



# THE ABSENCE OF MEMORY DISTURBANCE IN DEEP SEA SATURATION DIVERS

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# Background



## 1. The possibility of long-term effects of deep sea saturation diving on memory function (?)

- Although several studies have reported deterioration of memory function in experienced saturation divers, there is no conclusive data concerning this issue.

## 2. The possibility of short-term effects of deep sea saturation diving on memory function (?)

- Short-term or transient changes in memory function after deep sea saturation diving have not yet studied.

## 3. The purpose of this study

- A) analysis of memory function prior to compression to great depth (deep diving)
  - a. for the comparison with normal adults
  - b. for the detection of long-term effects (differences due to diving careers)
- B) analysis of memory function after decompression
  - a. for the detection of short-term effects (transient changes)

# Methods



## 1. STM—COMET was used as a memory test; the merits of this test are:

- A) enables detailed analysis for memory function (Appendix-1);
- B) provides a set of 6 batteries with different contents, thus repetitive measurements are applicable without the learning effect;
- C) has a database of normal adult group (20 – 80 years old);
- D) can evaluate abnormality by comparing with dementia patients data.

## 2. Subjects and age-matched control group

- A) subjects ( $n=21$ , mean age= $34.7 \pm 3.90$ )
  - a. saturation divers who participated in a simulated saturation dive greater than 400 msw (Appendix-2)
  - b. with various diving careers (the maximum depth prior to the measurement: 60 – 440 msw, years of experience as a saturation diver: 6 – 14 years)
- B) age-matched control group ( $n=35$ , mean age= $33.9 \pm 5.76$ )
  - a. extracted from the normal adult database

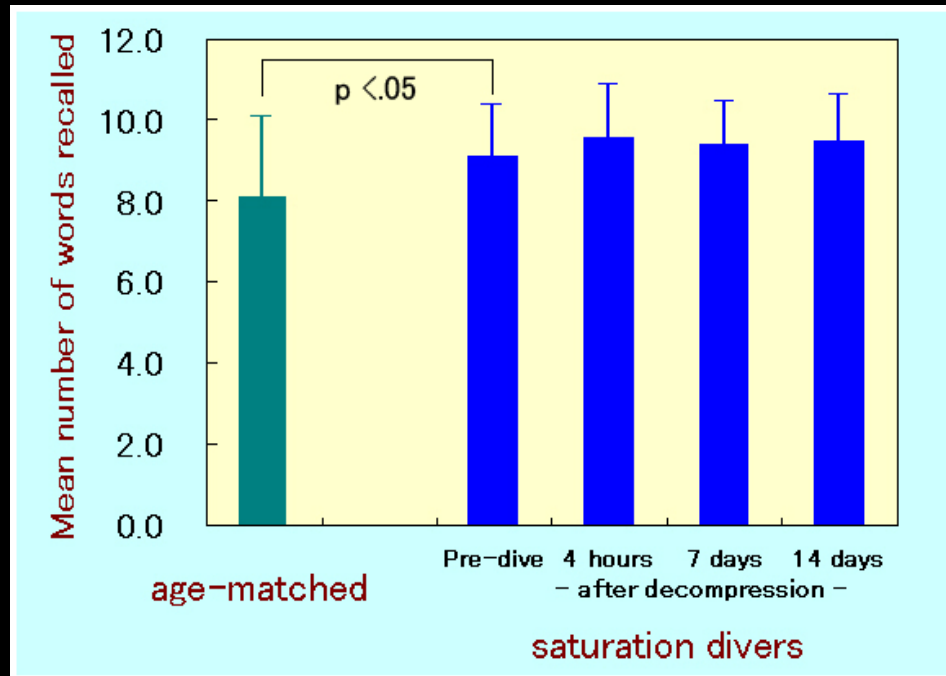
## 3. Timing of measurements

- A) 7 days prior to the simulated dive
- B) 3 times after decompression: 4 hours, 7 days and 14 days

