Engaging young children in the research process

It can be challenging to engage children of primary school age in research – especially when biological samples (e.g. hair, blood, cheek swabs), or potentially distressing assessments (e.g. brain scans) are involved. It is important to explore carefully the acceptability and feasibility of the proposed assessments. Researchers need to think about how each individual process is communicated, how permission and consent can be managed in an ethical and valid way with the children and their families, and how participation might be sustained over time. Young children are best placed to inform this.

We explored the potential for working with children to help them understand the research process in a fun and engaging way. Our philosophy here, borrowed from previous work on "Children's Voice" (Ruddock et al 1996), is that young children are fully capable of joining professional researchers in becoming scientists. The Oxford English Dictionary describes "scientist" as "*a person who is studying or has expert knowledge of one or more of the natural sciences*". The concept of developing 'Young Scientists' is in line with the United Nations Convention on the Rights of the Child (United Nations, 1989) and builds on work around 'students as researchers' (Kellett, 2010; Thompson & Gunter, 2006). We did not want the children to simply be a consultative group but, rather, for them to have the potential for meaningful involvement in the project as partners, with expertise in being children being equally as important in achieving the wider project aims as the epigeneticists, psychologists, psychiatrists and medics. Taking this approach helped us to enable the children to move towards a position where they could participate fully at a decision-making level (Lundy & McEvoy, 2012; Fielding, 2001).

An iterative process of workshop development was undertaken, incorporating activities that facilitated dialogue with the children allowing time to reflect, to talk through their understanding, and to pose questions to each other and us in such a way as to inform next steps. We developed a shared language and understanding of core concepts that might underpin a scientific project. This gradually helped us understand the extent to which it was acceptable to obtain various biological measures and conduct potentially distressing assessments with young children. There was a strong ethical thread throughout the work, consistently reinforced by the children's enquiry focus. We also had a strong emphasis on how such processes might be communicated and disseminated from a child's perspective.

Importantly, we have also seen real benefits for researchers in being supported in working alongside children and young people. It quickly became apparent that some researchers lacked the skills to engage with this age group in an appropriate way. Where they had done school outreach previously, it was usually with upper secondary school students. In order to work with younger children, it is essential that they are open to the experience and to the input of Education colleagues.

In order to develop a programme of the type we describe below, a group of experts in Children's Voice – each with a teaching background – collaborated with a group of scientists to teach 9 year old children, during their science curriculum, once a week for five weeks. This showed that it was possible, within this timescale, for children of this age to develop a sophisticated understanding of science: what research is; what ethical research is and some of the ways good research is conducted. We then used this learning to develop the three-day programme described on page 4. We suggest that, for more vulnerable children (e.g. children in the care system or who have mental health problems) conducting the programme in shorter sessions with more time in between for reflection is advisable. We would also anticipate that a greater number of overall hours will be required.

For such an approach to work effectively in partnership with children, we see a range of learnings central in taking this work forward, in replicating, and scaling-up:

LEARNING 1: Flexibility

When designing a programme based on partnership approaches it is essential that there is ‘space’ for deviations, follow-up and in-depth examination. If the facilitators engage in active listening (Wall et al., 2018) with the children, then consideration is made of their understanding of core concepts and ideas, but also to ensure prior knowledge is accounted for as well as their interests and questions as they emerge.

LEARNING 2: Positioning

The stance taken by the facilitators and the stance encouraged in the children should be considered. How we position ourselves as adults in relation to the children and the way this resembles partnership working needs to be continually reflected on as practice develops in regard to being recognised as scientists with decision-making powers in shaping what happens next.

LEARNING 3: Language

Scientific research is full of language that may not be familiar to children and young people; it might also not transfer seamlessly across research domains – medical research to educational research for example. Shared language is essential around general science, empirical processes, and dissemination - but also ethical considerations. This should recognise and build on the base provided by the school curriculum.

LEARNING 4: Curiosity

Ultimately scientific enquiry can be characterised as curiosity. Multiple opportunities for modelling the dispositions and behaviours associated are important, as are the moments when curiosity can be followed through independently and along personal lines of enquiry.

LEARNING 5: Creativity

Approaches used to engage the children and young people need to be pedagogically appropriate, as well as creative and varied in supporting a range of input and levels of understanding. Exploring new and/or difficult scientific concepts and approaches in a familiar way is helpful in making the content accessible for all.

LEARNING 6: Context sensitivity

Each school and classroom will have different needs. A common understanding of the project (aims, duration, outputs, etc) must be established with school staff and management teams right from the beginning. It is also important to consider the cultural and contextual characteristics of a classroom while preparing activities. For this reason, frequent dialogue between the research team and school staff is essential.

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Diary of a Young Scientist

Day 1

What is Science?

Venue: Seminar Room 1, Kelvin Hall, Glasgow.

