INTERACTION OF TWO SIGNAL SYSTEMS IN NORMAL, NEUROTIC AND SCHIZOPHRENIC INDIVIDUALS IN RELATION TO PERSONALITY INVENTORY

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In attempts to investigate relations between conditioned reflexes and verbal reports about stimulus (6), the writer concluded that discrimination of frequency difference of tones was believed to be a function of the signal transmission from the first to the second signal system, but in discrimination of inclination difference of the line stimulus the second signal system was shown to play a predominant function over the first signal system. Attempts to classify typological peculiarities of the higher nervous activities of the subjects in terms of signal systems were also made in those studies.

In American psychology, experimental studies to investigate relationships between perception and personality traits have recently become one of the characteristic tendencies in psychological researches. Verbal response has been applied as a usual method for the index of our judgements in perceptual phenomena, and the reason of its validity was that verbal response has had a definite signal nature for the stimulus. Though verbal responses were convenient implements as indices of judgements, they were not sufficient for the analysis of the mechanism in perception (especially in relation to personality). For that purpose it was necessary to determine the signal nature of judgement in perception by different kinds of S-R connections of certain signal significances. In that respect, experimental studies to determine signal nature of stimuli by method of conditioned reflexes (6), became to have important significance for the analysis of relations between perception and personality traits. If application of the theory of conditioned reflexes to experiments in perception were possible, it would become a new method in the field of perception as well as in conditioned reflexes.

The present experiments were conducted to investigate relations between perception and personality traits through the theory of signal systems and to confirm writer's previous conclusions about signal natures of stimulus materials with the method of conditioned reflexes.

EXPERIMENT I

Apparatus & Procedures

1) Preliminary test

Subject was seated at a table in a dark room with his chin supported by an adjustable chinrest. Minimal discriminable differences were measured of the visual and auditory stimuli in the following way. Here the visual and auditory stimuli were the same ones as in the writer's previous experiments by conditioning (6). (*auditory task*): The tone of 1200 cps (standard stimulus) and the tone of lower cps (variable stimulus) were presented before the subject each 10 sec. with the duration of 1 sec. Sound pressure levels of the tones were about 50 db. Subjects were asked to report the nature of each stimulus whether it was a "high" or a "low"

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sound. The order of presentation of two kinds of tones was so prearranged that no more than same two stimuli occurred in succession and that in successive 20 trials were contained two kinds of stimuli equally. If the subject could perfectly differentiate those two kinds of stimuli in successive 20 trials, the pitch of the lower tone was brought close to 1200 cps, with the step of 2 cps and the subject was asked to judge the difference in 20 trials. The starting point of variable stimulus was pre-determined by the simplified method so that the pitch of variable stimulus was a little lower than the minimal discriminable difference. Thus the difference of the tone of lower cps from that of 1200 cps was reduced gradually with the step of 2 cps in each 20 trials, until they were of the minimal discriminable difference with the correct responding rate of 80-90%, i.e., 8-9 correct report in 10 trials for each stimulus.

(visual task): The visual task was an inclination discrimination of a slant line of 50 cm in length and 5 mm wide which was presented 2 meters before the subject. The standard stimulus was a line inclined 60° from the horizontal line and the variable stimuli were lines less inclined. The technique of measuring the minimal discriminable difference of the lines was the same as that in auditory task, in which the variable stimulus varied 0.2° .

2) Main experiment

After determining minimal discriminable difference of two stimuli, visual and auditory stimuli were paired as a simultaneous stimulus compound, in which each stimulus component varied in such two ways with the minimal discriminable differences that were determined in the preliminary test. Combinations of two stimulus materials in simultaneous compound were: — 1) H-U (tone of 1200 cps + line of 60°), . . 2) L-U (tone of lower cps + line of 60°), 3) H-D (tone of 1200 cps + line of less angled) and 4) L-D (tone of lower cps + line of less angled). Each combination of stimulus compounds was applied 15 trials in verbal and motor response procedure respectively. Order of presentation of simultaneous stimulus compounds were so prearranged that no more than same two compounds occurred in succession. The duration of the stimulus compound was 1 sec. and the intertrial interval was about 10 sec.

