Changes in cognitive performance during open-sea 200MSW saturation diving

Nozomu Kageyama, Koji Ozawa, Yutaka Tadano, Michiya Sato
(Undersea Medical Center, Maritime Self Defense Force, Yokosuka, Japan)

Key words : Deep saturation diving, Stroop interference, Selective attention

1. Background

- In a previous study, we examined cognitive performance within a hyperbaric chamber using **Stroop and Reverse-Stroop test** (Appendix 1).
- We observed that cognitive impairment within an artificial hyperbaric environment was influenced by the elevation of environmental pressure rather than psychological stress (Kageyama et al., 2010).
- On the other hand, it was reported that the accumulation of sleep debt, fatigue, and loss of psychological vigor occurred while open-sea saturation diving (Townsend and Hall, 1974).
- Consequently, relationship among hyperbaric environment, degree of cognitive performance and psychological stress has not been clarified.
- The goal of this study was to investigate whether psychological stress causes cognitive impairment during open-sea saturation diving or not.

Stroop interference effect(Stroop, 1935)

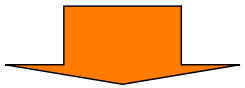
- **Stroop interference is a robust measure of selective attention in cognitive psychology (MacLeod, 1992).**

The schema of Stroop effect

To name the ink color in which different color word is printed		*To name the color which is expressed by the word*
BLUE⇒〖RED〗	**V.S**	**BLUE⇒〖BLUE〗**

⇒*To name "the color" which is expressed by the word is faster than to name the ink color in which different color word is printed.*

- **This effect originates from two different processes: Stroop interference and Reverse-Stroop interference (Appendix 3).**



Detailed analysis of selective attention under hyperbaric environment can be performed using Stroop and Reverse-Stroop interference which has different generated processes.

2. Methods: Procedures

Participants Subjects were six male professional divers (age: 34±2.45).

Cognitive test Stroop and Reverse-Stroop Color-Word interference test (Hakoda and Watanabe, 2005)

Psychological stress test Japanese version of POMS(Profile of mood states; Yokoyama, 1994), and GVA(Global and Vigor; Monk, 1989).

Procedure The three tests were carried out at eight points throughout a open-sea 200MSW(21ATA) saturation dive: Pre-diving(P1), 0-150m compression(P2), 200m-1(P3), 200m-2(P4), 200m-3(P5), 200m-150m decompression(P6), 100m-0m(P7), and Post-diving(P8). These test were conducted at Deck Decompression Chamber.

2. Methods: Measuring points

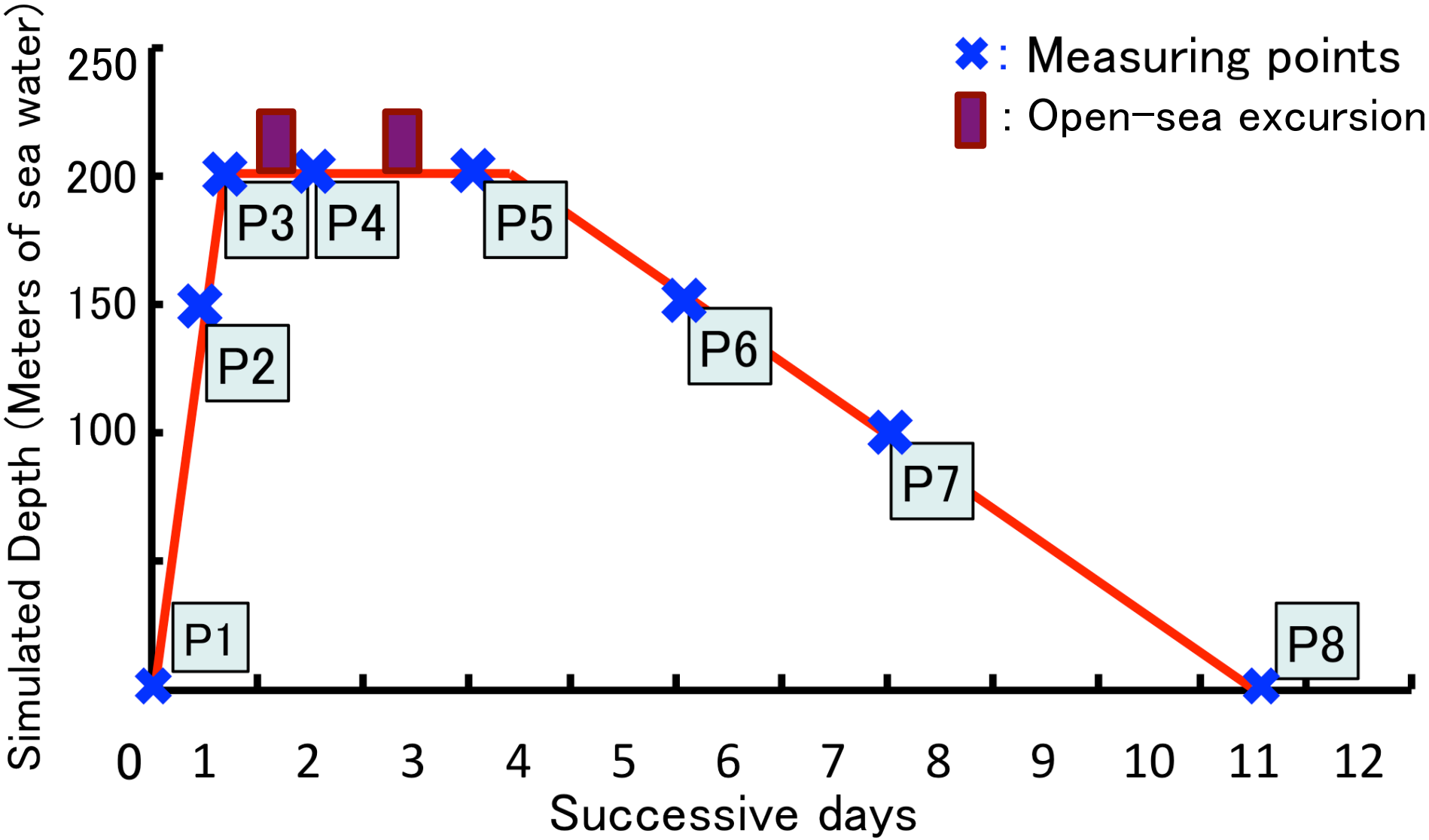
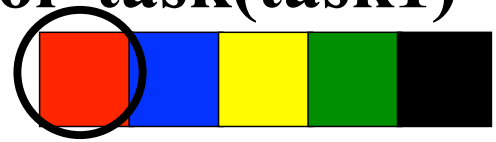


