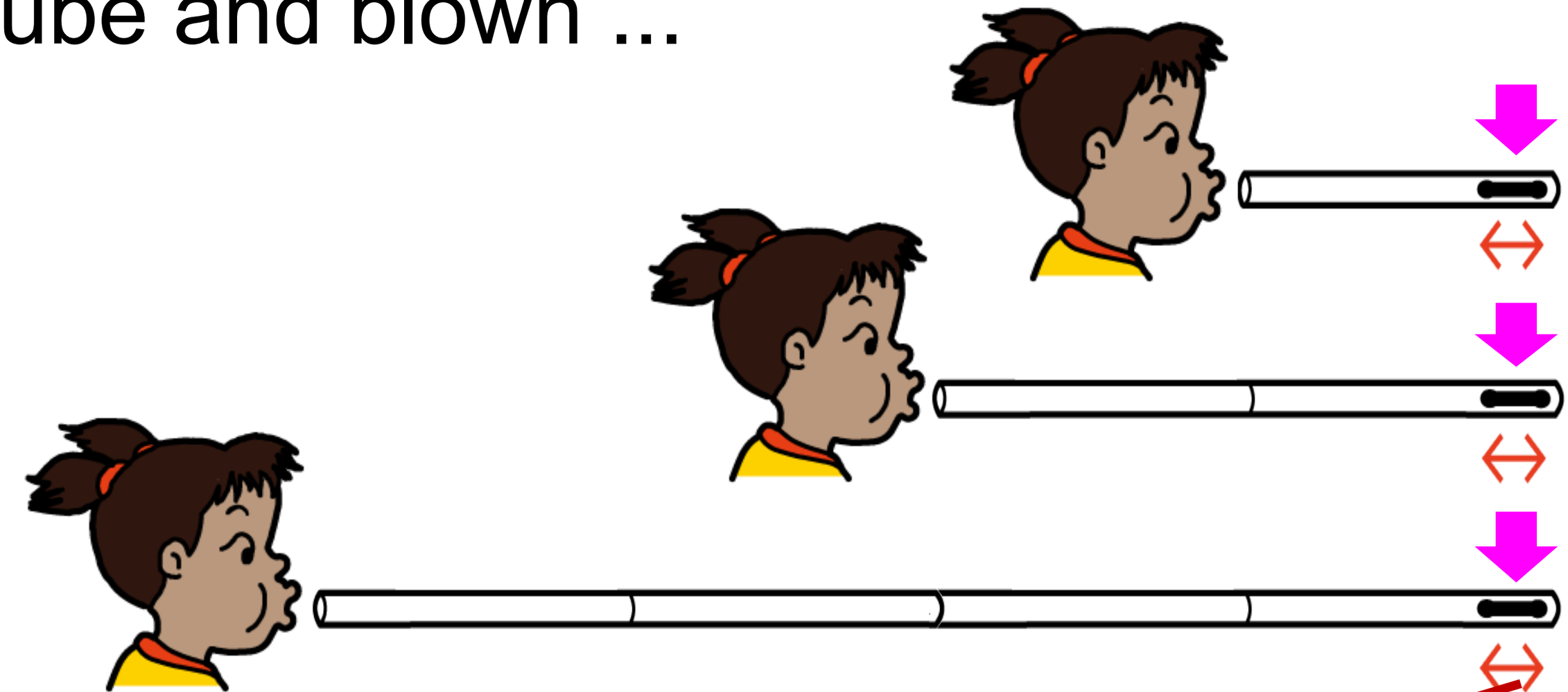
Push, push, push, and push

Blow the swab all the way through until it flies out of the pipe. This will create the effect of a long tube. Even the same size force can speed up the dart in the pipe by 'pushing, pushing, pushing'.



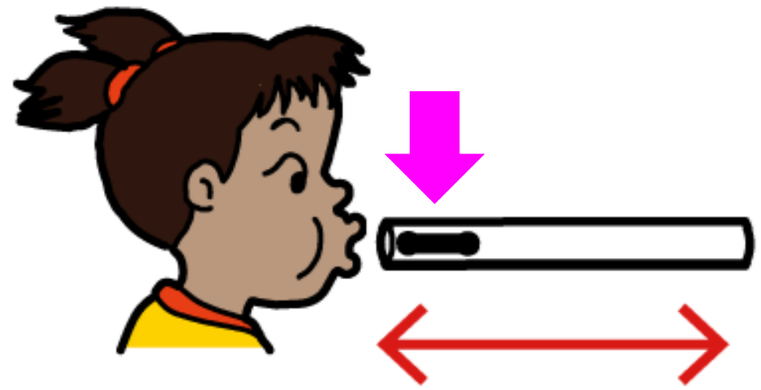
The swab gets faster in the pipe.

If a cotton swab is placed at the **tip** of the tube and blown ...

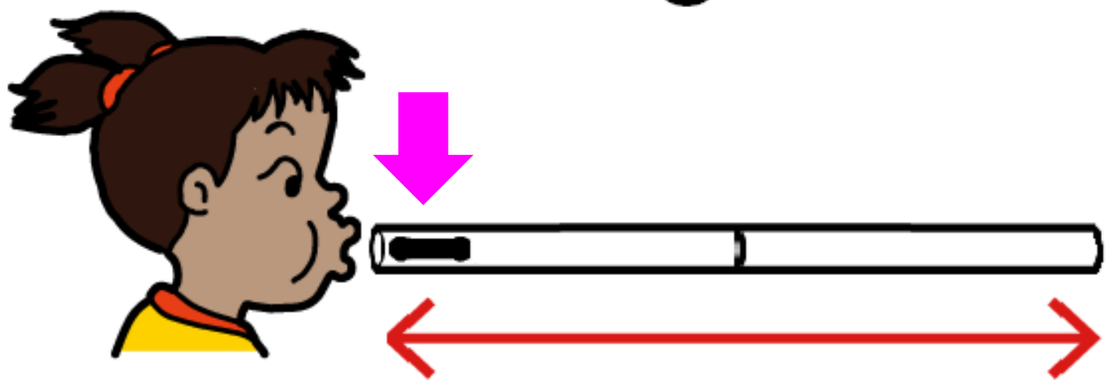


The force is only applied during this period.

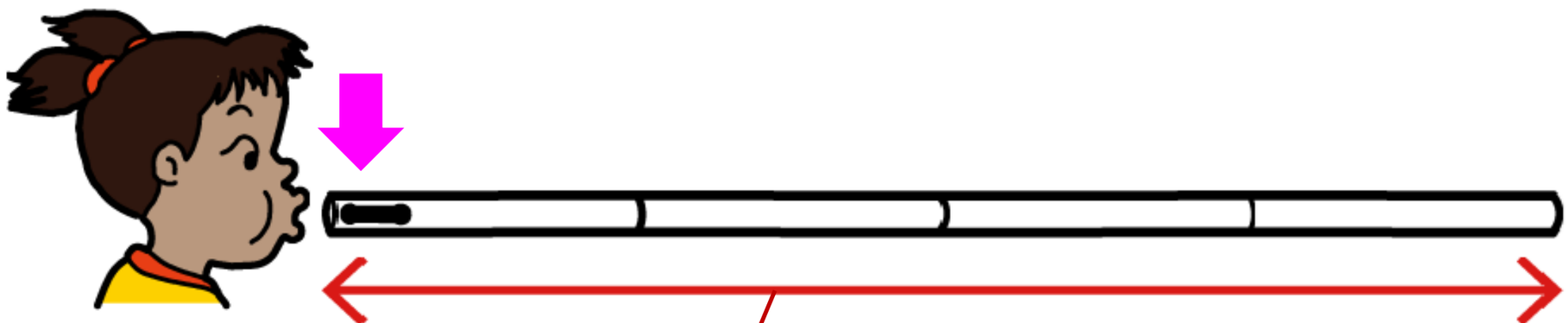
If a cotton swab is placed at the **base** of the tube and blown ...



Getting faster.



Getting faster and faster.



