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Title: Scanning Dos and Don'ts: Using Magnetic Resonance Imaging in Awake Children Aged 3 to 5 years to Assess Brain Structure and Function

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Author Questionnaire

- 1. Microscopy:** Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

- 2. Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **No**

- 3. Filming location:** Will the filming need to take place in multiple locations? **No**

- 4. Testimonials (optional):** Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **No**

Current Protocol Length

Number of Steps: 21

Number of Shots: 38

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

Authors: Please note that **the questions will not appear on screen**. Please answer in **stand-alone full sentence with sufficient context**.

INTRODUCTION:

~~REQUIRED: Summarize your research focus and the main questions it aims to answer.~~

- 1.1. **Jade Dunstan:** The goal of this protocol is to promote safe acquisition of high-quality brain images during early childhood using MRI
 - 1.1.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

~~Describe the research gap or limitation in existing methods and how this protocol addresses them.~~

- 1.2. **Tracy Riggins:** Early childhood presents unique challenges for awake scanning; this protocol introduces flexible, developmentally appropriate strategies to address them.
 - 1.2.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

CONCLUSION:

~~What does this protocol allow researchers to study or measure?~~

- 1.3. **Jade Dunstan:** This protocol outlines practical steps from recruitment through scanning to enable successful awake neuroimaging in young children.
 - 1.3.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

~~Describe the most important consideration or challenge when performing this protocol.~~

- 1.4. **Erin Ratliff:** Flexibility is crucial; adapting procedures to each child's needs in ways that help each child feel safe and ready to participate helps ensure optimal data quality.
 - 1.4.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

~~Are there any additional methods or analyses that can be performed following this procedure?~~

- 1.5. **Erin Ratliff**: This protocol aims to increase transparency regarding how MRI data are successfully acquired with young children.

- 1.5.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

Videographer: Obtain headshots for all authors available at the filming location.

Ethics Title Card

This research has been approved by the Institutional Review Board (IRB) at the University of Maryland

Protocol

Videographer's NOTE: Some of the steps of the procedure were combined during filming. The slate should reflect these groupings.

- A few steps have Alt takes or Inserts to better illustrate the procedure

Because the camera is not allowed in the MRI Room the last part of the procedure had to be filmed from a single position right outside the door.

2. Mock MRI Preparation and Child Acclimation for Pediatric Neuroimaging

Demonstrator: NOTE: Not provided

2.1. To begin, introduce the child to the mock scanner suite and allow the child to explore the space on their own terms [1]. Have the child listen to pre-recorded scanner sounds that mimic those heard during the actual scan as an opportunity to scaffold their experience [2].

2.1.1. WIDE: Talent standing with the child in the mock scanner suite, gesturing to the room as the child looks around and explores independently.

2.1.2. Talent starting the scanner sound playback while the child listens in the room.

2.2. Allow the child to listen to the sounds while standing in the room [1] and ask them to identify things the sounds remind them of [2-TXT].

2.2.1. Talent standing with the child as the sounds play in the room.

2.2.2. Talent prompting the child to describe what the sounds resemble. **TXT: Map the unfamiliar sounds onto familiar sounds to reduce anxiety**

2.4. Remind the child to be still like a statue but soft for the same duration as an actual magnetic resonance imaging sequence [1]. NOTE: This step is moved here as per the authors request

2.4.1. Talent speaking to the child using the statue and stuffed animal analogy.

2.4.2. Talent observing the child lying still on the bed during the practice interval.

2.3. Now, let the child practice lying still on the mock magnetic resonance imaging bed while watching a movie with scanner sounds playing [1].

2.3.1. Shot of the child lying on the mock magnetic resonance imaging bed as a movie plays with scanner sounds.

~~2.4. Remind the child to be still like a statue but soft for the same duration as an actual magnetic resonance imaging sequence [1].~~ NOTE: 2.4 is moved after 2.3

~~2.4.1. Talent speaking to the child using the statue and stuffed animal analogy.~~

~~2.4.2. Talent observing the child lying still on the bed during the practice interval.~~

2.5. Provide feedback to the child on their motion and attention during this time [1]. Continue practice until the child can remain still for 2 minutes straight [2].

2.5.1. Talent giving verbal feedback to the child about movement and focus.

2.5.2. Shot of the child lying still on the mock imaging bed.

2.6. Next, push the mock MRI scanner bed to move the child into the mock scanner, mimicking the real scanning experience [1].