Figure 1. The dive profile and timing of measurement.

2. Methods: Materials

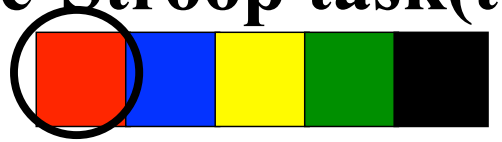
Stroop interference is a robust measure of selective attention in cognitive psychology (MacLeod, 1992).

①Control task(task1)

Red 

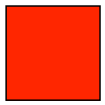
To select a color from five color patches

②Reverse-Stroop task(task2)

Red 

To select a color which is expressed by the word from five color patches

③Control task(task3)

 Red Blue Yellow Green Black

To select a color word from five color words

④Stroop task (task4)

Red Red Blue Yellow Green Black

To select a color word with which the word is printed from five color words

⇒Each task has a 10-second practice session following by a 60-second main session.

Stroop Interference Effect

Stroop interference:(③－④)/ ③, Reverse-Stroop interference:(①－②)/ ①

3. Results: Cognitive performance-1

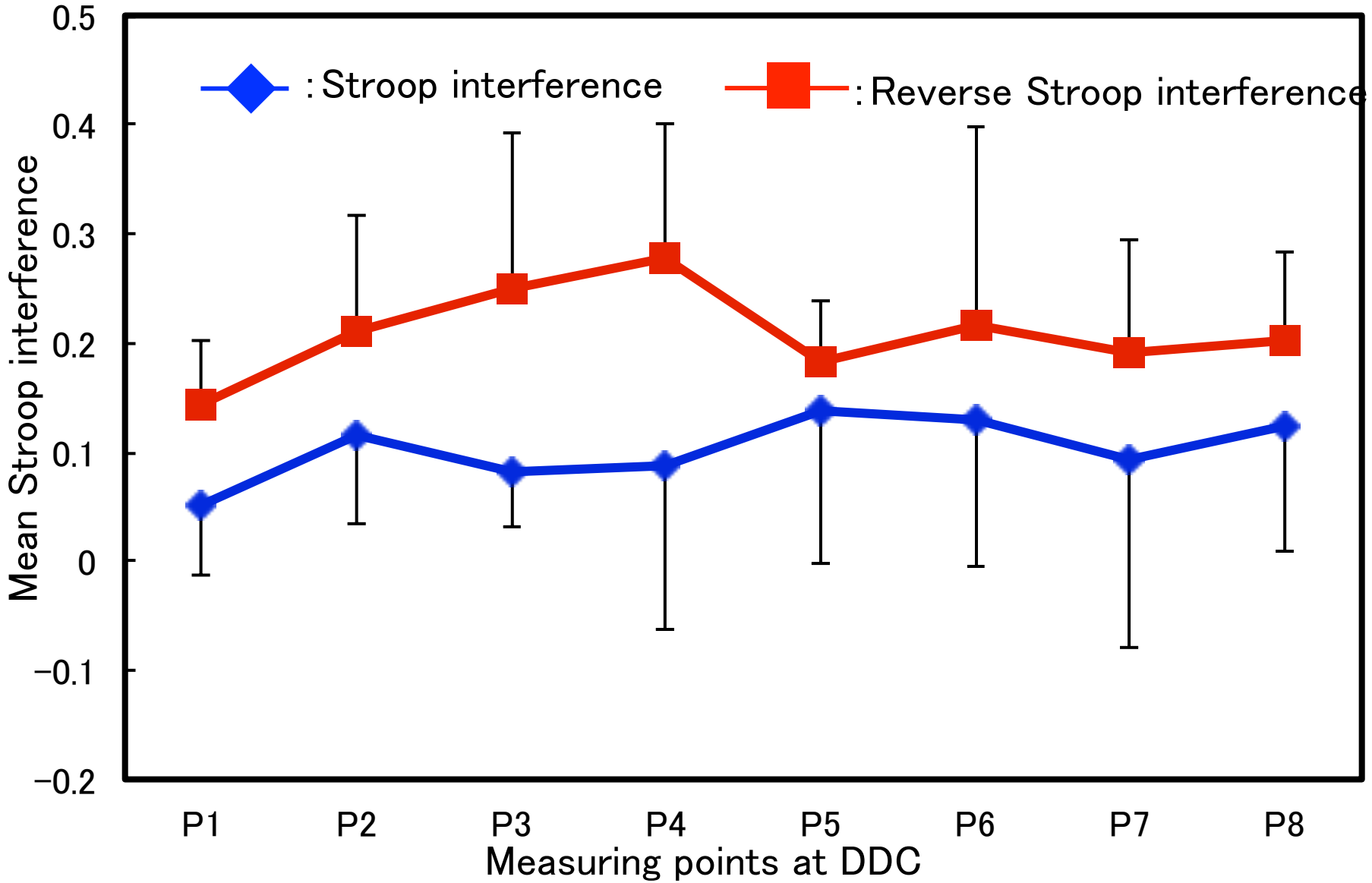


Figure 2. Comparison between the amount of Stroop interference interference during the 200MSW saturation dive(N=6). Error bar: SD. ＊:p <.05.