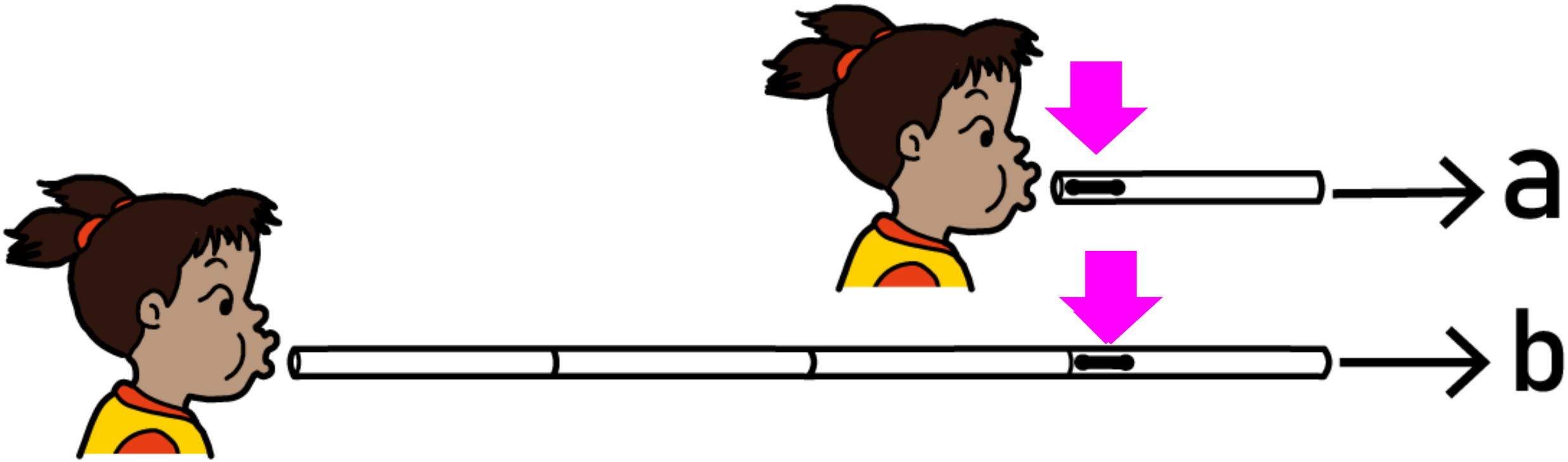
Getting faster, faster, faster and faster.

The force is applied during this period.

Problem 6

Use the one-straw and the four-straw pipes.
Place a cotton swab at the same distance from the tip.

Which do you think will make the cotton swab fly further?



Problem 6

Choose what is closest to your **expectations.**

a. The **1-straw pipe** will make the swab fly further.

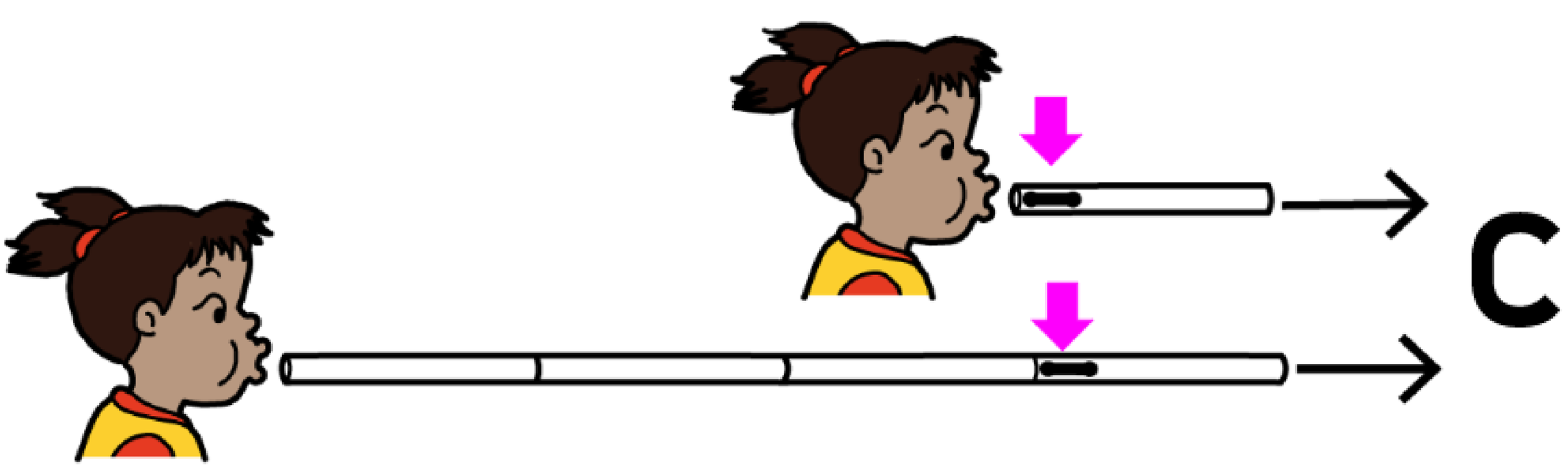
b. The **4-straw pipe** will make the swab fly further.

c. Both are **about the same**.

Let's express our thoughts. Then, check the results with an experiment.

The results
of the experiment showed that

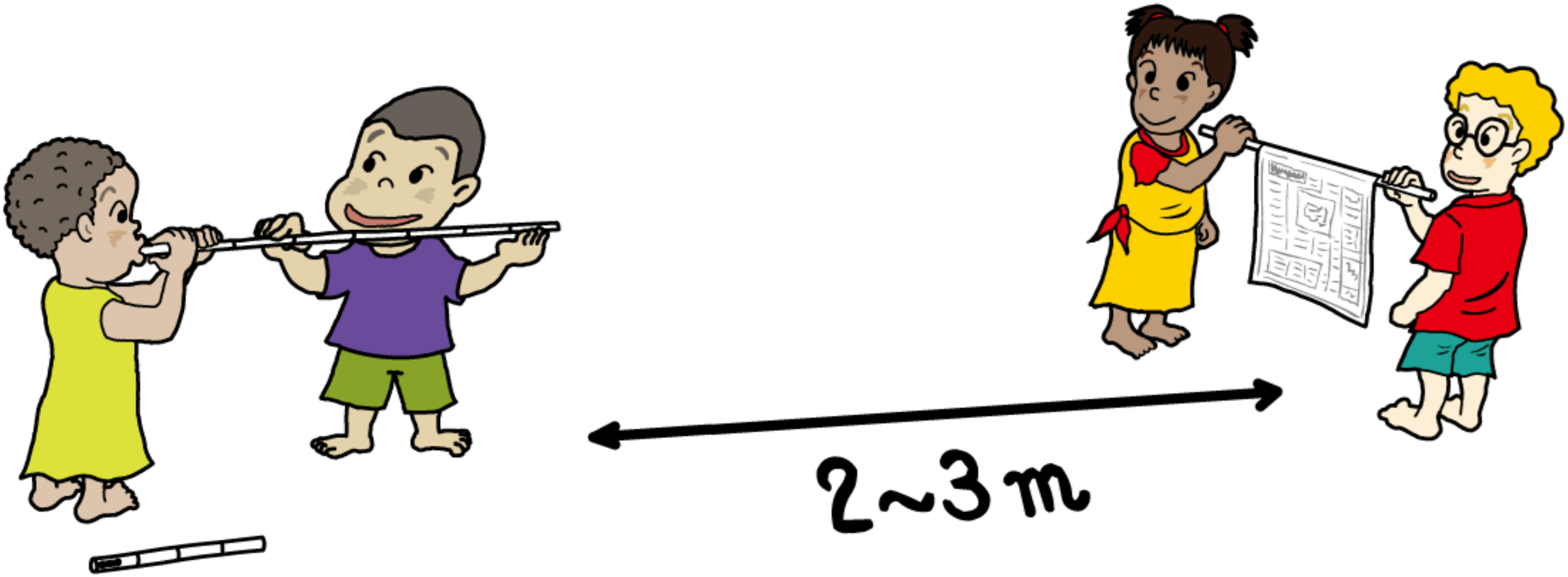
C.



Both are about the same.

Problem 7

Experiment with **an eight-straw pipe** and **a four-straw pipe**. Suspend a newspaper 2-3 m away from the tip of the pipe and compare the force with which the cotton swab hits the newspaper.

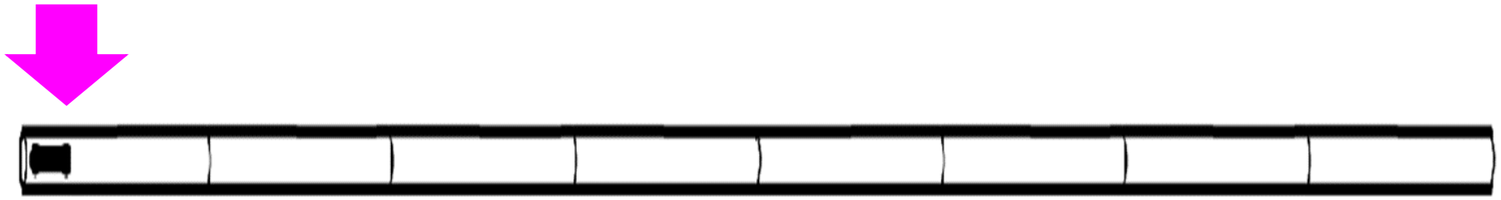


Have someone hold the end of the straw and blow it as straight as possible.