Equipped with: Computer connected to internet, overhead projector, microphone, flipchart stand, 1 large table with chairs.

In attendance: Two research assistants, two volunteer helpers, three participating children (aged 8-12)

The first workshop in a series of three, focused on introducing the scientific method, and the purpose of research.

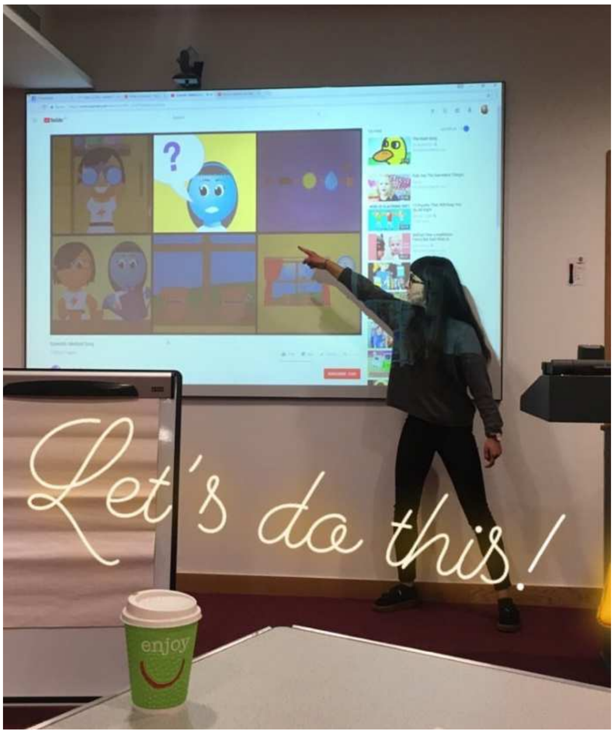


Figure 1: One of the researchers practising presenting the scientific methods song before the children arrived.

Introductions and Icebreakers

Upon arrival, children were asked to write their own name badge and wear it. Age-appropriate ice breaker games were used to build some initial rapport with children and to get an idea of any group dynamics. An example of a game which worked particularly well here, is “Two Truths and a Lie”. Each member of the group had a turn at telling the rest of the group two things which are true about themselves, and one thing which is untrue. The rest of the group tried to guess which statement is untrue.

Next, the aim of the workshops was explained using the children’s existing knowledge about the purpose of their attendance.

My Research Diary

Research diaries were introduced to the children as their own record for all their thoughts and opinions about science and research. Research diaries were comprised of a clipboard with a cover, and 10 sheets of lined paper inside. Children could insert extra pieces of work or drawings, and rearrange their order.

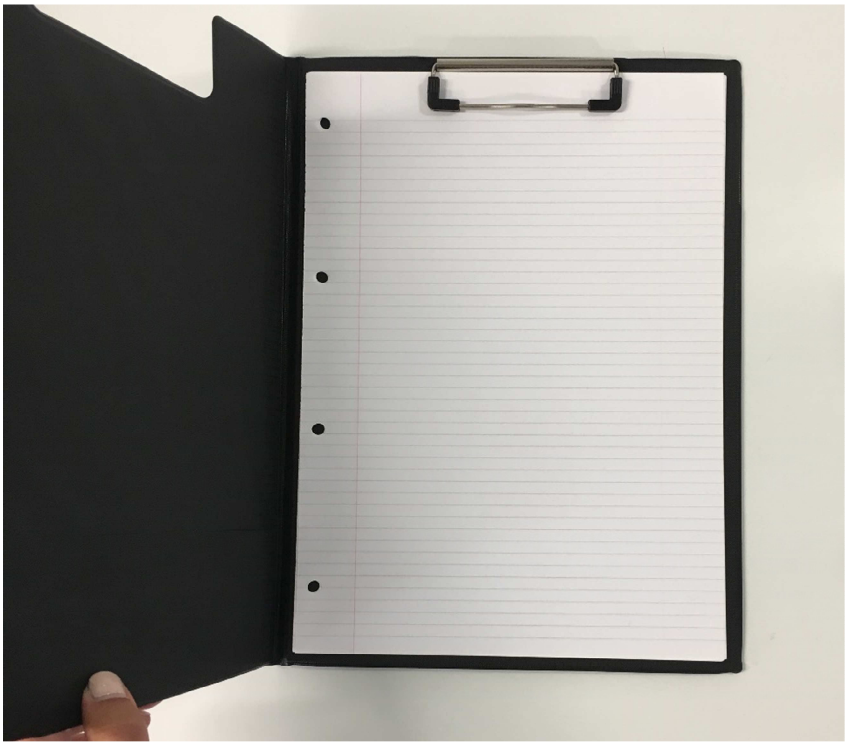


Figure 2: One of the blank research diaries

To begin, researchers posed the question to the children: "what is research?" followed by more probing questions such as:

- "**How** do we do research?"
- "**Why** do we do research?"
- "**Who** does research?"