3. Results: Cognitive performance-2

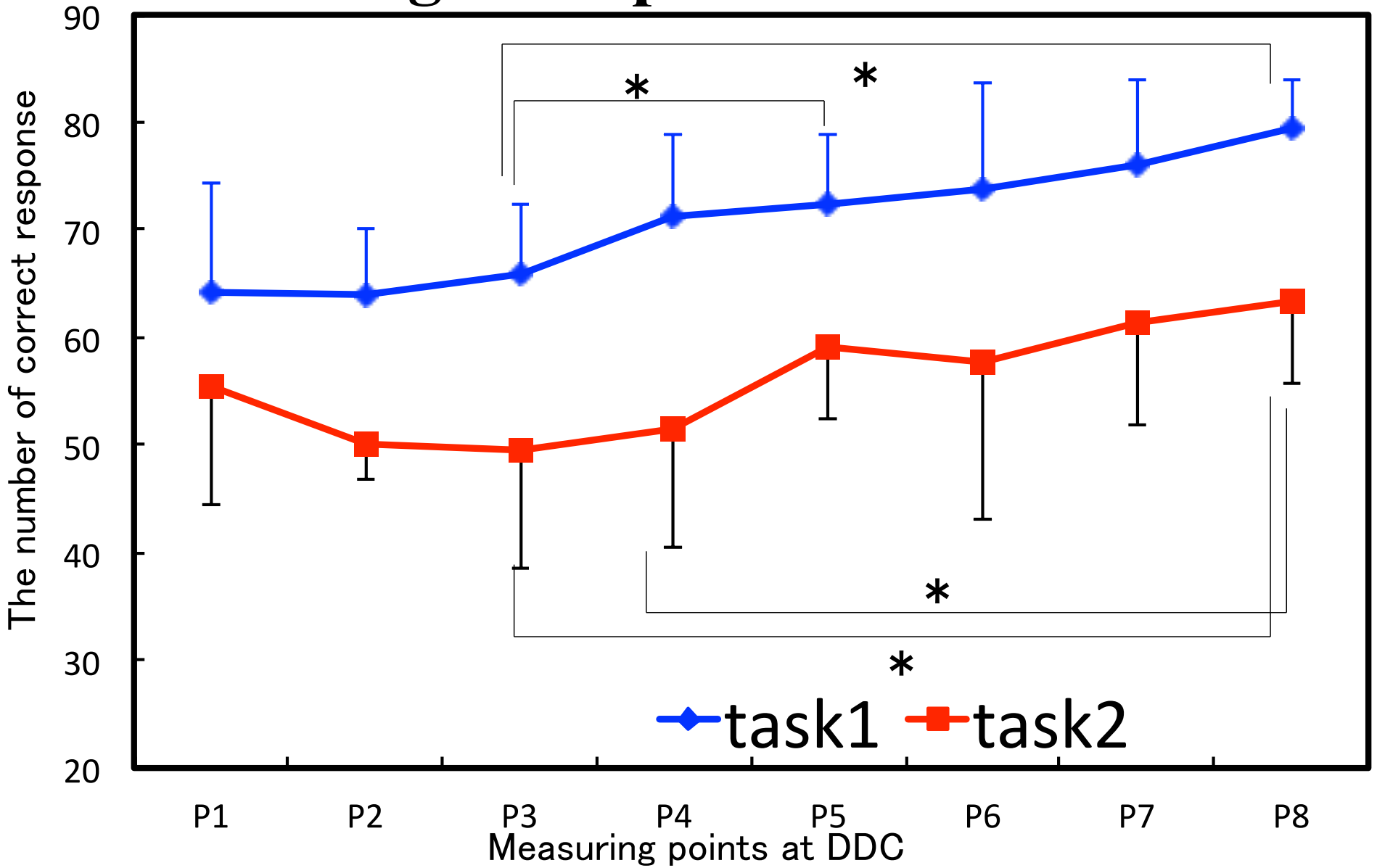


Figure 3. Comparison between the number of correct response of task 1 and task 2 during the 200MSW saturation diving (N=6). Error bar: SD.*: $p < .05$

