LEVELS OF INFORMATION PROCESSING IN YOUNG AND AGED PEOPLE.

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SUMMARY

An open question is at which level of information processing young and aged people differentiate. This study aimed to compare the performance of young (<25 yr) and old (>60 yr) subjects in : a) a go-no/go task to gratings of different spatial frequency (0.9 to 13 c/deg), and b) choice reaction time (RT) to pairs of letters. Both situations were studied with peripheral presentation of stimuli. Whereas, in the }st experiment (n=26), for both groups there were slower RTs for higher spatial frequencies, young and old people did not differ in the speed of response (400 vs 434 msec). In the 2nd experiment (n=3l) there was a significant difference between tho two groups: 1) on the speed of response, the young being factor (731 vs 958 msec.); and 2) on the difference between two identity }ovals of "same" responses, with a greater difference for young than for old people (128 vs 74). In both experiments laterality differences wore not clear Present between tho two groups. It is suggested that the difference between young and old people can be found only in more complex levels of information analysis and in tho strategies used.

INTRODUCTION

Different laboratory experiments have been conducted to determine the effects of age on the ability of a person to perform perceptual and cognitive tasks. According to Rabbitt (1981) some persistent methodological errors have affected most age studies making very difficult to understand which is the nature of the difference between young and old people.

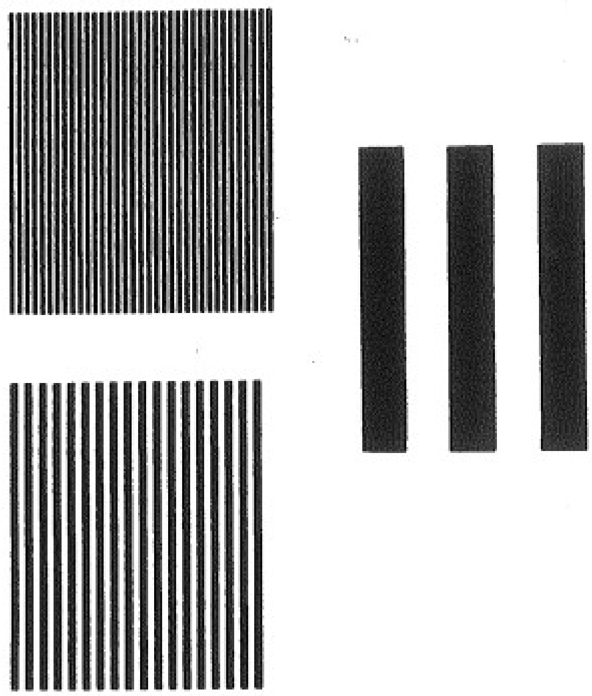
The aim of this paper is to reconsider some of the hypothesis proposed to explain the performance decrements as a function of age and to assess at which complexity levels the differences between young and aged people appear. It is commonly reported that reaction time (RT) increases as a function of aging and that this slowing is not attributable to peripheral (8otwinick, 1971! 1972) and/or motor factors. This conclusion is drawn from the observation that the difference between age groups increases with the processing complexity. However, in most studies of psychology of aging the paradigms used are either too complex or not standardized in order to isolate the mechanisms involved. Furthermore no paradigm provides a unique index for the information processing or response speed. Taken together experiments conducted so far do not provide an integrated description of the factors involved in the cognitive processing in the aging.

Four experiments were carried out: the first one was aimed to answer the question of a difference in elementary functions between old and young people; the other three were devoted to assess a difference in complex tasks.

EXPERIMENT 1

In the first experiment the hypothesis of a general slowing in response speed associated with aging was considered. According to this hypothesis we would expect that old subjects would be slower also in the case of simple reaction time tasks. To test this hypothesis we decided to use as stimuli gratings of various spatial frequency (see examples in Figure I). The decision was made on the basis of two considerations: a) according to electrophysiological and psychophysical studies, spatial frequency analysis involves elementary and basic aspects of visual system (Campbell & Maffei, 1974; De Valois & Do Valois; 1980; Maffei, 19781; b} it has been proposed that young and old people differ in their sensitivities to spatial frequencies (Kline et al., 1988/ Bakulor et al., 1980).

