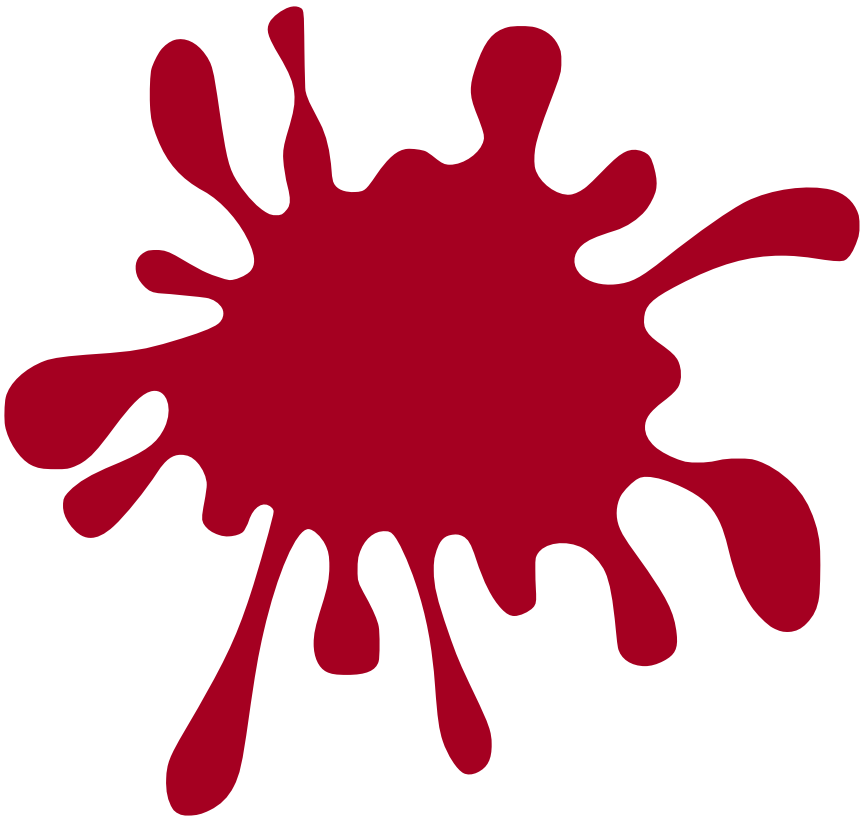
With blood splatter, does height or surface matter?



By Anthony D'Amore

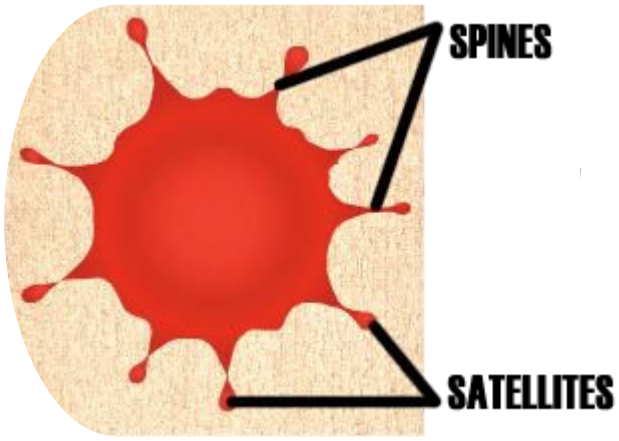
Grade 3, Age 8

Paynesville Primary School

Introduction

My father chopped his fingers in a lawn mower accident earlier this year. He went to hospital in an ambulance, however he went inside our house to wrap up what was left of his fingers and to try to stop the bleeding. When I got home, I saw the driveway and corridors in our house. There were trails of hundreds of drops of blood splatter on the floor. At first, they all seemed the same round circles, but when I started to help clean them up, I noticed that there were differences. The splatter in the kitchen seemed bigger than those in the entranceway. The splatter on the tiles were slightly irregular shapes, but the few that landed on a cardboard box were a perfect circle.

I talked to my father about the differences. My father said he had to reach up to get a clean tea towel in the kitchen and in the entranceway he bent down to change his boots, so may be that made a difference. Therefore, I wondered if there was an actual difference in blood splatter size depending on the height from where it was dropped. I also wondered if the type of surface that the blood landed on made a difference given what I had observed.



