Erratum to: Assessment of individual cognitive changes after deep brain stimulation surgery in Parkinson's disease using the Neuropsychological Test Battery Vienna short version

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Due to a calculation error, SEDs (standard error of difference) were incorrectly calculated. We have corrected this in the clinical case calculation in Table 2 and in Table 3. The corrected values are shown in the case example in Tables 2 and 3.

Mean test z-scores and standard deviations are used for calculating the reliable change index (RCI) as follows:

$$RCI = ((X_2 - X_1) - (M_2 - M_1)) \times SED$$

The difference of $(X_2 - X_1)$ characterizes the individual test scores of a participant at the two test sessions over time. M_2 and M_1 represent the mean scores of the group the participant is compared to. The calculation of the critical difference uses the standard deviation and test-retest reliability of the specific comparison group. The standard deviation is taken from the first test session. The retest-reliability coefficient

of a given test is calculated by using test scores of the first test session (X_1) and test scores of the second test session (X_2).

$$SED = \sqrt{2 \times SEM^2}$$

$$SEM = SD \sqrt{(1 - r_{tt})}$$

This formula is based on Chelune et al. [11] and a significant change can be assumed at a change of ± 1.64 ($p = 0.05$). Based on this, a confidence interval is calculated to determine a minimum and a maximum limit which represent significant changes.

In order to ensure replicability for future studies, the calculations are shown here using a case example. A patient taken from the DBS group is compared to the PD group for the memory domain. All scores have already been transformed into z-scores. The calculation process is divided into two steps. At first, calculation of the confidence interval using mean score and standard deviation of the PD group is performed for both test sessions. Mean score of the memory domain at first testing session was -0.188 with a standard deviation of 0.538 for the PD group. Mean score of the memory domain at the second testing session was -0.472 with a standard deviation of 0.671 for the PD group. The test-retest reliability coefficient ($r_{tt} = 0.649$) results from the correlation of the test scores across time for the PD group. The formula for the standard error of measurement (SEM) is derived by including the test-retest correlation coefficient and standard deviation from the PD group.

$$SEM = 0.538 \times \sqrt{(1 - 0.649)} = 0.319$$

Based on the standard error of measurement, the standard error of difference (SED) is calculated.

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Table 2 rtt, SEM, SED and limiting values for the PD-BMT group, control group and MCI group

	Mean score and SD 1 st testing	Mean score and SD 2 nd testing	rtt	SEM	SED	Limiting value deterioration	Limiting value improvement
<i>PD-BMT group</i>							
Attention	-0.7 ± 1.4	-1.0 ± 1.2	0.7	0.7	0.9	-1.9	1.1
Language	-0.5 ± 0.7	-0.5 ± 0.8	0.6	0.5	0.6	-1.1	1.0
Executive function (phonemic fluency)	-0.5 ± 1.0	-0.4 ± 1.1	0.7	0.5	0.7	-1.1	1.3
Memory	-0.2 ± 0.5	-0.5 ± 0.6	0.6	0.3	0.5	-1.0	0.5
Executive function (nonverbal planning)	-0.8 ± 1.1	-0.6 ± 1.0	0.6	0.7	1.0	-1.5	1.8
Total NTB short	-0.5 ± 0.7	-0.6 ± 0.6	0.8	0.3	0.5	-0.8	0.6
<i>Control group</i>							
Attention	0.8 ± 1.2	0.2 ± 0.9	0.3	0.9	1.3	-2.7	1.7
Language	-0.1 ± 0.5	-0.2 ± 0.6	0.5	0.3	0.5	-0.8	0.7
Executive function (phonemic fluency)	0.1 ± 0.9	0.2 ± 1.1	0.6	0.6	0.9	-1.2	1.6
Memory	-0.1 ± 0.7	-0.3 ± 0.5	0.2	0.6	0.8	-1.7	1.0
Executive function (nonverbal planning)	0.6 ± 0.8	0.7 ± 0.7	0.5	0.5	0.8	-1.0	1.5
Total NTB short	0.3 ± 0.5	0.2 ± 0.5	0.5	0.3	0.4	-0.7	0.7
<i>MCI group</i>							
Attention	-0.2 ± 1.3	-0.1 ± 1.3	0.6	0.7	1.0	-1.6	1.8
Language	-0.6 ± 0.8	-0.7 ± 0.9	0.6	0.5	0.6	-1.2	0.9
Executive function (phonemic fluency)	-0.6 ± 1.2	-0.5 ± 1.0	0.6	0.8	1.1	-1.8	1.9
Memory	-0.5 ± 0.9	-1.0 ± 1.1	0.6	0.5	0.7	-1.6	0.6
Executive function (nonverbal planning)	0.1 ± 1.1	-0.1 ± 1.2	0.7	0.6	0.8	-1.6	1.1
Total NTB short	-0.3 ± 0.7	-0.4 ± 0.8	0.6	0.4	0.6	-1.1	0.8