FIGURE 1 : SPATIAL FREQUENCY EXAMPLES



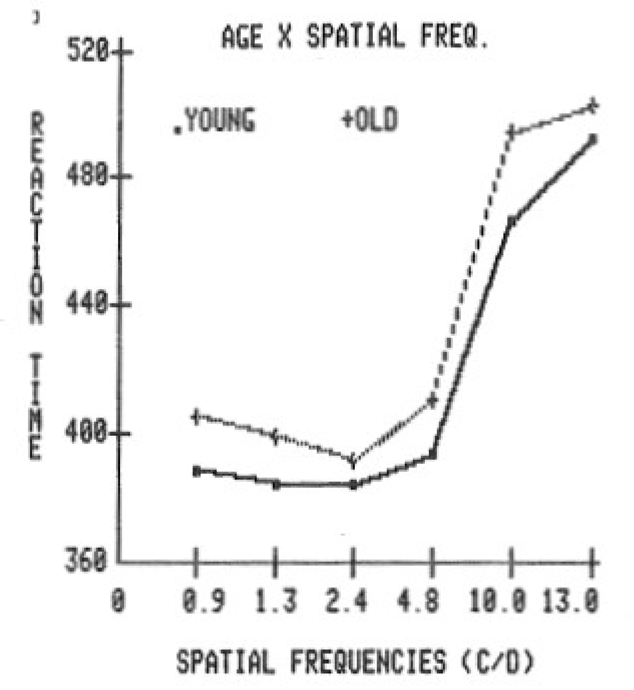
Method

Subjects - Fifteen young (18 to 25 years) and 11 old (54 to 81 years) volunteers participated in the experiment. Young were mainly university students, while elderly were recruited from special University courses for old people in Rome. All participants had a minimum of 13 years formal education. They were without any apparent neurological and/or psychological problems that might interfere with experimental procedures. All subjects were classified as right-handedness as assessed by a questionnaire (Salmaso & Longoni, in press). They had a mean laterality quotient of 0. 70.

Stimuli - Stimuli were 6 vertical gratings of various spatial frequencies (from 0.9 to 13 c!deg). The gratings had all the same mean luminance (44.2 Cd/m2) and the same contrast CO. 5). The contrast is defined as (Lmax-Lmin)/CLmax+Lmin), where L is the luminance of any point on the screen. The gratings were mounted in slide holders for tachistoscopic projection on a back-projection screen. and were flashed through a disk of 2.3 degrees (D) of visual angle in peripheral presentation. The center of the disk was about 2.1 D from the fixation point. Empty disks of the same mean luminance of the gratings were used as blank stimuli.

Procedure - The subjects were seated in front of a transparent screen at a distance of 60 cm. They maintained a constant head position by leaning their foreheads against a head-rest. An acoustic signal (O. 2 sec) prompted the subjects to fixate a clearly marked central point on the screen. Half second after the warning signal a slide was displayed for 90 msec. The interval between presentations was of 4 sec. Each frequency was randomly presented 24 times, while blank stimuli were totally 16. Presentations were evenly distributed between left (LVF) and right visual field (RVF). Subjects were instructed to respond by pressing a key with their right (or left) index finger as soon as they detected the gratings and to refrain from responding when a blank stimulus was presented. Eye movements were controlled via a TV camera.

FIGURE 2 : LATENCIES AS A FUNCTION OF SPATIAL FREQUENCY FOR YOUNG AND OLD SUBJECTS



RESULTS - Responses longer than 1 sec. and errors were eliminated by the analysis. They were below 1% of trials, and hence ware ignored. RTs varied significantly as a function of spatial frequency (F=97.88: DF: 5,120: P<. 001) going from 395.3 to 496.4 msec. Elderly were not significantly slower than young and the spatial frequency for age interaction was not shown. In figure 2 RTS for both groups are reported. A significant interaction was present between spatial frequency and visual field (F=2. 9: DF:5,120 : P<. 025) : low frequencies were analyzed faster by the RVF.

