Title: Web-Based Clinician Guide to Record Compatible Video of Standardized Drinking Task Kinematics for Computer Vision Analysis

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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? **Yes, all done**

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

If **Yes**, how far apart are the locations? **N/A**

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: 14
Number of Shots: 43 (12 SC)

Introduction

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

INTRODUCTION:

    1.1. **Justin Huber:** My research explores precision rehabilitation of the upper limb using affordable tools such as videos, wearable sensors, and open-source AI.

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

    1.2. **Justin Huber:** AI technology, such as computer vision, and sensor technology, including videos and wearables, enable measurement of recovery more frequently and objectively.

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

CONCLUSION:

    1.3. **Justin Huber:** Upper limb biomechanics measurement no longer requires complex setups, as our standard video recordings combined with computer vision offer a simplified alternative.

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

    1.4. **Justin Huber:** This work improves access to upper limb biomechanics and is expected to accelerate precision rehabilitation research and clinical translation.

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

1.5. **Justin Huber:** My future research will focus on precise measurements of fine motor skills and development of biomechanical feedback interventions using computer vision.

    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.

Protocol

2. Workspace and Equipment Setup

Demonstrators: Justin Huber, Alison Huber

2.1. To begin, position an adjustable-height chair with a seatback so the subject can sit with palms resting face down on the table and the wrist crease aligned to the table edge [1]. Adjust the seat height to achieve approximately 90 degrees of flexion at both hips and knees [2]. Modify the table height so that the subject maintains an upright posture, with arms resting comfortably at the sides and elbows flexed at 90 degrees [3].

    2.1.1. WIDE: Talent placing the adjustable chair at the table and positioning it so the subject's wrists align with the table edge.

    2.1.2. Talent adjusting the seat height to achieve 90-degree hip and knee flexion.

    2.1.3. Talent modifying the table height until the subject's elbows rest at 90 degrees with an upright posture.

2.2. Align the front edge of the placemat with the table edge directly in front of the subject [1]. Ensure that the target square box on the placemat is centered with respect to the subject's midline [2].

    2.2.1. Talent placing the placemat so its front edge aligns with the table's front edge.

    2.2.2. Talent adjusting the placemat so the square is centered with the subject's midline.

2.3. Then, place a 250-milliliter plastic cup in the square box on the placemat, locating it 30 centimeters from the table edge and directly in front of the subject [1]. Fill the cup with 100 milliliters of drinking water [2].

2.3.1. Talent positioning a plastic cup in the square box on the placemat.

2.3.2. Talent filling the cup with 100 milliliters of water.

2.4. Now, position the stereo camera to capture a frontal overhead view of the subject and cup **[1]**. Adjust the camera position to ensure the target volume is fully visible **[2]**.

2.4.1. Talent placing the stereo camera in front and above the subject to provide a clear overhead view.

2.4.2. Talent repositioning the camera.

Videographer's NOTE: 2.4 was filmed together

3. **Capturing Calibration Images**

3.1. For calibration, open the calibration activity module by navigating to the web application dashboard and selecting the **Calibration Activity Guide** from the menu **[1]**. Before starting the recording **[2]**, hold the checkerboard pattern at approximately chest level, perpendicular to the tabletop surface **[3]**. Initiate recording by clicking the **Start Recording** icon in the web application **[4] [5]**.

3.1.1. SCREEN POPS UP: 69336_screenshot_1.mp4 00:00-00:14.

3.1.2. SCREEN MINIMIZES.

3.1.3. Talent holding the checkerboard pattern at chest level, perpendicular to the tabletop.

3.1.4. SCREEN POP UP MAXIMIZES: 69336_screenshot_2_ extended.mp4 00:20-00:30.

3.2. When cued to begin the calibration activity, move the checkerboard pattern forward toward the camera in a smooth and controlled manner **[1 and 4]**. Then reverse the motion and move the checkerboard pattern backward, away from the camera, maintaining smooth and controlled motion **[2 and 4]**. Repeat the forward and backward movement until image capture is complete **[3 and 4]**.

3.2.1. Talent smoothly moving the checkerboard forward through the workspace toward the camera.

3.2.2. Talent reversing the checkerboard movement away from the camera.

3.2.3. Talent showing that the image capture is complete.

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3.2.4. SCREEN MINIMIZES: 69336_screenshot_2_extended.mp4 00:30-00:40 *Video editor: Please keep playing 3.2.4 throughout the duration of step 3.2 in a minimized view as an inset*

Videographer's NOTE: 3.2 was filmed together

3.3. Review the recorded calibration video **[1]**. Ensure the entire checkerboard pattern remains visible throughout the video and that the lighting provides clear visibility **[2]**. If the recording is unsatisfactory, click the **Retry** option to re-initiate the video recording for another attempt **[3]**.

