**Supplementary Material for “Exploring Symptom Clusters in Mild Cognitive Impairment and Dementia with the NIH Toolbox”**

In this Supplementary Material document, we compare EFA results from the aMCI/DAT sample to those in a cohort of healthy older adults (n = 156) that were enrolled to serve as healthy controls in the larger ARMADA study. In addition, we also provide subgroup comparisons for all included NIHTB subtests across the two diagnostic categories (aMCI vs. DAT; Table S3).

**Results from Older Adults in a Healthy Control Sample**

Compared to the aMCI/DAT group, the healthy control group was on average younger [M = 72.7, SD = 5.0; vs. aMCI/DAT: *t* (249.7) = -5.13, *p* < .01] and had a larger proportion of females compared to males [Females = 104 (66.7%), Males = 52 (33.3%); vs. aMCI/DAT: *χ2* (1) = 19.88, *p* < .01]. No differences were observed between samples on ethnicity [Hispanic or Latino = 3 (1.9%), Not Hispanic or Latino = 153 (98.1%); vs. aMCI/DAT: *χ2* (1) < .001, *p* = 1.00] or race [American Indian or Alaskan Native = 2 (1.3%), Black or African American = 24 (15.4%), More than One Race/Other/Not Provided = 3 (1.9%), White = 127 (81.4%); vs. aMCI/DAT: *χ2* (6) = 5.28, *p* = .51].

To compare factor loadings across samples, we first estimated a 6-factor EFA model in the healthy control sample. Due to rotational indeterminacy, it is difficult to compare loadings across samples directly. Therefore, factor loadings from the healthy control 6-factor solution were subsequently rotated using Procrustes rotation (via the ccpsych package version 0.2.6; Fischer & Karl, 2019) to be as similar as possible to those in the main paper. The Procrustes rotated loadings for the healthy control group are provided in Table S1. For convenience, we also provide factor loading differences between samples in Table S2 (i.e., aMCI/DAT loadings – Healthy Control loadings). Tucker’s Φ – a factor congruence coefficient that ranges from 0 to 1 – was also estimated to compare the similarity of factors across samples based on the loading patterns; Φ values > .85 is often used as a cutoff to indicate factor similarity).

Tucker’s Φ values for the 6 factors were as follows: (1) *Fluid Intelligence* = 0.84, (2) *Crystallized Intelligence* = 0.86, (3) *Negative Affect* = 0.94, (4) *Positive Affect / Life Satisfaction* = 0.78, (5) *Social Health* = 0.89, and (6) *Physical Function* = 0.43. Of these, Φ values were lowest and did not meet the .85 threshold for the *Physical Function* and *Positive Affect / Life Satisfaction* factors. Upon inspection of the loading patterns and differences between samples, it appears that the *Fluid Intelligence* and *Physical Function* factors are more highly correlated (as evidenced by the highlighted cross-loadings between Factors 1 and 6 in Table S1) in the healthy control sample. Furthermore, the two memory tests load less strongly onto *Fluid Intelligence* and Pain Interference loads less strongly onto *Negative Affect* in the healthy control sample. Finally, loadings for *Positive Affect / Life Satisfaction* were lower in the healthy control sample compared to the aMCI/DAT sample. Taken together, these results should be interpreted as preliminary and are subject to certain limitations – notably, (1) age and gender differences between samples, described above, and (2) potential instability in the rotation procedure, possibly resulting from inclusion of low communality indicators and use of oblique rotation in the initial factor analysis models. That said, the patterns of factor loading differences do generally correspond to differences in correlations among relevant subtests, and thus do in fact deserve further study.

Table S1. Procrustes Rotated Factor Loadings for Older Adult Healthy Controls (n = 156)