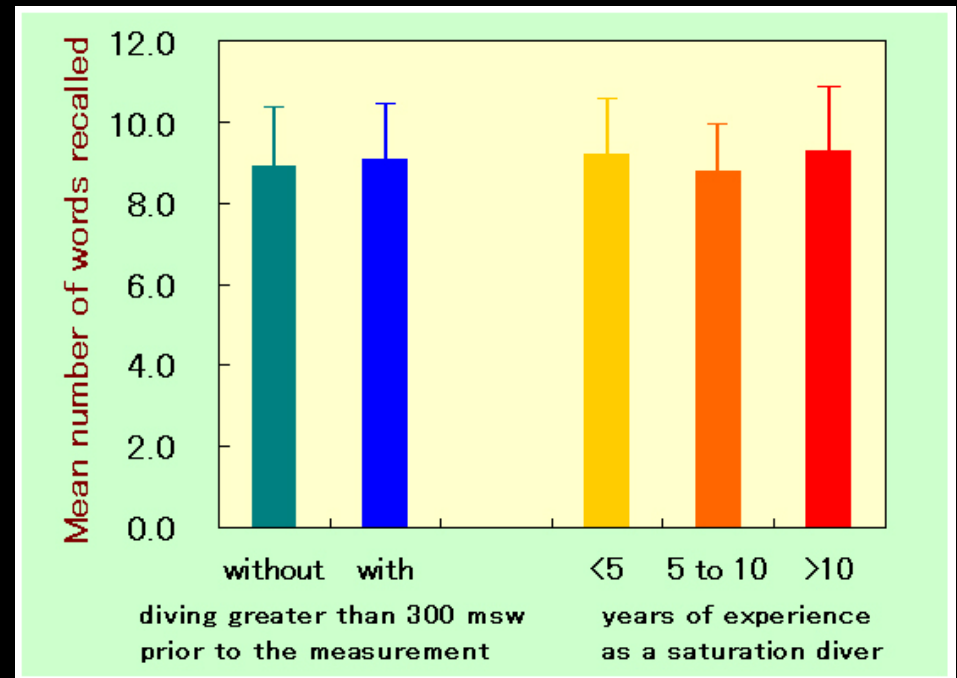
# Result-1: Short-term memory – capacity



Comparison between the age-matched group (AM) and the saturation divers (SD)



Differences due to diving careers

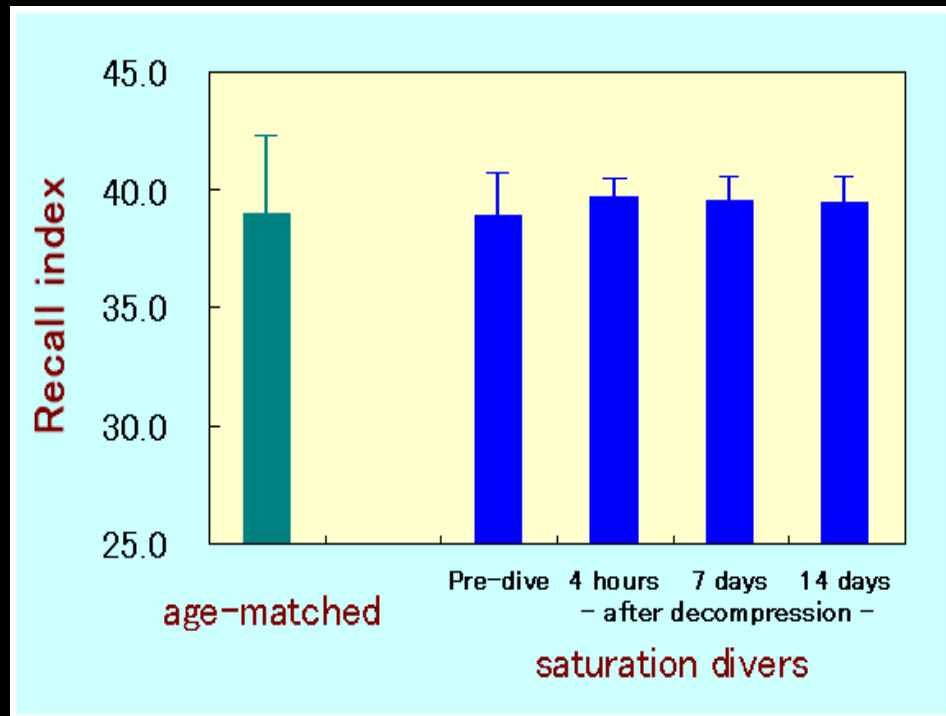


- SD had significantly larger memory capacity than AM ( $t=1.934$ ,  $df=53.64$ ,  $p<.05$ , Welch method).
- The capacity remained stable throughout the measurements.
- Diving careers (experience of diving greater than 300 msw prior to the measurement; years of experience as a saturation diver) caused no significant differences in the capacity.

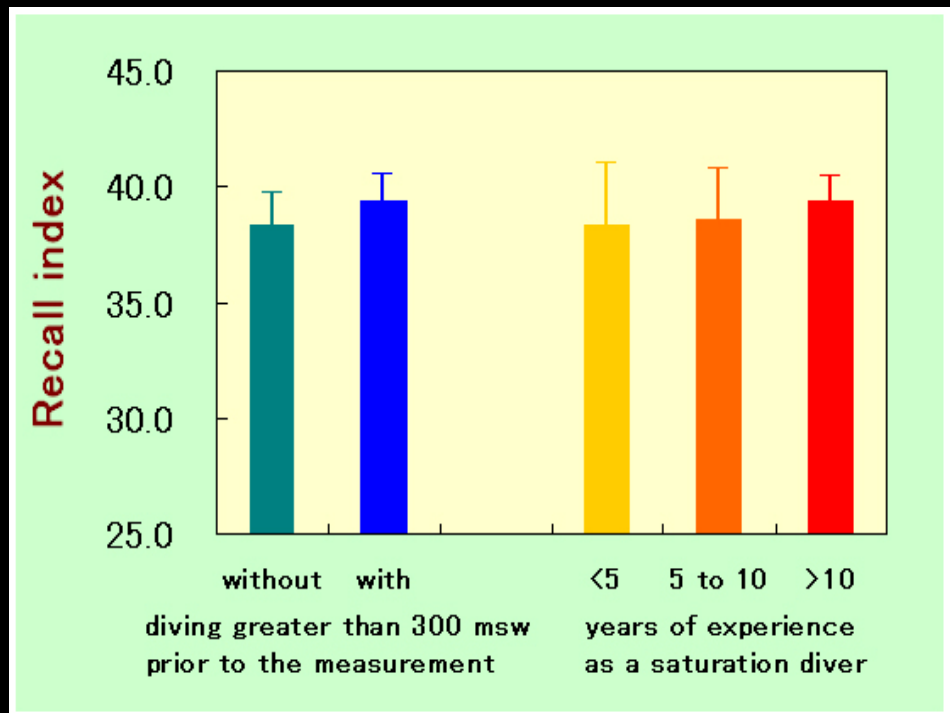
# Result-2: Short-term memory – rehearsal