3. Results: Cognitive performance-3

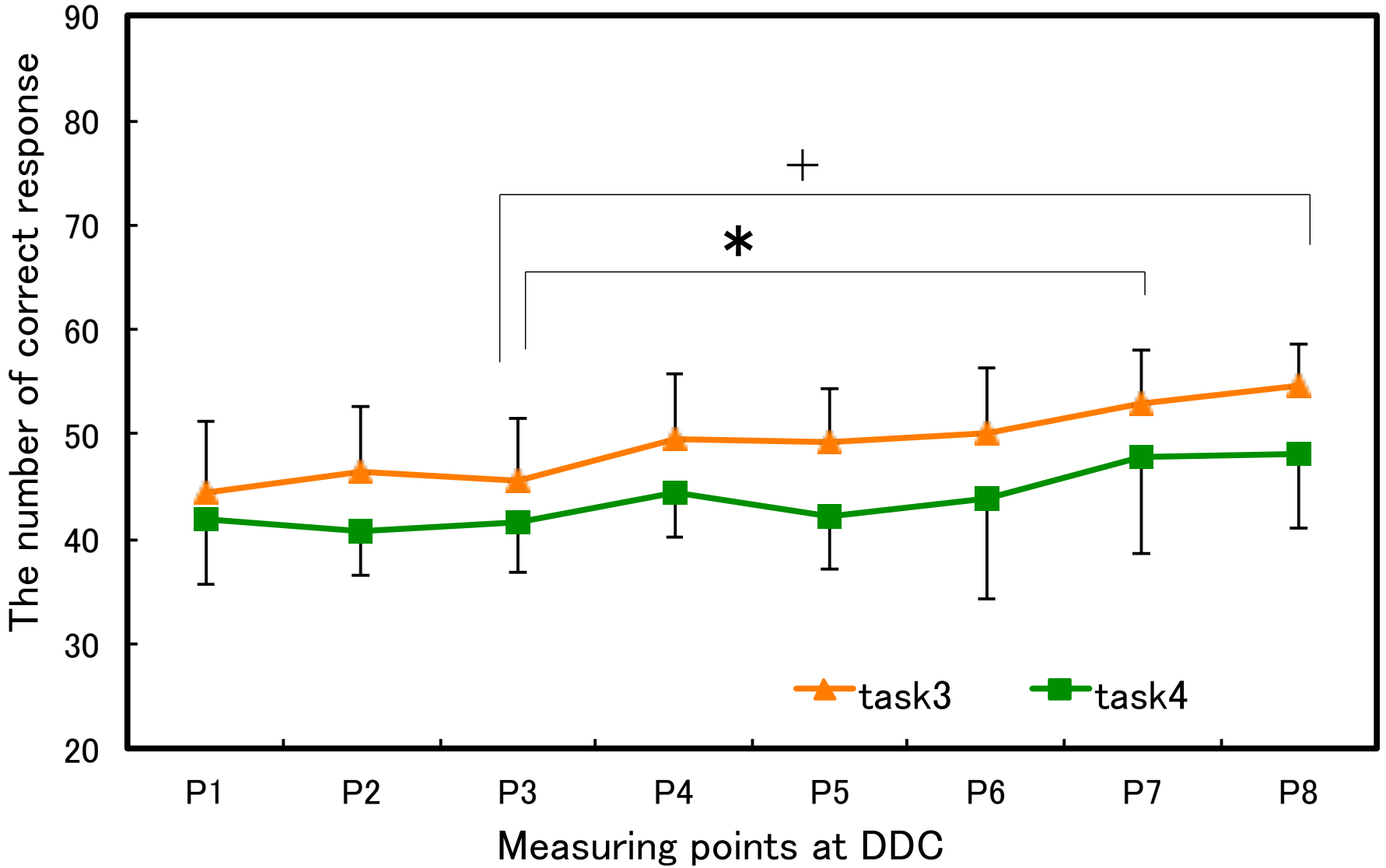


Figure 4. Comparison between the number of correct response of task 3 and task 4 during the 200MSW saturation diving (N=6). Error bar: SD. *:$P < .05$, +: $P < .10$

