

The Analysis of Vocational Aptitude Changing with Age

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Synopsis

The assumption that vocational aptitude changed with age and with the kind of occupation was examined from the tendency of the fitted curve for the score of the aptitude test. 9 vocational aptitudes were measured by the general vocational aptitude test by Japan Labor Ministry.

Subjects were 382 male workers (design engineers, turners, welders, can manufacturing workers, and crane operators) of from 20 to 59 years old, and 348 male and female students (junior high school, vocational school, and university) of from 15 to 19 years old.

The design engineers' aptitudes advanced along the quadratic curve until 31 years old, but almost all the aptitudes of the other workers fell along the linear curve with age. The design engineers preserved various aptitudes until 52 years old, the turners 44, and the welders, the can manufacturing workers, and the crane operators 37.

The students' aptitudes were equal to those of the workers of from 15 to 25 years old. The workers preserved Spatial aptitude and Numerical aptitude until 45 years old. This could be said in all the occupations here.

Further it was made clear from the micromotion study that the influence of age was caused by therbligs

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Plan (think) and Use (write) in the paper test, and
Reach, Move, Position, Assemble, Holding and Avoidable
Delay in the board test.

1. Introduction

As at the present time the rate of the old is increasing rapidly, making clear the change of a worker's vocational ability by age is one of the most important problems from a view of redistributing labor[1]. But with the variety of occupation it is very difficult to estimate the change of his vocational aptitude by age by a unified measure.

Well, in Japan the general vocational aptitude test has been used widely for junior high school students and high school students as a method of to make their vocational aptitudes clear and as a part of an entrance examination.

So in this paper, we examined what aptitude was influenced by age and the kind of occupation using the general vocational aptitude test. Further the effect of age was analyzed from the time of therbligs composing test items by the micromotion study.

2. Method

2.1 Measurement and Analytical Method of the Aptitude Test

The vocational aptitude was measured by the general vocational aptitude test by Japan Labor Ministry. This test was composed of the paper test and the board test, and was shown in Table 1. The paper test consisted of 11 items, and the board test 4 items. 9 aptitudes were measured by the combination of these items. The score of each item was calculated by using the table given by the Ministry of Labor[2]. This table was determined from the data of age 15 and 16 in a high school, and the mean was 100 marks, and the standard deviation was 20 marks.

Subjects were 379 male workers of from 20 to 59 years old, design engineers, turners, welders, can manufacturing workers, and crane operators (5 occupations), 68 male and 55 female junior high school students of from 13 to 15 years old, 84 male and 112 female university students 18 and 19 years old, and 29 male vocational students 18 and 19 years old. Various students took the test because they were not

classified by occupations. The workers were classified into 8 consecutive age groups every five years from age 20. The number of the subjects in each age group and occupation was shown in Table 2. And the average score in each age group and occupation was calculated.

Hasegawa K. and Nasu S.[3] made clear that Intelligence showed a linear curve or a quadratic curve after age 20.

So, the change of the score in each occupation by age was explained by the fitted linear equation or the quadratic one[4]. If this tendency was shown by the quadratic equation, the age showing the maximum score was used as one parameter to explain this tendency. This age was denoted