Comparison between the age-matched group (AM) and the saturation divers (SD)



Differences due to diving careers

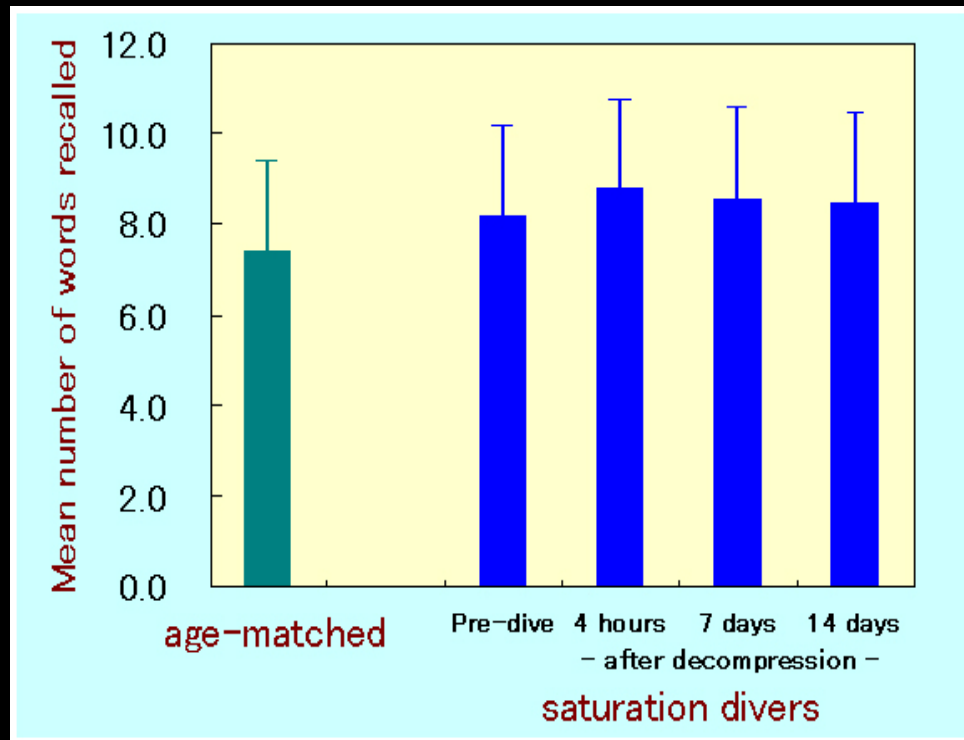


- No difference was found in rehearsal function between SD and AM.
- The rehearsal function remained stable throughout the measurements.
- Diving careers caused no significant differences in the rehearsal function.

