

Supplemental Methods

Details of Normative Reference Range Calculations

For each parameter, we began by grouping all data together and testing the data for normality. If a parameter was not normally distributed (Lillifor's test, $P < 0.05$), the data was transformed with a logarithmic, square root, inverse, or exponential transform and retested for normality. A normal distribution was obtained for a majority of parameters (10 of 12). For those parameters with a normal or transformed-to-normal distribution, we used parametric methods to compute a normative reference range (95% confidence intervals) taking age, sex, and test-arm into account.

We began by taking the grouped data together and using linear regression find any age-related trends in the data. For parameters with a significant regression fit (F -tests, $P < 0.05$), the regression model was subtracted out from the original or transformed values. We then examined the data for any effects of sex (males versus females) and test-arm (dominant versus non-dominant). If any effects of sex or test-arm were present (Kolmogorov-Smirnov tests, $P < 0.05$), we repeated above steps on the males and females and/or dominant and non-dominant arms separately. Finally, percentile values (2.5%, 5%, 95%, 97.5%) needed to compute the normative reference range were obtained from the data after all effects of age, sex, and test-arm had been removed.

A normal distribution could not be obtained for IDR and ISR, thus non-parametric methods were used to obtain their normative reference range. Wilcoxon rank sum tests were used to examine the effects of age (<40 versus ≥ 60), sex, and test-arm. For each significant effect ($P <$

0.05), separate percentiles were obtained for each age (<40, 40-59, ≥60), sex (male, female), and/or test-arm (dominant, non-dominant).

The final step in our analysis involved computing the normative reference range specific to each parameter. The normative reference range was obtained using the first 95% of subjects for most parameters (0-95%: PS, RT, MS, IDE, NSP, MSD, Var, Shift), whereas the top 95% was used for three parameters (5-100%: MS, IDR, ISR) and the central 95% was used for one parameter (2.5-97.5%: C/E). Each subject also had a distinct normative reference range for all parameters with significant linear regression fits. The following formulae were used depending on which transformation, if any, was used to obtain a normal distribution of data.

None: $Y = \text{age} * \text{slope} + \text{intercept} + \text{percentile}$

Logarithmic: $Y = \exp(\text{age} * \text{slope} + \text{intercept} + \text{percentile})$

Square root: $Y = (\text{age} * \text{slope} + \text{intercept} + \text{percentile})^2$

Inverse: $Y = 1 / (\text{age} * \text{slope} + \text{intercept} + \text{percentile})$

Exponential: $Y = \log(\text{age} * \text{slope} + \text{intercept} + \text{percentile})$

Individual TBI subjects were flagged for abnormal performance on any given parameter if their reaching or matching performance fell outside of their specific normative reference range for that parameter.

Details of Normalized Scoring

For visualization purposes, values for each parameter were also transformed into a normalized score, akin to a z-score using the median, fifth and ninety-fifth percentiles (p50, p5,

p95 respectively). Values greater than p50 were normalized by the difference between p50 and p95 after subtracting p50 from each value. Values less than p50 were normalized by the difference between the p50 and p5 after subtracting p50 from each value. Following this transformation, the values of p5, p50, and p95 obtained normalized scores of -1, 0, and 1, respectively. For C/E, we used p2.5 and p97.5 rather than p5 and p95. Normalized scores between -1 and 1 were within the normative reference range. Normalized scores greater than 1 are considered abnormal for PS, RT, MT, IDE, NSP, MSD, Var and Shift. Scores less than -1 for these parameters represent performance in the top 5% of non-disabled control subjects. For MS, IDR and ISR, normalized scores less than -1 represent abnormal values, whereas scores above 1 represent performance in the top 5% of non-disabled control subjects. Values greater than 1 or less than -1 indicated abnormal values for C/E.