



Correction to: Minimally conscious state “plus”: diagnostic criteria and relation to functional recovery

Aurore Thibaut^{1,5} · Yelena G. Bodien^{2,3} · Steven Laureys^{1,5} · Joseph T. Giacino^{3,4}

Published online: 19 March 2020
© Springer-Verlag GmbH Germany, part of Springer Nature 2020

Correction to: Journal of Neurology
<https://doi.org/10.1007/s00415-019-09628-y>

Following electronic publication of the above-referenced manuscript, we discovered that one of the three criteria we proposed to establish command-following in the MCS+ syndrome was inadvertently omitted in some parts of the manuscript. Specifically, "object recognition" was omitted from the criteria used to diagnose MCS+. We operationally define command-following as a Coma Recovery Scale-Revised (CRS-R) Auditory Subscale score of 3 (i.e. reproducible command-following: A3) or 4 (i.e. consistent command-following: A4), or a Visual Subscale score of 5 (i.e. object recognition: V5). However, in Tables 1 and 2 and Figs. 2 and 3, we failed to include object recognition as a criterion for MCS+. In addition, in Fig. 4 (CRS-R Face Sheet), object recognition is not labeled as a criterion for MCS+. Therefore, we would like to highlight the corrected parts of our manuscript to clarify that the criteria for "command-following" include object recognition (V5) as well as reproducible (A3) and consistent (A4) command-following.

The original article can be found online at <https://doi.org/10.1007/s00415-019-09628-y>.

✉ Aurore Thibaut
athibaut@ulg.ac.be

- ¹ Coma Science Group, GIGA-Consciousness, University of Liège and University Hospital of Liège, Allée de l'hôpital, 11-B34, 4000 Liège, Belgium
- ² Department of Neurology, Massachusetts General Hospital, Center for Neurotechnology and Neurorecovery, Harvard Medical School, Boston, MA, USA
- ³ Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital, Harvard Medical School, Boston, MA, USA
- ⁴ Department of Psychiatry, Massachusetts General Hospital, Boston, USA
- ⁵ Centre du Cerveau², University Hospital of Liège, Liège, Belgium

Please note that these modifications do not change any of the findings of the study.

Please find the individual corrections here:

In the section “Methods” the paragraph “consistent command following” needs to be replaced by:

Command following: At least three clearly-discernible behavioral responses are observed over four consecutive trials on at least one of two commands. Note that this definition also includes object recognition.

At the end of the “Procedures” paragraph, the following text needs to be added before Table 1.

Note that we did not include “attention” from the Arousal Subscale as a criterion for MCS+ because all responses, regardless of accuracy, are considered when scoring this item. This item can be scored even in the absence of intact language function. For example, a patient with aphasia who does not comprehend language but understands that a response is anticipated may meet the required criteria.

At the end of the section “Results” the word “lower” needs to be replaced by “higher”:

The MCS– group had significantly higher (i.e., worse) DRS scores than all other groups (all p values < 0.05—supplementary Fig. S3).

Please find the corrected Figs. 2, 3 and 4, as well as supplementary Fig. 3, on the following page:

Fig. 2 DRS total scores (means and SEs) for each group at transition from UWS to MCS– (black column) or at transition from UWS or MCS– to MCS+ (six grey columns). *CF* command following; *IC* intentional communication; *IV* intelligible verbalization; *DRS* Disability Rating Scale, *MCS–* minimally conscious state minus; Black asterisks represent statistical differences between groups corrected for multiple comparisons (Bonferroni corrected). Grey asterisks represent a significant difference uncorrected for multiple comparisons

