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Title: Revised and Neuroimaging-Compatible Versions of the Dual Task Screen

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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 similar? **N**

2. **Software:** Does the part of your protocol being filmed demonstrate software usage? **Y**

   Videographer: All screen capture files provided, do not film

3. **Interview statements:** Considering the Covid-19-imposed mask-wearing and social distancing recommendations, which interview statement filming option is the most appropriate for your group? **Please select one**.

   ☒ Interviewees wear masks until the videographer steps away (≥6 ft/2 m) and begins filming. The interviewee then removes the mask for line delivery only. When the shot is acquired, the interviewee puts the mask back on. Statements can be filmed outside if weather permits.

4. **Filming location:** Will the filming need to take place in multiple locations (greater than walking distance)? **N**

Protocol Length
Number of Shots: **42**

Introduction

1. Introductory Interview Statements

REQUIRED:

1.1. **Jaclyn Stephens**: Previous work has used dual task measures to evaluate athletes with recent concussions. Our protocol is significant, because we have created a shorter, cost-efficient measure that permits simultaneous neuroimaging **[1]**.

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

REQUIRED:

1.2. **Jaclyn Stephens**: If effective at eliciting greater dual task costs in athletes with concussion, our Dual Task Screen measure will be applicable for use in a variety of clinical settings **[1]**.

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

Ethics Title Card

1.3. Procedures involving human subjects have been approved by the Institutional Review Board (IRB) at Colorado State University.

Protocol

2. Revised Dual Task Screen (DTS): Lower Extremity (LE) Subtask

2.1. For a single condition lower extremity subtask, place three yoga blocks in a horizontal position exactly 4.5 metes apart along an 18-meter walkway **[1]** and firmly attach smart devices to both of the Participant's ankles **[2]**.

2.1.1. WIDE: Talent placing block(s) *Videographer: Important step*

2.1.2. Talent attaching device to Participant ankle *Videographer: Important step*

2.2. Instruct the Participant that they will have to walk as quickly as possible while stepping over the obstacles **[1]** and quickly tap both accelerometers to start the test **[2]**, using a stopwatch to measure the time it takes the Participant to complete the task **[3]**.

2.2.1. Talent gesturing/demonstrating while Participant watches/nods *Videographer: Important step*

2.2.2. Talent tapping accelerometer *Videographer: Important step*

2.2.3. Talent starting stopwatch/Participant performing task *Videographer: Important step*

2.3. As the Participant's heel strikes the ground, raw data that will be generated that can be analyzed to assess the Participant's gait characteristics **[1][2]**.

2.3.1. Participant's heel striking ground *Videographer: please film to allow 2.3.2. to be included as inset*

2.3.2. SCREEN: Heel Strikes Partial Trial: 00:03-00:13 *Video Editor: please include as inset in 2.3.1.*

2.4. At the end of the task, inform the Participant the time it took them to complete the task from their single motor condition **[1-TXT]**.

2.4.1. Talent telling Participant time/showing stopwatch *Videographer: Important step*
TEXT: Round time up to full second

2.5. Then ask the Participant to say as many words as they can that begin with a particular letter **[1]**.

2.5.1. Talent gesturing and Participant saying words

2.6. For a dual lower extremity subtask, after instructing the Participant how to perform the task **[1]**, tap both accelerometers to start the task **[2]** and time the Participant while they step over obstacles as quickly as possible while simultaneously stating as many words as possible that begin with a particular letter **[3]**.

2.6.1. Talent explaining/Participant nodding
2.6.2. Talent tapping accelerometer
2.6.3. Talent timing/Participant walking fast/stepping and saying words

3. DTS: Upper Extremity (UE) Subtask

3.1. For a single upper extremity subtask, use masking tape to mark a 1.5-meter distance from a wall **[1]** and instruct the Participant to stand behind the tape **[2]**.

3.1.1. WIDE: Talent marking distance
3.1.2. Talent gesturing/Participant moving behind tape

3.2. Place a basket of tennis balls next to the Participant **[1]** and have the Participant complete a wall-toss with alternating hands for 30 seconds **[2]**, using a new ball from the basket for any balls they fail to catch **[3]**.

3.2.1. Talent placing basket next to Participant *Videographer: Important step*
3.2.2. Participant doing well toss *Videographer: Important step*
3.2.3. Participant missing ball, then getting new ball from basket *Videographer: Important step*

3.3. At the end of the task, ask the Participant to sequentially subtract by 7 from a given number for 30 seconds **[1]**.

3.3.1. Participant subtracting 7 from number *Videographer: Important step*

3.4. For a dual upper extremity subtask, have the Participant perform the wall-toss with alternating hands while sequentially subtracting by 7 from a given number for 30 seconds **[1]**, selecting a new ball from the basket after any misses as necessary **[2]**.