|  |  |  |
| --- | --- | --- |
| **NIHTB** **Module** | **Measure** | **Factors** |
| **1** | **2** | **3** | **4** | **5** | **6** |
| Cognition | Flanker Inhibitory Control and Attention | **0.64** | -0.10 | 0.05 | -0.27 | 0.15 | **0.43** |
| Cognition | Dimensional Change Card Sort | **0.58** | -0.05 | 0.01 | -0.27 | 0.12 | **0.40** |
| Cognition | Pattern Comparison Processing Speed | **0.62** | -0.20 | -0.02 | -0.06 | 0.05 | 0.29 |
| Cognition | List Sorting Working Memory | 0.26 | 0.22 | -0.15 | 0.18 | -0.20 | 0.20 |
| Motor | 9-Hole Pegboard Dexterity – Dominant | **0.44** | 0.02 | 0.01 | 0.23 | 0.06 | -0.08 |
| Cognition | Picture Sequence Memory | 0.24 | 0.26 | 0.07 | **0.32** | -0.23 | 0.09 |
| Sensory | Odor Identification | **0.33** | 0.14 | -0.06 | **0.35** | -0.17 | -0.03 |
| Cognition | Picture Vocabulary | -0.05 | **0.73** | -0.02 | 0.01 | -0.02 | 0.09 |
| Cognition | Oral Reading Recognition | -0.02 | **0.91** | -0.08 | **-0.34** | 0.19 | 0.14 |
| Emotion | Fear (Affect) | -0.02 | 0.03 | **0.90** | -0.07 | 0.15 | 0.02 |
| Emotion | Anger (Affect) | -0.20 | -0.04 | **0.72** | -0.03 | 0.01 | **0.35** |
| Emotion | Perceived Stress | -0.02 | -0.02 | **0.79** | -0.21 | 0.06 | -0.07 |
| Emotion | Sadness | -0.07 | 0.07 | **0.67** | -0.10 | -0.18 | -0.01 |
| Sensory | Pain Interference | 0.00 | -0.14 | 0.15 | -0.16 | 0.04 | -0.05 |
| Emotion | Loneliness | -0.10 | 0.06 | **0.47** | -0.11 | **-0.38** | 0.11 |
| Emotion | General Life Satisfaction | -0.14 | -0.02 | -0.24 | **0.43** | 0.26 | **0.38** |
| Emotion | Positive Affect | -0.20 | -0.15 | -0.29 | 0.24 | 0.29 | 0.20 |
| Emotion | Meaning & Purpose | -0.17 | 0.01 | 0.00 | **0.42** | **0.47** | 0.16 |
| Emotion | Friendship | 0.13 | 0.01 | 0.00 | **0.40** | **0.71** | -0.26 |
| Emotion | Emotional Support | 0.05 | 0.02 | -0.15 | 0.21 | **0.59** | 0.03 |
| Motor | 2-Minute Walk Endurance | 0.41 | 0.17 | 0.03 | -0.01 | 0.06 | **0.32** |
| Motor | 4-Meter Walk Gait Speed | **-0.32** | -0.17 | -0.09 | -0.21 | 0.18 | -0.10 |
| Motor | Grip Strength – Dominant | 0.02 | -0.16 | -0.20 | -0.25 | -0.10 | **0.50** |
| Sensory | Visual Acuity | -0.08 | 0.03 | -0.08 | -0.26 | 0.21 | -0.22 |
| Sensory | Words-In-Noise | -0.28 | 0.10 | -0.09 | -0.17 | 0.08 | 0.01 |

*Note*. Factor loading absolute values > .3 are highlighted in boldface.

Table S2. Factor Loading Differences between aMCI/DAT and Procrustes-Rotated Healthy Controls