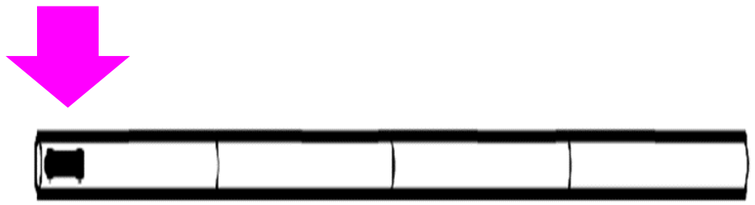
Problem 7

Choose what is closest to your **expectations.**

a



b



a. The **8-straw pipe** will make a bigger impact.

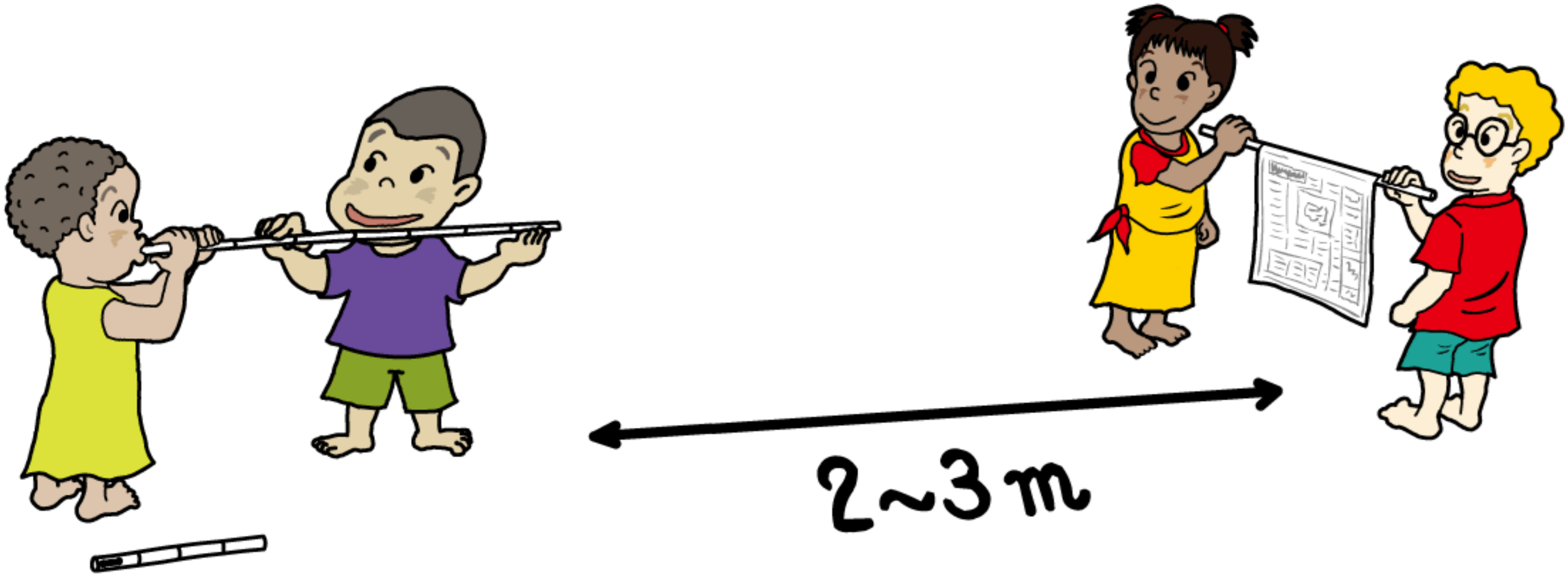
b. The **4-straw pipe** will make a bigger impact.

c. Both are **about the same**.

Let's express our thoughts. Then check the results with an experiment.

Experiment

Suspend a newspaper 2-3 m away from the tip of the pipe and compare the force with which the cotton swab hits the newspaper.



Have someone hold the end of the straw and blow it as straight as possible.