rtt test–retest reliability, *SEM* standard error of measurement, *SED* standard error of difference, *PD-BMT* Parkinson's disease best medically treated, *MCI* mild cognitive impairment, *NTBV* Neuropsychological Test Battery Vienna, *SD* standard deviation

Table 3 Results of individual comparison between PD-BMT group–PD-DBS group, control group–PD-DBS group and MCI group–PD-DBS group

	<i>N</i> deteriorated	% deteriorated	<i>N</i> no change	% no change	<i>N</i> improved	% improved
<i>PD-BMT – PD-DBS</i>						
Attention	0	0.0	18	100	0	0.0
Language	0	0.0	18	100	0	0.0
Executive function (phonemic fluency)	2	11.1	14	77.7	2	11.1
Memory	2	11.1	12	66.7	4	22.2
Executive function (nonverbal planning)	0	0.0	18	100	0	0.0
Total NTB short	0	0.0	18	100	0	0.0
<i>Control – PD-DBS</i>						
Attention	0	0.0	18	100	0	0.0
Language	0	0.0	18	100	0	0.0
Executive function (phonemic fluency)	2	11.1	14	77.7	2	11.1
Memory	0	0.0	17	94.4	1	5.5
Executive function (nonverbal planning)	0	0.0	18	100	0	0.0
Total NTB short	0	0.0	18	100	0	0.0
<i>MCI – PD-DBS</i>						
Attention	0	0.0	18	100	0	0.0
Language	0	0.0	18	100	0	0.0
Executive function (phonemic fluency)	1	5.5	15	83.3	2	11.1
Memory	0	0.0	16	88.8	2	11.1
Executive function (Nonverbal planning)	0	0.0	17	94.4	0	5.5
Total NTB short	0	0.0	18	100	0	0.0

PD-DBS Parkinson's disease deep brain stimulation, *PD-BMT* Parkinson's disease best medically treated, *MCI* mild cognitive impairment

$$SED = \sqrt{(2 \times 0.319^2)} = 0.451$$

According to Ringendahl et al. [10], a deviation of ± 1.64 can be assumed as statistically significant.

$$CI = 1.64 \cdot 0.451 = 0.74$$

The upper and lower scores of the confidence interval (CI) serve as limiting values for defining statistical significance. After subtracting the second and the first mean score ($M2 - M1$), the confidence interval is added or subtracted. Difference of mean scores (DM): $M2 - M1 = -0.284$. Limiting value deterioration: $-CI + DM = -0.74 + -0.284 = -1.024$. Limiting value improvement: $CI + DM = 0.74 + -0.284 = 0.456$. A patient's RCI has to be higher or lower than the limiting values in order to detect a statistically significant change between the first and second testing. The scores of reliability coefficient, standard error of the mean and standard error of a difference are calculated as shown above. For the memory domain the figures are as follows: $rtt = 0.577$; $SEM = 0.621$; $SED = 0.878$; $M1 = -0.456$; $M2 = -0.635$.

The patient chosen for the illustrative example reached a z-score of -2.4 (X1) in the first and -1.9

(X2) in the second testing in the memory domain. The mean scores of the group and the individual test scores are put into the formula for calculating the reliable change index: $RCI = \{[(-1.9) - (-2.4)] - [(-0.635) - (-0.456)]\} \cdot 0.878 = 0.596$. This results in a RCI score of 0.596 for this patient. This value is compared to the limiting values calculated above. The upper limiting value of 0.456 is surpassed. Therefore an improvement of memory ability in this patient in comparison to the Parkinson group has been detected.

Conflict of interest T. Foki, D. Hitzl, W. Pirker, K. Novak, G. Pusswald, E. Auff and J. Lehrner declare that they have no competing interests.

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