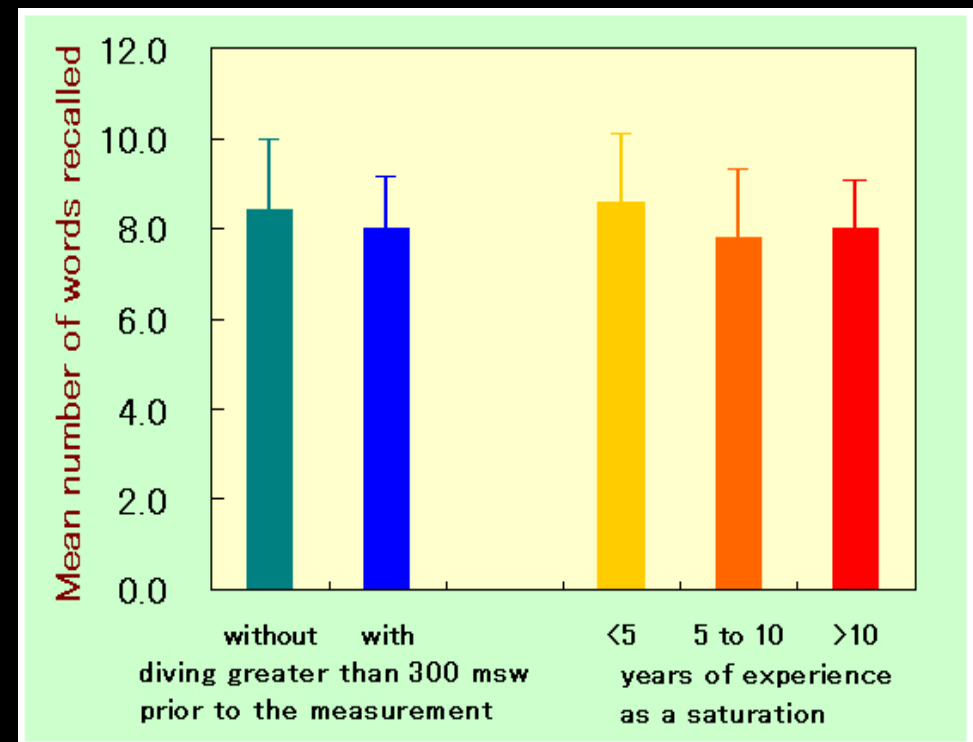
# Result-3: Long-term memory – recall



Comparison between the age-matched group (AM) and the saturation divers (SD)



Differences due to diving careers



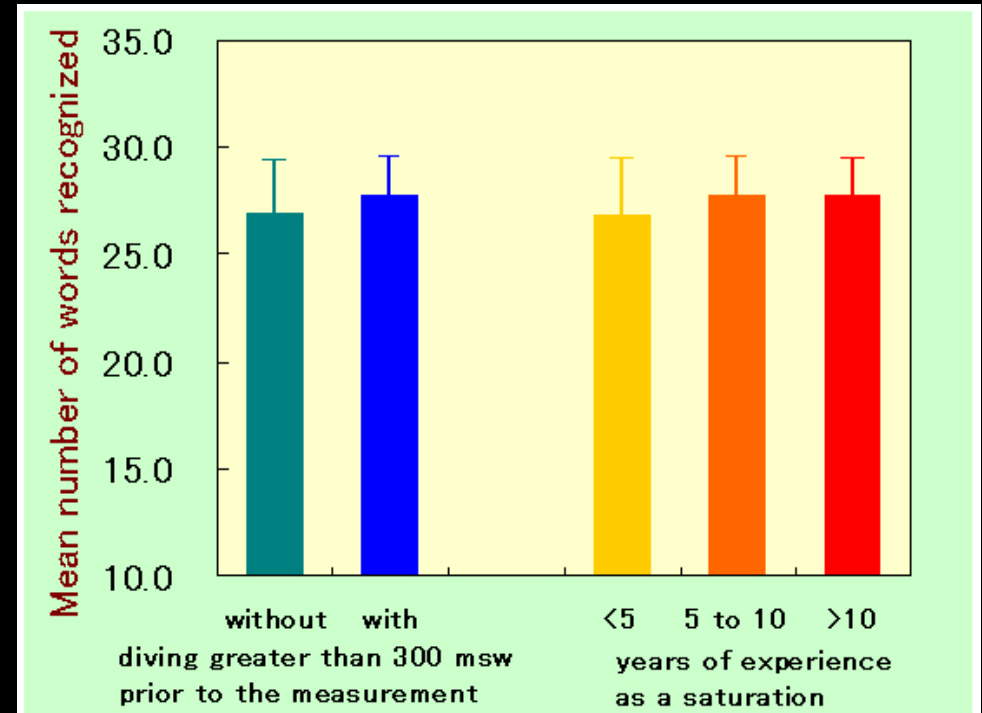
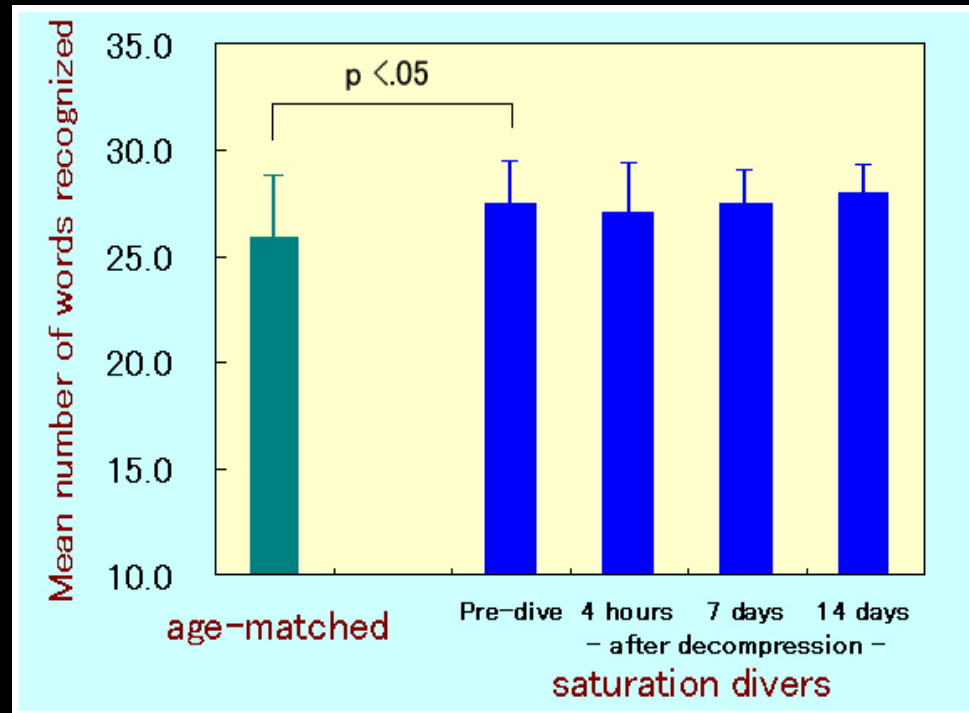
- No difference was found in recall process between SD and AM.
- The recall process remained stable throughout the measurements.
- Diving careers caused no significant differences in the recall function.