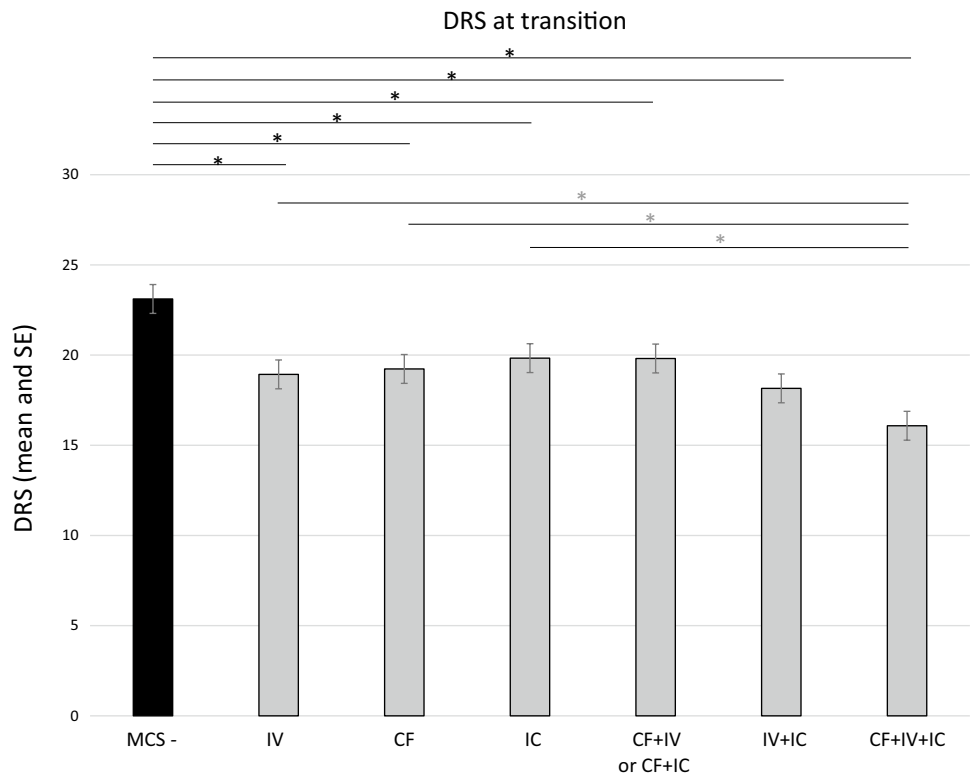
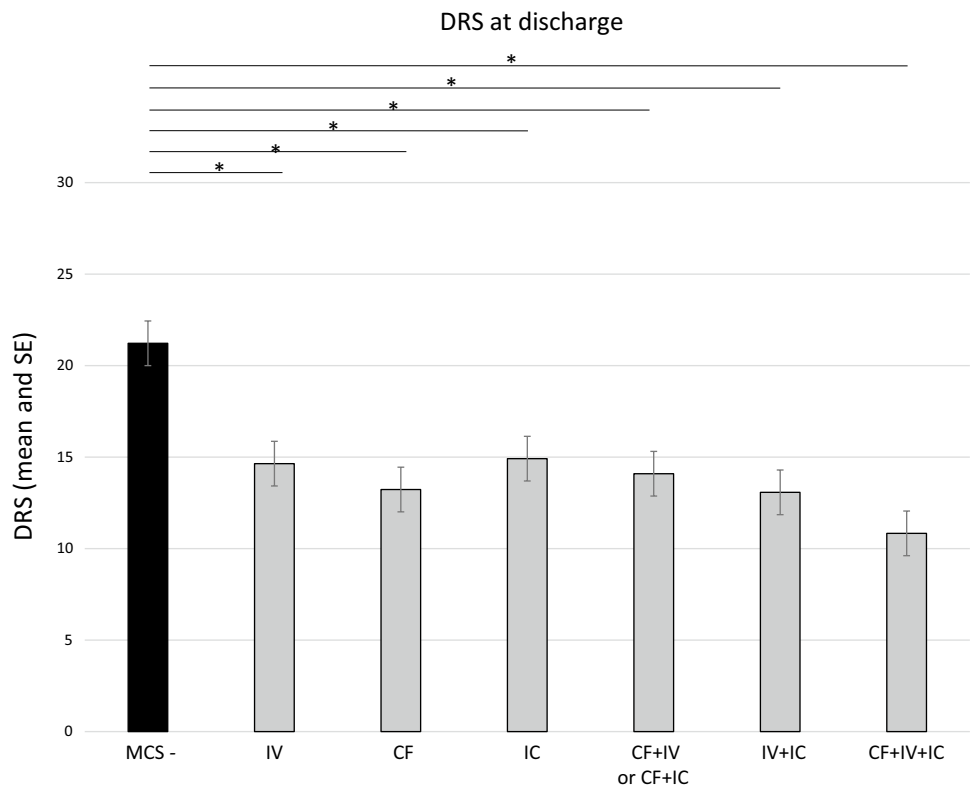


Fig. 3 DRS total scores (means and SEs) for each group at discharge from rehabilitation. *CF* command following; *IC* intentional communication; *IV* intelligible verbalization; *DRS* Disability Rating Scale, *MCS–* minimally conscious state minus; Black asterisks represent statistical differences between groups corrected for multiple comparisons (Bonferroni corrected). Grey asterisks represent a significant difference uncorrected for multiple comparisons