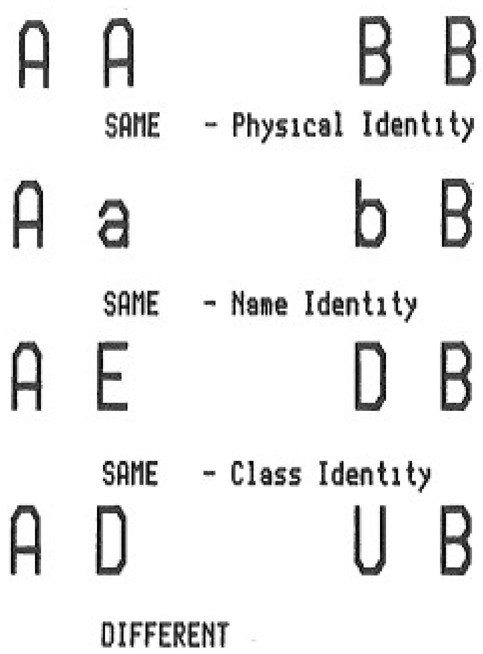
DISCUSSION

In this experiment in which a simple reaction time paradigm was used we did not find a significant difference for the response speed between young and old subjects. This result seems to confirm the idea that there is not a general slowing for elderly people (ES) caused by peripheral and motor factors. Moreover, since tho effect of spatial frequency on RT is the same for the two groups, those findings seem to exclude that some deficiency in the spatial frequency analysis may explain performance decrement revealed in more complex tasks. The reason for the discrepancy between these results and other works (Kline et al., 1983; Sekuler et al. , 1980) is not clear. We may suggest that the difference may depend on the contrast level used in the previous experiment, where lower contrast may have affect aged people reaction times (RT). Furthermore, two other recent works (McGrath et al., 1951; Moscovitch, 1982) did not find a selective impairment for some spatial frequencies with aging.

EXPERIMENT 2

In the first experiment we proved that simple RT of ES can be faster as for young people CYS). Many experiments have shown that the difference between the age groups increases as a function of the perceptual difficulty (Birren, 1970). However, increasing perceptual difficulty does not give the opportunity to study, with the same task, different levels of processing. Among the psychological paradigms, that developed by Posner & Mitchell (1967) is one of the most extensively studied (see reviews in Posner, 1978; Posner & McLeod, 1982). The paradigm can be summarized as follows. If we present pairs of letters like those drawn in the figure 3, we see that RTs for physically identical pairs are faster than those sharing only the same name or belonging to the same class (Posner, 1970; Taylor, 1978). Such a difference in RT is usually attributed to the fact that two physically identical letters can be matched on the basis of the physical code, whereas name and class identical pairs must be matched on the basis of an abstract code common to auditory and visual input (Posner & McLeod, 1982J Salmaso & Umilta', 19821. Hunt (1978) proposed that this paradigm is sensitive to both developmental and brain dysfunction. A recent work has also proved that vowels are matched faster than consonants (Salmaso, 1985) . The paradigm so far described was used for the next 3 experiments.

FIGURE 3 : EXAMPLES OF LETTER PAIRS



Method

Subject - Two new groups of subjects participated in the experiment. Old group was composed of 16 subjects (5 M and 11 F) ranged in age from 54 to 81 yr. (mean = 64.75). Young group included 15 subjects (8 M and 7 F; aged 18-25 yr.). All subjects were right-handed and they were recruited as previously.

Stimuli - 4 consonants (B,D,P,T) and 4 vowels

(A,E,O,U) were used to make 64 pairs of letters. There were 32 SAME pairs and 32 DIFFERENT pairs. Of the same pairs 8 were physically identical (PI) and 24 were class identical (CI). Only uppercase letters were used.