What does a Scientist Look Like?

Figure 3: The children's initial interpretations of a 'scientist'

Children were then asked to draw what they think a scientist looks like. Most children drew a person in a lab coat, surrounded by non-descript machinery and 'potions'. All depictions of a scientist involved an animal, used for testing. The idea of 'mad' and 'good' scientists was raised. Here, researchers posed questions relating to what makes a scientist 'good' or 'mad', and whether the children thought there were any rules relating to the use of the various animals they had included in their drawings.

It was revealed to children that they would meet a real brain-scientist tomorrow, and that throughout the course of the first day, they should think about any questions they had for a real scientist. Researchers noticed that many of the questions were related to sleep and dreaming, therefore in addition to arranging for a neuroscientist to come to speak to the children, a sleep specialist at the University of Glasgow was sourced. Dr Maria Gardani created video responses to the questions regarding sleep, which were shown to children on the final day.

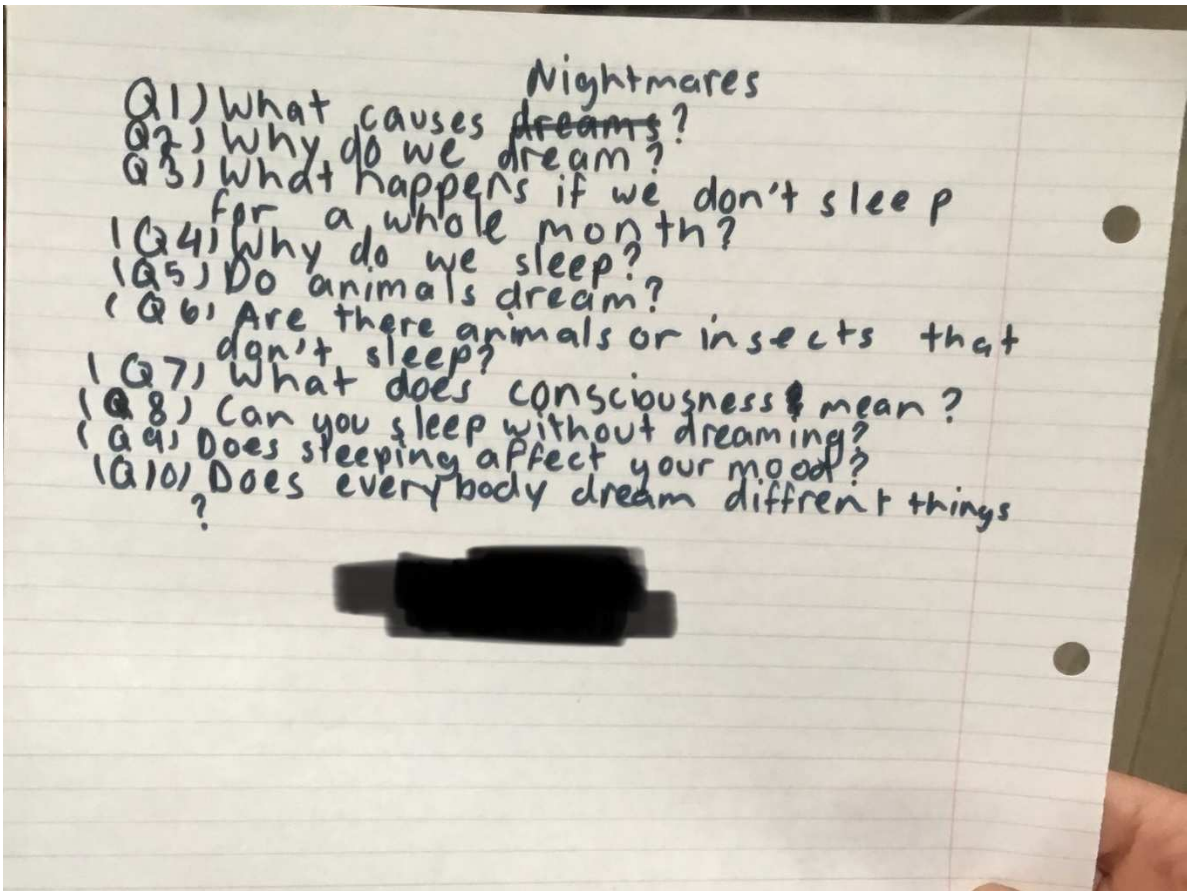


Figure 4: A sample of questions for the sleep specialist

Our Paper Plane Experiment

Age-appropriate videos explaining the scientific method were shown to the children. A group discussion followed, and one child thought about a research question regarding how far different types of paper plane could fly. In keeping with the idea that the children were our research colleagues as opposed to our students, researchers decided to execute a simple experiment using the paper planes idea. Children were prompted to think about the paper planes experiment using the steps in the scientific method, that we had just learned about:

1. Research Question
2. Prediction (Hypothesis)
3. Test or Experiment
4. Analyse the Data (What did we find?)

Each child made their own paper plane, and made a prediction about which paper plane would fly the farthest. Children were prompted to think about the reasons behind their prediction, although most reasons were superficial (the neatest plane, the coolest looking). One child pointed out that the planes should all be thrown by the same person, from the same spot – to keep the research fair. This showed that there was some existing understanding in the group regarding standardising measurement. After a group discussion about the ‘data’ collected (distance travelled by plane), children showed curiosity regarding **why** the furthest flying plane was more successful than the others.

Our Survey Work

Developing our Method - After a lunch break during which we played a game of ‘Simon Says’, children were given a choice of three research questions to choose from, which they would aim to answer by asking the general public on the Kelvin Hall premises.

1. In general, do people prefer cats or dogs? Why?
2. In general, do people prefer summer or winter? Why?
3. In general, do people prefer green or red apples? Why?

All children opted to use a tally chart to record their data in their research diaries. Each research question prompted a ‘Why?’ response in order to demonstrate the difference between ‘number data’ and ‘word data’ and what each of these types of data can show us.

Analysing our Results - Each child was supervised by a research assistant or volunteer in their data collection and analysis. Group feedback followed the analysis of individual data.

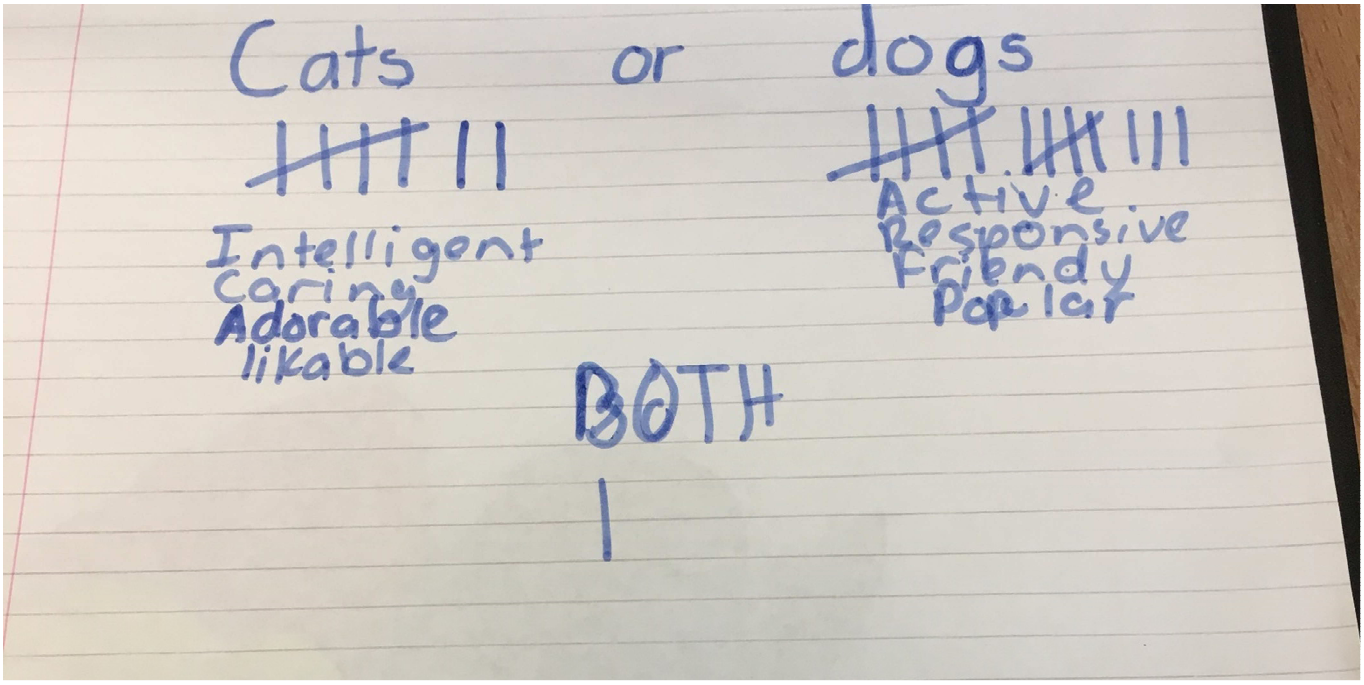


Figure 5: Data collected by one of the young scientists

The session ended with a recap of the scientific method, although children were distractible and preferred to play charades until they were picked up.

