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Marta KUTAS and Bernard RENAULT

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An Evaluation of Age Differences in the Development of Automaticity

William J. Gehring, David L. Strayer, Arthur F. Kramer,
Emanuel Donchin, and Gregory A. Miller
Cognitive Psychophysiology Laboratory
University of Illinois
Champaign, Illinois

The present study examines the development of automaticity, as reflected in overt performance and in the P300 component of the event-related brain potential, in healthy elderly and young adults. The subjects practiced consistently (CM) and variably (VM) mapped versions of the Sternberg memory search task. Four elderly (mean age = 74) and two young (mean age = 22) adults performed the task for four consecutive days; performance from the first and last days was compared.

Reaction time (RT) increased with memory load for both groups, although the effect was greater for the elderly subjects. The effect of memory load was greater under VM conditions than under CM conditions for young subjects, but for elderly subjects the effect did not differ between conditions. Overall, RT performance improved over the four sessions, but RTs decreased more for young subjects than for the older subjects. Furthermore, the effect of memory load decreased with practice only for the young subjects. Taken together, these results suggest that the young subjects developed automatic processing more rapidly than the elderly subjects.

An examination of detection sensitivity revealed that, under CM conditions, A' was very high, and was unaffected by both memory load and training for young subjects. For elderly subjects, however, A' decreased with memory load early in training; after consistent practice, A' was relatively unaffected by memory load. Further, by session 4, detection sensitivity was higher for elderly

subjects than for young subjects.

In VM training, A' decreased as a function of memory load for all subjects and all conditions, but was lower for the elderly than for the young subjects. By session 4, A' was less affected by memory load for the young than for the elderly subjects.

Examination of B'', a measure of response criterion, revealed that younger subjects' performance became less conservative with CM practice. Elderly subjects, however, did not decrease their response criterion with such practice, although A' increased significantly. With VM training, young subjects did not change their response criterion, whereas elderly subjects became more conservative. These results suggest that elderly subjects did not vary their response criterion on the basis of improved sensitivity. It has been previously suggested that such a conservative strategy decreases the rate at which automaticity develops (Schneider & Fisk, 1982).

In CM conditions, the effects of memory load on P300 latency were equivalent for young and elderly subjects early in training. Following consistent practice, however, P300 latency was insensitive to memory load for young subjects, but remained affected by memory load for elderly subjects. In addition, practice in CM conditions resulted in a greater overall reduction in P300 latency for the young. These results are consistent with the pattern of RT results and suggest that the stimulus evaluation process became automated more rapidly for the young.

In contrast, P300 latency increased as a function of memory load in VM conditions for young subjects across the four sessions. For the elderly subjects, however, P300 latency was insensitive to memory load throughout the experiment. Moreover, P300 latency for older subjects increased with training. These results are paradoxical, given the pattern of RT results. Similar findings of P300 slope

diminishing with age have been reported by Pfefferbaum (1980) and Strayer, Wickens, and Braune (1985). One possible explanation for these results is that P300 was smaller and more variable for the elderly subjects. Indeed, P300 latency distributions for memory load 2 and memory load 4 were rectangular and overlapping for the elderly. Given the reliability of our measure of P300 latency (Gratton, 1984) these results suggest that the latency of the process manifested by P300 was more variable in the elderly.

The flat slopes observed following CM practice in the young should be contrasted with the flat slopes observed in the elderly in the VM conditions. The distributions of the young subjects were always Gaussian, but overlapped following consistent practice, yielding a flat slope. The distributions of the elderly, in contrast, were rectangular, and thus the overlap of these distributions--and the resulting flat slope--was due to the high variability in the P300s of the elderly.

RT distributions were analogous to the P300 latency distributions: following practice in any condition, the variance of the distribution decreased for all subjects. This effect was more pronounced in CM conditions. Distributions for the elderly, however, were more variable than for the young subjects, and the effect of practice on the variance was less for the elderly. These results further support the notion that the P300 distributions were rectangular due to variability in stimulus evaluation time.

In sum, it appears that the performance of the elderly was characterized by conservative response strategies and by highly variable stimulus evaluation and response processes. For the elderly subjects, performance improved following CM practice; nevertheless, they failed to attain automatic processing over 5000 trials, in contrast to the young subjects. It remains to be determined if automaticity would develop in the elderly with additional training.