Procedure - Letter pairs were generated by an Apple computer and displayed on a b/w monitor. The pairs were viewed from a distance of 40 cm. and they subtended about 0.7 x 3.0 D. A chin-rest and a forehead support assured the constant distance of subject's head. An acoustic signal prompted the subject to fixate a cross on the screen. After 500 masc a pair was presented for 140 msec on the center below the cross. The S were given written instructions and they were told to respond as accurately and as quickly as possible. The subject’s task was ta press one button if the two letters belonged ta the same class (e.g. AA or DD) and another button if they were different (e.g. AB or DE). Each S was tested during one session of 320 trials, divided into 5 blocks of 64 presentations. The first block served as practice and was excluded from the analysis. Each session lasted about 45 min. RT and accuracy feedback was displayed for 2 sec. and a 3 sec. interval separated the trials. A 4 min rest period was given after each block.

RESULTS - All RTs shorter than 250 msec or longer than 1900 msec were discarded from the analysis. The factors considered were: age, type of letter (consonant/vowel) and type of identity (physical/class). Table 1 summarizes mean RT on main factors. Statistical analysis conducted on same responses showed that ES were slower than YS (F=34.75: DF=1, 29: P<. 001) . A significant effect was present, in both groups, for the type of identity (YS- F=117.84: DF=1,14: P<. 001; ES- F=6. 95: DF=1,15: P<. 025) , while the effect of type of letter was present only for YS (F=25.23: DF=1,14: P<.OO1). An interaction type of letter x type of identity was present for YS (F=30.53; DF=1,14:P<.OO1) but not for ES. Table 2 shows that the most difficult condition was when two different consonants are presented for matching. This interaction was present for ES only in the case of accuracy (F=6. 13: DF=1,15: P<.05)

TABLE 1 : RESULTS OF THE EXPERIMENT 2

		YS	ES
TYPE OF LETTER	CONSONANT	616.0	824.9
	VOWEL	534.8	783.2
		P<.001	NS
TYPE OF IDENTITY	PHYSICAL	501.4	747.3
	CLASS	649.4	860. 8
		p<.001	<.025
MEAN	SAME	575.4	804.1
	DIFFERENT	730.7	941.5

TABLE 2 : LETTER x IDENTITY TYPE INTERACTION

		CONSONANT	%	VOWEL	%
PI	YS	517,6		485,2	
	ES	753,4	87,7	741,2	85,4
CI	YS	714,5		584,3	
	ES	896,4	77,1	825,3	84,2

DISCUSSION

As reported by different authors (Birren & Botwinick, 1955, Birron, 1970; Levison, 1991; Lindholm & Parkinson, 1993) differences between ES and YS are much evident for complex than for simple tasks. In this second experiment an increase of the task complexity, at the level both of the stimulus analysis and response selection, revealed age differences in response speed that were not apparent in the first experiment. Furthermore some qualitative differences appeared on main factors suggesting that YS and ES differentiate on how they accomplish the task (Rabbitt, 19811. In fact the difference in vowel and consonant processing found in YS was significantly reduced in ES.

EXPERIMENT 3

The same paradigm of the experiment 2 is useful to study the problem of the cerebral lateralization in aging. According to previous results (Umilta', Sava & Salmaso, 1980; Salmaso & Umilta', 1982) we know that the right hemisphere (RH) is faster in evaluating a physical identity, while the left hemisphere CLH) is faster in evaluating a name identity. The classic aging pattern is that of a relative preservation of verbal skills and a decline in performance skills (Beckor, Nebes & Bol1er, 1985). This pattern is attributed to a selective decline in RH processing efficiency. Up to date there is no convincing evidence for this hypothesis (Moscovitch, 1952; Nebes et al. , 1983; Obler et al., 1984; Shelton et al. , 1982) and it was worthy to reconsider it. Letter pairs used in the exp. 2 were peripherally presented to obtain RT for the left visual field - RH (LVF) and for the right visual field - LH (RVF) .

