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ABSTRACT

Attempts to modify or ameliorate the effects of declining cognitive abilities of the elderly have met with limited success. To focus on the effects of age in cognitive processing capacity (CPC), Furukawa's (1977) CPC test was administered individually to 3 age groups (16-30, 31-45, and 45-60) of 15 subjects each. Speed of processing old and new verbal knowledge and old quantitative knowledge was also examined. Analyses of results revealed that the oldest subjects: (1) had the lowest mean CPC; (2) experienced the most difficulty with verbal knowledge but surpassed younger subjects with quantitative knowledge; and (3) were not affected by proactive interference across four learning lists. Middle-aged subjects surpassed both younger and older subjects in processing antonyms and showed a possible proactive interference effect. The youngest subjects excelled in retrieval of synonyms and in the acquisition of new knowledge. Overall, the strongest correlations between CPC and performance existed in processing new knowledge. (Author/JAC)

Age Effects in Information Processing

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Abstract

Age effects in cognitive processing capacity (CPC) and in speed of processing old and new knowledge were investigated. The results revealed that the oldest subjects (a) had the lowest mean CPC, (b) experienced the most difficulty with verbal knowledge but surpassed younger subjects with quantitative knowledge, and (c) were not affected by proactive interference across four learning lists. The middle-age subjects surpassed both younger and older subjects in processing antonyms and manifested an irregular up-and-down pattern across learning lists indicating a possible proactive interference effect. Youngest subjects excelled in retrieval of synonyms and in acquisition of new knowledge. Overall, strongest correlations between CPC and performance existed in processing new knowledge.

Age Effects in Information Processing

Attempts to modify or to ameliorate the effects of declining cognitive abilities of the elderly have met with limited success (Carroll & Maxwell, 1979). As an extension of these attempts, the present study focused on the effects of age in cognitive processing capacity (CPC)--a persons' ability to recall stimuli after a single brief exposure--and in speed of processing old verbal and quantitative knowledge (acquired years earlier) and new verbal knowledge (acquired a few minutes earlier).

A decline in processing capacity may have caused elderly subjects to experience difficulty with episodic memory (Wingfield & Byrnes, 1981). Episodic memory was reported to be highly susceptible to interference (Tulving, 1972), probably proactive since it may be more potent than retroactive interference (Underwood, 1957). These studies suggested that (a) the CPC of subjects should decline with age, and (b) proactive interference should have a greater adverse effect in processing new verbal information by elderly subjects.

Speed of information processing and secondary memory were found to be negatively correlated with age (Tchabo-Robertson & Arenburg, 1976); consequently, when speed was a consideration, the elderly were at a greater disadvantage than younger subjects (Anders, Fozard, & Lillyquist, 1972). In terms of secondary memory, however, verbal knowledge apparently did not decline with age (Walsh & Baldwin, 1977). but numerical ability registered a serious decline (Owens, 1966). Based on the apparently contradictory findings, further research on speed of processing old verbal and quantitative knowledge was suggested.

A more recent investigation on speed of processing (i.e., the

number of correct responses in a 45-second interval) old and new knowledge found that it was positively related to CPC, but the speed of processing quantitative knowledge was not (Furukawa & Harris, Note 1). Assuming the validity of their findings and also assuming that CPC declines with age, then the present investigation should provide support for their findings instead of those of other investigators.

Subjects. Three age groups (16-30, 31-45, and 46-60) of 15 subjects each participated in the experiment.

Procedures. Furukawa's (1977) CPC test was administered individually to each subject according to the procedures he prescribed.

Speed of processing old verbal knowledge (two separate lists of 15 synonyms each and two separate lists of 15 antonyms each required subjects to select the correct response from among four options) and old quantitative knowledge (two lists of 15 addition problems) were tested by giving subjects 45 seconds to complete a list. A correct response was worth one point, except for multiplication problems. As these proved to be exceedingly difficult for all subjects, each separate multiplication step was scored one point (e.g., 22 x 33 with an answer of 726 was worth four points, one for each correct multiplication step completed).

The speed of processing new verbal knowledge and possible proactive interference effects were tested by having subjects study four separate lists of 15 Hawaiian words each for two minutes. A recall test followed each list and required subjects to respond to randomly arranged English equivalents of the Hawaiian words.

Results. CPC, speed of processing old verbal and quantitative knowledge, and speed of processing new verbal knowledge are discussed, in that order.

Significant differences were found between the three age groups on CPC (see Table 1), F (2, 42) = 5.35, $p < .01$.

A two-way analysis of variance for repeated measures (three age groups across synonyms and antonyms) on the data in Table 2 revealed two significant main effects and an interaction: for age, F (2, 42) = 3.05, $p < .10$, favoring the performance of the younger groups; for synonyms and antonyms, F (1, 42) - 58.38, $p < .001$, with better-performance on antonyms; and an interaction between age and type of verbal knowledge, F (2, 42) = 4.58, $p < .01$, probably caused by the middle age subjects (31-45) changing their 1, 2, 3 rank order by age on synonyms by surpassing all groups on antonyms.