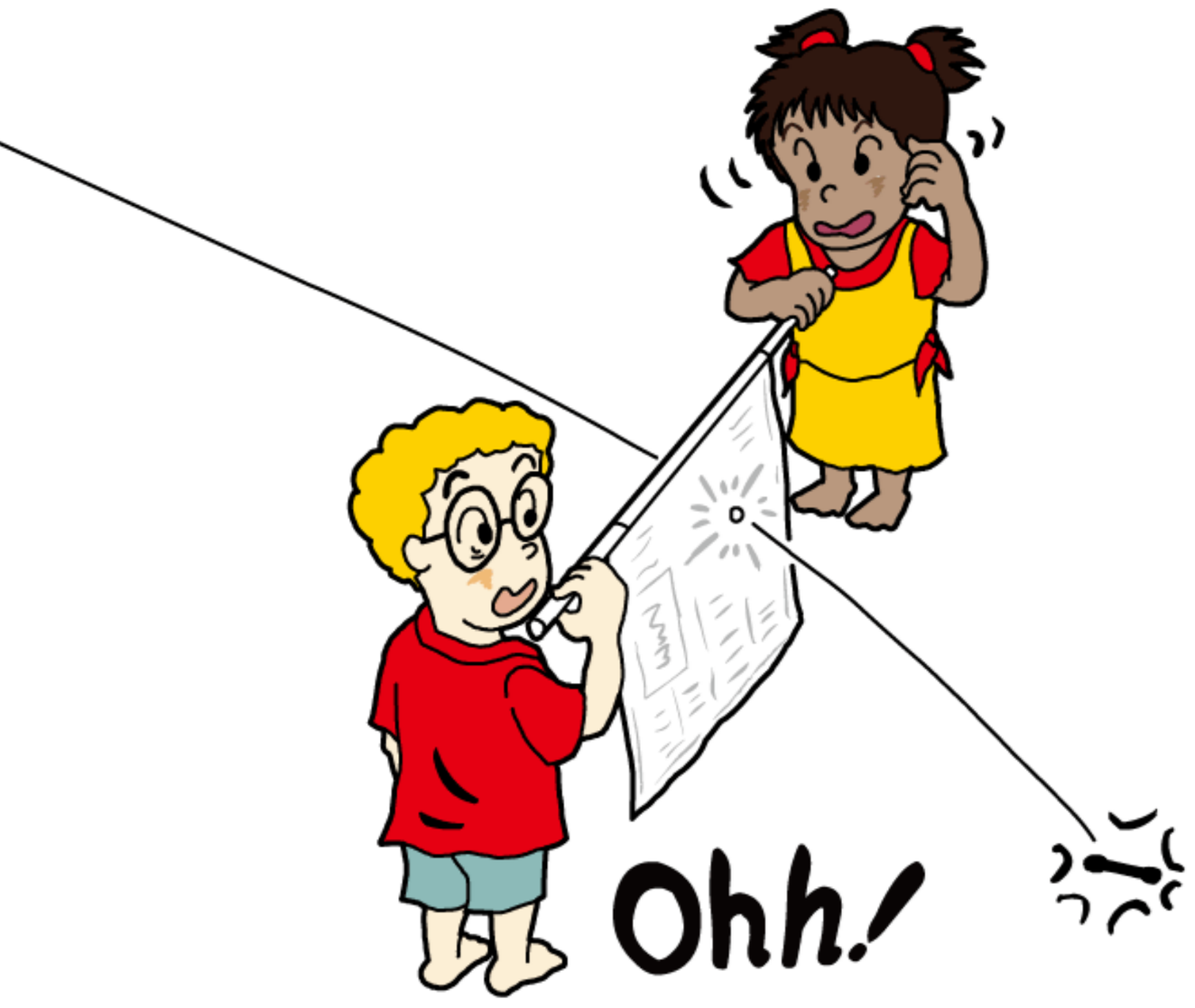
The results

of the experiment showed that

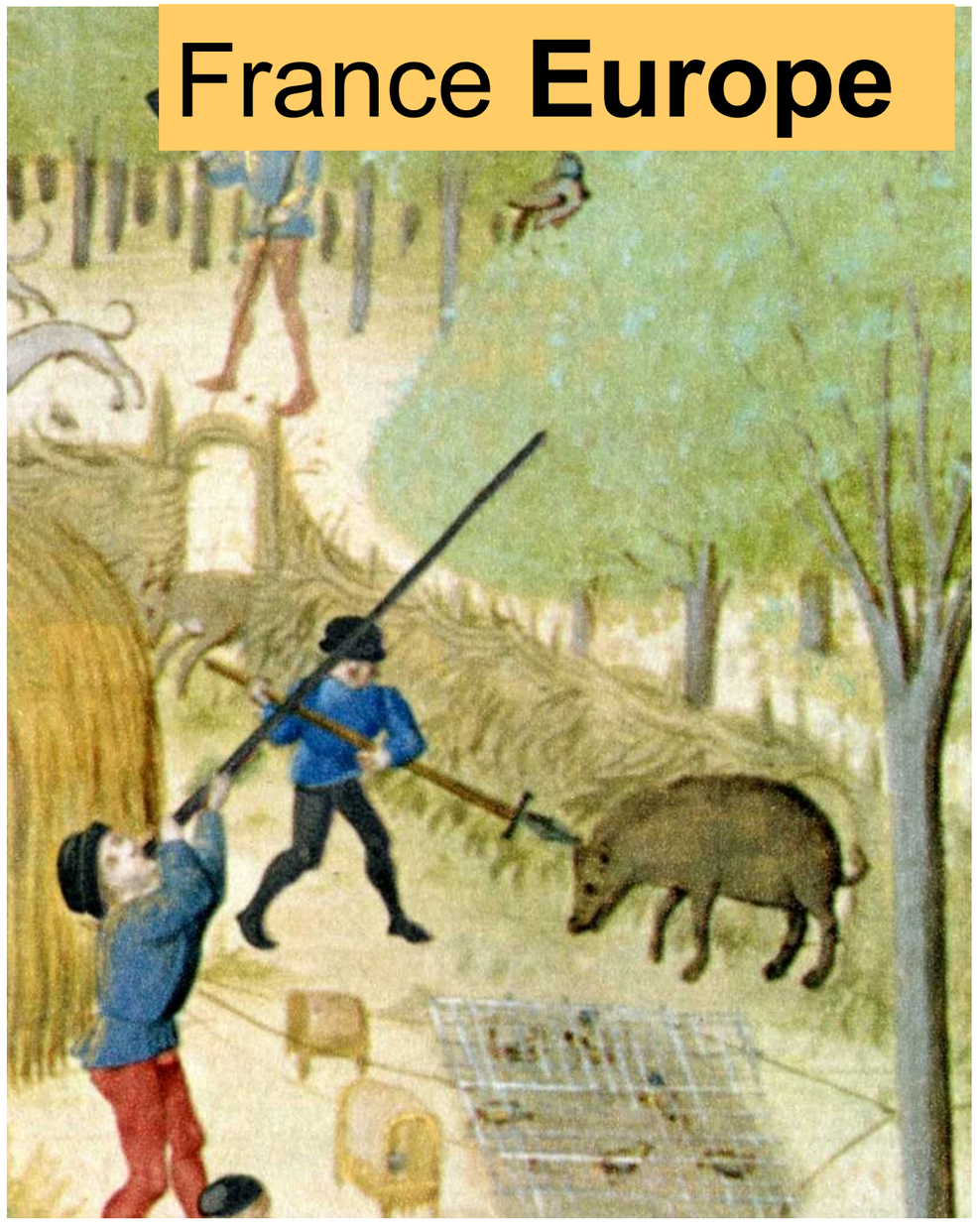
a.

The 8-straw pipe will make a bigger impact.

Even if the straws are connected to a length of more than two meters, the longer they are, the more momentum the cotton swab will gain and the faster it will fly. It will even pierce a hole in the newspaper and fly further.



Long blowpipes were historically used as a practical hunting tool in many parts of the world.



France **Europe**

Mexico **Central America**

Japan **East Asia**

Peru **South America**

By JialiangGao www.peace-on-earth.org - Own work, CC BY-SA 4.0,

work, CC BY-SA 3.0,

Guatemala **Central America**

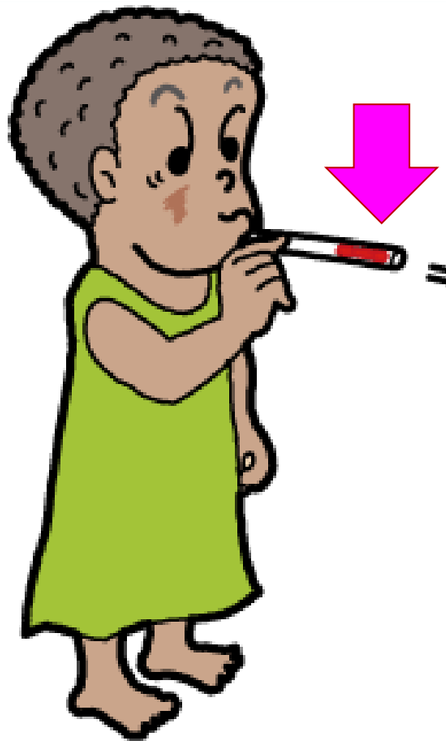
People made long, straight tubes with hard wood, bamboo, or cane.

Indonesia **South-East Asia**

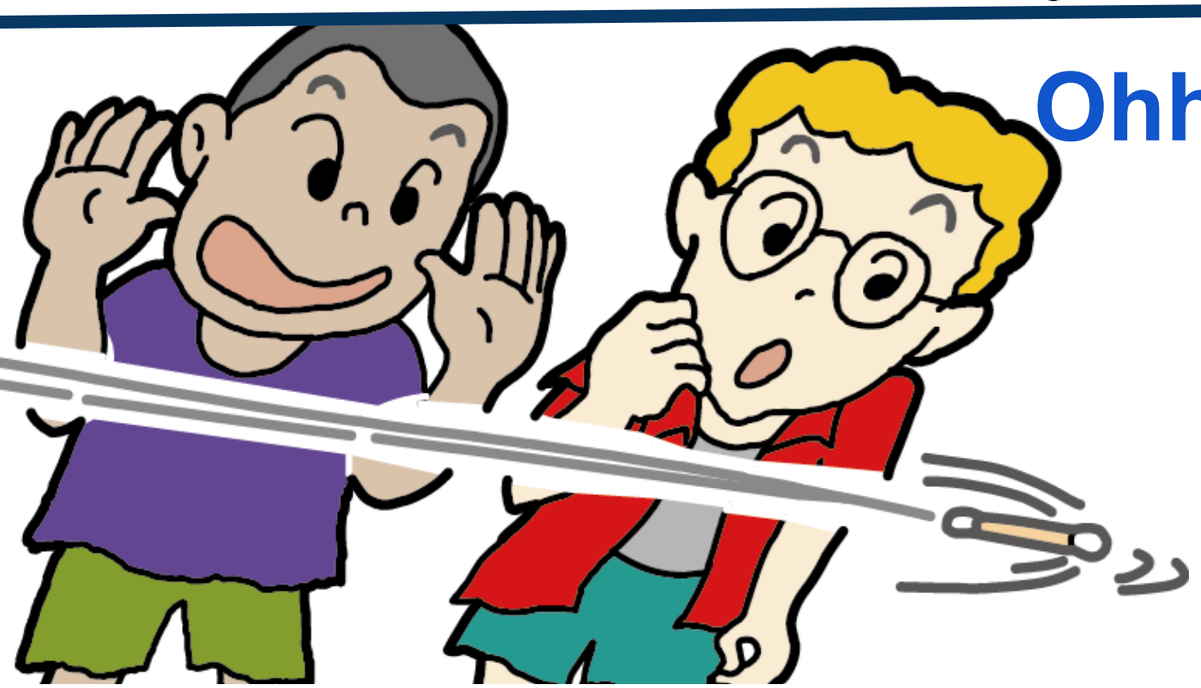
By Tropenmuseum, CC BY-SA 3.0, https://commons.wikimedia.org

Today, blowing darts is also a popular game and sport. Blowpipes are made from a variety of materials.

I didn't blow with much force,but the dart at the base flew far.
With a longer tube I can make it fly further!