Method

Subjects - 21 ES (7 M and 14 F) ranged in age from 50 to 82 yr (mean=64.86) and 17 YS students participated in the experiment. They were all right-handers and they were selected as previously.

Procedure - The material was the same of experiment 2. Pairs were randomly presented to the LVF and to the RVF and they extended from 6.9 to 9.9 D to the left or to the right. Eye movements were controlled by a TV camera.

RESULTS - RTs for ES were slower than RTs for YS (F=15.62: DF=1,36: P<. 001) . Letter type was significant for YS (F=17: DF=1,16: P<. 001) . but not for ES, while identity type was significant for both groups (YS - F=28.4: DF=1,16: P<. 001 / ES - F=27.9: DF=1,20: P<. 001) . Table 3 summarizes these results. For what concern visual field (VF) presentations, a three-way interaction was present in both groups C(YS- F=9.74: DF=1,16: P<.01/ ES- F=5.67: DF=1,20: P<. 05) . Table 4 shown: a) that the condition CI-Consonant was faster when presented to the RVF mainly for ES; b) that ES took less advantage from vowel conditions than YS. For accuracy EB presented an interaction type of letter x visual field (F=9.6: DF= 1,20: P<. 01) showing a reverse pattern between LVF and RVF (see Table 5).

TABLE 3 : RESULTS OF THE EXPERIMENT 3

		YS	ES
TYPE OF LETTER	CONSONANT	760,2	977,0
	VOWEL	701,5	938,1
		P<.001	NS
TYPE OF IDENTITY	PHYSICAL	666,8	920,6
	CLASS	795,0	994,5
		p<.001	<.001
MEAN	SAME	730,9	957,5
	DIFFERENT	951,3	1125,0

TABLE 4 : LETTER x IDENTITY x VF INTERACTION

		LVF		RVF	
		CONSONANT	VOWEL	CONSONANT	VOWEL
PI	YS	672,7	659,8	693,2	641,3
	ES	924,7	924,6	948,6	884,7
CI	YS	848,9	743,2	826,1	761,8
	ES	1053,2	979,1	981,5	964

TABLE 5 : LETTER x VF INTERACTION (ES)

%	LVF	RVF
CONSONANT	64,2	64,6
VOWEL	60,4	70,8

DISCUSSION

As it is well known from studies on RT there was an increase of RTs going from central to peripheral presentations (Lefton & Haber, 1974). However, this effect was the same for both groups and did not modify the relationship between the two factors. For ES, vowels were not significantly faster than consonant pairs, while the identity type appeared to be a very strong effect in both groups. As already reported consonant names are produced faster by the LH both for acoustic (Shankweiler & Studdert-Kennedy, 1967), and visual modality (Salmaso & Umilta', 1983). This effect was present for both groups and in this sense does not support the hypothesis of a laterality effect associated with aging (Nebes et al., 1983; Obler et al. . 1984). However, considering only LVF presentations we observed, for ES, a reduced difference between consonant and vowel pairs that could be caused by some qualitative difference in the RH with aging.

EXPERIMENT 4

A variant farm of the hypothesis of laterality and aging considers that a decline of the interhemispheric communication appears with age. This problem was first examined by Starandt (1972) presenting random shapes across visual fields. He found that recognition involving transfer from one VF to the other was more difficult than recognition within the same field, but that this result was the same far YS and ES In order to study this problem, one letter of the pair was presented to one VF and the other letter to the other one. As in the previous experiments, Ss had to decide if the two letters were same or different pairs.

Method

Subjects - 25 ES (9 M and 16 F) ranging in age between 47 and 79 yr. (mean = 60.45) and 17 YS students took part in the experiment. They were all right-handers and they were selected as previously.

Procedure - One letter of the pair was presented to about 9.5 D to the LVF and the other at same eccentricity in the RVF. There were 2 sequences of trials of 224 presentations. One sequence was made with the left hand and the other with the right one. In each sequence 32 trials served as practice.