|  |  |  |
| --- | --- | --- |
| **NIHTB** **Module** | **Measure** | **Factors** |
| **1** | **2** | **3** | **4** | **5** | **6** |
| Cognition | Flanker Inhibitory Control and Attention | 0.23 | 0.12 | -0.09 | 0.28 | -0.19 | **-0.47** |
| Cognition | Dimensional Change Card Sort | 0.13 | 0.13 | -0.06 | 0.12 | -0.08 | **-0.36** |
| Cognition | Pattern Comparison Processing Speed | 0.10 | 0.14 | 0.06 | 0.06 | 0.02 | -0.24 |
| Cognition | List Sorting Working Memory | **0.34** | -0.07 | 0.18 | -0.09 | 0.09 | -0.13 |
| Motor | 9-Hole Pegboard Dexterity – Dominant | -0.01 | -0.06 | 0.07 | -0.07 | -0.09 | **0.33** |
| Cognition | Picture Sequence Memory | 0.20 | -0.10 | 0.01 | **-0.30** | 0.18 | -0.13 |
| Sensory | Odor Identification | 0.02 | -0.10 | 0.24 | -0.08 | 0.17 | 0.13 |
| Cognition | Picture Vocabulary | 0.08 | 0.27 | 0.05 | 0.02 | 0.04 | -0.11 |
| Cognition | Oral Reading Recognition | 0.08 | -0.29 | -0.08 | 0.20 | -0.13 | -0.06 |
| Emotion | Fear (Affect) | 0.05 | -0.11 | -0.03 | 0.03 | -0.11 | 0.02 |
| Emotion | Anger (Affect) | 0.15 | 0.05 | 0.12 | 0.02 | 0.03 | **-0.34** |
| Emotion | Perceived Stress | -0.01 | 0.06 | 0.03 | 0.12 | -0.11 | 0.10 |
| Emotion | Sadness | 0.10 | -0.05 | 0.16 | 0.05 | 0.08 | -0.01 |
| Sensory | Pain Interference | 0.14 | 0.04 | **0.34** | 0.11 | 0.14 | -0.20 |
| Emotion | Loneliness | -0.01 | 0.03 | 0.02 | 0.17 | -0.12 | -0.12 |
| Emotion | General Life Satisfaction | 0.05 | 0.07 | 0.00 | 0.23 | -0.20 | **-0.34** |
| Emotion | Positive Affect | 0.25 | 0.09 | 0.17 | **0.36** | -0.09 | **-0.34** |
| Emotion | Meaning & Purpose | 0.17 | -0.08 | -0.14 | 0.14 | -0.20 | -0.09 |
| Emotion | Friendship | -0.18 | 0.04 | 0.07 | **-0.30** | 0.10 | 0.28 |
| Emotion | Emotional Support | -0.05 | 0.05 | 0.03 | -0.09 | 0.06 | 0.02 |
| Motor | 2-Minute Walk Endurance | **-0.36** | -0.20 | -0.01 | -0.04 | -0.01 | **0.65** |
| Motor | 4-Meter Walk Gait Speed | **0.30** | 0.06 | 0.13 | 0.05 | -0.12 | **-0.53** |
| Motor | Grip Strength – Dominant | -0.12 | 0.25 | 0.16 | 0.02 | 0.08 | -0.08 |
| Sensory | Visual Acuity | 0.18 | -0.07 | 0.00 | 0.16 | -0.18 | -0.14 |
| Sensory | Words-In-Noise | **0.31** | -0.26 | -0.10 | -0.03 | 0.06 | -0.26 |

*Note*. Absolute differences between factor loadings > .3 are highlighted in boldface. Positive values indicate higher factor loadings in the aMCI/DAT sample compared to the health control sample and vice versa

**Subtest Group Comparisons**

Comparisons between the aMCI and DAT subgroups on each NIHTB subtest included in the EFA models are shown in Table S3.

