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Levels of Processing and Picture Memory: An Eye movement Analysis

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Introduction

This study examined the underlying mechanisms of the levels-of-processing and picture superiority effects. In contrast to most of the memory research using off-line measurements, this study recorded participant's eye movements during study and testing. Levels-of-processing effects were found not only in verbal materials, but also in pictorial materials such as pictures of faces (e.g., Mueller, Courtois, & Bailis, 1981) and common objects (Lee, 1999). However, using different sets of pictorial materials, Intraub and Nicklos (1985) found the physical superiority effect. They suggest that when visually distinctive pictures are used, having attention drawn to the pictures' unique visual characteristics would lead to a more elaborate trace, than having attention drawn to their semantic attributes. To resolve these inconsistencies, further research examining the role of both semantic distinctiveness and perceptual distinctiveness in producing a better memory for various kinds of pictorial materials is needed. A related issue is that pictures are remembered better than words on conceptually driven memory tests such as free recall and recognition. One of the earliest theories to explain the picture superiority effect is Paivio's dual coding hypothesis. Other researchers focus on the importance of conceptual processing in producing the picture superiority effect. Pictures access meaning codes more directly than words do, and so pictures naturally engage more conceptual processing, which leads to a better memory for pictures than for words.

Eye Movement Analyses

In a typical memory study, participants' differences in encoding or storage of information is inferred from their memory performance in the subsequent testing. In contrast to this off-line measurement, measuring participants' eye movements during study or learning provides an on-line measurement of information processing. Moreover, it has been assumed that the number of features attended to is positively correlated with the number of features actually encoded by participants. Recording the number of eye movements during learning thus makes it possible to observe how many features of a target stimulus were examined. On the other hand, physiological measures can be used to measure the conceptual processing, which is related to the semantic quality of stimuli. In particular, the pupil diameter has been shown to be related to the cognitive processing level in the standard matching paradigm.

Bloom & Mudd (1991) tested *the semantic quality hypothesis* and *the feature quantity hypothesis* in face recognition and found that a deeper processing of face led to an increase in the number of eye movements and an im-

provement in subsequent recognition performance. Along with evidence from the measure of pupillary dilation, which is considered an index of cognitive effort or processing load, they concluded that the feature quantity hypothesis and not the semantic quality hypothesis was supported. This study investigated whether eye movement analyses can be valid indexes of perceptual distinctiveness/richness and conceptual processing/effort. This question was tested by examining the relationship between eye movement analyses and memory performance.

Results and Discussion

Participant's eye movements during study and testing were recorded. During the study phase, participants studied object pictures, object names, photos of faces, and persons' names. After a distractor task, participants performed a recognition test. The results in memory performance showed that both object pictures and persons' names revealed a ceiling effect. The effects of study condition were significant for object names and photos of faces. Deeper processing produced a better recognition performance. Numbers of eye movements and amount of inspection time were not related to recognition performance, even when the ceiling effect was avoided. Analyses on the pupil sizes also did not reflect the differences in memory performance. In conclusion, recognition accuracy of either verbal or pictorial materials and eye movement behaviors were affected by different variables.

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