Reflections: This initial session is useful for establishing any existing understanding of ideas underpinning good research. Hands-on activities were the most effective in engaging this age group. It was more difficult to engage children after lunch, and so using the last couple of hours of a workshop was best spent on a hands-on activity. Quieter or younger children may need more 1:1 engagement initially to build confidence. The scientific methods song would have worked better with a larger, younger group. Initial ice-breaking tasks were invaluable to the gelling of such a small group, and it was essential to break up the science content with unrelated games.

Diary of a Young Scientist

Day 2

What is Ethical Research?

Venue: Activity Room, Kelvin Hall, Glasgow.

Equipped with: One large table with chairs, a kitchen room, and various craft materials.

In attendance: Two research assistants, two volunteer helpers, three participating children (aged 8-12)

The second workshop of three aimed to consolidate the children's knowledge of the scientific method, what a scientist is and does, and build on this knowledge with regards to the 'rules' we need to follow in research – i.e. what is ethical research?

The session started with some ice breaker games – this time the children chose which games they wanted to play.

Meeting a Brain Scientist

The neuroscientist, Greta Todorova, arrived and started with the content she had prepared. The neuroscience content included some hands-on examination of different brain structures, and a puzzle activity.

Figure 6: Visit from the neuroscientist and brain games

The children engaged well with the craft activities, and the younger child (aged 8) particularly engaged with the model brain, and asking the neuroscientist questions. Notably here, although it was explained that the visiting scientist is an expert in brain science, children were still keen to ask questions regarding space and the universe for example, and other unrelated aspects of science in general.

NOW What Do We Think a Scientist Looks Like?

Feedback from the children indicated that their ideas of what a scientist is had changed slightly, which prompted further discussion relating to their drawings of a scientist from the previous day. Researchers reminded the children about the animals they had drawn in their pictures yesterday along with their 'mad scientists' – what if we swapped the animal in their drawings for a child – would that be acceptable? Why not? It was explained that, when we do research, it's important to think about how the research might affect those taking part, and that there are rules for collecting information from people and animals.

What Do We Need to think About When We Are Doing Good Research?

Children were prompted to think about yesterday's data collection – was there anything we could have done differently? What about if we were collecting data such as names or age? This discussion prompted thinking about informed consent – researchers prompted children to think about the concerns that participants might have about what researchers were going to do with

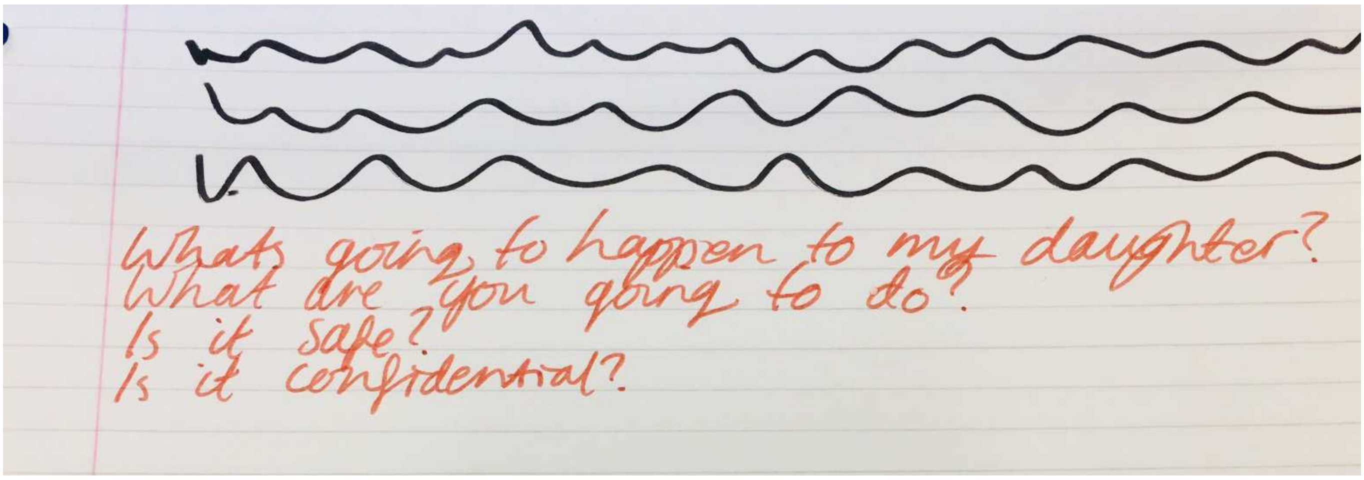


Figure 7: Thoughts about good research – 'What's going to happen to my daughter? What are you going to do? Is it safe? Is it confidential?

the data collected from them.

What is 'Ethics'?