Subjects were asked to report about the nature of both visual and auditory stimuli after termination of each stimulus compound by verbal or motor response. The required verbal responses were either that the tone of 1200 cps was "high," and the tone of lower cps was "low"; the line of 60° was "near vertical" or "up" and the line less inclined was "near horizontal" or "down." As the motor response, a bulb pressing reaction with the right hand by preliminary verbal instructions was used. Those preliminary verbal instructions were as the following; 1) to press the bulb to the "high" tone and to the "near vertical" line and 2) not to press to the "low" tone and to the "near horizontal" line according to the experimenter's question about the stimulus, "How about the sound?" or "How about the line?" Those verbal questions were made following the termination of each stimulus compound and the order of questioning the visual and auditory tasks was randomly arranged in the experiment so that about 15 trials of each procedure occurred in succession. Before discrimination experiment mentioned above, Yatabe-Guilford Personality Inventory (8) was tested to measure personality traits of the subjects. Correlations between those personality traits and results from the discrimination experiment were investigated.

Subjects: Thirty students (24 male and 6 female) in the Dept. of Psychol., Kyoto Univ. served as the subjects. Out of thirty subjects, 20 (Group 1) were required to report by verbal and motor response and 10 (Group 2) were only to report by verbal responses. Subjects in Group 2 were selected from the students so that the distribution of scores in each personality trait between subjects was nearly identical with the distribution between 20 subjects in Group 1.

Results & Discussions

As the distribution of scores in each personality trait in Group 1 was nearly identical with that in Group 2, the mean scores of each personality trait in Yatabe-Guilford Test were shown between 30 subjects (Table 1). Scores of each scale were found to be normally distributed between subjects. Table 2 showed minimal discriminable differences of visual and auditory stimuli in the preliminary test. Pearson's correlation coefficients were calculated between scores of each scale of Y-G Test and various responding scores from the discrimination experiment. Mean verbal responses in various combinations in Group 1

nearly coincided with the corresponding verbal responses in Group 2. Correlations of various verbal responding rates to Y-G scores in Group 1 were also nearly identical with those in Group 2. Thus it was shown that the nature of verbal response was not influenced by inserted motor response. For that reason in verbal procedure data from 30 subjects were shown in the following table.

Table 1 Mean Scores of the Yatabe-Guilford Personality Inventory (N=30)

Personality Trait	S	T	D	C	I	N	O	R	G	A	Ag	Co
M	9.4	12.3	10.5	9.8	7.2	9.8	8.5	10.5	11.7	12.2	10.8	6.8
SD	5.9	4.5	5.5	5.3	5.5	4.8	5.5	5.1	5.7	6.0	4.1	4.5

S: Social introversion T: Thinking introversion D: Depression C: Cyclic tendency R: Rhathymia G: General activity A: Ascendance I: Inferiority feeling N: Nervousness O: Lack of objectivity Ag: Lack of agreeableness Co: Lack of cooperativeness

Table 2 Minimal Discriminable Differences (80-90 % Correct Response) of Sound Pitch and Visual Inclination of Lines (N=30)

Stimulus	Tone (cps)	Line (Degree)
M	14.5	2.6
SD	7.7	0.5

Significant correlations of scores of discrimination experiment were obtained to scores of *D*, *C*, *I*, *N*, *O* and *T* scale respectively. As *Depressive*, *Cyclic*, *Inferior*, *Nervous* and *Objective* scales were concerned with the primary factor *E* (*Emotional Unstability* factor), the total of those five scale was calculated and for convenience turned to account as *Emotional Unstability* factor *E*. As we shall see in Table 4, high correlations were obtained between frequency discrimination of the tone and the *Emotional Unstability* factor *E*. Correct verbal response percentages in H-U compound (high tone + up line) were negatively correlated to *E*. Correct verbal response percentage of the "high" tone component (irrespective of the component of line stimulus) was also negatively correlated to *E* factor. No such correlations were obtained between motor responses and personality traits.

Table 3 Mean Verbal and Motor Reports on Simultaneous Stimulus Compounds (in Verbal, N=30; in Motor, N=20)

Response Category	Correct H-U	Correct L-U	Correct H-D	Correct L-D	Correct H	Correct L	Correct U	Correct D	Total* H	Total* U
Verbal M (%)	64.4	57.8	51.2	59.2	78.9	71.9	83.0	71.4	53.5	55.4
SD	15.5	20.9	12.8	16.6	11.1	17.4	8.8	15.3	8.1	8.5
Motor M (%)	66.7	59.8	59.2	61.3	81.0	71.3	83.5	76.1	52.4	54.9
SD	16.5	24.7	15.6	15.6	14.0	17.4	7.1	11.9	9.6	8.4

H represents "high tone," L... "low tone," U... "up line," D... "down line."

* Total of L is 100-total of H, total of D is 100-total of U.