I searched on the internet and found a few websites that talked about height and surface for blood splatter, however their results for height were not the same and seemed highly variable. Most studies talked about the look of the splatter, describing spines and satellites.

Glass Smooth outside edges	Rough surface Scalloping edges with spines
	

https://accessdl.state.al.us/AventaCourses/access_courses/forensic_sci_ua_v17/06_unit/06-01/06-01_learn_text.htm#:~:text=As%20the%20height%20increases%2C%20the,by%20a%20droplet%20also%20increases.

The websites said that this varied by surface, however they noted neat circles with glass or smooth, polished surfaces. They also noted rough edges with spines and satellites when the blood drop landed on a rough surface.

This was also described on another website as, “if blood is dropped onto a smooth surface, such as glass or marble, the edge of the drop of blood appears smooth and circular. However, if the blood lands on a porous surface, such as wood or ceiling tile, then the edge of the drop of blood may form small spikes or extensions.” (from page 226: https://jkeilscience.weebly.com/uploads/1/3/1/2/131222493/chapter_8.pdf)

These descriptions were very different to what I had seen throughout my house, where the drops on cardboard, which was rough, were the neatest circles with smooth regular

circumferences. There was also no consistent information on any of the websites about what diameter you would get from different heights, so I wanted to look at this more closely through an experiment.

Aim and Hypothesis

My aim was to see if blood splatter from drops of blood change in shape or diameter when dropped from different heights or onto different surfaces?

Even though my internet research showed that smooth surfaces would have neat round circumference splatters and rough surfaces, like cardboard, would have lots of spines, I am basing my hypothesis on what I observed. Therefore, my hypothesis is that the blood splatter would have smooth edges on rough surfaces (like cardboard) and would have more irregular shapes on smooth surfaces (like shiny floor tiles).

I also hypothesis the diameter of the blood splatter would increase as the height of dropping increased, which was supported by my previous observations and my reading on the internet.

Based on my reading, there would be some variability in the diameter of blood splatter from each drop height.

Materials

For this experiment the materials needed are:

- Fake Blood
  - Teaspoons, tablespoons and a fork
  - Kitchen measuring cups
  - Cornstarch
  - Glucose Syrup
  - Red Food Colouring
  - Green Food Colouring
  - Water
  - Bowl
- Dropper (expired COVID RAT tests work well)
- Clear plastic ruler
- Tape Measure
- Step ladder
- Polished floor tiles
- Pencil
- 6 pieces of flat, fibrous textured cardboard (each about A4 size)
- 6 small pieces of paper or stickers
- A phone with internet (a Samsung A21 phone with 4G internet)
- A computer (this experiment used a DELL laptop).

Methods

Here are the variables that were tested and controlled for during this experiment.

Tested Variables (changed for experimental groups)	Controlled variables (stayed the same for experiments)
• Height of the drop in 300mm steps	• Measurement tools (ruler, measuring tape)
• Surface (rough cardboard or smooth tiles)	• Same surface for each group (cardboard all taken from the one box or same floor tiles)
	• Dropper (size of the drop)
	• Temperature/Wind/air movement
	• Same fake blood (same properties and viscosity)
	• Same angle of impact (perpendicular – 90^{o})

Things to remember during the experiment

The fake blood can stain, so only do this experiment over surfaces that can be easily cleaned, or if a cleanable surface is not available you might want to cover the area with newspaper or cling film, to prevent stains. Be careful to not touch the food colouring and measure the food colouring at arm's length in case it splashes on you.

Be careful not to disturb the drops of fake blood while they are drying. The fake blood drops look glossy and wet even after they have dried. If you are worried you could make an extra drop on one of the cardboard pieces that you can test (by touching it) to see when the drops have completely dried. You can't touch the test drops that you are using for the experiment otherwise this might change the results.

If any of the fake blood drops land on another drop or in a crease, fold, join or edge, do not count these drops in the experiment.

