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# Relationship Between Performance Error and Human Information Processing

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## INTRODUCTION

Human information processing (HIP) performance using the working memory can be assessed by two types of indicators when an HIP task is carried out. One is error occurrence, and the other is HIP time taken when the HIP task is carried out using the working memory. Errors are classified into the error caused by the task requirement exceeding some human limitation, or the error caused by carelessness, even though all human limitations still allow enough capacity to do the task (Reason, 1990). The former is regarded as an error that is caused by the lack of the HIP ability in order to do the required information processing. The latter is regarded as an error that is caused by the temporary reduction of some HIP ability such as attention. Even though there are many kinds of factors of error generation, from the view point of HIP, error can be considered to be caused by the relationship between the required quantity or quality of the information processing and the HIP ability. The characteristics of HIP can be considered to influence error generation directly. In this chapter the characteristics of HIP related to the error are illustrated with the results of the experiments (Karashima, Okamura & Saito, 1994; Karashima & Saito, 2001).

## BACKGROUND

In regard to error occurrence, the difference of the error ratio (calculated by the ratio of the number of error occurrences divided by the number of trials) in the HIP tasks has been explained by the degree of the efficiency of the information processing and storage with the interference in the working memory (Carpenter, Just, Keller, Eddy & Thulborv, 1999; Daneman & Carpenter, 1980, 1983; Just & Carpenter, 1992). Interference in the working memory means that the working memory is a system responsible for processing and storing information, and the processing and storage compete with the limited-capacity workspace in the working memory (Baddeley & Hitch, 1974; Carpenter et al., 1999; Case, Kurland & Goldberg, 1982; Danemen & Carpenter, 1980, 1983; Miyake, Just & Carpenter, 1994). These suggest that the error ratio increases when the storage information increases, and that the ways of the increase are different between the information processing in the HIP tasks.

On the other hand, the error ratio in the HIP task is rarely 0%. The HIP task is performed correctly in some cases but in some others performed incorrectly, even though all the conditions and the protocol for each subject are fixed. This means that there might be the variation of the performance under the same task. In a typical case, the subjects try to memorize and recall 7±2chunk, which is reported as the upper limit by Miller (1956) (Broadbent, 1975). But it is difficult to explain the variation by the influence of the working memory resource. The variation has not been studied enough to explain these characteristics of the error occurrence.

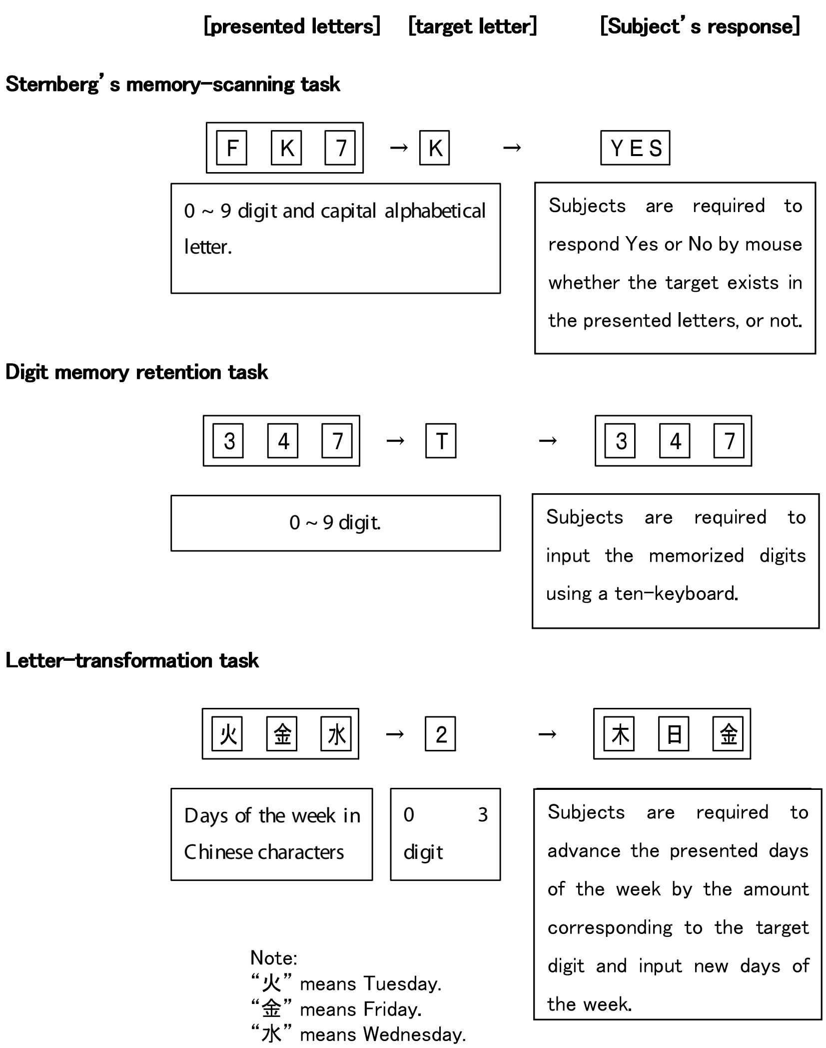
## MAIN FOCUS OF THE CHAPTER

### The Transformation of the Human Information Processing Ability by the Content of Human Information Processing

Generally, error occurs when the HIP ability is not enough to do the required information processing. This ability is sometimes transformed by the content of the required information processing or the environments. As the illustration of these characteristics of HIP, it is known that the HIP ability to deal with the presented information quantity is influenced by the constraints of the working memory, the interference of the working memory caused by the constraints, and the tradeoff caused by the interference between information processing and storage. The constraints mean that the working memory resource has the capacity; the interference means that the information processing and storage compete with the capacity. The trade-off means that the capacity of information storage in the working memory decreases when the difficulty of information processing in the working memory increases, while the information processing in the working memory becomes more delayed when the quantity of information storage in the working memory increases. Because of the trade-off, concretely, the information processing ability to deal with the presented information quantity decreases as the difficulty of information processing in the working memory increases.

Karashima, et al. (1994) examined the relationship between the presented information quantity and the error ratio in three difficulties' tasks: Sternberg's memory-scanning task (Sternberg, 1966), digit memory retention task, and letter-transformation task. Figure 1 shows the details of three tasks. The Sternberg task is easiest, and the letter-transformation task is most difficult in three tasks. His experimental results reveal that the information processing ability to deal with the presented information quantity decreases as the difficulty of HIP increases. As Figure 2 shows, for example, in the case of six presented letters, the error ratio of letter-transformation task is more than 50%, although the error ratios of the other tasks are less than 10%.

*Figure 1. Three experimental tasks*



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