3. Results: Psychological states-1

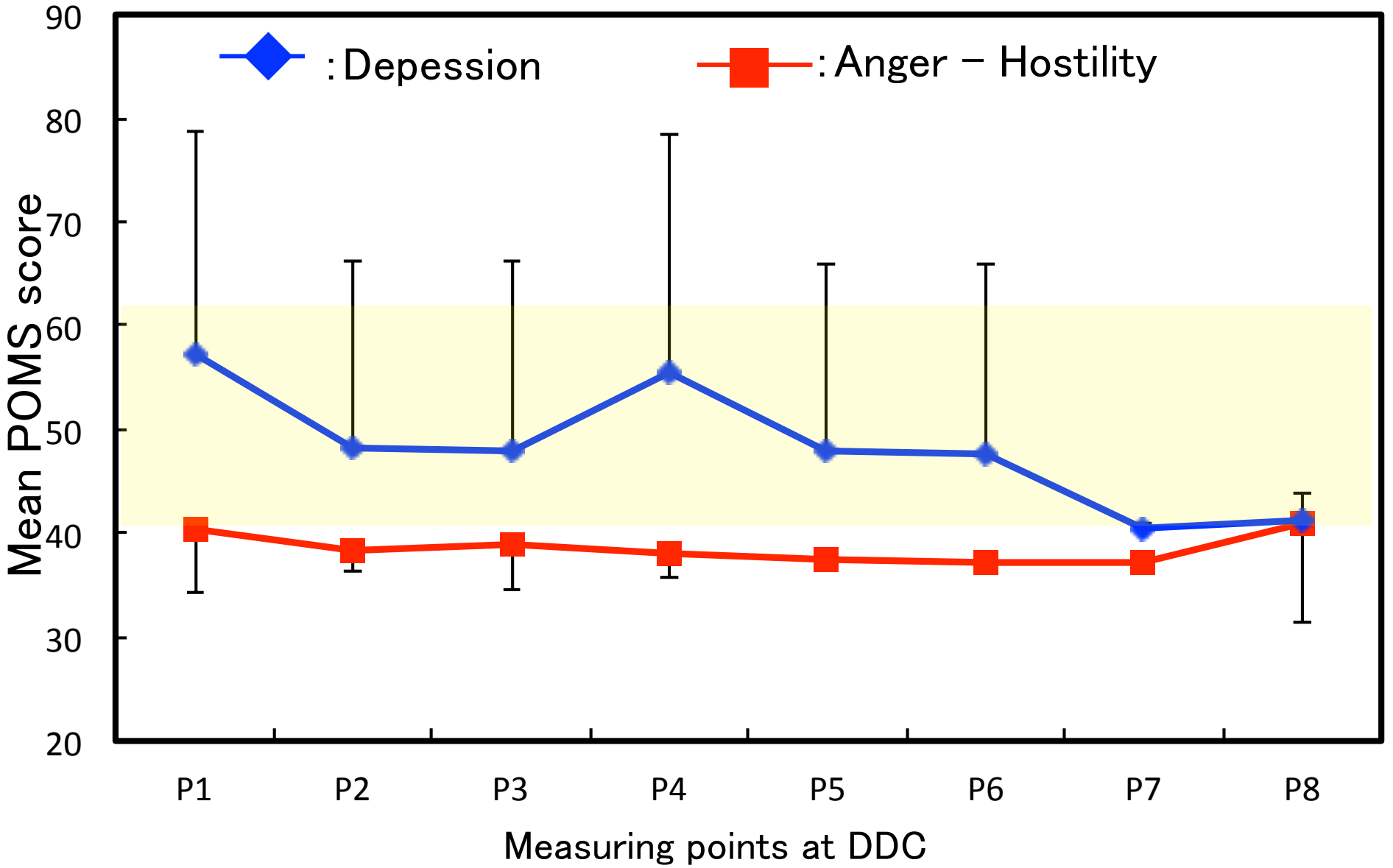


Figure 5. Comparison between mean POMS scores during the 200MSW saturation dive(N=6).
Error bar: SD, : The range of normal fluctuation

3. Results: Psychological states-2

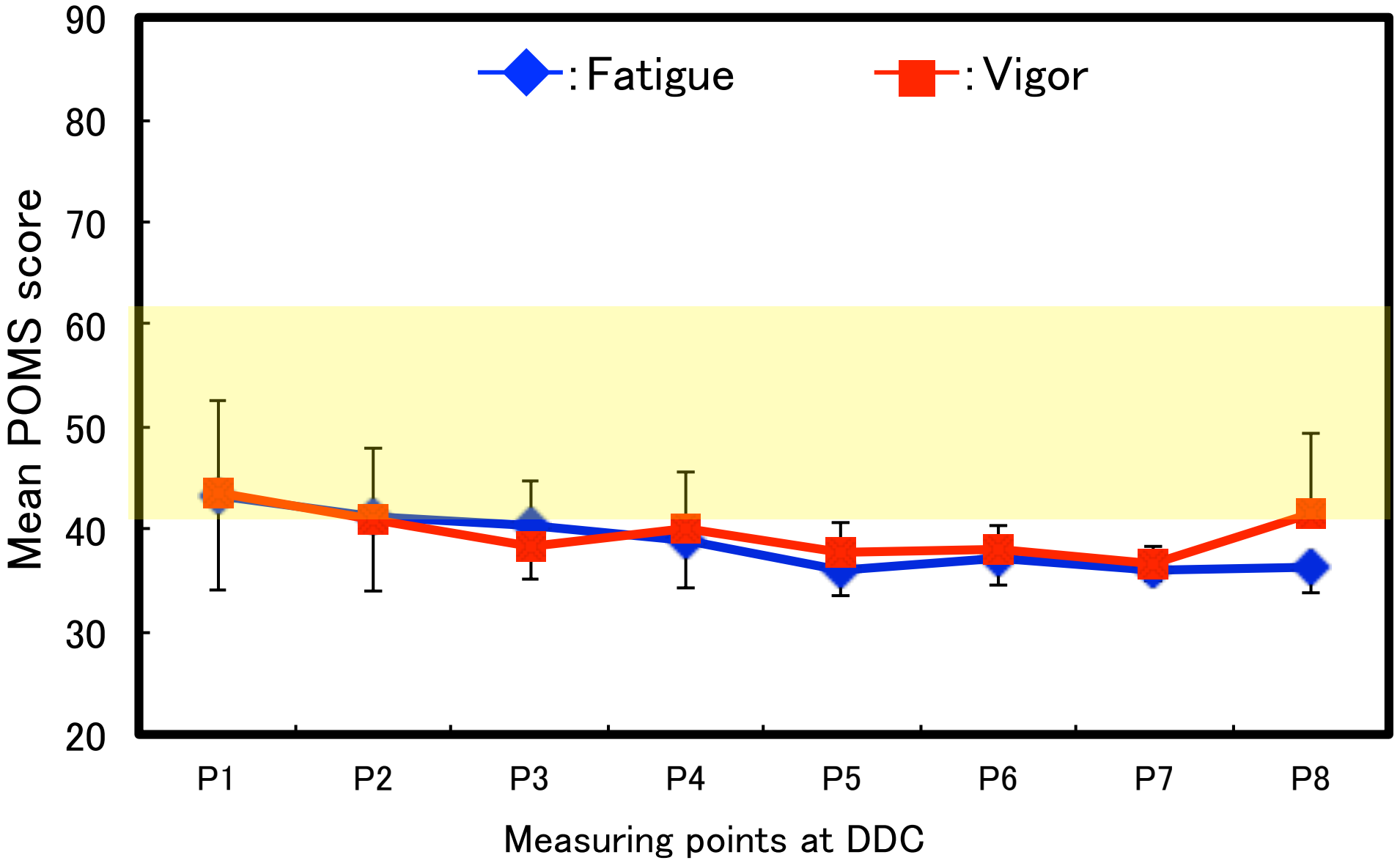


Figure 6. Comparison between mean POMS scores during the 200MSW saturation dive(N=6).
Error bar: SD, : The range of normal fluctuation.

