Title: Working Memory Training for Older Participants: A Control Group Training Regimen and Initial Intellectual Functioning Assessment

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Author Questionnaire

1. Microscopy: Does your protocol involve video microscopy, such as filming a complex dissection or microinjection technique? **N**

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

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

Introduction

1. Introductory Interview Statements

REQUIRED:

1.1. **Olga Matysiak**: Working memory is critical for cognitive function and determines the efficiency of learning new skills. Our training aims to improve cognitive performance, while also considering the initial level of the trainee **[1]**.

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

REQUIRED:

1.2. **Olga Matysiak**: By carefully designing procedures for experimental and active control groups, we have developed a training that incorporates use of the critical factor for determining the expected differences in training effectiveness **[1]**.

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

Introduction of Demonstrator on Camera

1.3. **Olga Matysiak**: Demonstrating the procedure will be Aleksandra Bramorska, a PhD student from my laboratory **[1][2]**.

　1.3.1. INTERVIEW: Author saying the above
　1.3.2. The named demonstrator(s) looks up from workbench or desk or microscope and acknowledges the camera

Ethics Title Card

1.4. Procedures involving human subjects have been approved by the Institutional Review Board (IRB) at SWPS University of Social Science and Humanities in Warsaw and was conducted in accordance with the Declaration of Helsinki.

Protocol

2. Operation Span (OSPAN) Task Assessment

2.1. Before beginning each procedure, give very clear and detailed instruction to the Participants about how to perform each task **[1]**.

    2.1.1. WIDE: Talent instructing Participant

2.2. For an initial operation span task assessment, run a training block that automatically estimates the individual time needed for each Participant to calculate a simple mathematical equation **[1-TXT]**.

    2.2.1. Participant solving equation, with monitor visible in frame *Videographer: Important step* **TEXT:** *i.e.*, **addition, subtraction, division, or multiplication of single digits**

2.3. In the next training block, display one letter on the screen at a time for 500 milliseconds per letter **[1]**.

    2.3.1. SCREEN: screenshot_1: 00:51-00:58

2.4. After a full set of 3-9 letters, present a matrix of 12 letters to the Participant and have the Participant click on the letters in the order that they were presented without a time limit **[1-TXT]**.

    2.4.1. SCREEN: screenshot_1: 00:59-01:11 **TEXT: Record memory correctness**

2.5. In the final block, combine the two training blocks, presenting 2-5 equation-letter pairs before displaying the letter matrix **[1-TXT]**.

    2.5.1. SCREEN: screenshot_2: 00:30-00:46 *Video Editor: please speed up* **TEXT: Record mathematical and memory correctness**

3. Running Memory Span Task

3.1. For a running memory span task assessment **[1]**, present information about the number of letters to be remembered in the task and have the Participant begin the task when they are ready **[2-TXT]**.

3.1.1. WIDE: Participant looking at information on screen, with monitor visible in frame

3.1.2. SCREEN: 60806_3: 00:00-00:06 **TEXT:** *i.e.*, **3-6 letters depending on block difficulty level**

3.2. A sequence of letters should be presented in black font in the center of a white screen for 0.25 seconds per letter **[1]**.

   3.2.1. SCREEN: 60806_3: 00:08-00:19

3.3. After each letter sequence, display a 9-letter matrix on the screen and have the Participant mark the appropriate letters in the order that they appeared without a time limit **[1]**.

   3.3.1. SCREEN: 60806_3: 00:21-00:34

3.4. After confirming that the Participant understands the task, have the Participant repeat the task with the experimental sequence **[1]**.

   3.4.1. Participant at computer, repeating task, with monitor visible in frame

4. Switching Task Assessment

4.1. For a switching task assessment, use a horizontal line to divide the screen into two parts **[1]** and present red squares or rectangles composed of smaller squares or rectangles above or below this line **[2]**.

   4.1.1. WIDE: Talent turning on the task on the screen, with instructions for task visible on monitor

   4.1.2. SCREEN: 60806_4: 00:11-00:14

4.2. Instruct the Participant to click the left button and say "rectangle" when "small figures" are observed in the upper part of the screen **[1]** and to click the right button and to say "square" when a "whole figure composed from smaller figures" is observed the lower part of the screen **[2]**.

   4.2.1. Talent indicating top part of screen, then left button and saying "rectangle"

   4.2.2. Talent indicating bottom part of screen, then right button and saying "square"

4.3. Then display the figures above or below the middle line in random order **[1]**.

   4.3.1. SCREEN: 60806_4: 00:15-00:23

4.4. After completing the training block, have the Participant perform the experimental task **[1-TXT]**.

     4.4.1. Participant at computer, clicking mouse button and saying shape name **TEXT: Have Participants complete post-training assessments in same manner**

4.5. **Olga Matysiak**: Since the training takes place at home, it is essential to be sure that participants understand how to perform the tasks and that you are able to monitor their compliance **[1]**.