Be careful when using the step ladder, as you can fall from ladders if you aren't careful. Also, when you use your measuring tape, they automatically roll up again. Make sure you lock it when you have measured the right height so that it doesn't cut your fingers when it rolls up quickly.

There is a risk assessment for this project in the Appendix.

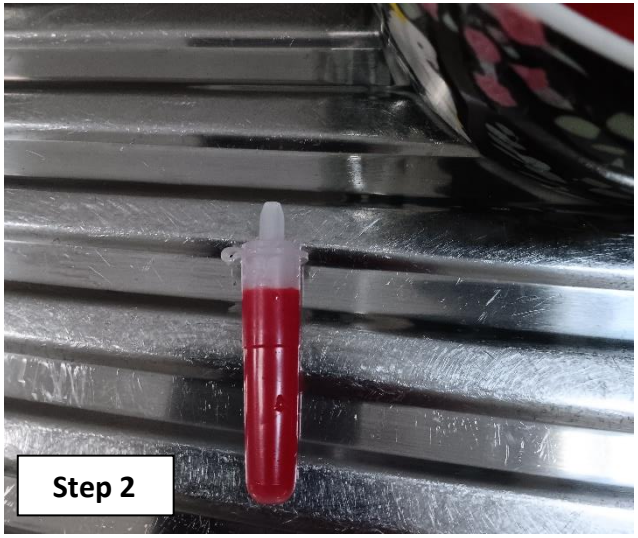
Step-by-Step Methods

1. Using a fake blood recipe from Halloween these were the steps to make the fake blood.
   a) Add 60ml of water to 2 tablespoons of corn starch in a bowl. Mix with a fork until smooth and no lumps remain.
   b) Add to this mixture, ½ cup of glucose syrup, 6 teaspoons of red food colouring and 1 drop of green colouring. Stir until mixed thoroughly.