3.3.1. SCREEN POP UP MAXIMIZES: 69336_screenshot_3.mp4 00:00-00:02.

3.3.2. SCREEN: 69336_screenshot_3.mp4 00:03-00:06.

3.3.3. SCREEN: 69336_screenshot_3.mp4 00:07-00:09.

3.4. Upon successful calibration, click the **Save Calibration Images** icon. When the save prompt appears, choose the desired destination folder to store the calibration images **[1]**.

3.4.1. SCREEN: 69336_screenshot_3.mp4 00:10-00:19.

3.5. After confirming the images have been saved, select **Confirm Save** to proceed **[1] [2]**.

3.5.1. SCREEN: 69336_screenshot_3.mp4 00:20-00:28.

3.5.2. SCREEN POP UP CLOSES

4. **Drinking Task Activity**

4.1. Instruct the subject to use a specified hand—either right or left—for the initial recording **[1]**. Ask the subject to practice the drinking task activity to become familiar with the procedure **[2]**.

4.1.1. Talent instructing the subject to use a designated hand.

4.1.2. Talent guiding the subject through a practice attempt of the drinking task.

Videographer's NOTE: 4.1 was filmed together

4.2. Open the drinking task activity module by navigating to the dashboard menu of the web application and selecting the **Drinking Task Activity Guide [1]**. Before recording **[2]**,

inform the subject about the 3-second visual and audio countdown provided by the app, followed by a cue to begin the task **[2]**. Initiate the video recording by clicking the **Start Recording** icon and instruct the subject to perform the drinking task when cued **[3] [4]**.

    4.2.1. SCREEN POPS UP: SCREEN: 69336_screenshot_4.mp4 00:00-00:15.

    4.2.2. SCREEN POP UP MINIMIZES.

    4.2.3. Talent briefing the subject about which hand to use and about the 3-second countdown by making actions. **Videographer's NOTE:** 4.2.3 & 4.3.1 and 4.3.2 was filmed together

    4.2.4. SCREEN POP UP MAXIMIZES: 69336_screenshot_5_extended.mp4 00:20-00:34.

    4.2.5. SCREEN POP UP MINIMIZES.

4.3. When cued to begin the drinking task, let the subject perform the activity using the specified hand **[1 and 3]**. Then instruct them to return the cup to the original outlined area and the hand to the original starting position **[2 and 3]**.

    4.3.1. Subject performing the drinking task on cue.

    4.3.2. Subject returning the cup and hand to original positions.

    4.3.3. SCREEN IN MINIMIZED VIEW AS AN INSET: 69336_screenshot_5_extended.mp4 00:40-00:55. *Video editor: Please keep playing 4.3.3 throughout the step 4.3 in a minimized view as an inset*

4.4. Review the recorded video of the drinking task activity **[1]**.

    4.4.1. Talent playing the recorded video showing the subject performing the drinking task.

4.5. Ensure that the recorded video shows the subject's face, torso, upper limbs, and the cup within all frames. Verify that the subject completes the entire drinking task—picking up the cup, taking a sip, returning the cup to its original position, and moving their body and hands back to the start position **[1-TXT]**. To conduct additional trials with the same subject, select the **Repeat Another Trial** option **[2]** and continue recording **[3]** and reviewing new trials using the same instructions **[4]**.

    4.5.1. SCREEN POP UP MAXIMIZES: 69336_screenshot_6.mp4 00:00-00:15.

    4.5.2. SCREEN: 69336_screenshot_6.mp4 00:16-00:25.

    4.5.3. SCREEN POP UP MINIMIZES

    4.5.4. Shot of the subject perform the action.

4.6. After all desired trials have been recorded, select the **Finished with all trials** option to initiate video file saving **[1]**. In the **Notes** field, enter comments relevant to future data processing, analysis, or interpretation, then select **Package and add Notes** to proceed **[2]**. Click the **Save Drinking Task Videos** icon and choose a folder destination when the prompt appears **[3]**. Once the video file save is complete, click **Confirm Save** to finalize **[4]**.