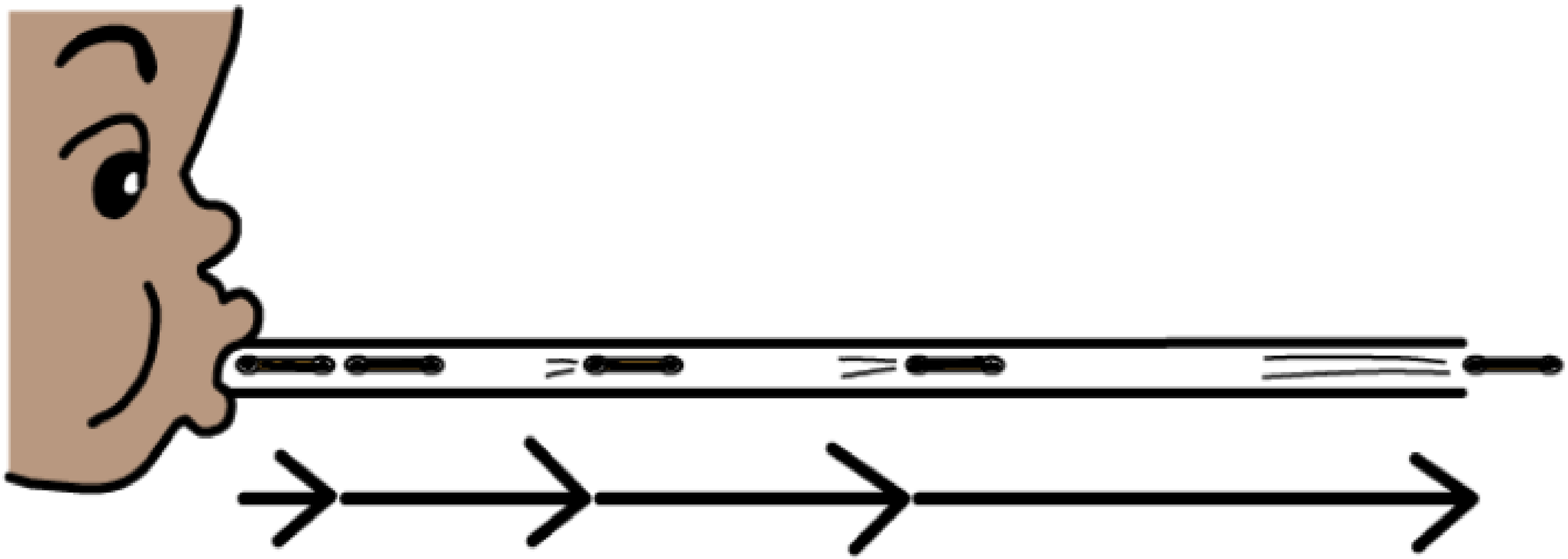


I blew with great force, but the dart in the tip didn't fly far.



Ohhh !

If you put the dart in the tip of the tube and blow, even blowing with great force, you cannot make it fly far because you can only apply force to the dart for a moment

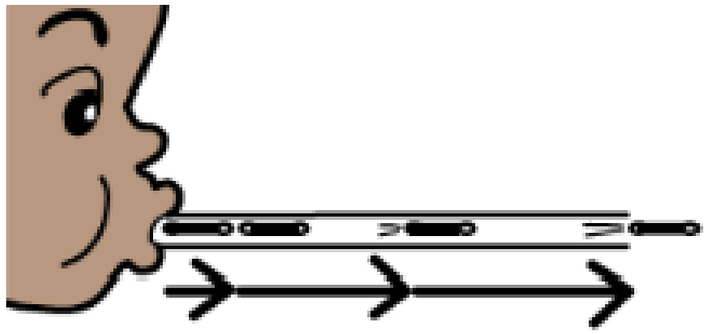


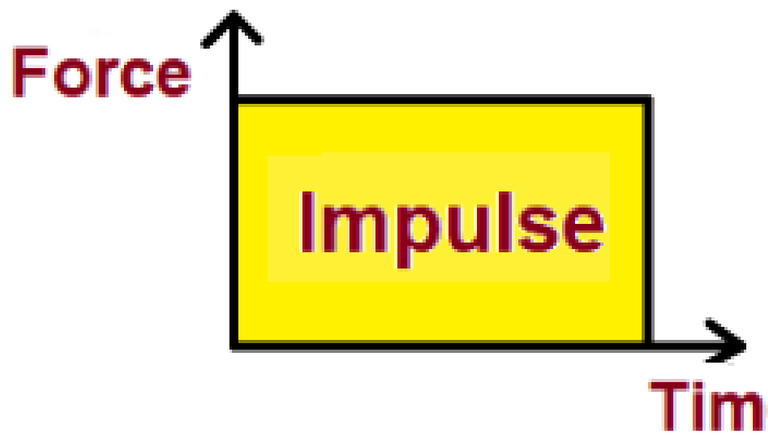
Blowpipes are designed to keep applying force to the dart for as long as possible before it flies out of the pipe.

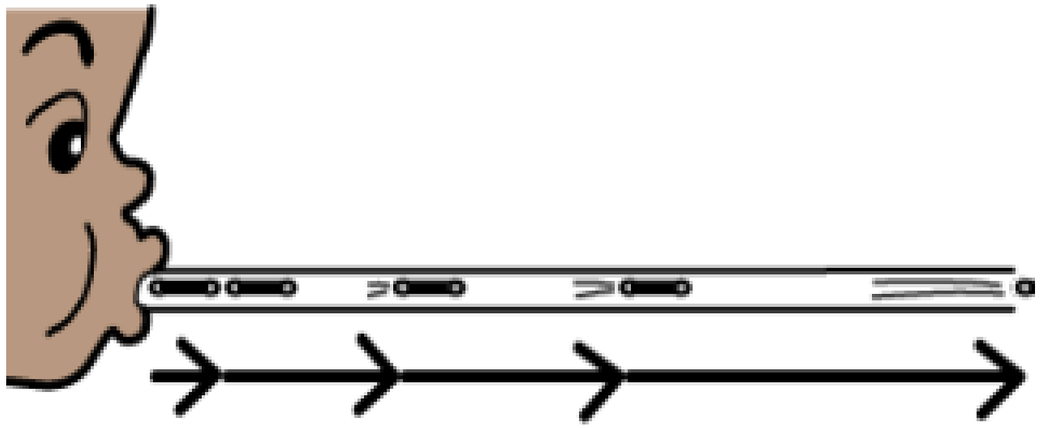
The velocity of a dart is not determined solely by the amount of force applied to the dart.

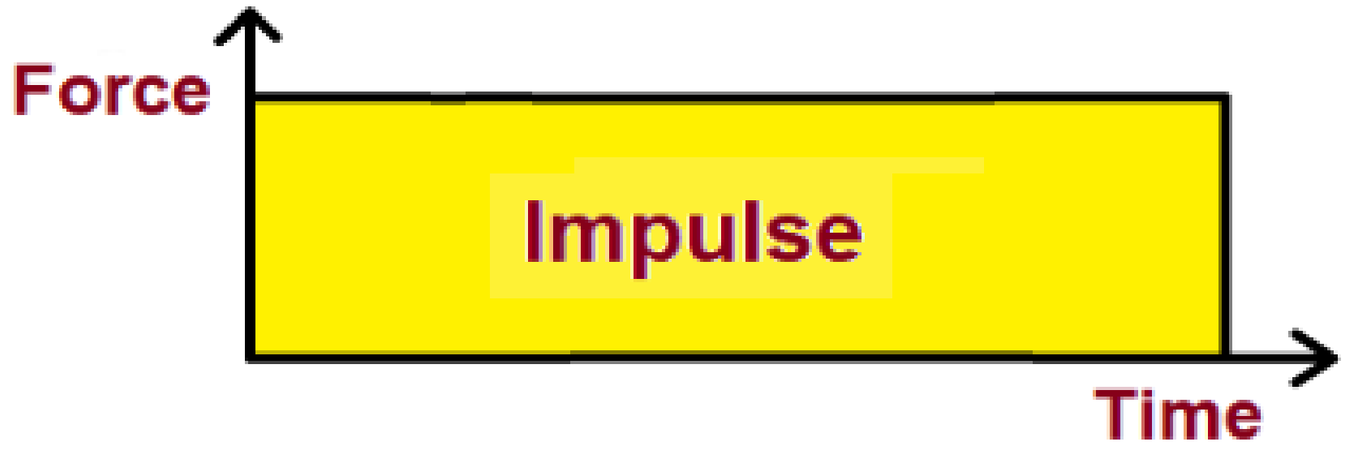
The amount of **force** applied to the dart multiplied by the **time** is applied to the dart.

This **force** x **time** is called the ***impulse***.