Table 1. The test items and the aptitudes composing the aptitude test

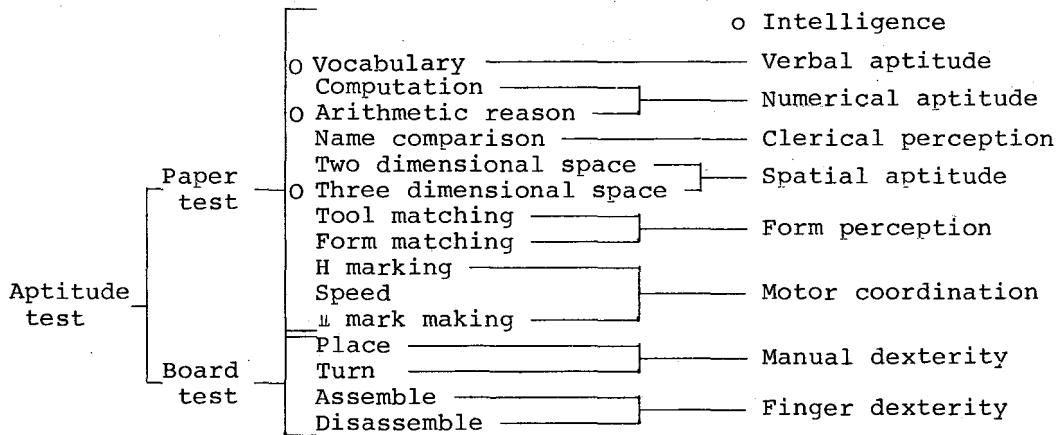


Table 2. The number of subjects in each age group and occupation

Occupation \ Age group		13-15	18-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	Total
Student	Junior high school	123										123
	Vocational school		29									29
	University		196									196
Worker	Design engineer			7	15	39	26	11	7	6	0	111
	Turner			9	10	17	11	25	12	16	11	111
	Welder			12	17	7	2	6	4	1	0	49
	Can manufacturing worker			6	22	13	13	8	3	2	8	75
	Crane operator			1	4	6	3	8	6	4	4	36
	Total	123	225	35	68	82	55	58	32	29	23	730

as maximum-age. For the people whose aptitudes were below 75 marks, their occupations sorted by Labor Ministry were extremely restricted. Then the age in which the aptitude was equal to 75 marks, that is standard score (100) - 1.25 standard deviation (25), was used as the other parameter characterizing this tendency. This age was denoted as 75 marks-age.

2.2 The Micromotion Study of the Aptitude Test

In order to know what kind of theblig was influenced by age, the items of the aptitude test were analyzed by the micromotion study by using VTR[5]. We measured the time required of each theblig per one problem in the paper test, or one cycle in the board test.

Subjects who showed average ability were selected. They were 11 years old (one person), 13 (one), 22 (three), 34 (two), 45 (one), and 49 (two).

3. Results and Discussions

3.1 The Tendency of Score of Aptitude by Age

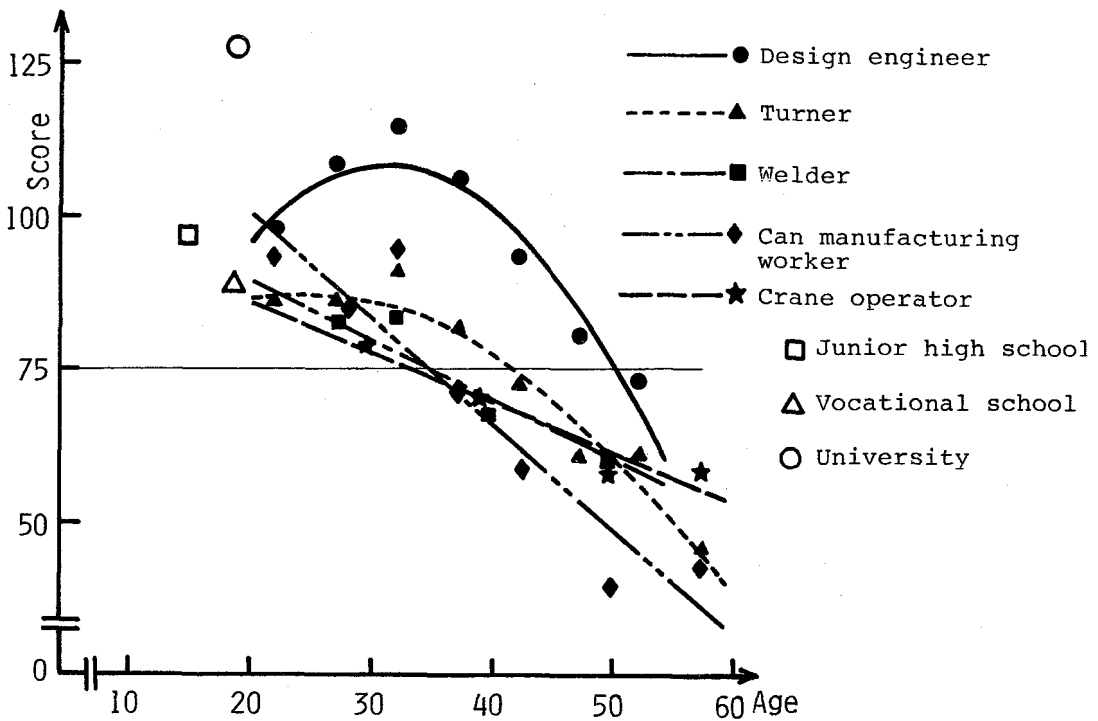
The tendency of the score of aptitude by age was shown in Fig.1 (a)-(i). Table 3 showed maximum-age, 75 marks-age and the fitted equation. Particularly, as for Intelligence we showed the average score and the fitted curve.