In terms of the theory of signal systems, the *Emotional Unstability* factor is functionally in close relation with the interaction of two signal systems (mainly with the signal trans-

mission from the first to the second signal system). In that respect, above mentioned correlations of the tone discrimination to *E* factor might be considered to confirm writer's previous conclusions with the method of conditioned reflexes (6), i. e., frequency discrimination of tones was a function of the interaction of two signal systems.

Table 4 Correlation of Verbal and Motor Reports on Simultaneous Stimulus Compounds (in Verbal, *N*=30; in Motor, *N*=20)

Response Category		Y-G Score	
		E	T
Correct H-U	Verbal	-.362	.010
	Motor	-.155	.034
Correct L-U	Verbal	.132	.081
	Motor	.053	.091
Correct H-D	Verbal	-.263	-.404
	Motor	-.095	-.117
Correct L-D	Verbal	-.309	-.249
	Motor	-.249	-.073
Correct H	Verbal	-.371	.152
	Motor	-.285	.091
Correct L	Verbal	-.187	-.001
	Motor	-.005	-.065
Correct U	Verbal	.125	.145
	Motor	-.026	.309
Correct D	Verbal	-.246	-.340
	Motor	-.036	-.190
Total H	Verbal	-.209	-.214
	Motor	-.204	-.127
Total U	Verbal	.296	.490
	Motor	.220	.000

Next we shall turn to the relation of inclination discrimination of lines to scores in personality traits. From Table 4, high correlation was shown between inclination discrimination and the *Thinking Introvert* score in Y-G Test. *Thinking Introvert* subjects responded to all visual inclined stimuli as "near vertical" or "up" more often than *Thinking Extrovert* subjects did. The lines used were about 60° inclined and those were the stimuli to be judged (by the second signal system) "near vertical" rather than "near horizontal" as only those two judgements were allowed. Significant correlation was not obtained between *T* score and motor response procedure. Those results also supported writer's previous conclusion that inclination discrimination of a line was mainly a function of the abstracting activity of the second signal system. That was, *Thinking Introvert* personality trait was largely concerned with the characteristic action of the second signal system and *Thinking Introvert* subjects judged the nature of the line by the abstraction and generalization of the second signal system as "near vertical" in verbal response procedure.

Thus, writer's conclusions on signal natures of pitch discrimination of the tone and inclination discrimination of the line drawn from the correlation of verbal reports to personality inventory seemed to confirm writer's previous conclusions by conditioning experiments (6). Then, what kind of conclusions could we draw from the correlations to motor re-

sponses? Bulb pressing motor response was the first signal system activity controlled directly by the second signal system and for that reason in a certain condition, *Thinking Introvert* personality trait could correlate significantly to motor procedure, which was directly controlled by the second signal system. In what condition? What was the difference between the second signal system activity represented by the verbal report and the second signal system activity represented by the motor report which was controlled by itself? The following experiment was partly designed to answer those questions.

EXPERIMENT II

As we saw in Experiment I, attempt to investigate relations of stimulus discriminations to personality traits seemed to support writer's previous conclusion on signal natures of stimuli with the method of conditioned reflex, in which the same stimulus materials of stimuli as those in Experiment I were used. Here arised the following questions. How were the response characteristics effected by the alteration of cycle range in auditory task and by that of inclination of lines in visual task? Can we get analogous conclusions as in Experiment I about the nature of auditory and visual stimuli? To answer those questions the following experiment was designed.

Apparatus & Procedures: Apparatus and procedures were the same as those in Experiment I excepting the stimulus ranges of visual and auditory stimuli in stimulus compounds and the number of trials applied to each stimulus compound. Two kinds of discriminations in different stimulus ranges were used in each stimulus modality. In visual task, one was the discrimination of lines near 60° and the another was the discrimination of lines near 30°. The discrimination of tones near 1200 cps and that of near 600 cps were used in auditory task. In discrimination of stimulus compounds, the difference of two stimuli in each modality was determined so that they were of the minimal discriminable difference by the same method as in the preliminary test in Experiment I (80-90% correct response). Thus the following four conditions of simultaneous stimulus compounds were given.

Condition	Stimulus Compounds (Required Response)			
	H-U (High Tone + Up Line)	L-U (Low Tone + Up Line)	H-D (High Tone + Down Line)	L-D (Low Tone + Down Line)
1. 1200-60	1200 cps* + 60°*	tone of lower cps** + 60°*	1200 cps* + line of less inclined**	tone of lower cps** + line of less inclined**
2. 1200-30	1200 cps* + 30°*	tone of lower cps** + 30°*	1200 cps* + line of less inclined**	tone of lower cps** + line of less inclined**
3. 600-60	600 cps* + 60°*	tone of lower cps** + 60°*	600 cps* + line of less inclined**	tone of lower cps** + line of less inclined**
4. 600-30	600 cps* + 30°*	tone of lower cps** + 30°*	600 cps* + line of less inclined**	tone of lower cps** + line of less inclined**

* They were standard stimuli in preliminary test in determining the minimal discriminable differences of stimuli.