3. Results: Psychological states-3

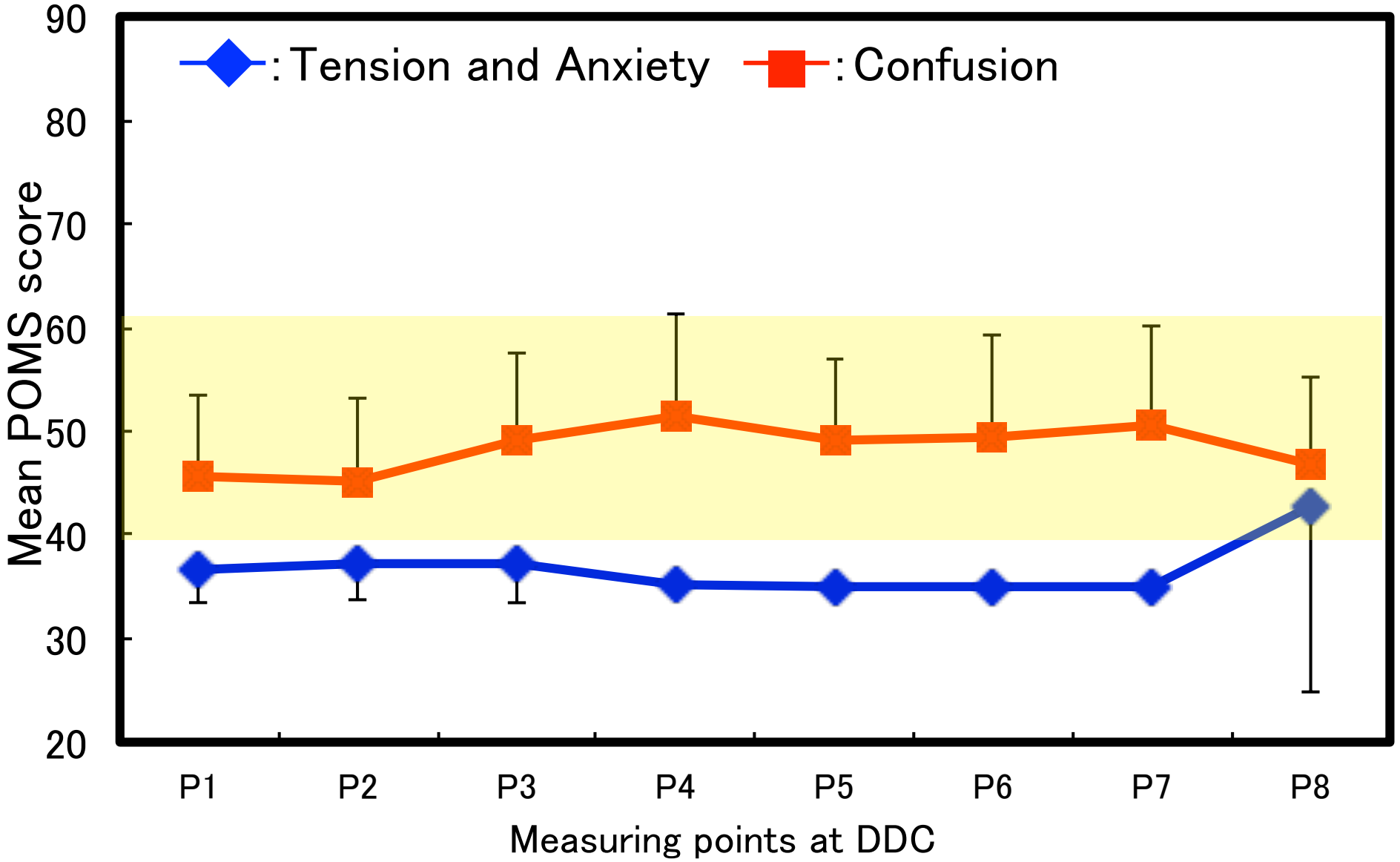


Figure 7. Comparison between mean POMS scores during the 200MSW saturation dive(N=6).
Error bar: SD, : The range of normal fluctuation

4. Conclusions

This study

Cognitive tasks The amount of interference **did not change** during eight test session.

Correct responses of both the Stroop and reverse-Stroop tasks **at 200MSW** were significantly lesser than those at other assessment points were.

Psychological stress Psychological stress was not detected throughout the dive.

