

Suitable for
3-7 years

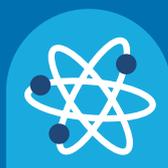
- ✓ Solo
- ✓ Pairs
- ✓ Groups

Circus activity

Juggling

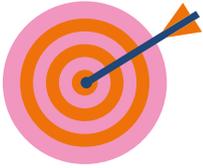
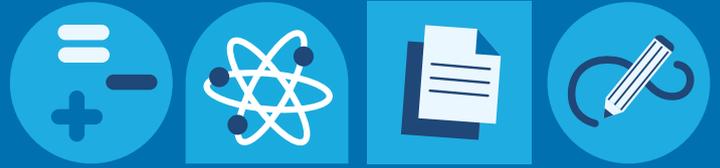
How to guide

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in collaboration with electrical engineer,
Paul Kirkland



Circus activity

Juggling and computer vision



Aim

The aim of this activity is to use circus skills to explore how our brain works to allow our eyes to follow objects and let us complete tasks like throwing, catching and juggling. This links with our activity on computer vision, thinking about how can computers perform the task as well as our eyes do.



Timings

~20 minutes.



Materials and equipment

- Our instructional videos on You Tube can be found [here](#). You can find step by step guides to what the children can do as well as some demos of advanced skills by circus professionals plus a video showing how our engineer Paul can use his camera to track/follow the progress of the ball during juggling.
- Balls



Instructions

Work through the below step by step guide building up juggling skills starting from watching balls to throwing and catching.

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1. Watch that ball!

Concepts & vocabulary

- **Push**
- **Curve**
- **Parabola (a symmetrical curve)**
- **Predict**
- **Rhythm**
- **Brain**
- **Focusing our attention**
- **The brain acting like a computer and vice versa**

How to perform 'Watch that ball!'

Try throwing a ball between your hands (or catch a ball thrown by an adult).

Try watching

- a. your hands;
- b. the ball as it moves;
- c. the top of the curve the ball makes.

When we juggle with more than one ball, we want to watch the top of the curve because our brain can do a quick calculation to know exactly when, where and how the ball will land.

Questions

- Which sort of throwing feels more difficult? Why do you think that is? Watching your hands will feel the most difficult. If you are only watching your hands, your brain can't collect any information about where the ball is in the air and when it is going to land, so you are less prepared for the landing.
- Why do you think your brain can predict where the ball will land? (Clue: look at the shape of the parabola) The parabola is symmetrical, which makes it easier for your brain to predict where the ball will land.

- **What helps to make your throw symmetrical?**
Hands at the same height.
- **How can you change the shape of the parabola?**
If you use a smaller pushing force to throw the ball, the parabola is lower. If you use a larger pushing force to throw the ball, the parabola is higher.
- **Can you make the parabola asymmetrical? Do you think that would make the ball harder or easier to catch? Why?**
Hands at different heights. It might be harder to catch as it might be harder for the brain to calculate where the ball will land.
- **Energy from your arm pushes the ball up. What makes it fall down again?** Gravity and air resistance.

Variations

Juggling with a Friend

- 1. Two-Person Passing:** Start facing each other with one person holding two balls (one in each hand) and the second person holding one ball in one hand. Between the two of you there should be one empty hand. The first person is going to put one of their balls into the empty hand by placing it. They will always go straight across, using the hand directly opposite the empty hand. The second person is now going to place the ball they started with into the first person's empty hand. The second person is always going to do this by going diagonally opposite (i.e. from their right hand to the other person's right hand). Once you've got the hang of this you can try it with throws, and adding in another ball.
- 2. Two-Person Cascade:** You can juggle three balls with a friend by standing directly next to each other. You each use one hand - the ones on the outside work best. It can be helpful to put the hands in the middle around each other's waists or behind your backs so you don't accidentally use them.
- 3. Two Ball version:** Start with two balls. One person starts by throwing a ball from their hand to their partner's hand. When this ball is at the top of the arc, throw the second ball. The pattern is complete once both balls are caught and have crossed over.

- 4. Three ball version:** One person holds two balls in one hand, the other holds one ball. The person holding two balls throws the ball at the front of their hand. When it is at the top of the arc, throw the second ball. When the second ball is at the top of the arc, throw the third ball. You can either catch all of the balls and take a pause, or if this is working well, keep going by taking turns to throw the next ball. This is the most well known juggling pattern and is called a cascade. To practice for doing a cascade on your own, swap positions with your partner so you practice both sides of the pattern.

Juggling with a clap!

Concepts and vocabulary

- Push
- Curve
- Parabola (a symmetrical curve)
- Predict
- Rhythm
- Brain
- Focusing our attention
- The brain acting like a computer and vice versa
- Thinking Time

How to perform 'Juggling with a clap!'

Throw the ball from one hand to another and see if you can clap your hands while the ball is in the air! Keep watching the top of the curve. Then try and see if you can clap more times.

Questions

- How can you clap more times? You can try to clap faster, to fit more claps into the same amount of time.
- How can you increase the amount of time you have for clapping? By throwing the ball higher.

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Two ball juggling

Concepts and vocabulary

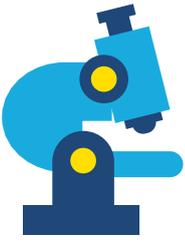
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How to perform 'Two ball juggling'

1. Throw one ball straight up in the air, and then the other one. Make sure the balls go as high up as your shoulder.
2. Cross over the balls making sure they go roughly the same height (not exactly the same height though, or they will bump into each other).
3. Throw one ball from one hand to the other. Make space to catch it by throwing the second ball. Both throws are crosses - crossing from one hand to the other. Both throws should be at the same height (about eye level).

Question

- One of the reasons that computers were designed was so that they could do lots of calculations and solve lots of problems at the same time. How is a human brain similar to a computer? Human brains are the most complex structures in the world. Both human brains and computers can perform many different tasks at the same time. Computers were designed to be like brains, so that they could solve lots of problems quickly. When a juggler is juggling, their brain is calculating where all of the balls are at the same time so that the juggler can catch all of them and not let them drop.



How it works?

Charlie the juggler is using his expertise in tracking objects by watching their movement in space. His eyes are watching the top of the parabola (an arc made by the ball which is symmetrical and therefore easy to predict) which is helpful because he doesn't have to look in many different places or be distracted by the movement of his hands.

Charlie is able to catch lots of objects quickly because he is practised in the muscle memory of throwing and catching, and his visual cortex is able to perform rapid calculations about where all six balls are going to be.

Like the silicon retina cameras which Paul works with, Charlie's visual cortex is triggered by movement. The technique which helps in juggling is knowing where to focus attention - the top of the arc.



Extensions

This circus activity links with our How do Computers see activity.

Also if you enjoyed learning through circus skills try our other activities like Structures and Balances, Spinning Plates and Wind Turbines or Hula hooping with Rocket Launching or Satellite Orbits