Intelligence of design engineers and turners showed the quadratic curve. The design engineers' score was the highest among all the occupations (examined occupations). It increased to be 108 marks at 31 years old and thereafter decreased along the quadratic curve. The turners' score preserved 87 marks until 30 years old and thereafter decreased along the quadratic curve. But Intelligence of welders, can manufacturing workers and crane operators fell with age at a slope of -0.98, -1.72 and -0.83. The score of junior high school students and vocational school students was equal to that of workers of from 15 to 25 years old. But the university students' score was the highest. 75 marks-age was 50 years old in design engineers, 42 in turners, 35 in welders and can manufacturing workers, and 33 in crane operators.

Design engineers' aptitudes except for Motor coordination showed the quadratic curve. Maximum-age was from 29 to 34 years old and its average was 31 years old. 75 marks-age was from 47 to 56 years old and its average was 52 years old. These aptitudes except for Finger

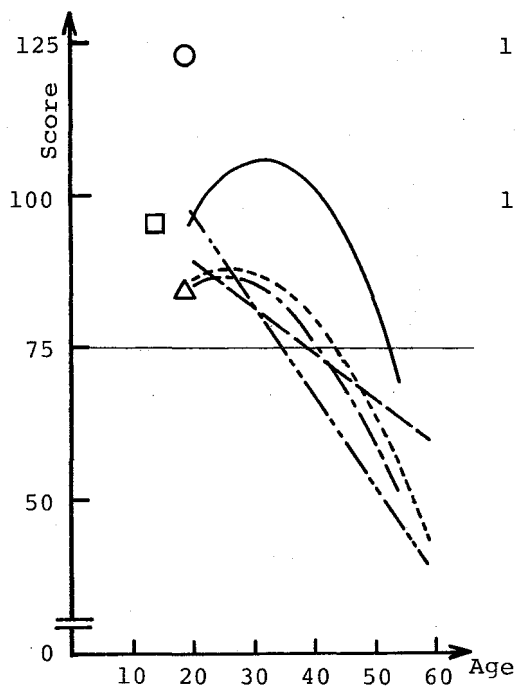
dexterity advanced until 31 years old and fell along the quadratic curve to be 75 marks at 52 years old. Motor coordination of design engineers fell a little at a slope of -0.19 , and was above 100 marks until 50 years old. But the score of Finger dexterity was the lowest among all the aptitudes here in all age groups. This trend was the same as all the occupations. Finger dexterity was stable until 28 years old and fell to be 25 marks at 50 years old. Therefore the aptitude of design engineers advanced until 31 years old and fell to be 75 marks at 52 years old. The aptitude used mainly at work did not fall until 50 years old.

Turners' aptitude showed the quadratic curve in Intelligence, Verbal aptitude, and Manual dexterity. These aptitudes advanced until 26 years old and thereafter fell. The other aptitudes showed the linear curve and fell at a slope of from -0.70 to -1.47 . Especially Manual and Finger dexterity were the highest of all the occupations. Almost all the aptitudes were above 75 marks until 44 years old.