** They were variable stimuli in preliminary test and the differences from the standard stimuli were determined so that they were of the minimal discriminable differences.

As the condition 1 was the same in its stimulus range of the stimulus compounds as that in Experiment I, data from the Group 1 of Experiment I were utilized for those of condition 1. Experiments were conducted

from condition 2 to condition 4, and each condition was separated for about ten days so as to reduce effects by replication. Each combination of stimulus compounds, i. e., H-U, L-U, H-D and L-D combination was applied 8 trials in verbal and motor response procedure respectively. Verbal and motor response procedures were randomly arranged so that about 15 trials of each procedure occurred in succession. Other procedures in Experiment II were all the same as those in Experiment I.

Subjects: Twenty students in the Dept. of Psychol., Kyoto Univ. served as the subjects in each experimental condition, in which about 15 students were common to all four conditions and others were randomly selected from students in the department. Though it was advisable to have the same subjects throughout four conditions, it became impossible on account of transition among subjects. In condition 1 and 2, fifteen were male students and 5 were female; in condition 3, 17 were male and 3 were female; in condition 4, 16 were male and 4 were female.

Results & Discussions

Table 5 showed mean scores of *Emotional Unstability* factor *E* and the *Thinking Introvert* trait *T* in four stimulus conditions. Analysis of scores showed that both *E* and *T* were normally distributed between subjects in all stimulus conditions. There was no difference of means between each score of Y-G Test in four conditions. In Table 5 were also shown the minimal discriminable differences of visual and auditory stimuli in preliminary test. Table 6 showed the mean verbal and motor reports on visual and auditory components of simultaneous stimulus compounds in various combinations.

Table 5 Mean Scores of *Emotional Unstability* Factor and *Thinking Introvert* Trait, and Minimal Discriminable Differences of Sound Pitch and Visual Inclination of Line (N=20 in Each Group)

Stimulus Condition	Y-G score					Tone (cps)		Line (degree)	
	<i>E</i>		<i>T</i>		<i>r</i> of <i>E</i> × <i>T</i>	M	SD	M	SD
1) 1200-60	46.9	22.3	12.6	4.6	.453	15.8	9.3	2.5	0.5
2) 1200-30	48.6	22.3	11.8	5.5	.378	17.2	6.2	2.5	0.3
3) 600-60	48.9	21.5	11.4	5.7	.437	8.1	3.7	2.5	0.4
4) 600-30	45.9	19.2	11.7	5.9	.525	8.1	3.0	2.5	0.4

Comparison of the mean verbal and motor response percentages in condition 1 with those in Group 1 of Experiment I showed no difference in response ratios, i. e., no practise effect was observed in the course of discrimination of stimulus compounds. Correlations of those response characteristics in condition 1 to Y-G scores also showed that response varieties due to personality traits were not fundamentally influenced by the amount of discrimination (compare Table 7 with Table 4).

As we shall see in the following experiment, these findings have special significance in analyzing response peculiarities of abnormal individuals, for in these subjects amounts of discrimination are restricted by their pathological peculiarities such as rapid accumulation of fatigue, lack of concentration in attention and so on. No practise effect of discrimination being observed in normal subjects, it became possible to compare data in abnormal individuals with those in normals without matching the number of trials in discrimination.

Analysis of Table 6 were as follows.

(1) Correct verbal reports about tone + line

i) correct report in H-U compound

$$1200-60 + 600-60 > 1200-30 + 600-30, t = 2.72 \quad df = 78 \quad p < .01$$

(1200-60 > 1200-30, $p < 0.5$; 600-60 > 1200-30, $p < .01$)

- ii) correct report in H-D compound

1200-60 + 600-60 > 1200-30 + 600-30, $t = 2.83$ $df = 78$ $p < .01$

(1200-60 > 1200-30, $p < 0.5$; 600-60 > 1200-30, $p < .01$)

- iii) correct report in L-U compound

1200-60 + 600-60 > 1200-30 + 600-30, $t = 2.45$ $df = 78$ $p < .05$

(1200-60 > 1200-30, $p < .01$)

- iv) correct report in L-D compound

1200-60 + 600-60 > 1200-30 + 600-30, $t = 1.66$ $df = 78$ $p < .10$

- (2) Correct motor reports about tone + line

As similar results as those by verbal report were obtained, statistical data were omitted.