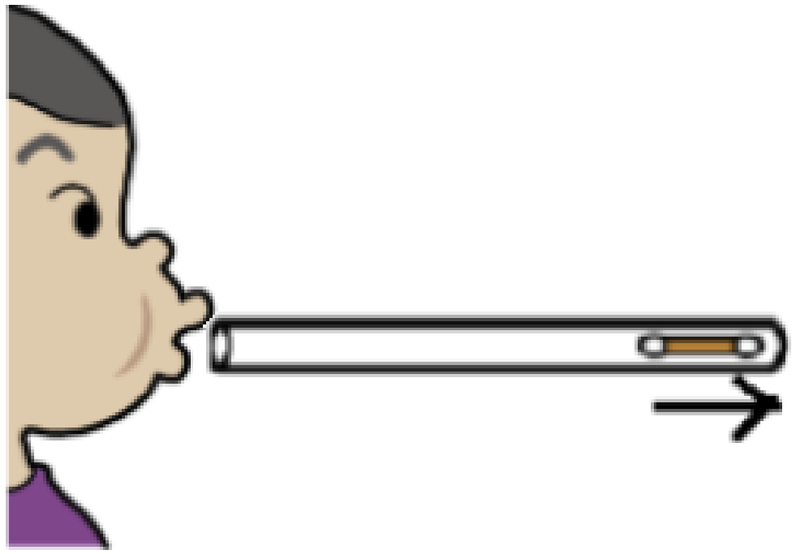


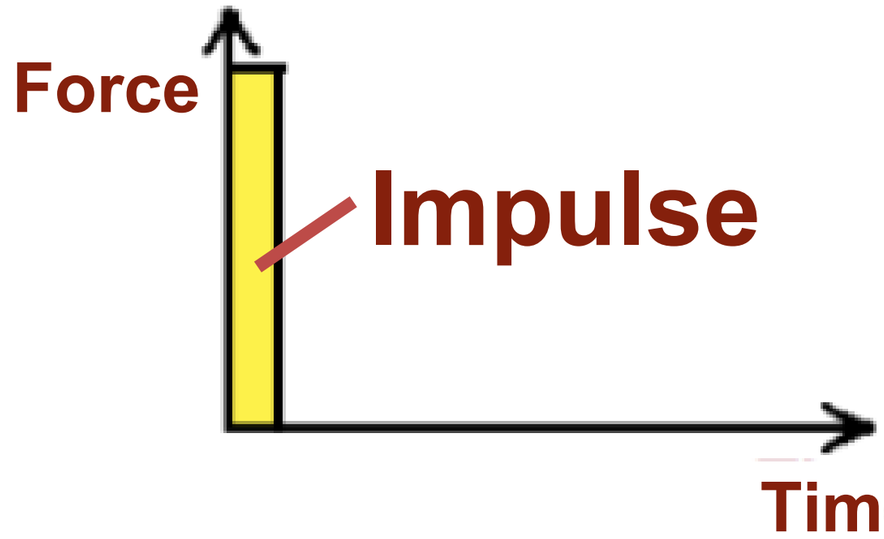


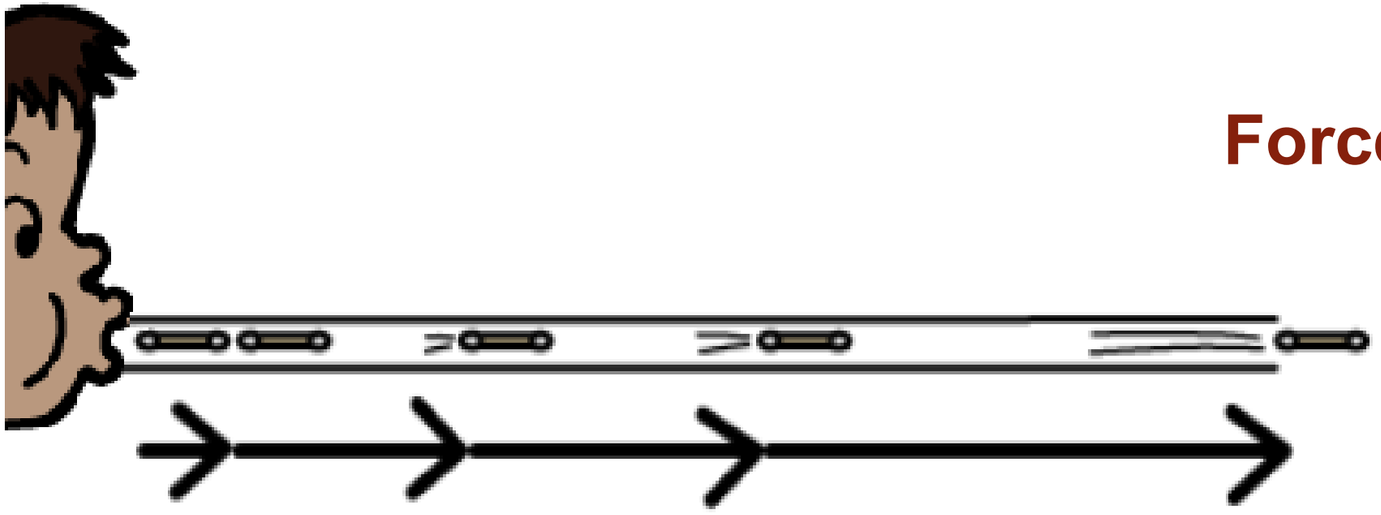


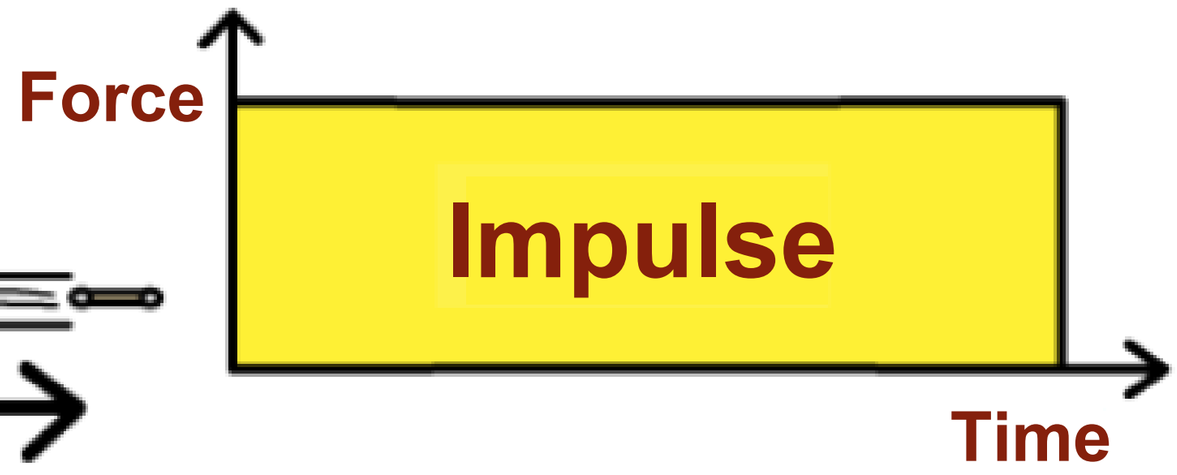
Force x Time = Impulse

The impulse determines the speed of the dart when it flies out.