Table S3. NIH Toolbox Subtest Group Comparisons: aMCI vs. DAT

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **aMCI** |  | **DAT** |  |  |  |  |
|  | **N** | **M** | **SD** | **Min** | **Max** |  | **N** | **M** | **SD** | **Min** | **Max** |  | **t** | **df** | **p** |
| *Cognition Module* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Picture Vocabulary** | **91** | **112.3** | **9.5** | **85** | **135** |  | **72** | **108.6** | **11.1** | **74** | **128** |  | **2.23** | **140.41** | **0.03** |
| Oral Reading Recognition | 92 | 108.0 | 7.6 | 84 | 119 |  | 71 | 106.1 | 7.0 | 90 | 119 |  | 1.61 | 155.97 | 0.11 |
| **Flanker Inhibitory Control and Attention** | **92** | **86.8** | **10.1** | **59** | **108** |  | **70** | **74.6** | **14.7** | **48** | **96** |  | **5.98** | **116.31** | **0.00** |
| **Dimensional Change Card Sort** | **92** | **91.6** | **12.9** | **51** | **119** |  | **71** | **82.0** | **17.1** | **46** | **110** |  | **3.93** | **126.02** | **0.00** |
| **List Sorting Working Memory** | **90** | **81.7** | **15.0** | **51** | **109** |  | **59** | **67.9** | **14.3** | **40** | **109** |  | **5.65** | **128.31** | **0.00** |
| **Picture Sequence Memory** | **84** | **83.8** | **7.2** | **76** | **109** |  | **52** | **79.3** | **4.0** | **76** | **94** |  | **4.71** | **132.73** | **0.00** |
| **Pattern Comparison Processing Speed** | **92** | **77.3** | **13.2** | **50** | **109** |  | **73** | **65.9** | **16.3** | **38** | **109** |  | **4.81** | **137.53** | **0.00** |
| *Motor Module* |   |   |   |   |   |  |   |   |   |   |   |  |  |  |  |
| 9-Hole Pegboard Dexterity Test | 90 | 88.5 | 16.6 | -23 | 110 |  | 72 | 83.5 | 17.9 | 9 | 109 |  | 1.83 | 147.19 | 0.07 |
| Grip Strength Test | 92 | 96.7 | 9.7 | 77 | 118 |  | 73 | 95.3 | 11.1 | 72 | 129 |  | 0.86 | 143.55 | 0.39 |
| **2-Minute Walk Endurance Test** | **80** | **83.3** | **15.3** | **43** | **126** |  | **58** | **76.9** | **15.1** | **39** | **109** |  | **2.47** | **123.53** | **0.01** |
| 4-Meter Walk Gait Speed Test | 81 | 3.8 | 1.0 | 1.9 | 8.2 |  | 59 | 4.1 | 1.1 | 2.2 | 8.9 |  | -1.64 | 117.03 | 0.10 |
| *Sensory Module* |   |   |   |   |   |  |   |   |   |   |   |  |  |  |  |
| Pain Interference | 91 | 49.9 | 8.7 | 39 | 76 |  | 73 | 48.8 | 7.5 | 39 | 70 |  | 0.85 | 161.17 | 0.40 |
| Odor Identification | **89** | **72.8** | **25.0** | **11** | **115** |  | **67** | **58.5** | **22.5** | **11** | **115** |  | **3.75** | **148.90** | **0.00** |
| Visual Acuity | 89 | 0.0 | 0.1 | -0.3 | 0.4 |  | 70 | 0.0 | 0.1 | -0.2 | 0.4 |  | 0.36 | 153.50 | 0.72 |
| Words-In-Noise | 90 | 16.3 | 6.4 | 6.8 | 26 |  | 67 | 16.3 | 6.4 | 7.6 | 26 |  | -0.01 | 141.88 | 0.99 |
| *Emotion Module* |   |   |   |   |   |  |   |   |   |   |   |  |  |  |  |
| Anger (Affect) | 92 | 46.7 | 9.6 | 27 | 77 |  | 71 | 47.8 | 10.9 | 27 | 70 |  | -0.67 | 140.09 | 0.51 |
| Fear (Affect) | 92 | 49.9 | 9.4 | 27 | 77 |  | 71 | 50.3 | 10.6 | 27 | 74 |  | -0.22 | 140.69 | 0.83 |
| Sadness | 92 | 48.5 | 9.4 | 30 | 73 |  | 71 | 48.9 | 11.1 | 30 | 73 |  | -0.29 | 136.82 | 0.77 |
| Positive Affect | 92 | 48.2 | 8.0 | 28 | 71 |  | 73 | 48.1 | 7.9 | 34 | 71 |  | 0.13 | 155.39 | 0.90 |
| General Life Satisfaction | 92 | 53.9 | 9.7 | 34 | 76 |  | 73 | 54.9 | 10.2 | 32 | 76 |  | -0.64 | 150.84 | 0.53 |
| Meaning & Purpose | 92 | 49.4 | 9.3 | 32 | 71 |  | 73 | 49.2 | 9.0 | 29 | 71 |  | 0.14 | 156.48 | 0.89 |
| Perceived Stress | 92 | 45.6 | 9.7 | 23 | 69 |  | 71 | 46.6 | 10.7 | 23 | 75 |  | -0.60 | 142.29 | 0.55 |
| Emotional Support | 92 | 47.1 | 8.5 | 22 | 62 |  | 73 | 47.0 | 7.9 | 25 | 62 |  | 0.03 | 158.46 | 0.98 |
| Friendship | 92 | 50.6 | 8.7 | 34 | 67 |  | 71 | 49.5 | 8.2 | 28 | 67 |  | 0.83 | 154.71 | 0.41 |
| Loneliness | 92 | 49.2 | 9.3 | 37 | 71 |  | 71 | 50.9 | 10.2 | 37 | 75 |  | -1.14 | 142.79 | 0.26 |

*Note*. Significant comparisons (p < .05) highlighted in **bold**.

**References**

Fischer, R., & Karl, J. A. (2019). A primer to (cross-cultural) multi-group invariance testing possibilities in R. *Frontiers in psychology*, 1507.