Step 1.b

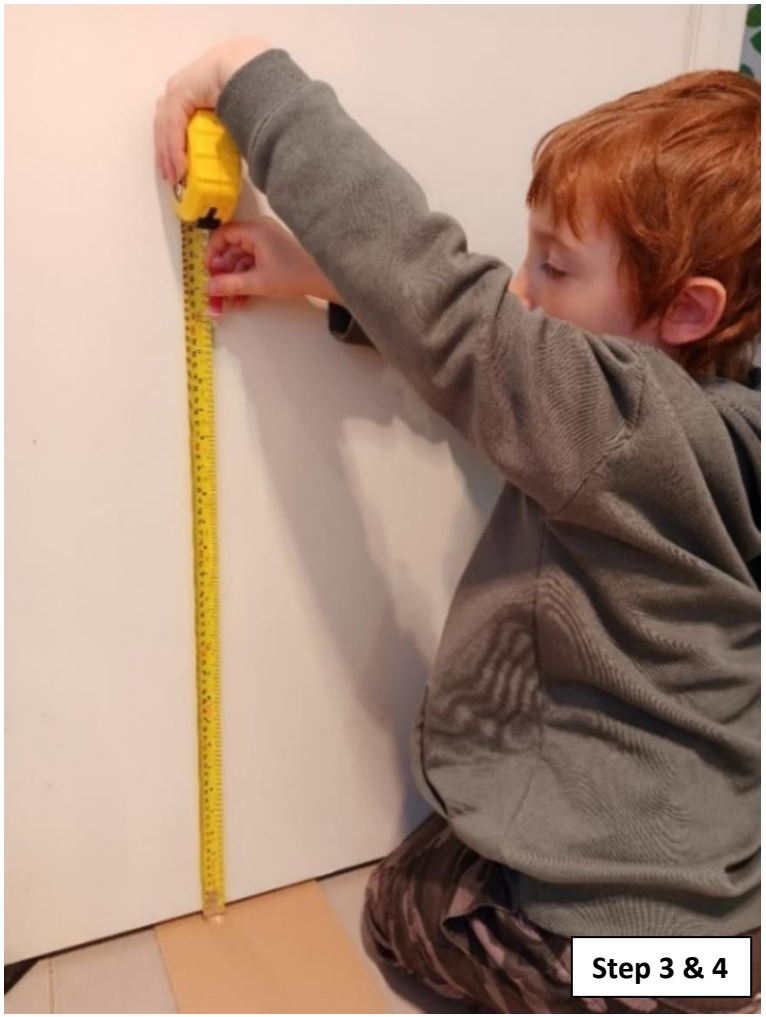

Step 1.b


Step 1.a

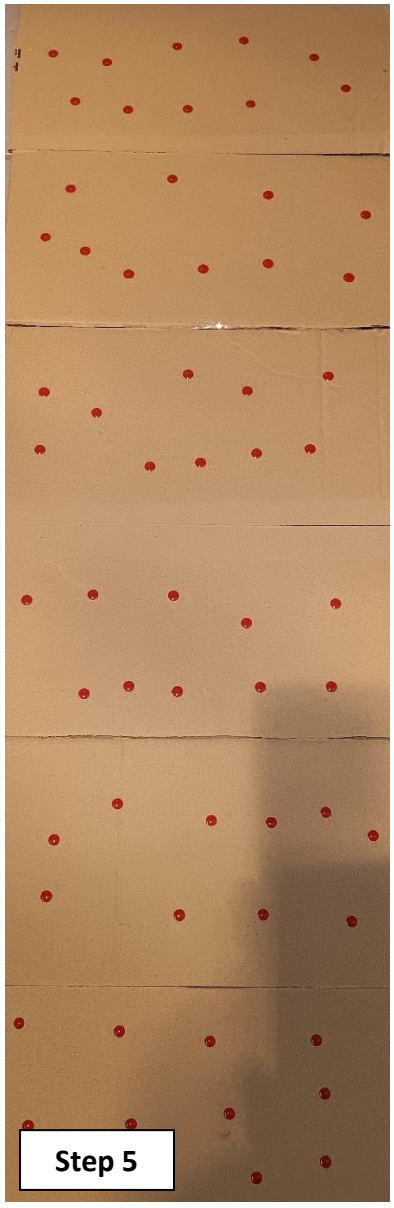

Step 2

2. Use a spoon to put the fake blood into the dropper.
3. Take the 6 pieces of flat cardboard (without folds). Lay one of the pieces of cardboard flat on the floor and then setup the measuring tape perpendicular (90^{o}) to the cardboard.
4. Hold the dropper vertically and drop the blood from the measured height. Move the cardboard across to a clear area and repeat with another drop. This should be repeated 10 times per height. The heights chosen for this experiment were 300mm, 600mm, 900mm, 1200mm, 1500mm and 1800mm. As the heights get higher you will need tape and will need to use a step ladder.
5. The cardboard should be labelled with a pencil and set aside to dry.
6. The same should be done for the floor tiles. Use a sticker or piece of paper to label each tile.

7. Once dry, the diameter of each blood drop was measured. Diameter was measured through the centre of the blood splatter and in up/down and left/right directions to ensure accuracy. Averages of measurements were used if they were different. The final measurement was noted in a table. The irregularities in the shape of the blood splatter were noted in photographs.
8. Data was analysed by calculating and comparing the mean (average) of each height and floor surface.




Step 5


Step 5


Step 7

Results

The drops that landed on the cardboard were all round circles with neat circumferences. The drops that landed on the polished floor tiles were all irregular circles with uneven circumferences. This made accurately measuring the diameter difficult.

Example of circular blood splatter on cardboard

Examples of irregular blood splatter on floor tiles

The blood splatter diameter increased as the drop height increased. Examples of the blood splatter from the different drop heights are shown in the table of photographs. The table of data shows the diameter of each blood splatter and the graph shows the average diameters of blood splatter for each of the drop heights and surfaces.