3.4.1. Participant tossing ball while subtracting *Videographer: Important step*
3.4.2. Participant missing ball, then picking new ball from basket *Videographer:*

Important step

4. Neuroimaging-Compatible DTS Setup

4.1. To set up a neuroimaging-compatible task, place yoga blocks in a vertical position to mark the start and end of a 15-meter walkway **[1]** and place two yoga blocks in a horizontal position exactly 5 meters apart along the 15-meter walkway **[2]**.

4.1.1. WIDE: Talent placing vertical block at top, with start blocks already placed visible in frame
4.1.2. Talent placing horizontal block

4.2. Then mark a 1.5-meter distance away from a smooth wall surface **[1]**.

4.2.1. Talent taping distance

4.3. Next, measure the Participant's head circumference **[1]** and place an appropriately sized fNIRS (f-nears) cap with pre-placed optodes and short-channel detectors onto the Participant's head **[2-TXT]**.

4.3.1. Talent measuring Participant head
4.3.2. Talent placing cap onto Participant head **TEXT: fNIRS: functional near-infrared spectroscopy**

4.4. Turn on a dedicated acquisition laptop and connect the laptop the fNIRS device WiFi network **[1]**.

4.4.1. Talent turning on laptop
~~4.4.2. Talent connecting laptop to wifi, with monitor visible in frame~~

4.5. In the fNIRS acquisition software, select the fNIRS device **[1]** and perform a calibration to optimize the light intensity **[2]**.

4.5.1. SCREEN: 4.5.1: 00:28-00:35
4.5.2. SCREEN 4.5.1: 01:02-01:55 *Video Editor: please speed up*

4.6. At the end of the calibration, check the optode signal levels, which should be acceptable or excellent **[1]**.

4.6.1. SCREEN: 4.6.1: 00:03-00:12

4.7. To fix any optodes with a less than acceptable signal level, remove the optode from the cap **[1]** and part the Participant's hair to ensure a direct connection to the Participant's

scalp **[2]**.

4.7.1. Talent removing optode
4.7.2. Hair being parted/optode being replaced *Videographer: Difficult step*

5. Subtask Data Acquisition

5.1. To acquire lower extremity subtask neuroimaging data, open the stimulus presentation software **[1]** and select the lower extremity subtask file **[2]**.

~~5.1.1. WIDE: Talent opening software, with monitor visible in frame~~
5.1.2. SCREEN: 5.1.2: 00:06-00:19

5.2. Have the Participant sit in a chair **[1]** and click **Start** to begin collecting baseline fNIRS data **[2]**.

5.2.1. Talent gesturing/Participant sitting
5.2.2. SCREEN: 5.2.2.: 00:08-00:18

5.3. Enter the subject ID_lower extremity, age, and sex into the pop-up window and click **Start experiment [1]**.

5.3.1. SCREEN: 5.3.1: 00:05-00:25 *Video Editor: please speed up*

5.4. Inform the Participant that a quiet rest period is beginning **[1]** and press the spacebar to start a 60-second rest period **[2]**.

5.4.1. Talent informing Participant/Participant nodding
5.4.2. Talent pressing spacebar NOTE: This step was repetitive, so it was only taped once and at the end of shooting.

5.5. At the end of the rest period, explain the lower extremity task schedule to the Participant **[1]** and press the spacebar to start the first trial **[2]**.

5.5.1. LAB MEDIA: Figure 4
5.5.2. Use 5.4.2.

~~5.6. **[1] [2]**.~~

~~5.6.1. Talent saying stop/Participant stopping~~
~~5.6.2. Talent pressing spacebar/Participant starting next trial~~

5.7. After 15 randomized trials of the lower extremity subtask have been performed, have

the Participant rest for another 60 seconds in the chair **[1]**.

5.7.1. Talent indicating chair/Participant sitting in chair

5.8. At the end of the rest period, exit out of the subtask file in the stimulus presentation software **[1]** and stop the data acquisition in the fNIRS data acquisition software **[2]**.

5.8.1. SCREEN: 5.8.1: 00:02-00:12
5.8.2. SCREEN: 5.8.2: 00:02-00:10

5.9. Then remove the accelerometers from the Participant's ankles and use the software to perform the upper extremity analysis as demonstrated **[1]**.

5.9.1. Talent removing accelerometer
~~5.9.2. Talent selecting UE subtask in software, with monitor visible in frame~~

5.10. At the end of the rest period, explain the upper extremity task schedule to the Participant ~~**[1]**~~ and press the spacebar to start the first trial **[2]**.