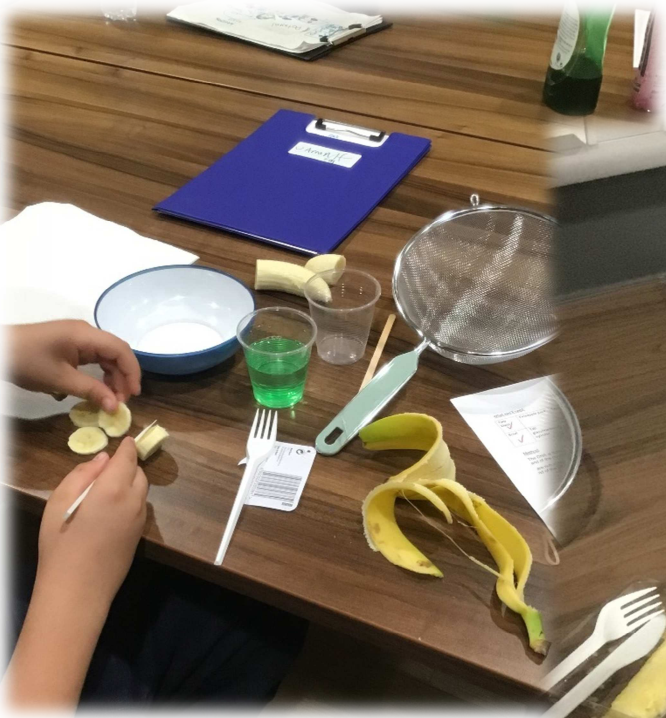
Several research scenarios were presented to the children – in relation to each scenario, children were asked whether the research was 'ethical', and what could be done to make the research plan more ethical. Here's an example of a scenario: Sarah wanted to find out how well 3 year olds can cross the road safely. She decided to take her 3 year old cousin and leave them by the side of the road to see what they would do. Is this ethical research? Why not? How could you answer this research question in a more ethical way?

We finished for lunch after discussing a few different scenarios, saving one scenario relating to the importance of accurate and precise research methods for after the break. The children were becoming noticeably restless – perhaps unsurprisingly, after almost two days spent inside. Researchers asked what the children would like to do for lunch, and it was decided that we would take a trip to the Kelvingrove Museum.

Returning to the activity room after the break, the children were more settled. One of the children volunteered to recap our previous discussion surrounding what ‘ethical research’ is.

Our DNA Experiment

Researchers presented the scenario relating to precision and accuracy of research methods to the children. This led researchers to present the final task of the day – a DNA extraction from fruit. Here, the importance of precise and accurate methods was reinforced, in that substance measurements and techniques had to be followed closely in order for the DNA extraction to work (i.e. for the desired data to be collected). Here it was important that each child was supervised 1:1.



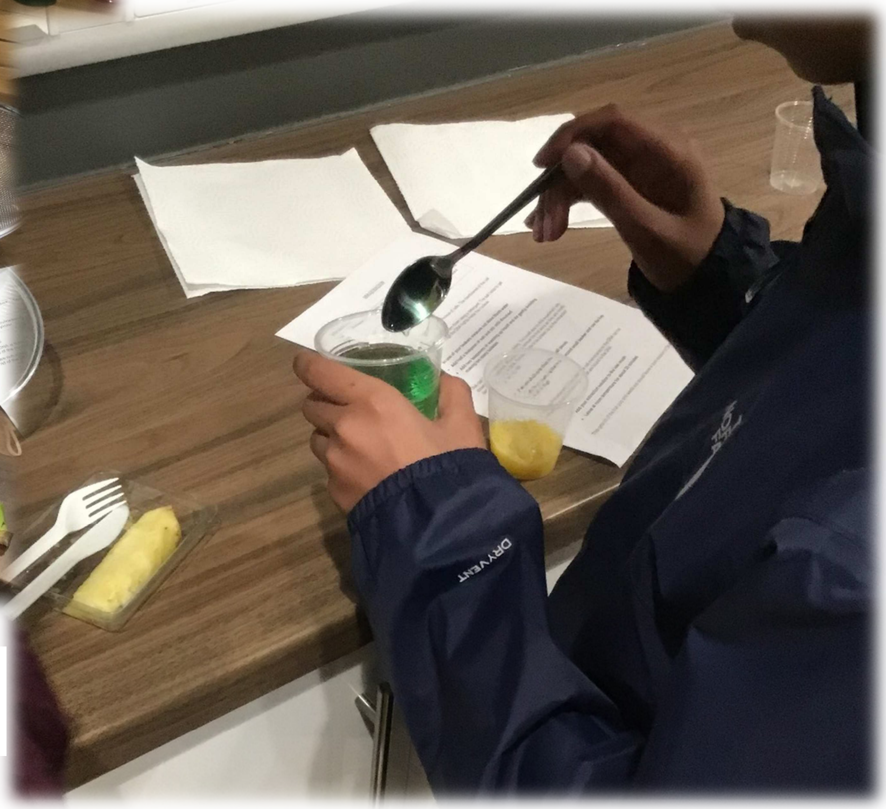


Figure 8: Extracting DNA from fruit

Reflections: Access to a computer connected to the internet is invaluable whilst working with such a small group – from playing some background music to draw attention away from the inevitable quiet, to being able to research a question quickly and watch videos on a large screen, it is advisable to utilise such a resource where the venue allows. Although the activity room space was ideal for the DNA extraction task regarding the wet room/kitchen space attached, the activity room was too large for the small group – the size of the table was intimidating and meant that there was very limited space for other games.