As we could see from analyses shown above, both in verbal and motor report procedures discrimination of stimulus compounds was better when connected with lines inclined 60° than when connected with lines inclined 30° , irrespective of their tone component. Such a low discrimination was remarkable in 1200-30 condition.

- (3) Correct verbal reports about tone component (H + L)

1200-60 + 600-60 > 1200-30 + 600-30, $t = 2.95$ $df = 78$ $p < .01$

(1200-60 > 1200-30, $p < .01$; 600-60 > 1200-30, $p < .01$)

- (4) In correct motor reports, similar results as those by verbal reports were obtained.

- (5) Both in verbal and motor reports on line component (U + D), no significant difference was obtained between four conditions.

- (6) Comparison of the correct verbal report with motor report in tone component (H + L)

1200-60 condition, motor > verbal, $t = 1.93$ $df = 19$ $p < .10$

1200-30 condition, motor > verbal, $t = 2.13$ $df = 19$ $p < .05$

- (7) Response percentages in total reports by verbal and motor procedures

- i) In 1200-60 condition, total response of H-U compound was greater than the expected value of response in verbal procedure (expected value was $100 / 4 = 25\%$). $t = 2.48$ $df = 19$ $p < .05$

- ii) In 1200-30 condition, total response of L-U compound was lower than the expected value of response both in verbal and motor procedures. $t = 3.66$ in verbal, $df = 19$ $p < .01$, $t = 5.15$ in motor, $df = 19$ $p < .001$

- iii) In 600-60 condition, total response of H-U compound was higher than the expected value in verbal procedure ($t = 2.73$ $df = 19$ $p < .05$) and total response of H-D compound was lower than the expected value in verbal procedure ($t = 3.16$ $df = 19$ $p < .01$).

- iv) In 600-30 condition, total response of L-D compound was higher than the expected value of response in verbal procedure. $t = 2.00$ $df = 19$ $p = .05$

First of all, we shall go to the detailed analyses of the verbal and motor reports on simultaneous stimulus compounds in Table 6.

As we saw previously, correct verbal and motor reports of stimulus compounds were lower when the line component was a line near 30° and it was mainly represented by the 1200-30 condition. Analysis of the data showed that above mentioned lower responding rates in compounds with lines inclined 30° were due to the disturbance of discrimination of tone component effected by the stimulus disposition of line component. Why was the tone component influenced by the line component? According to the writer's previous conclusions on signal nature of stimuli, discrimination of pitch was defined as a function of the signal transmission from the first to the second signal system. In the present data, it was also appropriate to interpret them by signal peculiarities of tone stimulus, that is, sound discrimination effected by the signal disposition of the line (peculiarities of the first signal system) was considered as a function of the interaction of two signal systems. We shall discuss them in details later in the analysis of the correlation coefficients.

Table 6 Mean Verbal and Motor Reports on Simultaneous Stimulus Compounds in Various Combinations.

Response Category		1200-60		1200-30		600-60		600-30	
		M	SD	M	SD	M	SD	M	SD
Correct H-U	Verbal	61.3	18.1	48.8	20.7	66.9	21.9	53.8	24.0
	Motor	66.3	17.1	53.8	21.5	65.6	22.0	52.5	22.1
Correct L-U	Verbal	56.9	23.1	38.8	23.9	61.9	24.1	50.6	23.1
	Motor	63.8	22.2	41.9	17.8	66.9	23.1	58.1	25.4
Correct H-D	Verbal	56.9	14.4	41.3	18.8	48.8	17.1	45.0	20.8
	Motor	60.0	18.8	51.9	21.6	50.0	25.7	56.3	20.5
Correct L-D	Verbal	61.3	18.6	50.6	21.7	63.8	12.2	61.9	15.4
	Motor	60.0	23.5	46.3	25.2	58.8	17.4	54.4	18.2
Correct H	Verbal	76.9	12.7	61.9	18.9	74.4	17.3	68.1	17.7
	Motor	81.6	13.4	68.8	11.6	74.7	17.2	71.6	18.1
Correct L	Verbal	70.0	18.1	57.2	13.4	74.1	15.2	69.1	21.9
	Motor	75.9	17.4	64.1	16.4	74.1	22.3	69.1	24.0
Correct U	Verbal	82.8	11.8	72.5	13.4	85.6	13.2	76.9	12.7
	Motor	82.5	8.2	71.9	12.4	82.8	12.6	76.3	19.9
Correct D	Verbal	78.1	11.2	79.7	10.1	75.6	17.0	78.8	13.4
	Motor	77.2	12.1	83.1	10.9	74.4	16.0	80.3	13.4
Total H	Verbal	53.6	9.1	52.7	9.0	50.1	6.7	49.6	8.8
	Motor	53.3	11.3	56.6	6.9	50.3	10.0	51.7	10.6
Total U	Verbal	52.3	6.2	46.4	6.9	54.9	7.2	48.7	10.0
	Motor	52.5	9.2	45.5	9.0	54.0	8.0	48.1	10.0
Total H-U	Verbal	28.9	7.0	26.7	6.8	30.1	8.0	27.3	8.3
	Motor	27.8	7.2	27.5	7.1	28.1	9.0	25.0	10.6
Total L-U	Verbal	23.4	8.2	19.7	6.5	24.8	8.4	21.4	8.0
	Motor	24.7	9.8	18.0	6.1	25.9	7.5	23.1	7.7
Total H-D	Verbal	24.7	5.7	26.0	8.4	20.0	7.1	22.3	10.4
	Motor	25.5	9.0	29.1	11.8	22.2	8.0	26.7	9.8
Total L-D	Verbal	23.1	5.9	27.6	7.5	25.0	7.9	28.9	9.0
	Motor	22.0	7.0	25.3	7.2	23.8	6.2	25.3	8.2