2.6.1. Talent slowly pushing the mock scanner bed with the child into the scanner bore.

2.7. Repeat the practice of playing a movie, playing scanner noises, and monitoring motion [1]. Continue until the child remains still for approximately 5 minutes [2].

2.7.1. Talent restarting the movie and scanner sounds while observing the child's motion.

2.7.2. Talent monitoring the child for stillness and alertness during the extended practice.

2.8. Before the actual scan, ensure the family leaves all belongings in a locker outside the control and scanner room [1]. Once in the control room, introduce the child to the magnetic resonance imaging operator and explain that this person will help take their brain pictures [2].

2.8.1. Talent directing the family to place belongings into a locker outside the scanner area.

2.8.2. Talent introducing the operator to the child in the control room. **NOTE: 2.8.2 filmed out of order**

2.9. Using a handheld metal detector, ensure the child and parent or caregiver do not have any metal on them [1]. If clothing has pockets, instruct them to check and empty their pockets [2].

2.9.1. Talent holding the handheld metal detector near the child and parent or caregiver.

2.9.2. Talent instructing them to check and empty clothing pockets.

2.10. Now instruct the child to stand straight like a pencil with hands at their sides and feet together [1]. Pass the metal detector along the front of the body from feet to head and then along the back [2].

2.10.1. Shot of the child in a straight standing posture.

2.10.2. Talent scanning the front and back of the child with the metal detector.

2.11. Then ask the child to spread their arms like a starfish [1]. Pass the metal detector along one leg, up the side, under the arm, along the arm and head, and down the opposite

side [2].

2.11.1. Talent guiding the child into the starfish position.

2.11.2. Talent carefully scanning along the child's body with the metal detector.

2.12. If the metal detector signals, check for metal, remove the item, and re-screen the child [1-TXT].

2.12.1. Talent removing a metal item and repeating the screening. **TXT: Repeat metal screening for the parent/caregiver**

2.13. Once in the scanner suite, give the child time to explore the scanner space or ask questions before directing them to sit on the scanner bed [1]. Provide a stool for the child to climb onto the scanner bed to increase autonomy [2].

2.13.1. Talent standing with the child as they explore the scanner room and ask questions. **NOTE: 2.13.1 – 2.20.2 was filmed as a single Wide Shot then went back and filmed again on a longer lens for coverage**
Added 2.13.1 – 2.20.2 Filmed off the monitor in the control room

2.13.2. Talent positioning a stool and assisting the child as they climb onto the bed.

2.14. When the child is sitting on the bed, show them the screen at the back of the scanner and remind them they will watch the movie using a mirror [1]. Before placing ear protection, let the child feel it and explain that it will reduce camera noise [2].

2.14.1. Talent pointing out the screen and mirror to the seated child.

2.14.2. Talent handing the ear protection to the child and explaining its purpose.

2.15. Once ear protection is in place, put headphones on the child [1] and have them lie down in the head coil [2]. Reposition the child until they are comfortable, and the head is straight [3].

2.15.1. Talent placing headphones on the child.

2.15.2. Talent guiding the child into the head coil.

2.15.3. Talent adjusting the child's position for comfort and alignment.

2.16. Play part of the child's movie through the headphones to confirm the volume is comfortable [1]. Then place a rolled towel under the child's knees to increase comfort and reduce leg movement [2-TXT].

2.16.1. Talent starting the movie audio and checking the child's response.

2.16.2. Talent positioning a rolled towel beneath the child's knees. **TXT: Use a scan safe weighted blanket for children that tend to move their legs**

2.17. Raise the brain camera bed [1]. **NOTE: The VO is edited for the deleted shot**

2.17.1. ~~Talent lowering and securing the head coil onto the child.~~ **NOTE: Not filmed**

2.17.2. Shot of the bed position being raised..

2.18. Once the bed is in the home position, place and adjust the mirror so the child can see the full screen using the screen check [1]. Ask the child to name the animals or colors they see [2].

2.18.1. Talent adjusting the mirror while viewing the screen check display.

2.18.2. Shot of the child naming the animals or colors. NOTE: Added 2.18.2 Insert of the Animal naming screen

2.19. Before moving into the scanner, check if the child is comfortable [1-TXT].

2.19.1. Talent speaking calmly to the child and confirming readiness. **TXT: Remind the child to respond verbally when a staff member checks in between pictures**

2.20. Remain close to the scanner bore and monitor the child for motion and alertness during the scan [1]. Avoid inconsistent physical contact unless the child becomes distressed [2]. Support transitions between sequences by talking to the child during long setups [3-TXT].