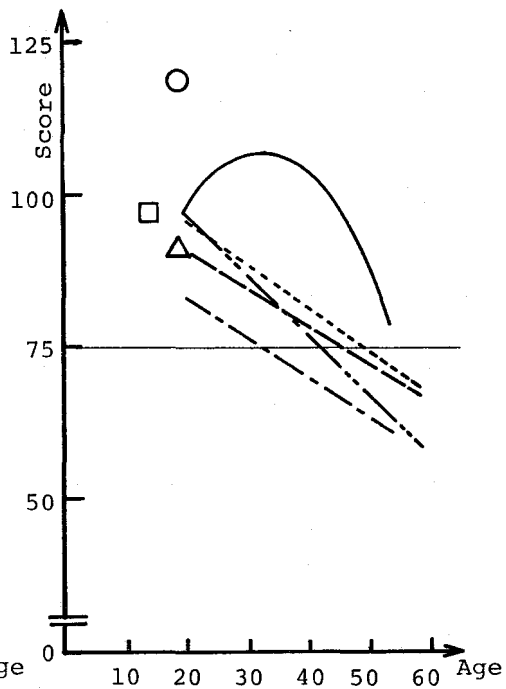


(a) Intelligence

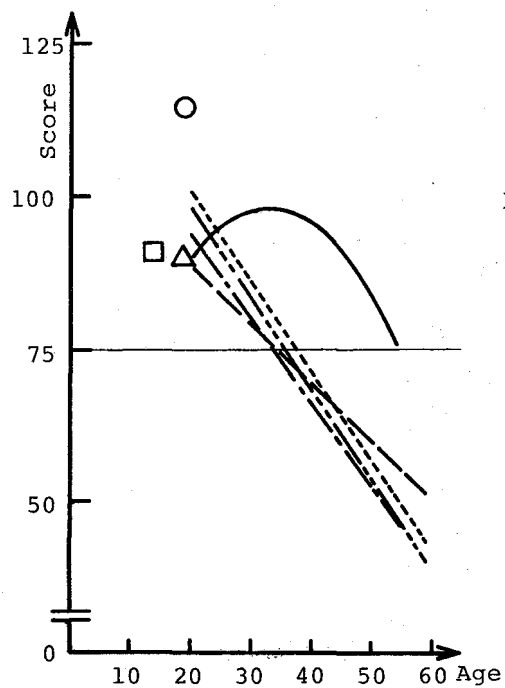
Fig.1. (a)-(i) The fitted curve for the score in each aptitude and occupation.