5.10.1. ~~LAB MEDIA:~~ NOTE: Authors can provide a screen capture if we want it. Since they haven't yet, I suggest putting the video together without it and they can let us know if they feel that something is missing.
5.10.2. *Use 5.4.2.*

Protocol Script Questions

A. Which steps from the protocol are the most important for viewers to see?

2.1., 2.2., 2.4., 3.2.-3.4.

B. What is the single most difficult aspect of this procedure and what do you do to ensure success?

4.6., 4.7. Ensuring that we have adequate signal for fNIRS data collection is arguably the most critical and most difficult step of the procedure. Individuals with dark, thick hair tend to be the most difficult to set-up. To ensure that we can collect data from these individuals, we use a cap size that is slightly smaller than the participant's head circumphrence, to ensure a snug fit. We also have a lab member who has a lot of experience donning caps work with more challenging participants.

Results

6. Results: Representative LE and UE Subtask Performance Analyses

6.1. In these representative analyses of three, male participants **[1]**, a slower gait speed **[2]**, longer average step duration **[3]**, and greater variability in step duration are observed during dual **[4]**, compared to single, condition tasks **[5]**.

6.1.1. LAB MEDIA: Figure 1A
6.1.2. LAB MEDIA: Figure 1A *Video Editor: Please emphasize data over Dual Task area of Gait Speed graph*
6.1.3. LAB MEDIA: Figure 1A *Video Editor: Please emphasize data over Dual Task area of Average Step Duration graph*
6.1.4. LAB MEDIA: Figure 1A *Video Editor: Please emphasize data over Dual Task area of Variability in Step Duration graph*
6.1.5. LAB MEDIA: Figure 1A *Video Editor: Please emphasize data over Single Motor task area in Gait Speed, Average Step Duration, and Variability in Step Duration graphs OR no animation*

6.2. In contrast, two of three participants showed no changes in the number of total steps **[1]** or the average step length under single motor versus dual task conditions **[2]**.

6.2.1. LAB MEDIA: Figure 1A *Video Editor: Please emphasize Total Number of Steps graph*
6.2.2. LAB MEDIA: Figure 1A *Video Editor: Please emphasize Average Step Length graph*

6.3. Two out of three participants also generated fewer words during the dual cognitive task condition **[1]** compared to the single task condition **[2]**.

6.3.1. LAB MEDIA: Figure 1B *Video Editor: Please emphasize orange and grey data lines over Dual Task area*
6.3.2. LAB MEDIA: Figure 1B *Video Editor: Please emphasize orange and grey data lines over Single Cognitive area OR no animation*

6.4. All three male participants had a dual task motor cost **[1]**, with fewer successful catches observed during the dual task condition **[2]** compared to the single motor condition **[3]**.

6.4.1. LAB MEDIA: Figure 2A
6.4.2. LAB MEDIA: Figure 2A *Video Editor: Please emphasize data over Dual Task area*
6.4.3. LAB MEDIA: Figure 2A *Video Editor: Please emphasize data over Single Motor*

area

6.5. Fewer correct subtractions during the dual task condition were also observed in two of the three participants **[1]** compared to the single task condition **[2]**.

6.5.1. LAB MEDIA: Figure 2B *Video Editor: Please emphasize blue and grey data lines over Dual Task area*
6.5.2. LAB MEDIA: Figure 2B *Video Editor: Please emphasize blue and grey data lines over Single Cognitive area*

6.6. Here a map of the placement of the 15 LED sources **[1]** and 15 detectors on the Participant's head can be observed **[2]**.

6.6.1. LAB MEDIA: Figure 3 *Video Editor: Please emphasize red circles*
6.6.2. LAB MEDIA: Figure 3 *Video Editor: Please emphasize white circles*

6.7. Use of the fNIRS cap during the lower and upper extremity subtask trials allows measurement and comparison of the oxygenated hemoglobin levels **[1]** produced by the Participant during the dual **[2]** and single motor subtasks **[3]**.

6.7.1. LAB MEDIA: Figure 5
6.7.2. LAB MEDIA: Figure 5 *Video Editor: Please emphasize D# data points*
6.7.3. LAB MEDIA: Figure 5 *Video Editor: Please emphasize S# data points*

Conclusion

7. Conclusion Interview Statements

7.1. **Jaclyn Stephens**: During the neuroimaging-compatible DTS, the most important thing to remember is to provide the participant with the correct instructions for the tasks and to ensure their comprehension **[1]**.

7.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera (2.2., 3.2.)

7.2. **Jaclyn Stephens**: Because fNIRS only allows us to evaluate superficial cortical structures, our data may suggest that we should complete complementary neuroimaging using fMRI to evaluate deeper brain structures **[1]**.

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