How were the response tendencies determined by the alteration of stimulus ranges? In condition 1 and 2, where the line component was about 60°, subjects tended to report (both by verbal and by motor response) the nature of compounds as "high tone and near vertical line" more often than the expected value of response (25%). That seemed to come from the fact that tone component was largely concerned with the signal transmission from the first to the second signal system (in other word, it had no frame of reference in the second signal system) and for that reason the frame of the tone was partly determined (shifted) by the stable frame (i. e., 60° inclined line). Besides, in 600-60 condition total response of H-D compound was lower than the expected value of response in verbal procedure. It suggested that it was difficult to report the nature of stimulus compounds in 600-60 conditions as "high sound and down line." In condition 2 (1200-30 condition) total response of L-U compound was lower than the expected value of response both in verbal and motor procedures. In condition 1 and 3, on the contrary, no such lower responding rates than the expected value were observed. The differences of response tendencies between four conditions were considered to come from the difference of the framework

of stimulus configurations. The results suggested that the absolute judgement (response tendency) of the tone near 1200 cps and the tone near 600 cps were located left and right on the *high-low* scale and that of the line 60° and the line 30° were on the *up-down* scale. That is, tones near 1200 cps were shown that they were the stimuli to be judged "high" sound rather than "low" sound and tones near 600 cps were the stimuli to be judged "low" sound rather than "high" sound: lines near 60° were shown that they were the stimuli to be judged "near vertical" rather than "near horizontal" and lines near 30° were the stimuli to be judged "near horizontal" rather "near vertical." In condition 2 and 3 where judgements of functionally opposite category (high-down, low-up) were accentuated, accentuated judgements were not higher than the expected value of response on account of the conflict between the functionally similar judgements and the accentuated judgements. In that case such judgements as were opposite in category to the accentuated judgements (stimulus configurations) — low-up, high-down — were difficult to be given (see analysis of correlations to Y-G Test shown below).

In condition 1 and 4 where the accentuated two components of judgement were functionally similar (high-up, low-down), the decrease of such judgements as were opposite in category to the accentuated judgements were slight. In condition 4 where L-D response was accentuated, accentuated L-D response was higher than the expected value of response.

Next we shall proceed to the analyses of correlations of discriminations to personality inventory. In correlations to *Emotional Unstability* personality factor *E*, significant correlations were mainly obtained in verbal procedure (out of 11 significant correlations, 9 were in verbal reports). In correlations to *Thinking Introvert* personality trait, on the contrary, significant correlations were largely obtained in motor procedure (out of 12 significant correlations 10 were observed in motor procedure). How could those be explained? From the theory of signal systems and also from the detailed examinations of items of Y-G Inventory, the writer had determined that *E* factor was in close relation with the interaction of two signal systems (mainly with the signal transmission from the first to the second signal system) and that *T* trait was mainly concerned with the characteristic action of the second signal system. Above mentioned peculiar function of verbal and motor response in relation to personality inventory supported the writer's classification of *E* and *T* in terms of signal systems. *E* factor being a function of the signal transmission from the first to the second signal system, individual signal peculiarities were prominent in the second signal system activity. *Thinking Introvert* trait being characterized by its controlling function of the second signal system over the first, controlled first signal system activity was shown to depend on *T* trait.