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

5. N-Back Training and Quiz Sessions

5.1. Before beginning either the experimental N-back or control Quiz trainings, provide the Participant with a login and password for the Internet platform **[1]** to allow the Participant to enter the site only once every 24 hours, to avoid situations in which the Participant trains more than once a day **[2]**.

     5.1.1. WIDE: Talent handing sheet with login information to Participant
Videographer: Important step
     5.1.2. SCREEN: screenshot_5: 00:04-00:13

5.2. Explain to the Participant that the initial level of N is 2 in the first block of the task **[1-TXT]** and that the difficulty level may increase or decrease depending on the performance **[2]**.

     5.2.1. Talent showing the setting of N equal 2, with monitor visible in frame
Videographer: Important step **TEXT: If accuracy >85%, increase difficulty in the next block; If accuracy <60%, lower accuracy in next block**
     5.2.2. SCREEN: screenshot_6: 00:00-00:05

5.3. Make clear that the whole session will last for 15 rounds with 20 plus N trials per round and that the whole training is set to 25 sessions **[1]**.

     5.3.1. Talent explaining session length to Participant

5.4. After explaining the task at level N equals 2, use alphabet letters as auditory stimuli and green squares in one of nine locations in a 3 x 3 matrix as visual stimuli **[1]**.

     5.4.1. SCREEN: screenshot_6: 00:20-00:30 *Video Editor: please include audio*

5.5. For a control quiz session, present 15 questions in each training session of the Quiz Task with no time limit for reading the questions. Instruct the Participant to select one of the four given possibilities within 40 seconds of answering the question **[1-TXT]**.

    5.5.1. SCREEN: screenshot_7: 00:00-00:11 **TEXT: Provide feedback for answer correctness**

Protocol Script Questions

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

2.2., 5.1., 5.2.

B. What is the single most difficult aspect of this procedure and what do you do to ensure success?
5.2.

Results

6. Results: Representative Outcome Measures and Multilevel Training Data Analysis

6.1. In this representative experiment **[1]**, 43 participants in the N-back training group **[2]** and 42 in the Quiz training group were analyzed **[3]**.

    6.1.1. LAB MEDIA: Table 1
    6.1.2. LAB MEDIA: Table 1 *Video Editor: please emphasize N-back training columns*
    6.1.3. LAB MEDIA: Table 1 *Video Editor: please emphasize Quiz training columns*

6.2. Multivariate analysis of variance of the independent variables **[1]** revealed statistically significant post-training improvement in the syllogisms **[2]** and attention switching tasks **[3]**.

    6.2.1. LAB MEDIA: Table 2
    6.2.2. LAB MEDIA: Table 2 *Video Editor: please emphasize Syllogisms Task data row in Pre- to post training-effect columns*
    6.2.3. LAB MEDIA: Table 2 *Video Editor: please emphasize Attention Switching Task data row in Pre- to post training-effect columns*

6.3. A significant training group effect was observed for the memory SPAN (span) **[1]** and OSPAN (O-span) tasks **[2]**.

    6.3.1. LAB MEDIA: Table 2 *Video Editor: please emphasize Memory SPAN Task data row in Training group effects columns*
    6.3.2. LAB MEDIA: Table 2 *Video Editor: please emphasize OSPAN Task data row in Training group effects columns*

6.4. None of the interaction effects were proven to be statistically significant **[1]**. However, in the OSPAN task, the N-back training group improved their results in the second session **[2]**, while both performances were similar for the quiz group **[3]**.

    6.4.1. LAB MEDIA: Table 2 *Video Editor: please emphasize Interaction effect columns*
    6.4.2. LAB MEDIA: Table 2 *Video Editor: please emphasize significant within-group: OSPAN data cell*
    6.4.3. LAB MEDIA: Table 2

6.5. The performances in the Sternberg's and go-no-go tasks were not related to a training group assignment or to the time of measurement **[1]**.

6.5.1. LAB MEDIA: Table 2 *Video Editor: please emphasize significant within-group: Sternberg's and Go/no-go data cells*

6.6. Multilevel analysis demonstrated that the OSPAN scores from the pre-training measurement were a significant predictor of the N-back outcome as, starting from the first session [1], participants with higher levels of OSPAN points had a much better performance of the N-back task throughout the training [2].

6.6.1. LAB MEDIA: Table 3
6.6.2. LAB MEDIA: Table 3 *Video Editor: please emphasize Time × Initial OSPAN score data row*

Conclusion

7. Conclusion Interview Statements

7.1. **Olga Matysiak**: It is essential to be sure that the participants understand and comply with the training protocols, as without their comprehension and acquiescence, you cannot be sure what influences the final results [1].

    7.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera (5.1., 5.4.)