Example blood splatter and their measurements from each height onto cardboard

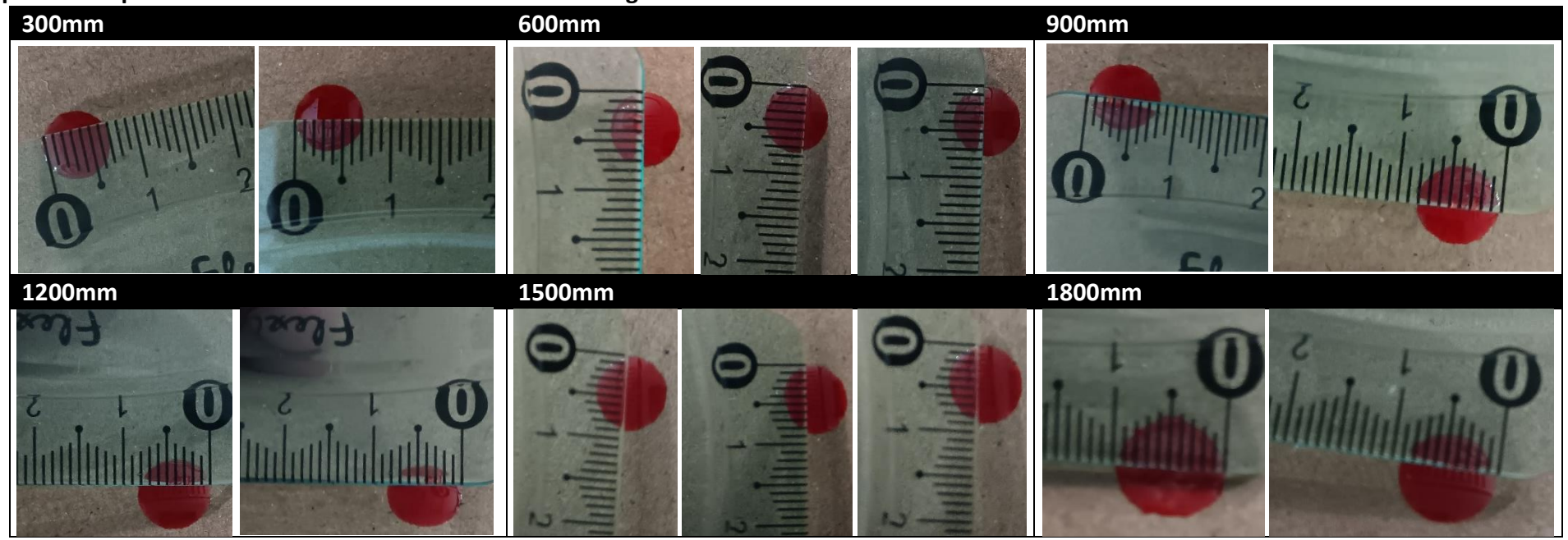
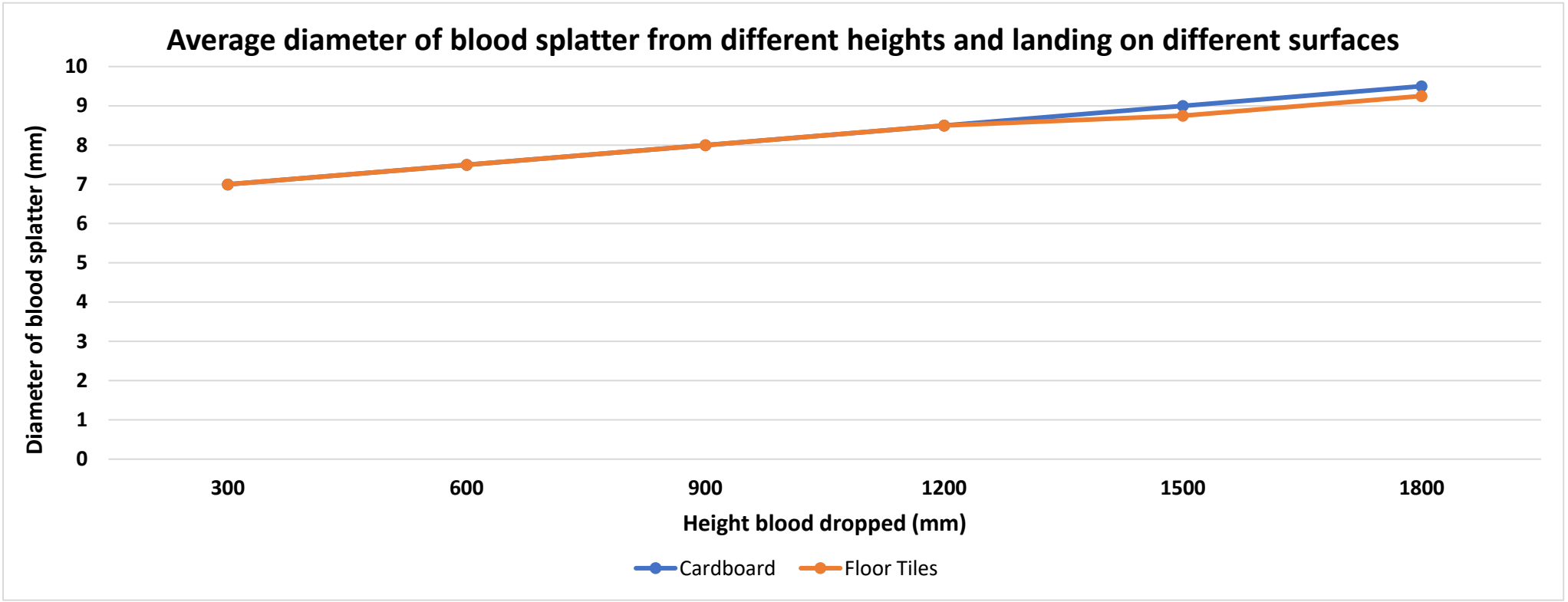