# Result-4: Long-term memory – recognition



Comparison between the age-matched group (AM) and the saturation divers (SD)

Differences due to diving careers

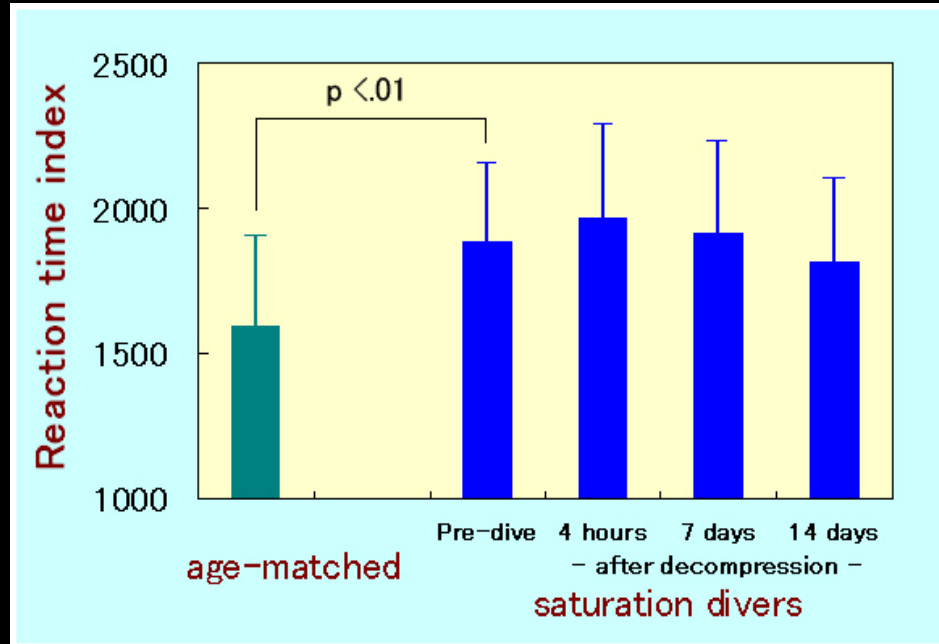


- Recognition process functioned more effectively in SD ( $t=2.210$ ,  $df=52.53$ ,  $P<.05$ , Welch method).
- The recognition process remained stable throughout the measurements.
- Diving careers caused no significant differences in the recall function .

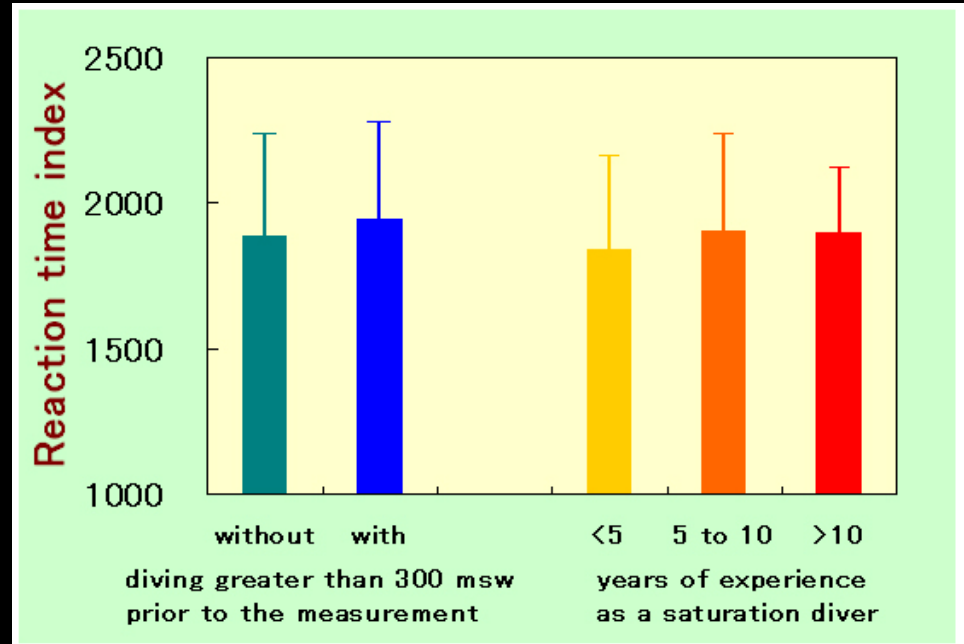
# Result-5: Efficiency of working memory