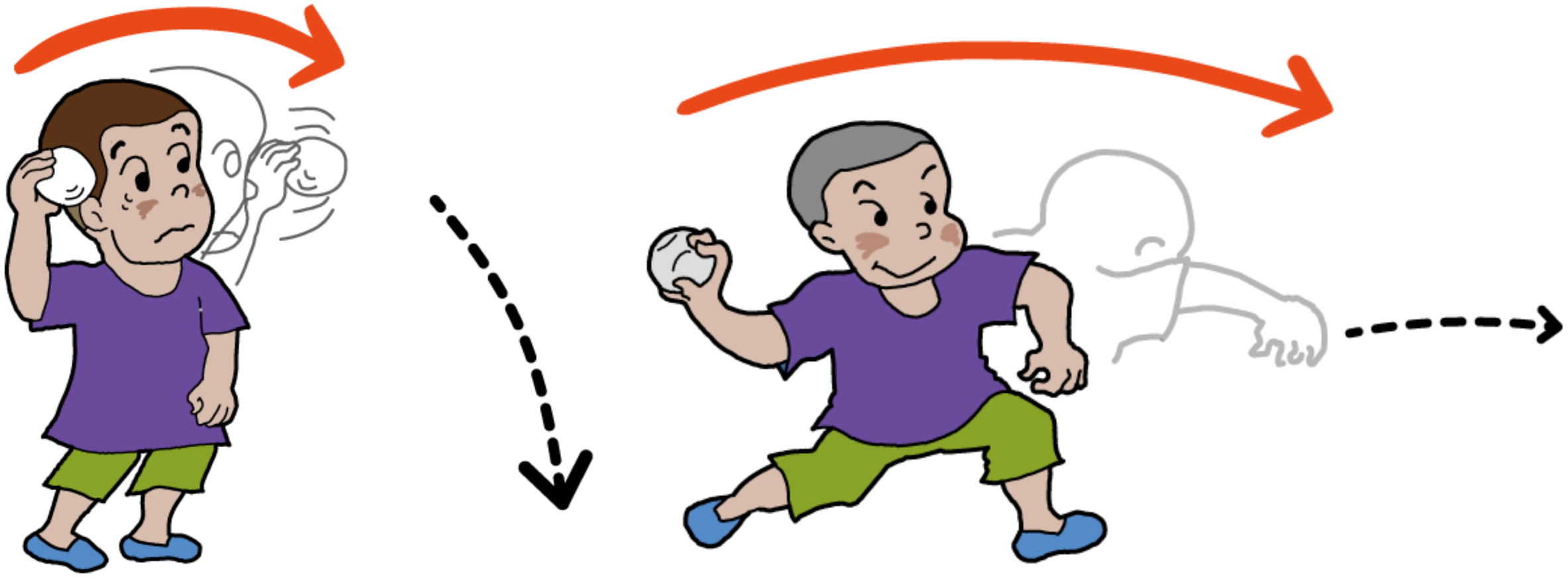


It means that no matter how great your force is, you can hardly make its movement faster if you can only apply it to an object for a fraction of a second.

Javelin throwers, for example, devise their form so that they can continue to exert force on the spear for as long as possible, right up to the last second. Force alone is not enough to achieve a good record.

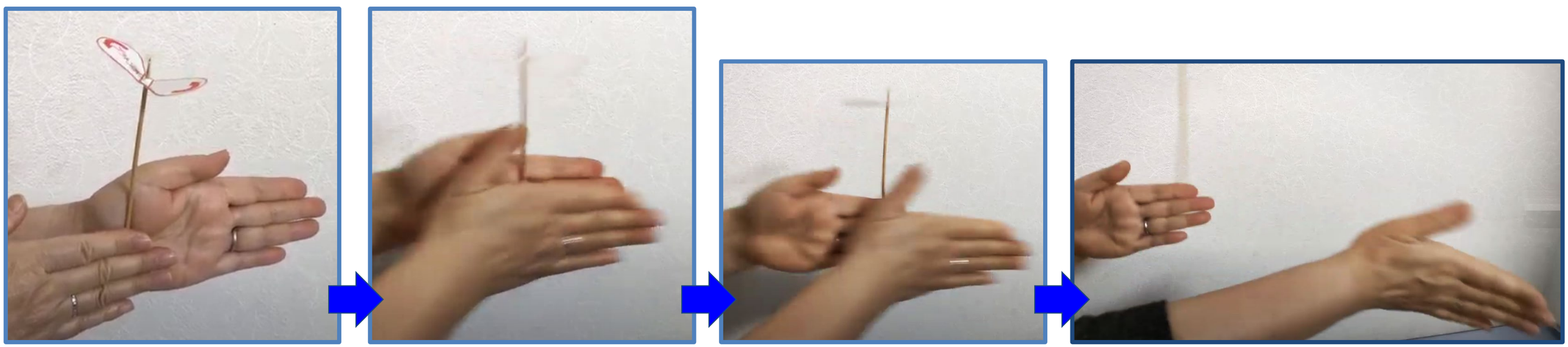
Have you ever played with throwing pebbles?
If you have a chance, be conscious of *impulse* and try to lengthen the time you apply force to the pebble as much as possible.
You will be able to fly it further.

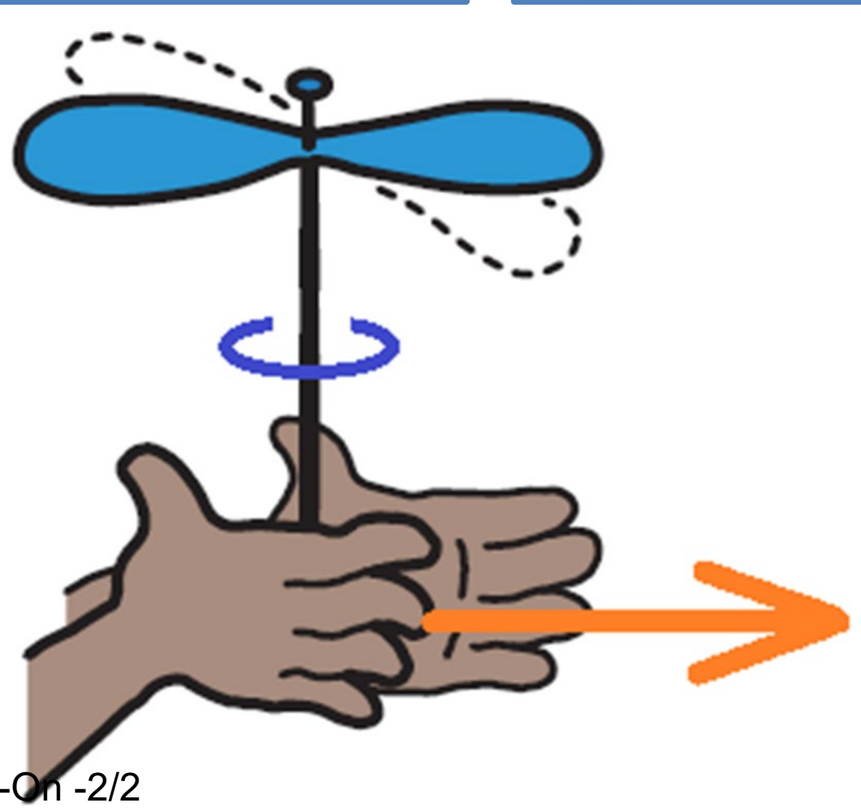
Note! Ensure there are no people around and no breakable objects in the direction of the throw.



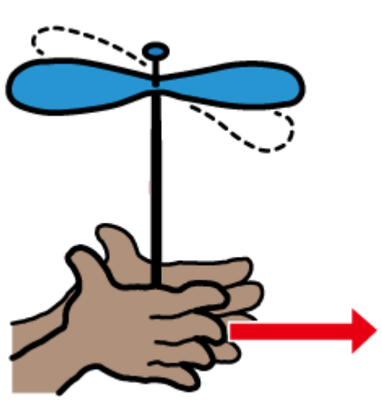
This is a toy called ‘Tombo’, which means ‘dragonfly’ in Japanese.
If you have the materials ready, make this toy and play with it while being aware of the ***impulse***.

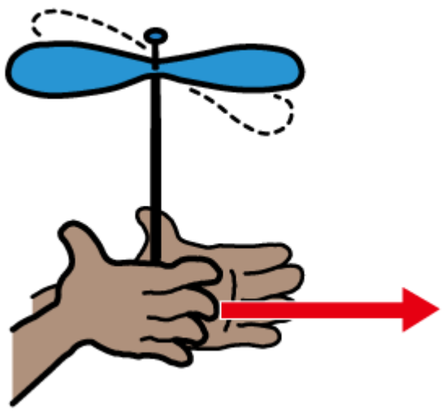
Grasp the shaft of the Tombo between your palms, rub the shaft with your palms and rotate it in one direction before releasing it. Then, the Tombo flies high into the sky.