Diary of a Young Scientist

Day 3

How Can We Make Research More Ethical?

Venue: Activity Room, Kelvin Hall, Glasgow.

Equipped with: One large table with chairs, a kitchen room, and various craft materials.

In attendance: One research assistant, three volunteer helpers, three participating children (aged 8-12).

An earlier end to the final session was agreed with parents owing to other commitments.

Just as the previous two sessions had started, ice breaker games were useful for energizing the young people, and allowing them to choose the games was effective in engaging all children in the activity.

The sleep Scientist Answers Our Questions

Children were reminded of their questions about sleep from a previous session and the videos sent to researchers by Dr Gardani were presented to children on a laptop. The children were excited that their questions had been answered and commented again that the scientist on the screen didn't look how they had expected.

One of the children volunteered again to recap what we had covered yesterday about ethical research. More scenarios of a similar premise as those presented in the previous session were discussed, and it appeared that the young people were able to think critically about research methods now.

Learning About Consenting to Research

Children were asked how they felt about creating some role plays in which they would use their ideas about ethical research. Children were told that their parents had said that it was ok for us to film these role-plays, and that the videos would not be published anywhere – only the researchers would see them. The researcher explained the purpose for filming the role plays. Children were asked to confirm whether they were happy to be filmed – all children agreed to the filming.