4.6.1. SCREEN POP UP MAXIMIZES: 69336_screenshot_7.mp4 00:00-00:02.

4.6.2. SCREEN: 69336_screenshot_7.mp4 00:03-00:05.

4.6.3. SCREEN: 69336_screenshot_7.mp4 00:06-00:15.

4.6.4. SCREEN: 69336_screenshot_7.mp4 00:16-00:21.

Results

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5. Results

5.1. The computer vision workflow extracted three-dimensional pose data from two-dimensional videos by applying calibration **[1]**, pose detection **[2]**, lifting procedures **[3]**, and smoothing filters **[4]**.

    5.1.1. LAB MEDIA: Figure 4A.

    5.1.2. LAB MEDIA: Figure 4C.

    5.1.3. LAB MEDIA: Figure 4B.

    5.1.4. LAB MEDIA: Figure 4D.

5.2. Using the extracted 3D pose data, kinematic metrics were computed including number of movement units, trunk displacement, and movement time **[1]**.

    5.2.1. LAB MEDIA: Figure 4D.

5.3. The wrist velocity profiles during the drinking task showed different numbers of movement units between the left **[1]** and right upper extremity in a subject with chronic post-stroke hemiparesis **[2]**.

    5.3.1. LAB MEDIA: Figure 5A.

    5.3.2. LAB MEDIA: Figure 5B.

1. Adjustable-height
   Pronunciation link: https://www.merriam-webster.com/dictionary/adjustable
   IPA: /əˈdʒʌstəbəl/
   Phonetic Spelling: uh·juhs·tuh·buhl
2. Flexion
   Pronunciation link: https://www.merriam-webster.com/dictionary/flexion
   IPA: /ˈflɛkʃən/
   Phonetic Spelling: flek·shuhn
3. Stereo
   Pronunciation link: https://www.merriam-webster.com/dictionary/stereo
   IPA: /ˈstɛrioʊ/
   Phonetic Spelling: ster·ee·oh
4. Calibration
   Pronunciation link: https://www.merriam-webster.com/dictionary/calibration

IPA: /ˌkælɪˈbreɪʃən/
Phonetic Spelling: ka·luh·bray·shuhn

5. Checkerboard
   Pronunciation link: https://www.merriam-webster.com/dictionary/checkerboard
   IPA: /ˈtʃɛkərˌbɔːrd/
   Phonetic Spelling: chek·er·bord

6. Perpendicular
   Pronunciation link: https://www.merriam-webster.com/dictionary/perpendicular
   IPA: /ˌpɝːpənˈdɪkjələr/
   Phonetic Spelling: per·puhn·dik·yuh·ler

7. Three-dimensional
   Pronunciation link: https://www.merriam-webster.com/dictionary/three-dimensional
   IPA: /ˌθriːdəˈmɛnʃənəl/
   Phonetic Spelling: three·duh·men·shuh·nuhl

8. Two-dimensional
   Pronunciation link: https://www.merriam-webster.com/dictionary/two-dimensional
   IPA: /ˌtuːdəˈmɛnʃənəl/
   Phonetic Spelling: too·duh·men·shuh·nuhl

9. Kinematic
   Pronunciation link: https://www.merriam-webster.com/dictionary/kinematic
   IPA: /ˌkɪnəˈmætɪk/
   Phonetic Spelling: kih·nuh·ma·tik

10. Extremity
    Pronunciation link: https://www.merriam-webster.com/dictionary/extremity
    IPA: /ɪkˈstrɛmɪti/
    Phonetic Spelling: ik·strem·uh·tee

11. Velocity
    Pronunciation link: https://www.merriam-webster.com/dictionary/velocity
    IPA: /vəˈlɑːsəti/
    Phonetic Spelling: vuh·laa·suh·tee

12. Hemiparesis
    Pronunciation link: https://www.merriam-webster.com/medical/hemiparesis
    IPA: /ˌhɛmɪpəˈriːsɪs/
    Phonetic Spelling: heh·mih·puh·ree·suhs

13. Trunk
    Pronunciation link: https://www.merriam-webster.com/dictionary/trunk
    IPA: /trʌŋk/
    Phonetic Spelling: truhngk

14. Displacement
    Pronunciation link: https://www.merriam-webster.com/dictionary/displacement
    IPA: /dɪsˈpleɪsmənt/
    Phonetic Spelling: dis·plays·muhnt

15. Post-stroke
    Pronunciation link: https://www.merriam-webster.com/medical/poststroke

IPA: /ˈpoʊstˌstroʊk/
Phonetic Spelling: pohst·strohk