2.20.1. Talent standing near the scanner bore watching the child.

2.20.2. Talent maintaining a steady presence without unnecessary contact.

2.20.3. Talent speaking to the child through the intercom during setup. **TXT: Instruct the scan buddy to avoid unnecessary talking**

2.21. Communicate information to the child close to when it is relevant and in small chunks to avoid overwhelming them [1].

2.21.1. Talent giving brief, timely instructions to the child during scan preparation.

Results

3. Results

- 3.1. Across Studies 1 through 4, most participants contributed at least 1 usable scan across timepoints [1], with unsuccessful sessions primarily occurring in the youngest participants [2].
 - 3.1.1. LAB MEDIA: Figure 4. *Video editor: Show all 4 panel and highlight the green dots*
 - 3.1.2. LAB MEDIA: Figure 4. *Video editor: Show all 4 panel and highlight the red dots*
- 3.2. At participants' first time point, structural scan success rates were lowest in the 3-to-4-year age group at 87 percent [1], while all participants aged 5 years and older successfully completed their first structural scan [2].
 - 3.2.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "% of successful structural scans" under Timepoint 1 for the column 3-4yrs*
 - 3.2.2. LAB MEDIA: Table 1. *Video editor: Highlight the row "% of successful structural scans" under Timepoint 1 for the columns 5-6 yrs, 6-7 yrs and 7-8 yrs*
- 3.3. At subsequent timepoints, structural scan success rates decreased slightly to 83 percent in the 3–4 year age group [1] and from 100 percent to 91 percent in the 5–6 year age group [2], while remaining high in older children [3].
 - 3.3.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "% of successful structural scans" under subsequent timepoints for the column 3-4yrs*
 - 3.3.2. LAB MEDIA: Table 1. *Video editor: Highlight the row "% of successful structural scans" under subsequent timepoints for the column 5-6yrs*
 - 3.3.3. LAB MEDIA: Table 1. *Video editor: Highlight the row "% of successful structural scans" under subsequent timepoints for the columns 6-7 yrs and 7-8 yrs*
- 3.4. For the task-free resting state functional scan using Insapes, success rates at the first timepoint were lower than for structural scans across all age groups [1].
 - 3.4.1. LAB MEDIA: Table 2. *Video editor: Highlight the row "% of successful task-free functional scans" across all age groups under Timepoint 1*
- 3.5. At subsequent timepoints, task-free resting state scan success improved in the 3–6 year age groups to a mean of 65 percent [1], while remaining stable at approximately 85 percent in children aged 6 years and older [2].
 - 3.5.1. LAB MEDIA: Table 2. *Highlight the row "% of successful task-free functional scans" for ages 3–4 yrs, 4-5 yrs and 5-6 yrs under subsequent timepoints*
 - 3.5.2. LAB MEDIA: Table 2. *Highlight the row "% of successful task-free functional*

scans” for ages 6-7 yrs, 7-8 yrs and 8-9 yrs under subsequent timepoints

- 3.6. Task-based functional scan success rates in Studies 1 and 3 were lower than structural scan success rates [1].
 - 3.6.1. LAB MEDIA: Table 3. *Video editor: Highlight the row labeled % of successful task-based functional scans.*
- 3.7. Setup time for magnetic resonance imaging scans was consistent across studies and age groups, typically ranging from 10 to 20 minutes [1].
 - 3.7.1. LAB MEDIA: Figure 5. *Video editor: Highlight the green bars representing setup time across all studies and age groups.*
- 3.8. In Studies 1 and 2, children spent similar amounts of time in the scanner regardless of age [1]. In Study 3, younger children spent less time in the scanner than older children [2]. In Study 4, younger children tended to remain in the scanner longer than older children [3].
 - 3.8.1. LAB MEDIA: Figure 5. *Video editor: Highlight the purple bars in Study 1 and Study 2 panels showing similar heights across age groups.*
 - 3.8.2. LAB MEDIA: Figure 5. *Video editor: Highlight the purple bars in Study 3*
 - 3.8.3. LAB MEDIA: Figure 5. *Video editor: Highlight the purple bars in Study 4.*