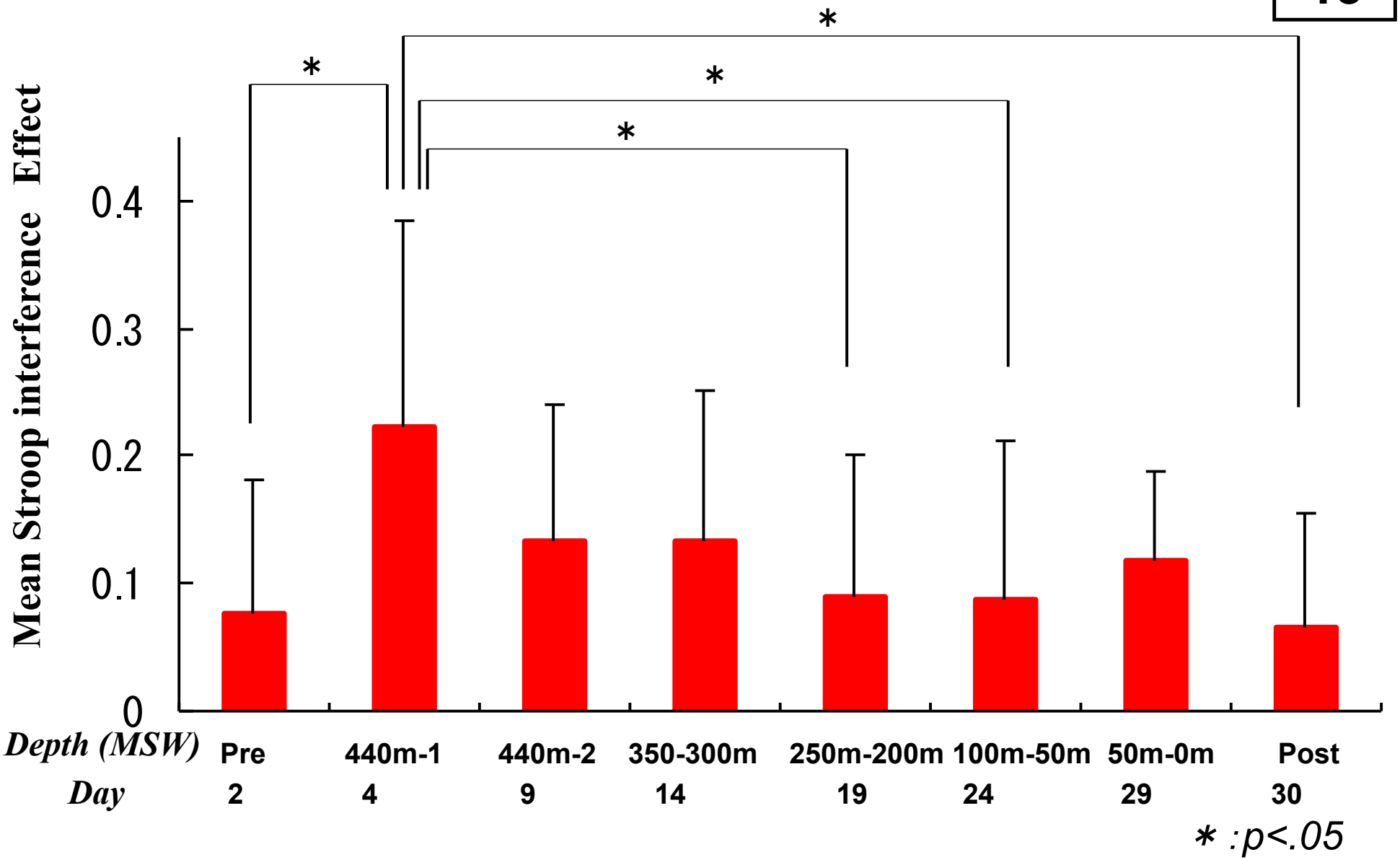
Previous study (Appendix 1, 2)

Cognitive tasks The amount of interference **was the highest at 440MSW**.

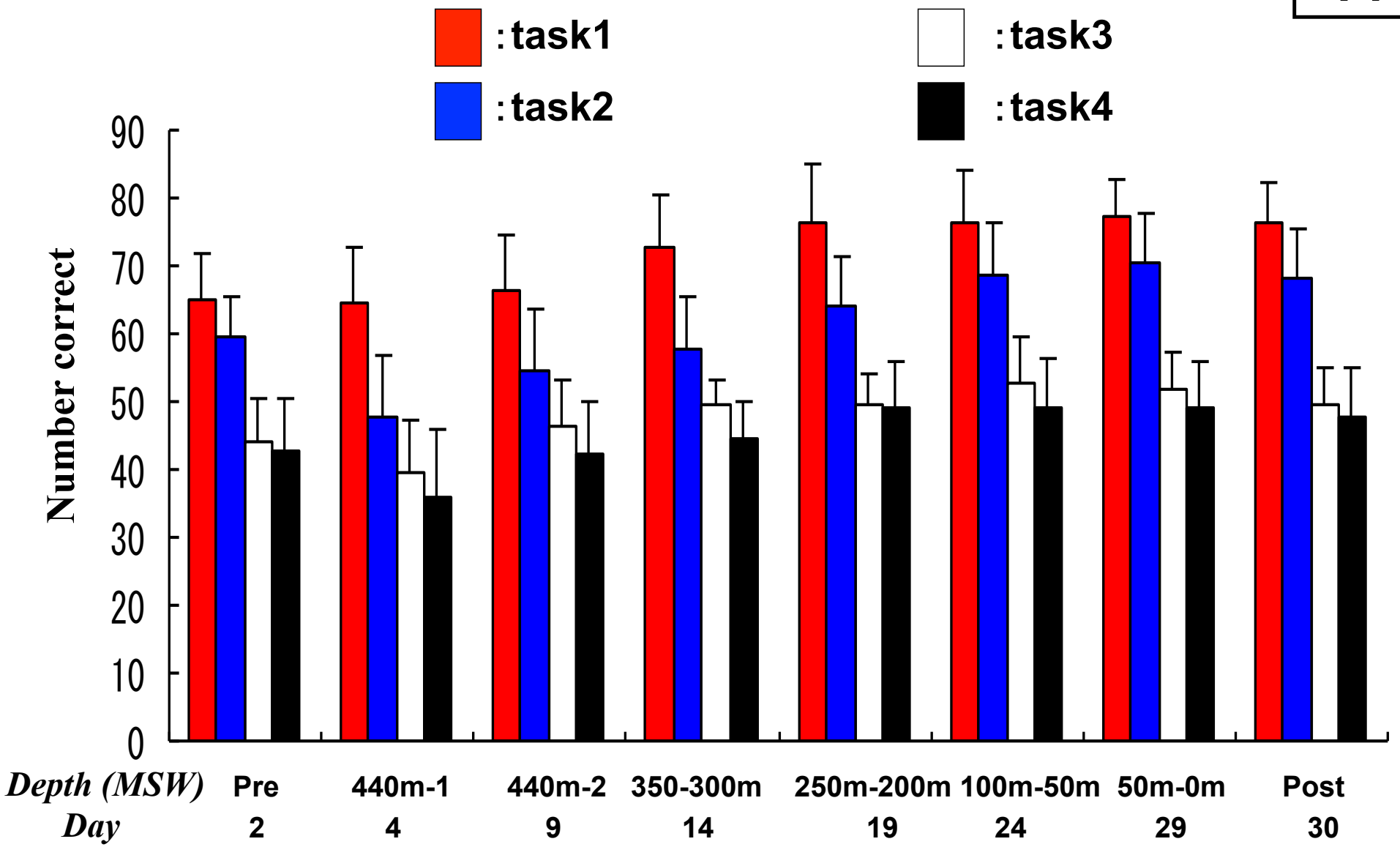
Correct responses of both the Stroop and reverse-Stroop tasks **at 440MSW** were significantly lesser than those at other assessment points were.