## Comparison between the age-matched group (AM) and the saturation divers (SD)



## Differences due to diving careers



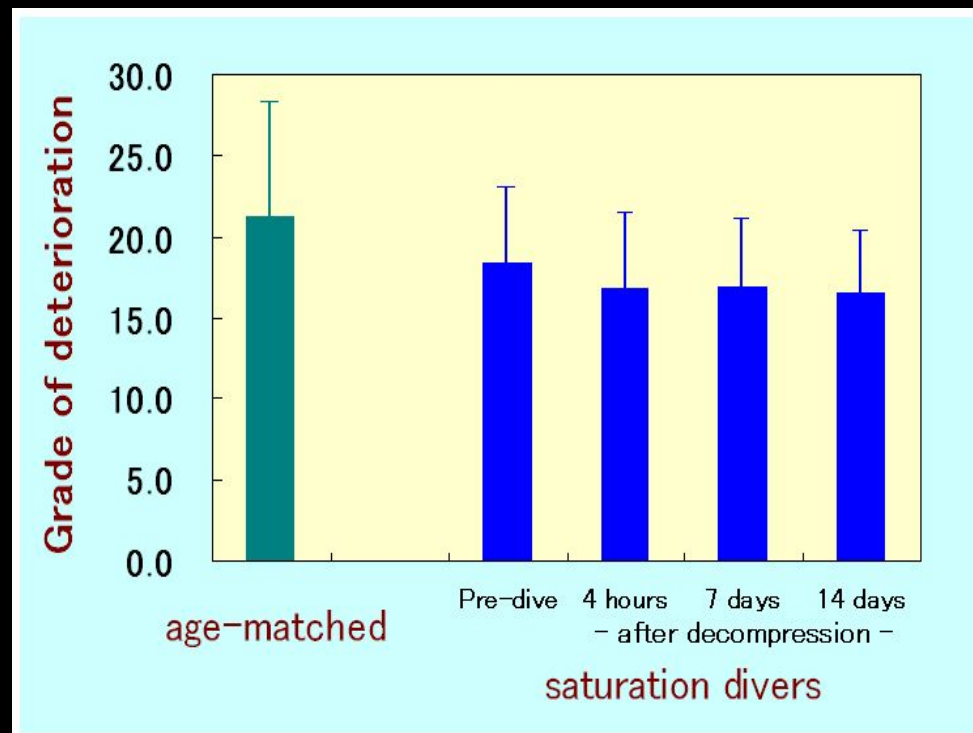
- The significant increase in reaction time index in SD ( $t=3.350$ ,  $df=54$ ),  $p<.01$ ) suggests that they were inferior to AM in working memory. However, working memory of SD was judged to be normal because the mean reaction time index was out of abnormal range ( $3794 \pm 1795.4$ ). Methodological limitations in using reaction time as the efficiency index should be taken into account.
- The working memory efficiency remained stable throughout the measurements.
- Diving careers caused no significant differences in the working memory efficiency.



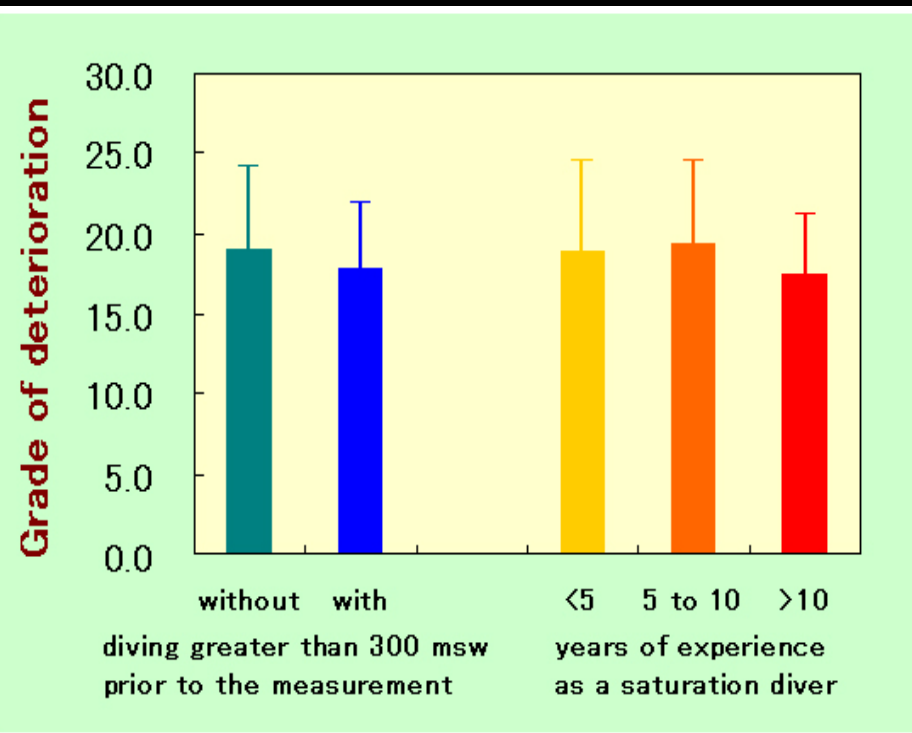
# Result-6: Overall evaluation of memory function