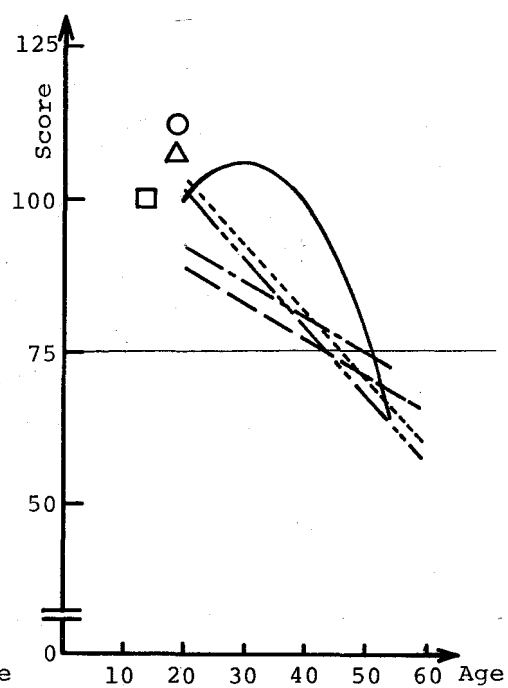
(b) Verbal aptitude



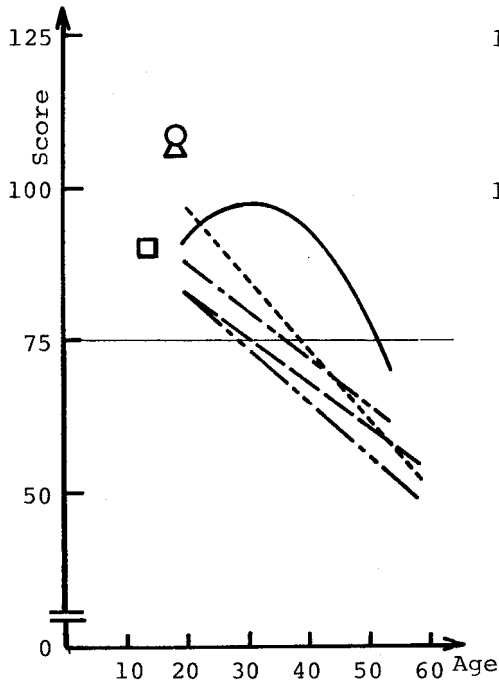
(c) Numerical aptitude



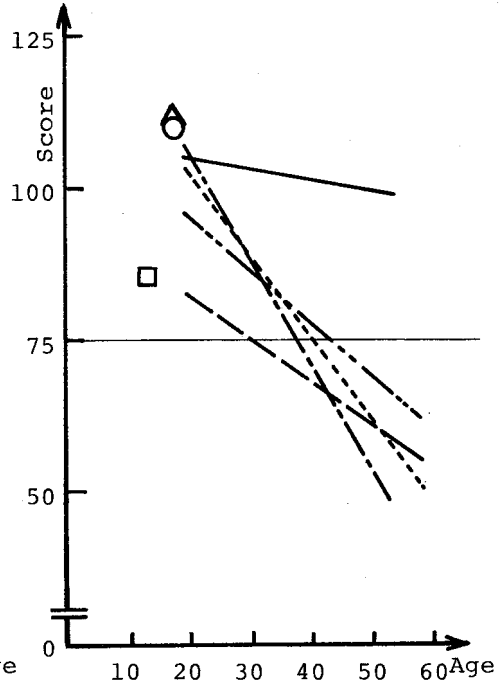
(d) Clerical perception



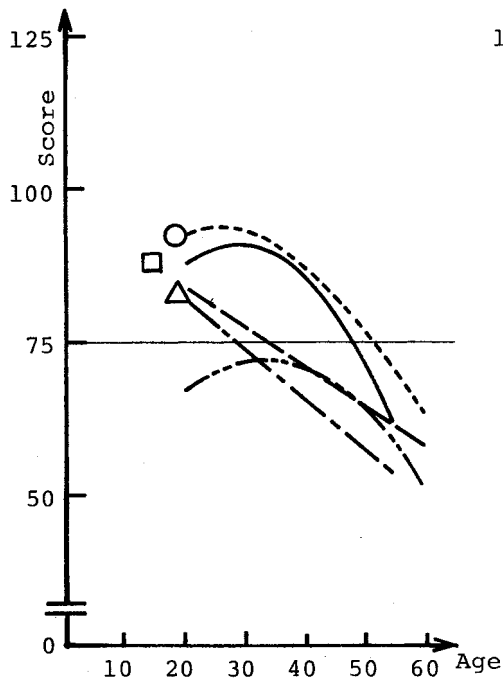
(e) Spatial aptitude



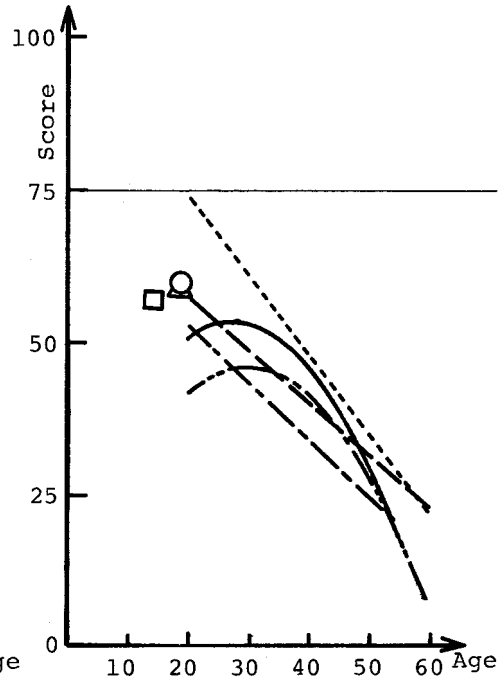
(f) Form perception



(g) Motor coordination



(h) Manual dexterity



(i) Finger dexterity

Table 3. Maximum-age, 75 marks-age and the fitted curve
in each aptitude and occupation.