Psychological stress Psychological stress was not detected throughout the dive.

Cognitive impairment within a hyperbaric chamber is influenced by the magnitude of environmental pressure rather than psychological stress, even in offshore diving was conducted on the open sea.

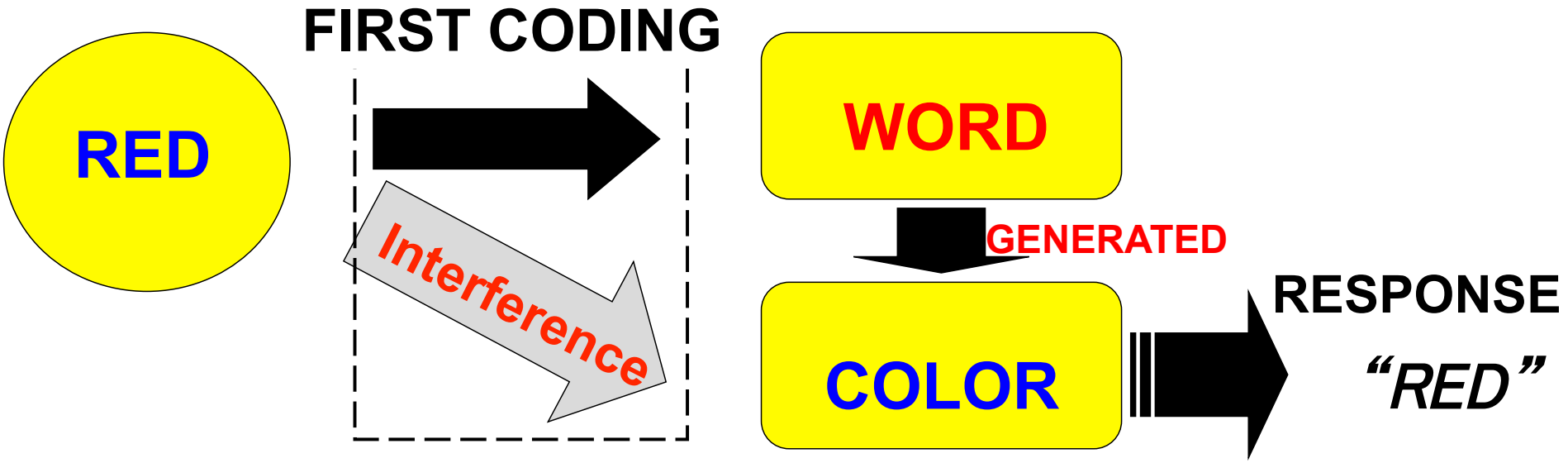


Appendix 1. Changes in the amount of Stroop interference effect during the 440MSW saturation dive (Kageyama et al., 2010).

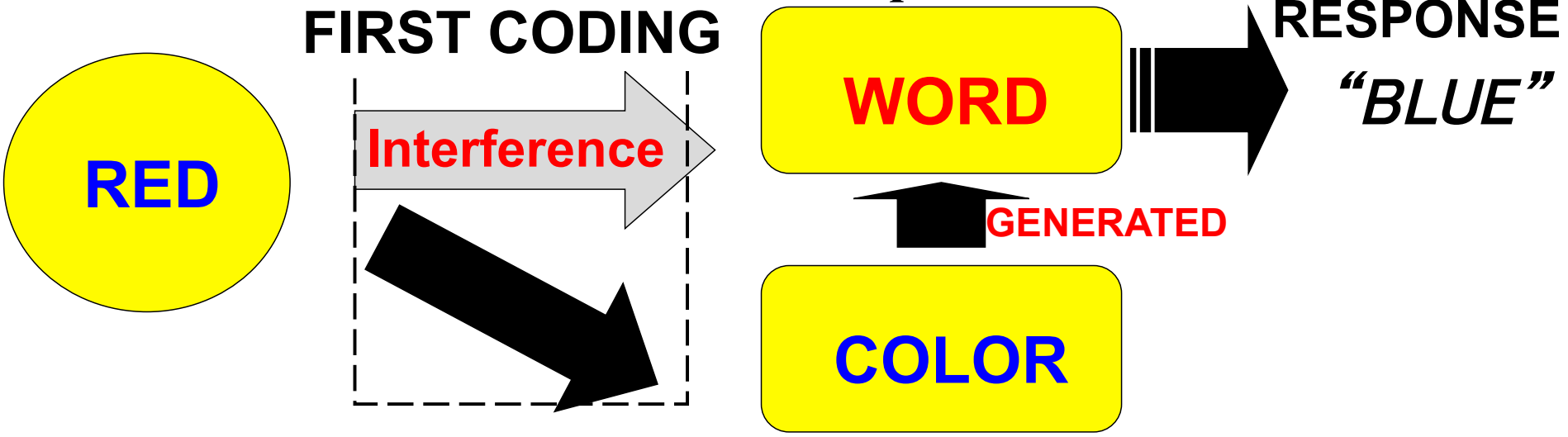


Appendix 2. Performance on each task of the Stroop and Reverse-Stroop Color-Word interference test during the 440MSW saturation dive.

A: *To name the color which is expressed by the word.*



B: *To name the color with which the word is printed.*



Appendix 3.(A) A Reverse-Stroop interference model. (B)A Stroop interference model (Sasaki & Hakoda,1993).