## Comparison between the age-matched group (AM) and the saturation divers (SD)



## Differences due to diving careers



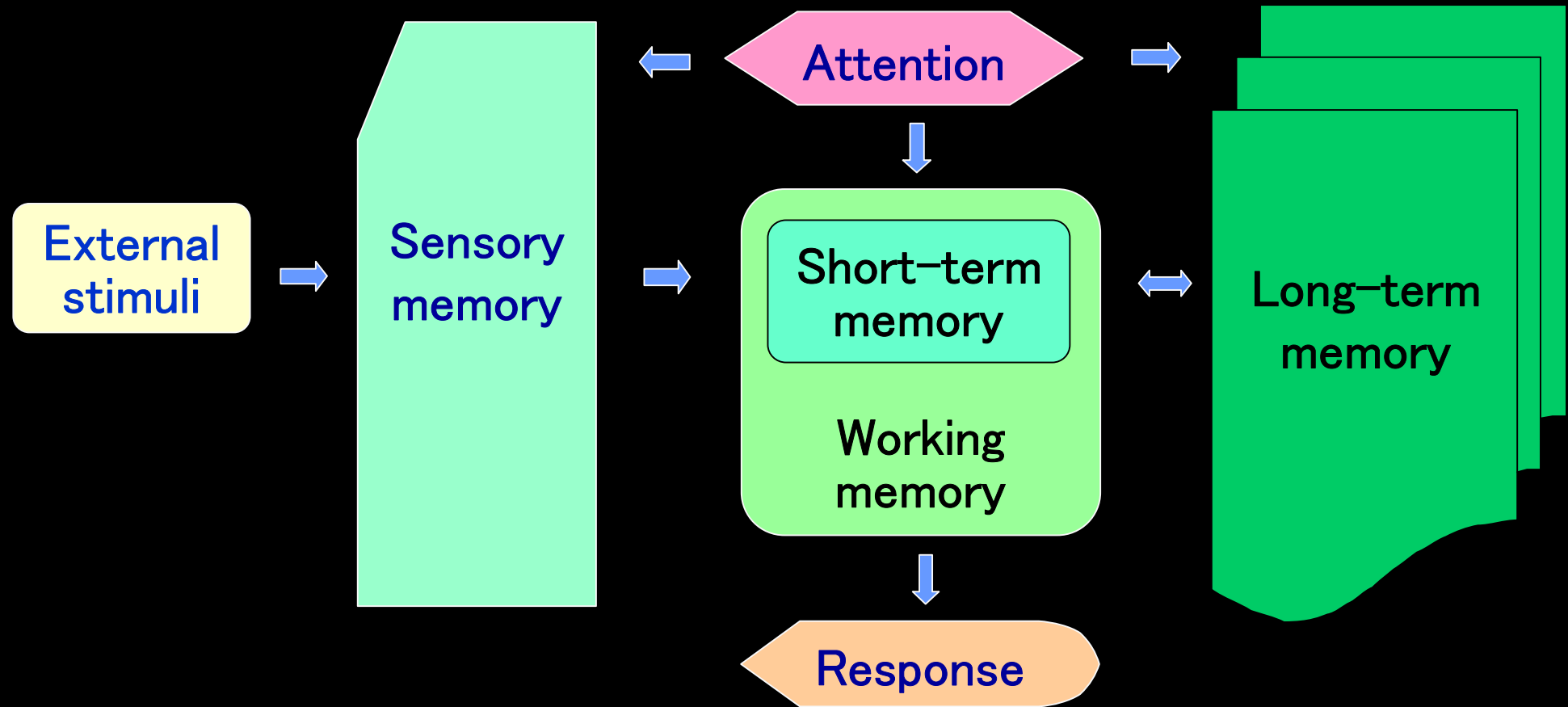
- SD showed lower grade of deterioration (i.e., memory function was less impaired in SD) compared to AM, although the difference did not reach a significant level.
- The grade of deterioration remained stable throughout the measurements.
- Diving careers caused no significant differences in the grade of deterioration.

