

# Professor Brainstorm's What's In The Box?

## Safety First

Care should be taken when making the holes in the shoe box. (An adult should do this job.)

## About this Activity

### (Information for Parents and Teachers)

This experiment teaches children about how they see things. In particular, many children have the misconception that they see things because light shines in to their eyes - and then shines on to the objects that they see. The aim of this experiment is to let children investigate whether or not this is correct.

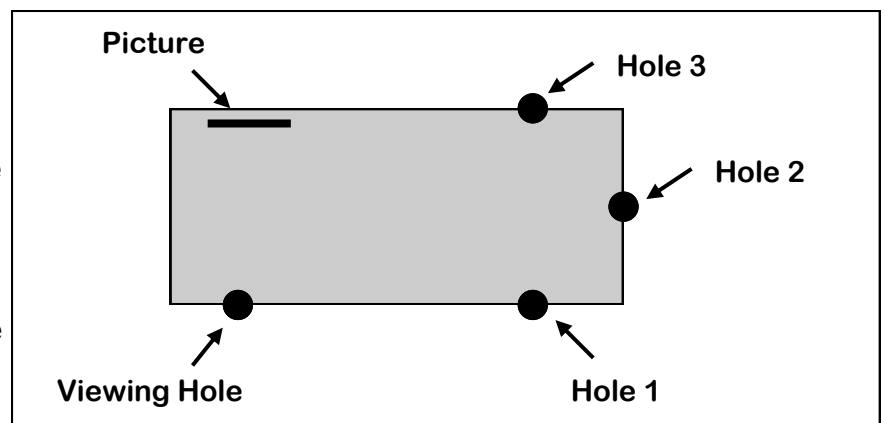
## What you Need

- A shoe box
- Black paint
- Sharp scissors
- Torch
- A small mirror



## How to make your 'What's in the Box?' activity

1. The first thing you need to do with your shoe box is to make sure that no light can get in to the box. For example, there may be 'thumb holes' or 'air holes' in the box. If this is the case, you need to cover them over with small pieces of card.
2. Next you need to paint the inside of the box with black paint. (If you don't have black paint, any other dark colour would do. Or if the inside of the box is a dark colour already, you may get away without painting it at all.)
3. Draw a small picture - and glue this on to the back of the box (as shown in the photo above).
4. Now use the sharp scissors to carefully make 4 small holes in the sides of the box. Each hole should be about 1cm in diameter. The holes should be in the positions shown in the plan view on the right. So there will be a 'Viewing Hole' in the front of the box, opposite where you have stuck the picture, and there will be 3 other holes (labelled Holes 1, 2 and 3 in the diagram), one in the front, one in the side and one in the back of the box, as shown.



### How to make your 'What's in the Box?' activity (continued)

5. Finally use some sticky tape to fix small cardboard flaps over each of the Holes 1, 2 & 3. (Just stick the flaps down on their top edge - so that each of the flaps can be lifted when necessary.)

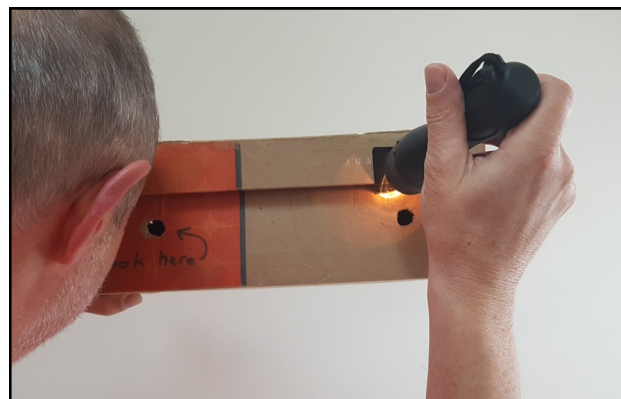
The front of your box should now look like the photo on the right.



### What's in the Box?

You will need to find an 'assistant' to help you do this activity.

1. First of all close the lid of the box look through the Viewing Hole. Can you see the picture inside the box? (If you can see the picture, there must be some light coming in from somewhere. Make sure the flaps are covering all of the Holes 1, 2 and 3, and that there are no other places where light can get in to the box.)
2. Ask your assistant to lift the flap on Hole 1 and shine the torch through that hole - as you look through the Viewing Hole again. (As in the picture on the right.)
3. Now try the same thing but with the torch shining through Hole 2.
4. And repeat again with the torch at Hole 3.



Could you see the picture each time? You should have been able to see the picture when the torch was directed through the holes in the front or side of the box (Holes 1 or 2), but you should not have been able to see it when the torch was shining through the hole at the back of the box (Hole 3).

### How does it work? (This is the science bit)

Let's think about how we could explain our findings using the idea that light shines in to our eyes and then on to the objects that we are looking at.

- When you shine the light in to the hole at the front (Hole 1), you can see the picture inside the box - but you can't actually see the light which is coming from the torch.
- When the torch is shone into the hole at the side (Hole 2), you can still see the picture - and you may just about be able to see the light coming from the torch.
- But, when you shine the torch in to the hole at the back (Hole 3), you can't see the picture any more. However, you probably can see the light from the torch as it comes through the hole.

So of these examples, only the second one (Hole 2) appears to agree with our idea that light shines in our eyes and then on to the picture.

However, we can explain all three of these findings if we make a different suggestion: We see an object because light shines on to the object - and then the light is **reflected**\* from the object to our eyes.

\* When we say that light is **reflected** from an object, this is not the same as saying that we can see our **reflection** in that object. To find out more about this, try the **Vanishing Reflection experiment**.

### How does it work? (continued)

So we can now explain the findings as follows:

- When the torch is shone in to Hole 1, this light shines on to the picture on the far side of the box. And the light reflects back from the picture to our eye. So we can see the picture. (Of course, the light doesn't only shine on the picture. It also shines on all of the back part of the box. However, since we painted the inside of the box black, none of the light that shines on these surfaces is reflected.\*)
- A similar thing happens when we shine the light in at Hole 2.
- However, when we shine the torch in through Hole 3, none of this light shines on to the picture. All of the light shines on to the black inside of the box - and is absorbed. So even though we can see the light which is coming directly from the torch, we cannot see the picture because there is no light shining on it.
- We should also of course mention the fact that we couldn't see the light when all of the Holes (1, 2 and 3) were closed. In this case there was no light coming in to the box. And as we have just discovered, we cannot see an object unless some light is shining on it.

(\* A perfect black surface would **absorb** all of the light that shines on it - so it would not reflect any light at all. However, in practice most black surfaces do reflect a small amount of light - but they reflect far less than surfaces which are other colours.)

### Now try this ...

Here is one more idea that you can try. If you had a small mirror, could you put the mirror somewhere in the box so that you could see the picture even when the torch is shone through Hole 3?

In fact you don't need a mirror to try this out. Just a small piece of kitchen foil will do. Stick the kitchen foil on to the inside of the box in the appropriate place - and see if it works. (If you can't work out where to put the foil, the answer is at the bottom of this page.)

**Where do you need to put the mirror?** If you stick a small mirror - or a piece of kitchen foil - on the inside of the front of the box (between the Viewing Hole and Hole 1), when you shine a torch through Hole 3, the light will reflect off the mirror on to the picture - and you should then be able to see the picture.