Aptitude		I	V	N	C	S	F	M	MD	FD	Average of age
Occupation											
Design engineer	75m	50.2	51.8	55.6	54.4	50.6	51.8		47.3		51.7
	max	31.3	31.9	33.1	33.5	29.6	31.1		28.7	27.7	30.9
	fit	Q	Q	Q	Q	Q	Q	L	Q	Q	
	s							-0.19			
Turner	75m	41.8	44.5	49.1	37.5	45.9	39.1	41.1	52.4		43.9
	max	24.2	27.5						26.5		26.1
	fit	Q	Q	L	L	L	L	L	Q	L	
	s			-0.70	-1.47	-1.09	-1.12	-1.34		-1.32	
Welder	75m	34.9	42.2	32.4	35.3	50.9	36.8	38.4	28.3		37.4
	max		26.2								26.2
	fit	L	Q	L	L	L	L	L	L	L	
	s	-0.98		-0.64	-1.52	-0.57	-0.78	-1.70	-0.82	-0.98	
Can manufacturing worker	75m	34.7	34.6	41.4	33.7	44.1	29.6	43.9			37.4
	max								33.5	30.3	31.9
	fit	L	L	L	L	L	L	L	Q	Q	
	s	-1.72	-1.14	-0.95	-1.40	-1.10	-0.87	-0.87			
Crane operator	75m	33.3	36.8	45.3	34.2	43.0	31.5	30.8	33.3		36.0
	max										
	fit	L	L	L	L	L	L	L	L	L	
	s	-0.83	-0.69	-0.63	-0.95	-0.62	-0.73	-0.72	-0.66	-0.87	
Average of 75marks-age		39.0	42.0	44.8	39.0	46.9	37.8	38.6	40.3		

I :Intelligence V :Verbal aptitude
 N :Numerical aptitude C :Clerical perception
 S :Spatial aptitude F :Form perception
 M :Motor coordination MD:Manual dexterity
 FD:Finger dexterity

75m : 75 marks-age max : Maximum-age
 fit : fitted curve
 Q : quadratic curve
 L : linear curve
 s : slope

Manual dexterity only was above 75 marks until 52 years old. As the turners' Numerical aptitude and Manual dexterity would be used mainly at work, they did not fall below 75 marks until 49 years old. But the scores of Clerical perception and Form perception decreased with age at a slope of -1.47 and -1.12, and was 75 marks at 39 years old. Therefore it was necessary to exercise them if they were needed.

Welders' Verbal aptitude only showed the quadratic curve, and advanced to 88 marks until 26 years old. The other aptitudes fell along the linear curve at a slope of from -0.64 to -1.70, and was above 75 marks until from 28 to 42 years old. Spatial aptitude only was above 75 marks until 51 years old. Then welders would use Spatial aptitude and Verbal one at work.

Can manufacturing workers' aptitude measured by the paper test all showed the linear curve and fell at a slope of from -0.87 to -1.72. The aptitudes of Intelligence, Verbal aptitude, and Clerical perception fell at a high rate. And 75 marks-age was from 30 to 44 years old. Numerical aptitude, Spatial aptitude, and Motor coordination were above 75 marks until from 41 to 44 years old. But Finger and Manual dexterity showed the quadratic curve and advanced until 30 or 34 years old. But both scores were lower than 75 marks.

Crane operators' aptitudes all showed the linear curve and fell at a slope of from -0.62 to -0.95. 75 marks-age was from 31 to 45 years old. Spatial aptitude and Numerical aptitude were above 75 marks until 43 and 45 years old.

From these results, as the average of 75 marks-age was 52 years old in design engineers, 44 in turners, 37 in welders and can manufacturing workers, and 36 in crane operators. Design engineers and turners preserved their aptitudes for a long time. Further as Spatial aptitude was above 75 marks in all the occupations until 47 years old, Numerical aptitude until 45, and Verbal one until 42, it was thought that these aptitudes were used as common ones in all the occupations.

Table 4. The therbligs composing the test items.