RESULTS - ES were slower than YS ($F=40.05$: $DF=1,40$: $P<.001$). Letter and identity type were significant in both groups. Table 6 summarizes these results. A three-way interaction age x letter x identity was significant ($F=5.45$: $DF=1,40$; $P<.025$) and considered in table 7. YS presented, for accuracy, an interaction letter x identity

(F=30.2: DF=1,16: P<.001) that was not present for ES.

TABLE 6 : RESULTS OF THE EXPERIMENT 4

		YS	ES
TYPE OF LETTER	CONSONANT	830,3	1071,8
	VOWEL	751,2	1019,0
		P<.005	P<.025
TYPE OF IDENTITY	PHYSICAL	682,8	971,2
	CLASS	898,7	1119,6
		p<.001	<.001
MEAN	SAME	790,7	1045,7
	DIFFERENT	888,5	1103,3

TABLE 7 : LETTER x IDENTITY TYPE INTERACTION

		CONSONANT	%	VOWEL	%
PI	YS	686,8	90,4	678,7	91,3
	ES	981,2		961,2	
CI	YS	973,7	57,5	823,7	84,2
	ES	1162,4		1076,8	

DISCUSSION

The most relevant result were the presence for ES of a significant letter-type effect and letter x identity-type interaction that were not present in previous experiments. According to Watson et al.(1975) we might suggest some type of facilitation for ES with bilateral presentations, that can manifest the difference between vowels and consonants. ES are not selectively impaired by bilateral presentations as proposed by a callosal hypothesis. confirming a previous work (Storandt, 1972) .

CONCLUSIONS

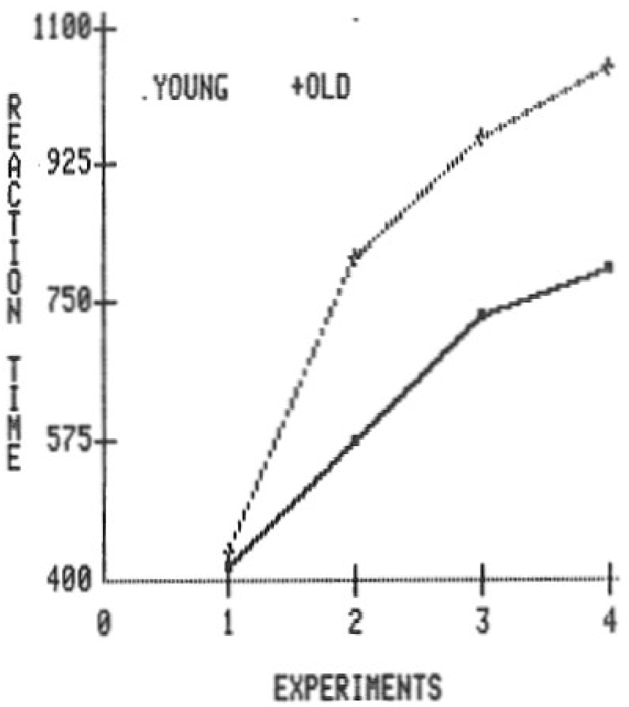
All together these experiments seem to confirm the hypothesis that YS and ES differ only at more complex levels of analysis and not for simple tasks. This result is graphically represented in figure 4, in which the overall means for each group in each experiment are reported. We observe that the increasing in RTs for aged people is constant independently to the task complexity.

Some differential effects appear across experiments on the way with which YS and ES access over-learned information, like that of deciding whether two letters are vowels or consonants. Elderly subjects seem less efficient in the use of some information that can favor faster decisions.

ES do not present cerebral lateralization patterns different from those of YS and therefore it is not possible. today. relate performance decrements to an impairment of the right, left or both hemisphere functions.

We conclude stressing the importance of studying the cognitive factors in aging, both for an understanding of the psychological functions in elderly people and for a more adequately oriented programming in rehabilitation and social intervention.

FIGURE 4 : MEAN RT FOR AGE GROUPS PLOTTED ACROSS TASKS



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