COMA RECOVERY SCALE - REVISED									
Record Form									
Patient:	Date:								
AUDITORY FUNCTION SCALE									
4 - Consistent Movement to Command ■									
3 - Reproducible Movement to Command ■									
2 - Localization to Sound									
1 - Auditory Startle									
0 - None									
VISUAL FUNCTION SCALE									
5 - Object Recognition ■									
4 - Object Localization: Reaching *									
3 - Pursuit Eye Movements *									
2 - Fixation *									
1 - Visual Startle									
0 - None									
MOTOR FUNCTION SCALE									
6 - Functional Object Use †									
5 - Automatic Motor Response *									
4 - Object Manipulation *									
3 - Localization to Noxious Stimulation *									
2 - Flexion Withdrawal									
1 - Abnormal Posturing									
0 - None/Flaccid									
OROMOTOR/VERBAL FUNCTION SCALE									
3 - Intelligible Verbalization ■									
2 - Vocalization/Oral Movement									
1 - Oral Reflexive Movement									
0 - None									
COMMUNICATION SCALE									
2 - Functional: Accurate †									
1 - Non-Functional: Intentional ■									
0 - None									
AROUSAL SCALE									
3 - Attention									
2 - Eye Opening w/o Stimulation									
1 - Eye Opening with Stimulation									
0 - Unarousable									
TOTAL SCORE									

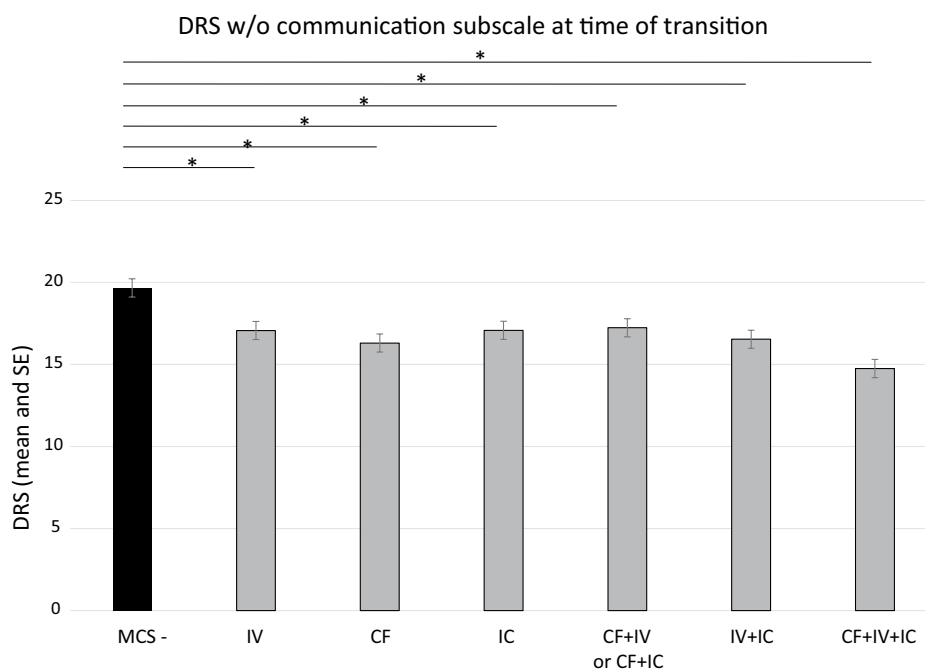
Denotes emergence from MCS †

Denotes MCS- *

Denotes MCS+ ■

Fig. 4 Coma recovery scale-revised (CRS-R) record form showing behavioral criteria for MCS-, MCS+ and MCS emergence

Supplementary Fig. 3 DRS without the communication subscale at time of transition. DRS total scores removing the communication subscale (means and SEs) for each group at transition from UWS to MCS- (black column) or at transition from UWS or MCS- to MCS+ (six grey columns). CF = command following; IC = intentional communication; IV = intelligible verbalization; DRS= Disability Rating Scale, MCS- = minimally conscious state minus. Black asterisks represent statistical differences between groups



Please find the corrected Tables 1 and 2 below:

Table 1 Operational criteria for minimally conscious state (MCS) plus and minus

Group	Operational criteria
1. MCS <i>plus</i> —command following only	Score of 3 or 4 on the auditory subscale or a score of 5 on the visual subscale
2. MCS <i>plus</i> —intelligible verbalization only	Score of 3 on the CRS-R verbal subscale
3. MCS <i>plus</i> —intentional communication only	Score of 1 on the CRS-R communication subscale
4. MCS <i>plus</i> —command-following and intentional communication or intelligible verbalization	Score of 3 or 4 on the auditory subscale or a score of 5 on the visual subscale and a score of 1 on the communication subscale or a score of 3 on the verbal subscale
5. MCS <i>plus</i> —intelligible verbalization and intentional communication	Score of 3 on the verbal subscale and score of 1 on the communication subscale
6. MCS <i>plus</i> —command following and intelligible verbalization and intentional communication	Score of 3 or 4 on the auditory subscale or a score of 5 on the visual subscale and a score of 3 on the verbal subscale and a score of 1 on the communication subscale
7. MCS <i>minus</i>	No evidence of language function but demonstrates at least one behavioral feature of MCS (i.e., visual pursuit, visual fixation, object localization, localization to noxious stimulation, object manipulation, automatic motor behavior)

Table 2 Demographic characteristics and DRS scores at admission, time of transition (from UWS to MCS–/+ or from MCS– to MCS+) and discharge

Group	N	Diagnosis at admission/ etiology	Age (gender- female)	DRS at admission (severity category)	Time at admission (days post injury)	DRS at time of transition to MCS (severity category)	Days post injury at tran- sition from UWS to MCS or MCS- to MCS+	DRS at discharge (severity category)	Days post injury at discharge
All	120	57 MCS–63 UWS 68 TBI–52 NTBI	46.68 ± 18.85 (46 women)	21.83 ± 2.79 (extremely severe)	32.23 ± 18.98	19.21 ± 3.21 (extremely severe)	48.20 ± 25.95	14.06 ± 5.07 (severe)	119.02 ± 78.88
CF	39	18 MCS–21 UWS 25 TBI–14 NTBI	38 ± 17 years (16 women)	22.56 ± 2.58 (vegetative state)	43.85 ± 13.42	19.23 ± 3.13 (extremely severe)	43.28 ± 13.43	13.23 ± 5.36 (severe)	118.615 ± 82.73
IV	14	9 MCS–5 UWS 7 TBI–7 NTBI	52 ± 17 years (6 women)	21.36 ± 3.18 (extremely severe)	34.29 ± 31.54	18.93 ± 3.49 (extremely severe)	59.00 ± 43.30	14.64 ± 6.38 (severe)	157.71 ± 113.123
IC	12	4 MCS–8 UWS 6 TBI–7 NTBI	45 ± 24 years (7 women)	22.00 ± 2.26 (vegetative state)	41.59 ± 32.65	19.83 ± 2.16 (extremely severe)	59.58 ± 37.55	14.92 ± 4.72 (severe)	145.58 ± 92.59
CF+IV or IC	21	9 MCS–12 UWS 15 TBI–6 NTBI	54 ± 21 years (5 women)	21.57 ± 3.20 (extremely severe)	26.29 ± 22.57	19.81 ± 3.30 (extremely severe)	42.57 ± 23.35	14.09 ± 3.78 (severe)	118.95 ± 82.60
IV + IC	13	7 MCS–6 UWS 4 TBI–9 NTBI	51 ± 16 years (6 women)	20.80 ± 2.80 (extremely severe)	38.78 ± 19.34	18.15 ± 2.64 (extremely severe)	45.92 ± 18.48	13.08 ± 3.97 (severe)	85.85 ± 27.51
CF+IV + IC	12	9 MCS–3 UWS 7 TBI–5 NTBI	54 ± 10 (4 women)	19.92 ± 2.31 (extremely severe)	30.08 ± 13.52	16.08 ± 2.27 (severe)	41.42 ± 14.59	10.83 ± 3.24 (moderately severe)	98.67 ± 36.77
MCS–	9	2 MCS–7 UWS 3 TBI–6 NTBI	43 ± 19 years (2 women)	23.89 ± 1.26 (vegetative state)	41.33 ± 16.53	23.11 ± 0.53 (extremely severe)	63.00 ± 32.88	21.22 ± 1.72 (extremely severe)	100.33 ± 31.67

DRS Disability Rating Scale; MCS minimally conscious state; UWS unresponsive wakefulness syndrome; CF command following; IV intelligible verbalization; IC intentional communication; TBI traumatic brain injury; NTBI non-traumatic brain injury; “+” two or more items are observed