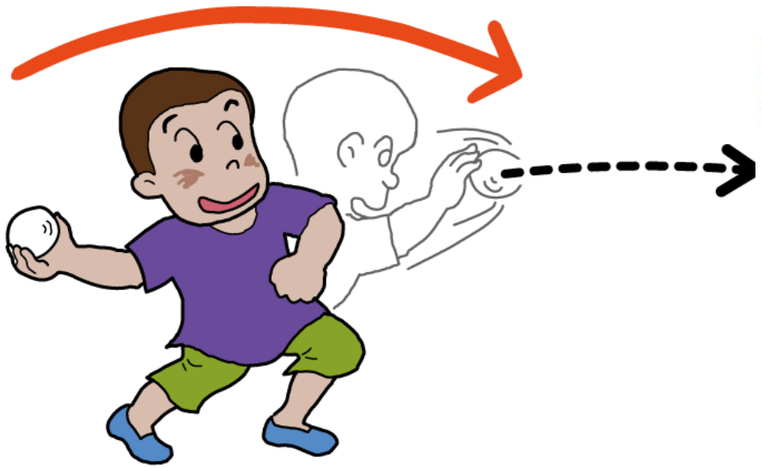


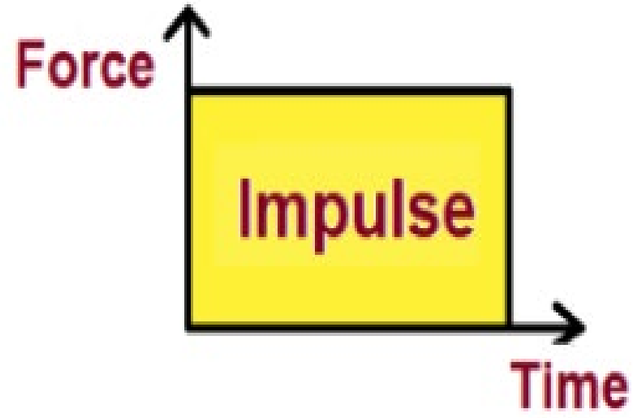


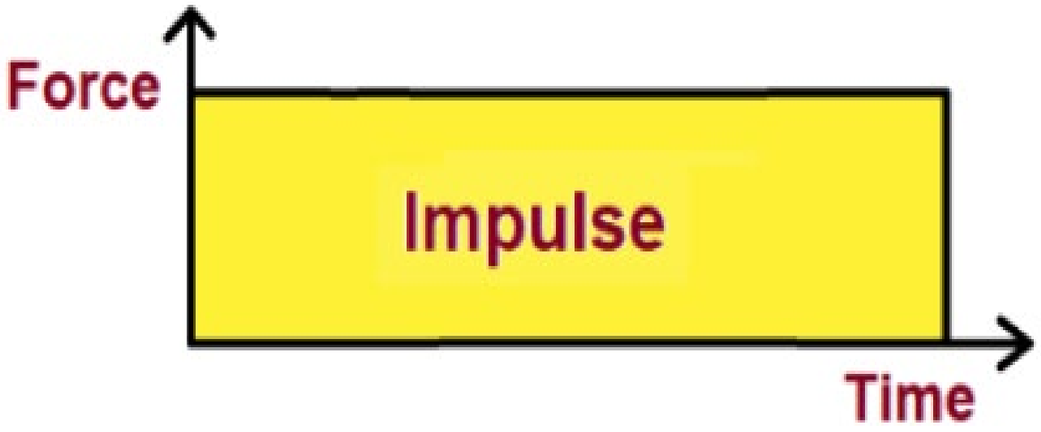
Rather than suddenly applying force and trying to turn the dragonfly faster, try gradually increasing the speed of your hand movements to transmit the force to the Tombo as long as possible.









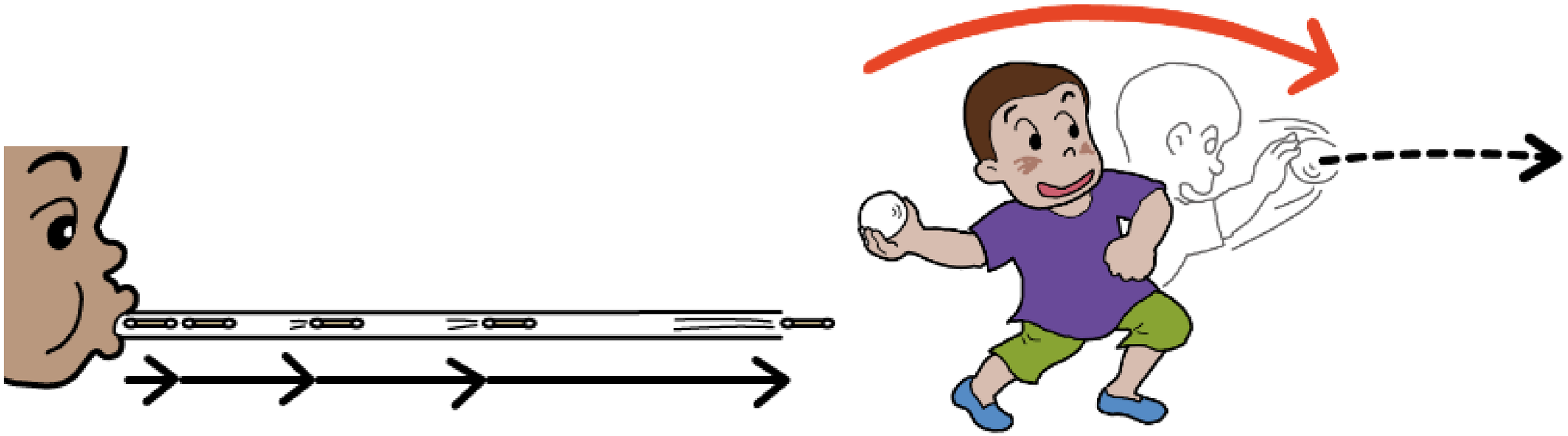


By being aware of the impulse learned with the blow dart, you can throw things far and make Tombo fly well.

Consider not only 'the size of the force' but also

Force x Time = Impulse

to move something successfully.

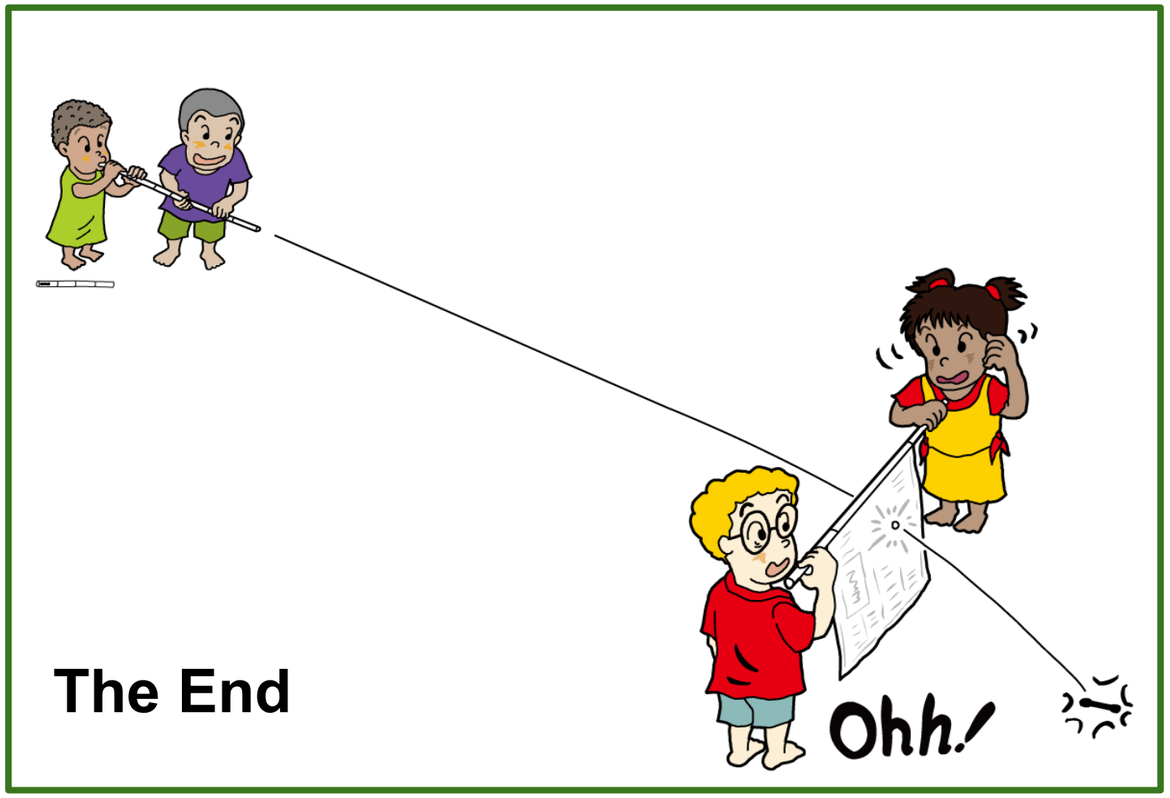


When we try to move something, we tend to focus only on the amount of force. But there is often a limit to how much force you can exert, depending on your ability.
However, the length of time can be increased even for those who cannot exert much force if they persistently apply it.

This can be applied in many more situations.
For example, people can be enthusiastic and spend more time on what they like and enjoy doing. People who are good at drawing or playing musical instruments and athletes are not born with excellent skills. Because they love what they do, they can continue to practice day in and day out, and the result is impulse, which enables the acquisition of excellent skills.

Moreover, you can even use it to influence people and society.
When negotiating something, it is often much more effective to make patient, incremental efforts repeatedly than to try hard once or twice.
Of course, it is possible to increase the force. However, it is essential to know there are also ways to apply small force for a longer time.

The End



Introducing Dynamics by Blow-Dart Experiment