In completing addition problems (see Table 3) the oldest group clearly surpassed the performance of both younger groups, F (2, 132) = 5.49, $p < .01$. In multiplication, however, the groups did not differ significantly although the highest mean score was again obtained by the oldest subjects.

As for new knowledge, there were significant differences between age groups (Table 4), F (2, 42) = 3.23, $p < .05$, but not between learning lists. There was a marginal interaction between learning lists and age created by an erratic, saw-toothed performance of middle age subjects across the four learning lists, F (6, 126) = 2.01, $p < .10$.

Overall, the speed of processing old verbal knowledge was superior to that of new knowledge (see Table 5), F (2, 42) = 132.52, $p < .001$, with significant differences found between the age groups in favor of the younger groups, F (2, 42) = 5.68, $p < .01$.

The strength of the relationships between CPC and speed of processing old and new verbal knowledge were as shown in Table 6. For old knowledge, a significant negative correlation was found in addition and a significant positive one in multiplication; for new know-

ledge, a number of significant positive correlations were found primarily for the youngest age group.

Conclusions. The investigation as a whole reveals that advancing age has a negative effect on CPC and on speed of processing old and new verbal information. However, age appears to have, if anything, an enhancing effect on the speed of processing quantitative knowledge, at least in addition and probably in multiplication as well.

CPC means decrease with advancing age, from 7.80, 6.88, and 5.27, from the youngest to the oldest age groups. Such a decline appears to be a problem for the elderly in the speed of processing verbal knowledge, particularly new knowledge. In acquisition, the expected proactive interference for the oldest subjects across four lists of Hawaiian words did not materialize; it may have manifested itself on the first list. The gradually increasing speed thereafter, except for middle age subjects, may reflect the influence of warmup. In contrast, addition and multiplication skills seem to improve over the years; possibly due to automaticity with practice. Some of these findings on age seem to be at odds with other findings, but the differences may be due in part to the type of materials used and to the time limitation imposed. In addition to these findings, the performance of the middle age subjects--surpassing other groups in performance on antonyms and the irregular performance on four Hawaiian word lists--suggests that they could be more susceptible to interference than either the younger or older subjects.

The immediate educational implications appear to be that older subjects will require additional information processing time in verbal knowledge areas, both old and new, and will need to make responses highly automatic by increasing rehearsals. Also, future research should consider the decline in CPC.

Reference Notes

1. Furukawa, J. M., & Harris, R. D. Cognitive processing capacity and gender differences in speed of processing old and new knowledge. Paper presented at the Fifth Annual Meeting of the Eastern Educational Research Association, West Palm Beach, Florida, February 1982.

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Table 1

Cognitive Processing Capacity Means and Standard Deviations

	Groups		
	A	B	C
M	7.80	6.68	5.27
SD	2.47	2.08	1.77

Table 2

Means and Standard Deviations in Speed of Processing Synonyms and Antonyms by Age Groups

Age Group		Synonyms	Antonyms
A	M:	15.67	20.80
	SD:	3.85	5.25
B	M:	15.07	22.87
	SD:	4.33	3.70
C	M:	13.60	16.33
		5.67	7.65

Table 3

Means and Standard Deviations for Speed of Processing Quantitative Knowledge by Age Groups

Age Group		Addition	Multiplication
A	M:	19.13	12.87
	SD:	6.23	5.54
B	M:	19.93	12.47
	SD:	5.47	5.00
C	M:	22.60	13.47
	SD:	4.01	5.66

Note. The scores in addition and multiplication are not comparable.

Table 4

Means and Standard Deviations on Hawaiian Word Learning Lists by Age Groups

Age Group		Learning List 1	2	3	4	Row Means
A	M:	3.86	4.53	4.53	4.80	4.43
	SD:	2.67	2.09	2.53	2.73	
B	M:	4.40	3.73	4.87	3.80	4.20
	SD:	2.56	2.12	2.45	2.40	
C	M:	2.47	2.73	2.87	3.13	2.80
	SD:	1.55	1.62	1.50	1.77	
Column Means:		3.58	3.66	4.09	3.91	

Table 5

Means and Standard Deviations for Speed of Processing Old and New Verbal Knowledge by Age Groups

Age Group		Old	New
A	M:	36.47	17.73
	SD:	7.03	8.62
B	M:	37.93	16.80
	SD:	7.65	7.94
C	M:	29.93	11.20
	SD:	12.64	4.94

Table 6

Correlations Between Cognitive Processing Capacity and Speed of Processing Performance for Old and New Knowledge

Type of Knowledge		Groups A	B	C
Old	Synonyms	.23	.36	.04
	Antonyms	-.42	.29	.18
	Addition	-.51**	-.08	.24
	Multiplication	.08	-.03	.49*
New	List One	.54**	.29	.09
	List Two	.56**	-.17	.16
	List Three	.62***	.32	.23
	List Four	.31	.55**	.42

* $p < .05$

** $p < .01$

*** $p < .005$