Next finding was worthy of note. In some condition, correct response percentages of verbal minus motor procedure were negatively correlated to *E* factor, i. e., the more *Emotionally Unstable* the subjects were, the more correct the motor reports became as compared with the verbal reports. The writer regarded the *Emotional Unstability* factor in Y-G Test as a function of the disturbance in the signal transmission from the first to the second signal system, and in that point the more *Emotionally Unstable* the subjects were, the more correct was the first signal system activity as compared with the second signal system

Table 7 Correlation of Verbal and Motor Reports on Simultaneous Stimulus Compounds in Four Experimental Conditions (N=20 in Each Group)

Response Category		1200-60		1200-30		600-60		600-30	
		E	T	E	T	E	T	E	T
Correct H-U	Verbal	-.491	-.014	-.490	-.396	.407	.000	-.010	-.179
	Motor	-.117	.257	.051	.389	.349	.193	.017	-.428
	V-M	-.433		-.487					
Correct L-U	Verbal	-.137	-.337	-.050	-.041	-.245	-.287	.133	.145
	Motor	-.060	-.098	.386	.086	-.245	-.213	.017	.037
	V-M								
Correct H-D	Verbal	-.124	-.292	.267	-.204	-.162	-.328	.177	.028
	Motor	-.069	-.151	.024	.220	-.110	.000	.141	.078
	V-M								
Correct L-D	Verbal	-.318	-.490	.041	-.262	.071	-.337	-.248	-.203
	Motor	-.266	-.109	-.091	-.062	-.097	-.272	-.242	-.332
	V-M								
Correct H	Verbal	-.478	-.230	-.064	-.370	.148	-.259	.135	-.084
	Motor	-.159	.000	-.155	-.223	.310	.108	.000	-.060
	V-M								
Correct L	Verbal	-.160	-.327	.252	-.033	-.188	-.338	.000	-.142
	Motor	.055	.026	.042	-.160	-.033	-.330	-.196	-.326
	V-M								
Correct U	Verbal	-.069	.195	-.627	.057	.324	.073	.053	.393
	Motor	-.315	.435	.279	.491	.347	.081	.181	-.010
	V-M			-.705					
Correct D	Verbal	-.337	-.422	-.319	-.455	-.028	-.195	-.415	-.185
	Motor	-.041	-.294	.162	-.391	.058	-.094	-.119	-.075
	V-M								
Total H	Verbal	-.179	.119	-.303	-.254	.467	.050	-.020	.044
	Motor	-.083	.000	-.176	-.192	.402	.559	.218	.318
	V-M						-.725		
Total U	Verbal	.241	.450	-.557	.272	.299	.117	.329	.336
	Motor	-.041	.220	.286	.574	.219	.144	.272	-.010
	V-M			-.631					
Total H-U	Verbal	-.032	.196	-.653	-.046	.634	.264	.024	.132
	Motor	-.036	.335	-.061	.452	.303	.480	.065	-.067
	V-M			-.504	-.475				
Total L-U	Verbal	.209	.051	.120	.376	-.385	-.010	.415	.379
	Motor	.163	.089	.502	-.328	-.135	-.534	.163	.084
	V-M								
Total H-D	Verbal	-.297	-.207	.026	-.333	-.334	-.253	.056	-.024
	Motor	-.075	-.288	-.053	-.423	.039	.046	.102	.442
	V-M							-.438	
Total L-D	Verbal	-.020	-.329	.097	-.129	.064	.028	-.450	-.399
	Motor	-.122	-.111	-.250	-.053	-.331	-.250	-.447	-.490
	V-M								

V-M represents "verbal response percentage minus motor response percentage" and only significant correlation coefficients (less than 5% level) to V-M were given in the Table. Underlined correlation coefficients were statistically significant at less than 5% level.

activity. Though the bulb pressing first signal system activity was mediated by the second

signal system, in which the signal message from the first signal system was distorted in the *Emotionally Unstable* subjects, it was important to stress the fact that in that case the stimulus-response connection was associated in the first signal system. As to the correlation to *T*, such verbal-motor relations in the correct reports as we saw in the correlation to *E* were not observed. For the sake of the abstraction and generalization of the second signal system, correlations to *T* were rather determined to emphasize the characteristic actions of the second signal system.