# Discussion



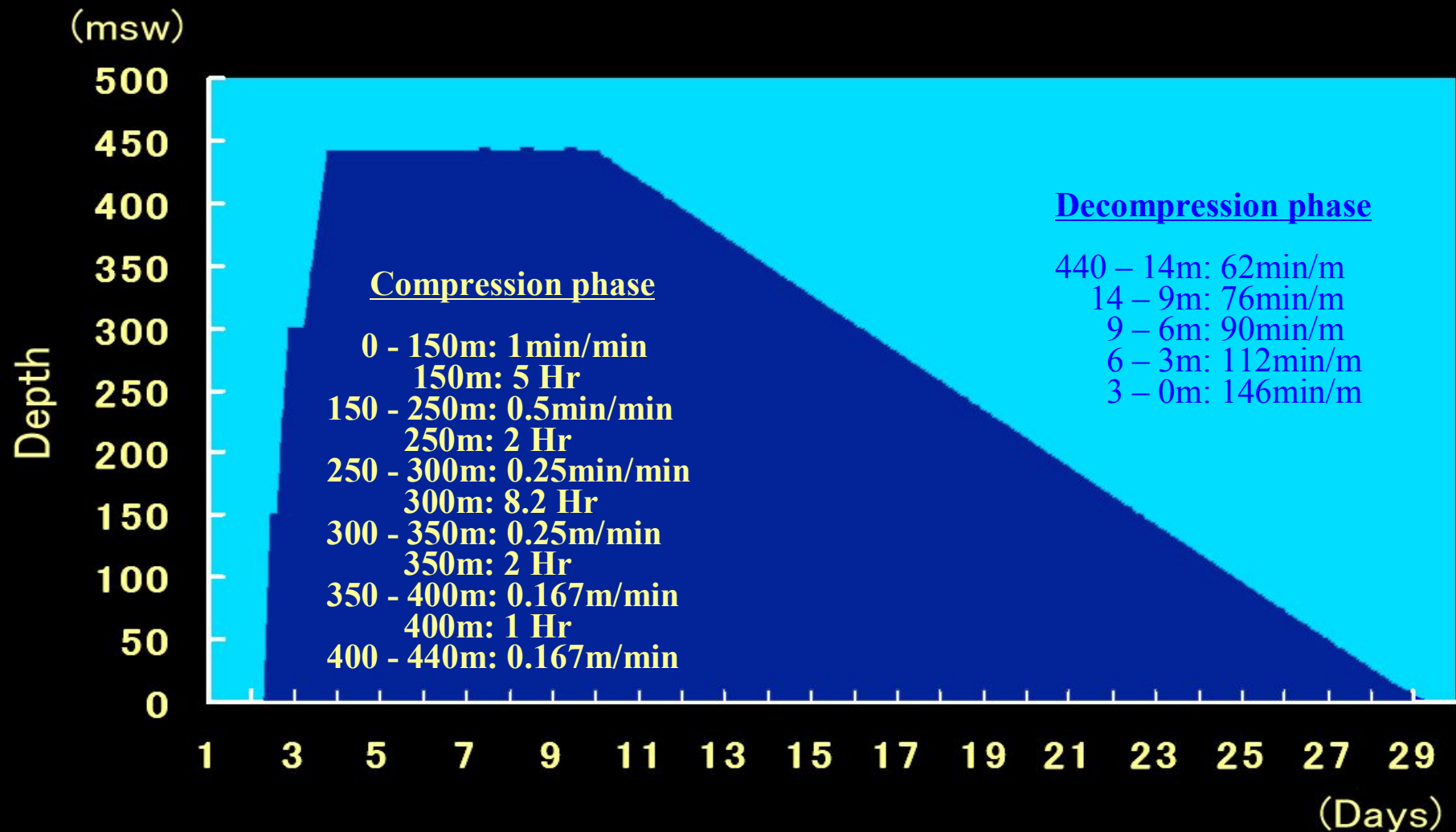
1. At the pre-dive measurement, the saturation divers' memory indexes except working memory efficiency were equal to or slightly better than those of the age-matched normal adult group. On the whole, it can be said that the saturation divers preserved normal memory function.
2. It is considered that deep sea saturation diving do not cause short-term effects on memory function because the memory indexes did not change significantly throughout the measurement periods (from the pre-dive to the 14th day after decompression).
3. Furthermore, it is considered that deep sea saturation diving do not bring even long-term effects on memory function because diving careers did not make significant differences in the memory indexes.
4. In conclusion, this study indicates that deep sea saturation diving itself does not induce adverse effects on memory function provided that both compression and decompression are properly performed.

# Appendix-1: Multi-storage memory model



**STM-COMET** is based mainly on the Multi-storage model (Atkinson & Shiffrin, 1971); it measures two important features of **short-term memory (capacity & rehearsal)** , two retrieval processes of **long-term memory (recall & recognition)** , and efficiency of **working memory**.

# Appendix-2: An example of 440 msw dive



Physiological states of the divers:

- ; minor HPNS (slight augmentation of EEG theta, no motor disturbances)
- ; no indication of decompression sickness