Table showing blood splatter diameters for each height onto both surfaces

		Drop 1	Drop 2	Drop 3	Drop 4	Drop 5	Drop 6	Drop 7	Drop 8	Drop 9	Drop 10	Mean
Cardboard	300mm	7mm	7mm	7mm	7mm	7mm	7mm	7mm	7mm	7mm	7mm	7mm
	600mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm
	900mm	8mm	8mm	8mm	8mm	8mm	8mm	8mm	8mm	8mm	8mm	8mm
	1200mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm	8.5mm
	1500mm	9mm	9mm	9mm	9mm	9mm	9mm	9mm	9mm	9mm	9mm	9mm
	1800mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm	9.5mm
Tiles	300mm	7mm	7.5mm	6.5mm	7mm	7mm	6.5mm	7mm	7mm	7.5mm	7mm	7mm
	600mm	7.5mm	7.5mm	8mm	7.5mm	7.5mm	7mm	7.5mm	7.5mm	7.5mm	7.5mm	7.5mm
	900mm	8.5mm	8mm	7.5mm	8mm	8mm	8mm	8.5mm	8mm	8mm	7.5mm	8mm
	1200mm	8.5mm	9mm	8.5mm	9mm	8.5mm	8.5mm	8mm	8.5mm	8.5mm	8mm	8.5mm
	1500mm	9mm	8.5mm	9mm	8.5mm	8.5mm	9mm	8.5mm	9mm	8.5mm	9mm	8.75mm
	1800mm	9mm	8.5mm	9mm	9.5mm	10mm	9.5mm	9mm	9.5mm	9.5mm	9mm	9.25mm



Discussion

The results showed that blood splatter landing on cardboard had round circumferences and blood splatter landing on smooth polished floor tiles had uneven circumferences. This supported my hypothesis, as this is what I had noticed on the day of my dad's accident, however this contradicts what I read on the internet. The reasons that were given on the internet regarding why the uneven circumferences were seen on rough surfaces were described as due to breaking surface tension. I am not sure why rough cardboard would keep the circular drop shape, but a polished tile would not. It is perhaps not related to surface tension. Perhaps the fibres in the cardboard hold the drop together and stops it from spreading out unevenly, whereas the smooth floor tiles had nothing to stop the spread of the drop. There were also no spines or satellites visible on any of the splatters on any surface.

Somewhat related to this result was that the diameter of the fake blood splatter was very consistent when dropped from the same height. However, there seemed to be a greater variability in diameter when they landed on the tiles. This was probably because it was more difficult to accurately measure a diameter for these blood splatters as the irregular circumference of each circle was so uneven, so perhaps this variability just related to the shape issues. The consistency noted in the diameter was different to what I hypothesized. My hypothesis was based on my research on the internet. Perhaps variables that I controlled for, were what caused the differences noted on the internet, for example air movement, variation in the size of the original blood drop or different angles of impact for each drop.