Test item \ Therblig	TL	U	PL	P	TE	G	RL	A	HA
Vocabulary	○	○	●						
Computation	○	○	●						
Arithmetic reason	○	○	●						
Name comparison	○	○	●						
Two dimensional space	○	○	●	○					
Three dimensional space	○	○	●	○					
Tool matching	○	○	○	○					
Form matching	○	○	●						
H marking	●	●		●					
Speed	●	●							
u mark making	●	●							
Place	●			●	●	○	○		
Turn	●			○	○	○	○		
Assemble R-hand	●			○	○	●	○	●	●
Assemble L-hand	●			○	○	●	○	●	●
Disassemble	●			●	●	○	○		●

Therbligs TL: Move (Transport loaded) U : Use (Write)
 PL: Plan (Think) P : Position
 TE: Reach (Transport Empty) G : Grasp
 RL: Release (Release Lad) A : Assemble
 HA: Holding and Avoidable Delay

● : Time was affected by age.

3.2 The Influence of Age in Therblig

Table 4 showed the therbligs composing items. Fig.2 (a)-(f) showed the time required of therbligs in some items.

Move (Transport loaded) was contained in all items. Use (write) and Plan (think) were done in 11 items of the paper test. The time of Move and Use was not affected by age in 8 items composing Intelligence, Verbal aptitude, Numerical aptitude, Clerical perception, Spatial