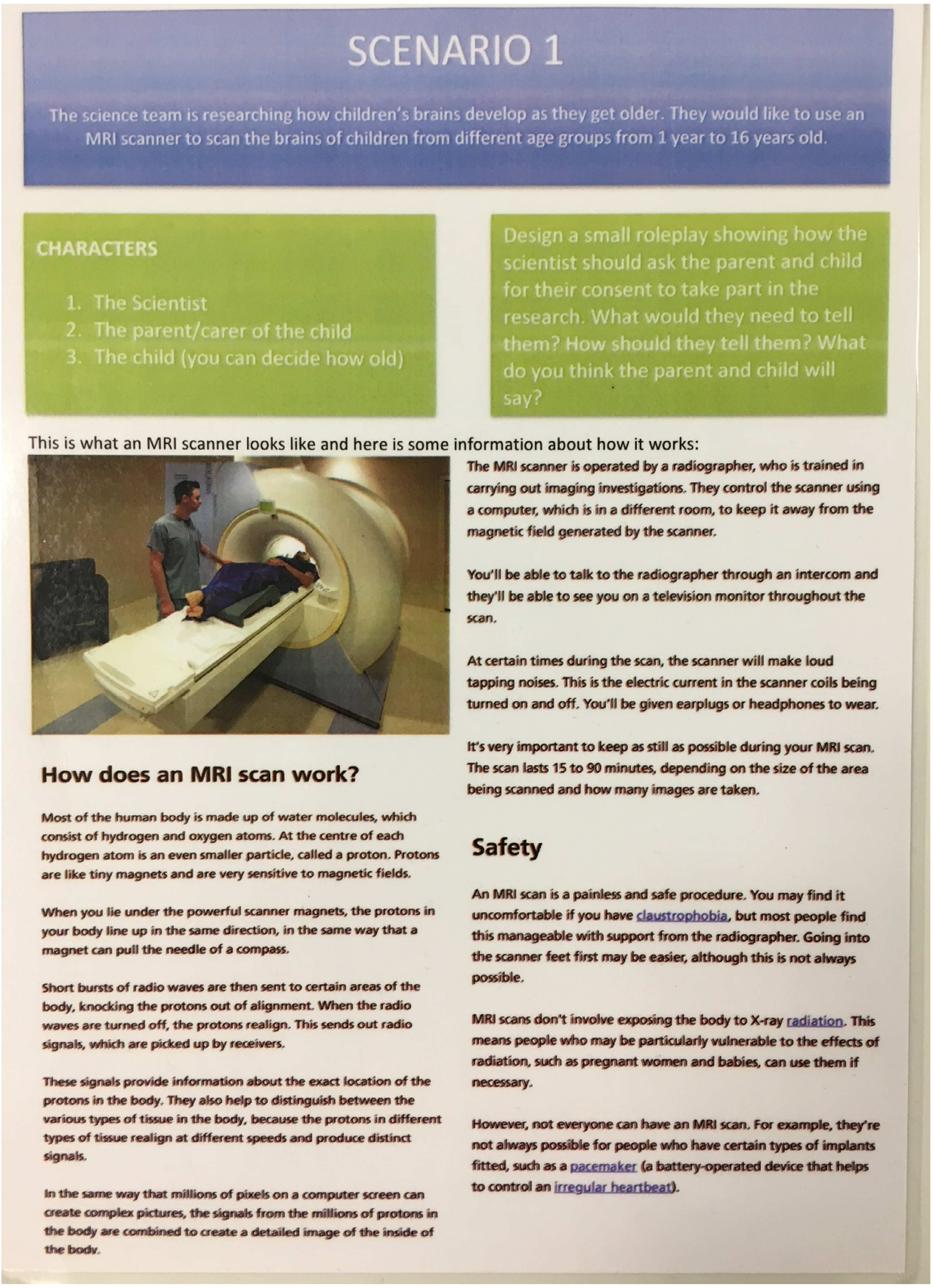
Some Role Plays About Ethical Research

The role plays required the children to assume the role of:

1. Scientist
2. Parent

3. Child

In each role play, the scientist was asking the parent of the child permission to collect biological data from the child, for example, blood samples or brain scans. The children were given a scenario card explaining the method of data collection. The group spent the majority of the final session discussing, working on, and then filming the role-plays of several different methods of



SCENARIO 1

The science team is researching how children's brains develop as they get older. They would like to use an MRI scanner to scan the brains of children from different age groups from 1 year to 16 years old.

CHARACTERS

1. The Scientist
2. The parent/carer of the child
3. The child (you can decide how old)

Design a small roleplay showing how the scientist should ask the parent and child for their consent to take part in the research. What would they need to tell them? How should they tell them? What do you think the parent and child will say?

This is what an MRI scanner looks like and here is some information about how it works:

The MRI scanner is operated by a radiographer, who is trained in carrying out imaging investigations. They control the scanner using a computer, which is in a different room, to keep it away from the magnetic field generated by the scanner.

You'll be able to talk to the radiographer through an intercom and they'll be able to see you on a television monitor throughout the scan.

At certain times during the scan, the scanner will make loud tapping noises. This is the electric current in the scanner coils being turned on and off. You'll be given earplugs or headphones to wear.

It's very important to keep as still as possible during your MRI scan. The scan lasts 15 to 90 minutes, depending on the size of the area being scanned and how many images are taken.

How does an MRI scan work?

Most of the human body is made up of water molecules, which consist of hydrogen and oxygen atoms. At the centre of each hydrogen atom is an even smaller particle, called a proton. Protons are like tiny magnets and are very sensitive to magnetic fields.

When you lie under the powerful scanner magnets, the protons in your body line up in the same direction, in the same way that a magnet can pull the needle of a compass.

Short bursts of radio waves are then sent to certain areas of the body, knocking the protons out of alignment. When the radio waves are turned off, the protons realign. This sends out radio signals, which are picked up by receivers.

These signals provide information about the exact location of the protons in the body. They also help to distinguish between the various types of tissue in the body, because the protons in different types of tissue realign at different speeds and produce distinct signals.

In the same way that millions of pixels on a computer screen can create complex pictures, the signals from the millions of protons in the body are combined to create a detailed image of the inside of the body.

Safety

An MRI scan is a painless and safe procedure. You may find it uncomfortable if you have claustrophobia, but most people find this manageable with support from the radiographer. Going into the scanner feet first may be easier, although this is not always possible.

MRI scans don't involve exposing the body to X-ray radiation. This means people who may be particularly vulnerable to the effects of radiation, such as pregnant women and babies, can use them if necessary.

However, not everyone can have an MRI scan. For example, they're not always possible for people who have certain types of implants fitted, such as a pacemaker (a battery-operated device that helps to control an irregular heartbeat).

Figure 9: One of the role play cards used

data collection.

After the lunch break, the group played brief ‘fact and opinion’ game as a break from the ethical research content, followed by games chosen and led by the young people.

Reflections: The young people were able to understand concepts such as consent by the end of the workshops, however particularly regarding younger children (aged 8) more time is necessary to be spent on each concept than with older children (aged 12). There was variation in the understanding of the young people regarding the research methods presented in the role play scenarios, therefore more time should be spent thinking about and discussing methods which are less unfamiliar to the children (e.g. this group found MRI scans particularly difficult to understand, which affected the final role play produced). In terms of the structure of the workshop sessions, shorter sessions delivered over a week, for example, may have been beneficial for maintaining engagement in the material, and ultimately to the children’s understanding of important concepts.