The results also showed that the diameter of the blood splatter increased as the height from which it dropped increased. This confirmed my hypothesis. This result makes sense as the drop spreads out because of the speed it hits the ground. If it is dropped from a greater height, gravity will cause the drop to accelerate and so will hit the ground faster than a drop released from a lower height.

Application of results

Blood is often collected at crime scenes so they can try and match DNA to a person who did it. Perhaps they should also measure the diameter, as these results showed the blood splatter followed a consistent pattern. This means that depending on where the blood splatter at a crime scene falls, if it landed on cardboard or paper, you could quite accurately predict what height it was dropped from. Therefore, you might be able to calculate the height of the criminal and other important information, which might help to catch the person responsible.

Future research

In the future, this experiment could be repeated by trying more different surfaces, such as concrete, plastic and floorboards. It could also be repeated using different liquids, such as liquids similar to urine or saliva.

Trying this experiment with different combinations of liquids and surfaces would have lots more applications. Firstly, I'd like to try something similar to urine on smooth plastic and floor tiles. I could use this regularly to prove my innocence when I'm blamed for messing up the toilet floor or toilet seat. If there was a similar increase in diameter, I could use those results to prove it is my much taller family members, by measuring the size of those splatter drops!

Conclusion

Blood splatters that landed on cardboard had round circumferences and blood splatters that landed on smooth polished floor tiles had uneven, irregular circumferences. The diameter of the fake blood splatter was consistent when dropped from the same height. The diameter of the blood splatter increased as the height from which it dropped increased.

Acknowledgements

Thank you, Mama, because she drove me into Bairnsdale and paid for all the materials for the experiments.

Thank you, Papa, for letting me use your phone, internet and computer. Papa helped with experiment as I needed someone to hold the measuring tape while I dropped the fake blood. Papa also helped by typing some of the report from what I handwrote and told him to type. Papa showed me how to draw tables and put in photos on a computer because I wasn't sure how to do that.

Thank you, Emily, for being the crime scene model for my Science Fair poster.

References

Access Virtual Learning, Alabama State Department of Education – 6.01 Blood Splatter https://accessdl.state.al.us/AventaCourses/access_courses/forensic_sci_ua_v17/06_unit/06-01/06-01_learn_text.htm#:~:text=As%20the%20height%20increases%2C%20the,by%20a%20droplet%20also%20increases (Accessed on 5th April 2024)

Forensic Science Simplified - Principles of Bloodstain Pattern Analysis https://www.forensicsciencesimplified.org/blood/principles.html (Accessed on 5th April 2024)

J Keil Science, New York – Chapter 8: Blood and Blood Splatter https://jkeilscience.weebly.com/uploads/1/3/1/2/131222493/chapter_8.pdf (Accessed on 5th April 2024)

Appendix: Risk Assessment Form

SCIENCE TALENT SEARCH

Risk Assessment Form:

Name of Entry With blood splatter, does height or surface matter?

Student Name: Anthony D'Amore Signature: _____ Date: 4 May 2024

Student Name: _____ Signature: _____ Date: _____

Your assessment should include sample handling, storage, disposal, spill procedures and use of machinery...

Use as many pages as necessary, a blank table provided on the next page.

Type of Risk	Hazard	Level of Risk	Precaution taken to control risk	Source of information
[x] Chemical or microorganism [ ] Procedure or equipment	Stains or injuries caused by food colouring.	Low	Conduct experiment over cleanable surfaces or cover the surface with newspaper or cling film to prevent stains. Take care not to touch the food colouring and carefully drop the food colouring at arms length so it doesn't splash your face.	
[ ] Chemical or microorganism [x] Procedure or equipment	Falling from ladder	Low	Take care when using the step ladder.	
[ ] Chemical or microorganism [x] Procedure or equipment	Cutting fingers with measuring tape.	Low	Make sure you lock the measuring tape so it doesn't wind back and cut your fingers	
[ ] Chemical or microorganism [ ] Procedure or equipment				

Possible sources of information to complete your risk assessment

- www.riskassess.com.au
- Search: safety data sheet