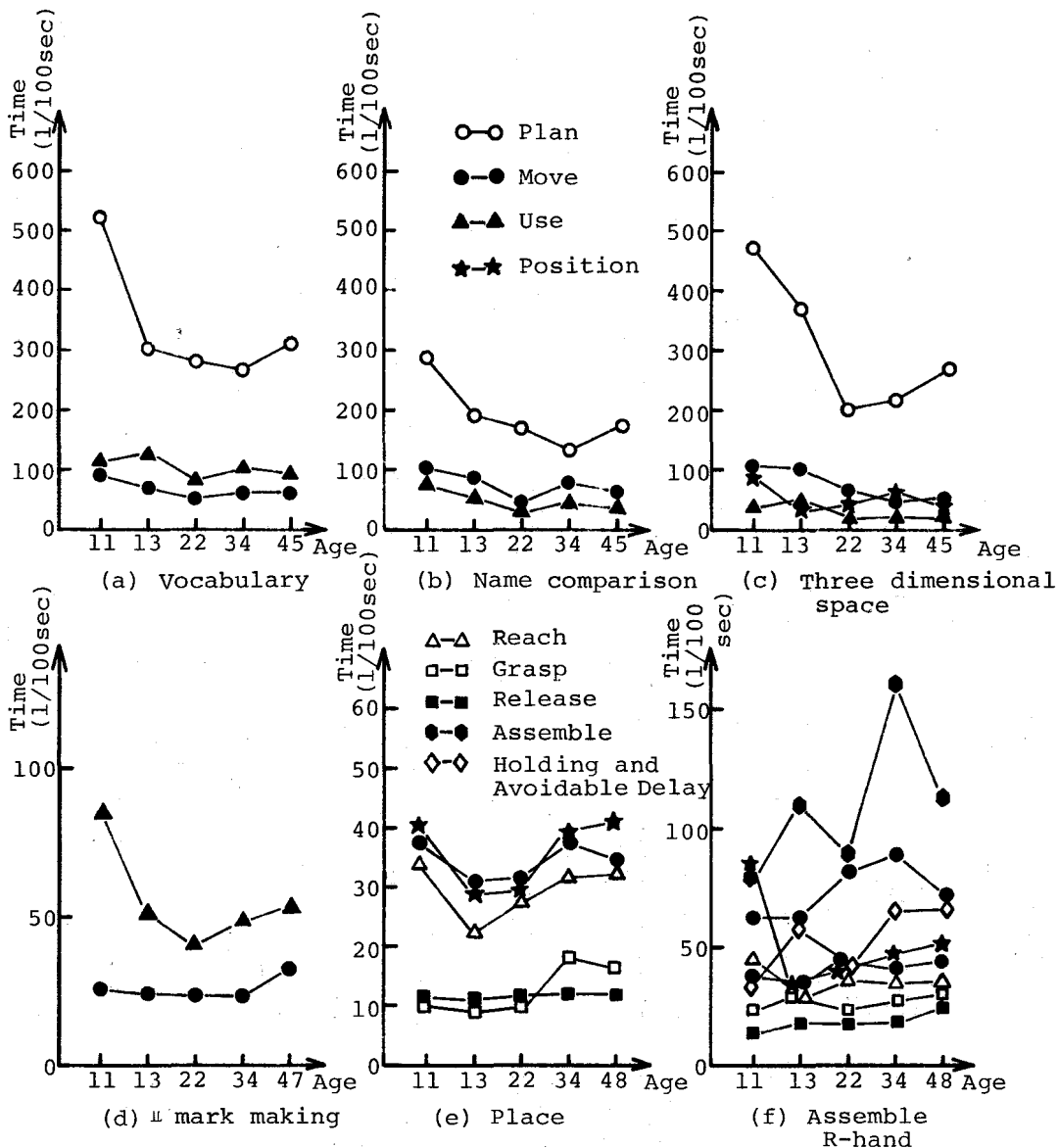


Fig.2. (a)-(f) The tendency of the therbligs composing the test items.

aptitude and Form perception. But that of Plan only was affected by age, and was the shortest in 22 or 34 years old. On the contrary, the time of Move and Use was affected by age in 3 items composing Motor coordination. But as the tendency of Move showed the convex curve, and that of Use did the concave curve, it was thought the influence of age was weakened in Motor coordination.

From these results, it was made clear that the influence of age in 6 aptitudes (Intelligence, Verbal aptitude, Numerical aptitude, Clerical perception, Spatial aptitude, and Form Perception) measured by the paper test was caused by Plan. And that of Motor coordination was done by Move and Use.

In the board test, Reach (Transport Empty), Grasp, Move, Position and Release were contained in 4 items. Holding and Avoidable Delay (HA) was the time of hands' waiting without doing anything or holding parts. The tendency of the time of Move, Position and Reach in 2 items composing Manual dexterity showed the concave curve and was the shortest in 13 or 22 years old. The other therbligs were not influenced by age. In the item of Assemble composing Finger dexterity, Move, Grasp, Assemble and HA was affected by age. The tendency of these therbligs was different as follows. The time of Move and Assemble showed the concave curve, HA the convex, and Grasp the linear curve. Then the influence of age was weakened in the item of Assemble. In the item of Disassemble, the time of Move, Position and Reach showed the concave curve and was the longest in 22 or 34 years old. The time of HA showed the concave curve and was the shortest in 22 years old. The other therbligs were not influenced by age.

From these results, the influence of age in Manual dexterity could be explained from Move, Position and Reach in two items. But in Finger dexterity, the therbligs influenced by age were different in two items. Therefore it was estimated that the tendency of Finger dexterity became varied by age and occupation.

4. Conclusion

In order to know what kind of aptitude was influenced by age and of occupation the aptitude was preserved in, the general vocational aptitude test was taken by students, design engineers, turners, welders, can manufacturing workers and crane operators. And the relation between aptitude and age was analyzed in all the occupations. Then the following results were obtained.

- (1) The design engineers preserved various aptitudes until 52

years old, the turners 44, the welders and the can manufacturing workers 37, and the crane operators 36. And the design engineers' aptitude advanced until 31 years old. But in the other occupations, a few aptitudes showed the advancing tendency.

In all the occupations, workers preserved Spatial aptitude, Numerical aptitude, Verbal aptitude, and Manual dexterity until 40 years old.

(2) The influence by age in the aptitudes measured by the paper test except for Motor coordination was caused only by the therblig Plan (think). That of Motor coordination was done by Move and Use. The influence by age in the aptitudes measured by the board test was caused by Move, Position, Reach, Assemble, Holding and Avoidable Delay.

Therefore, the influence by age in the aptitudes by the paper test could be explained simply by the tendency of one therblig or two. But that in the aptitudes by the board test was complicated.

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