Now we shall proceed to the analyses of correlations of discrimination to personality inventory one by one.

i) condition 1 (1200-60): Just the same as we saw in Experiment I, in verbal procedure *Emotionally Stable* subjects judged the nature of H-U compound more correctly than *Emotionally Unstable* subjects did, and it was shown to depend mainly on the discrimination of sound component. As to the relation to *T* trait, in verbal procedure *Thinking Extrovert* subjects judged more correctly than *Introvert* subjects did in L-D compound, in which the discrimination of "down" line was largely responsible for. The lower discrimination of "down" line in *Thinking Introvert* subjects caused them to respond to all visual inclined lines as "near vertical" or "up" more often than did *Thinking Extrovert* subjects.

In motor procedure, *Thinking Introvert* subjects responded more correctly in "up" component. What did those differences between two procedures come from? As was discussed previously in Experiment I, the lines used were about 60° inclined and those were the stimuli to be judged "near vertical" rather than "near horizontal" as only those two judgements were allowed. Judgements having already had response tendencies related to personality trait in process of the signal transmission from the first to the second signal system, such response tendencies were not observed in motor responses controlled by the second signal system. In the discrimination of "up" line component, required response coincided with the response tendency, i. e., "near vertical" or "up," and for that reason correlation of *T* to verbal report was low and personality differences were observed in motor reports controlled by the second signal system which was the functions of *T* trait.

ii) condition 2 (1200-30): *Emotionally Stable* subjects judged the nature of H-U compound more correctly than did *Emotionally Unstable* subjects in verbal procedure. Here the discrimination of "up" line component was responsible for that of H-U, i. e., *Stable* subjects judged "up" line component more correctly than did *Unstable* subjects. Analogous phenomena were observed in analyzing total frequencies responded as "high and up" and also in total frequencies of sound discrimination. As we had already seen in the mean response percentages in auditory discrimination (Table 6), correct verbal and motor responses (especially verbal) were lower in cases when connected with lines inclined 30° (tones near 1200 cps were more influenced than those near 600). These disturbances in tone discrimination may be considered to come from the specific characters of lines inclined 30°. According to the framework of vertical and horizontal line, lines inclined 30° were the stimuli to be judged "near horizontal" or "down" rather than "near vertical" as only those two judgements were allowed.

Discriminations of lines inclined 30° were doubly correlated to *E* and *T*. *T* trait

was, on the contrary, positively correlated to the judgement as "up" in motor procedure. From correlations of *T* trait to motor reports in condition 2 and 3 where one component of stimulus compounds was the stimulus to be judged "high" or "up," one will at once notice the fact that in those cases stimulus compounds were apt to be judged as "high and up" by *Introvert* subjects more often than by *Extrovert* subjects in motor procedure. By the generalization in process of the second signal system, functionally similar category — high and up — associated each other and for the sake of their controlling action of the second signal system over the first, above mentioned phenomena were obtained.

Thus lines inclined 30° of condition 2 have the conflicting character, i. e., lines by themselves were apt to be judged as "down" by the second signal system and apt to be judged "up" in combination with tones of 1200 cps. In that way, lines fundamentally correlated to *T* trait became to be unstable in the framework of vertical and horizontal line and *Emotionally Unstable* subjects shifted their judgements to the stable direction, i. e., to the horizontal. The verbal judgements on line component which was the framework of verbal response in pitch discrimination being *Emotionally Unstable*, pitch discrimination by verbal report which was fundamentally correlated to *E* factor was deeply disturbed and became to have no relation to the degree of *Emotional Unstability*.

iii) condition 3 (600-60): In condition 3 results were not so complicated as those in condition 2. Effected by the line stimulus inclined near to the vertical line, *Emotionally Unstable* subjects tended to report all the auditory stimuli as "high" more often than did the *Stable* subjects in verbal procedure. Here the framework of the vertical line was a stable one and the sound stimulus which had no such a frame as that in line stimulus was influenced by the framework of the line stimulus. As the writer had pointed out in the analysis of condition 2, by generalization in process of the second signal system, functionally similar category — judgement "high" was apt to be associated with the category "up" and thus signal nature of the sound stimulus was shifted in process of the signal transmission from the first to the second signal system. If the stimulus correlated to *E* factor had a definite framework of reference, the judgement of the *Unstable* stimulus was shifted to the stable frame of reference.

In correlation to *T* trait, by controlling action of the second signal system over the first, *Thinking Introvert* subjects tended to report all the stimuli as "high and up" more often than did *Extrovert* subjects in motor procedure according to the association of "high and up" in the second signal system.

In contrast with condition 1 and 2 where the tone component was near 1200 cps, in condition 3 and 4 where the tone component was near 600 cps, significant correlations of discrimination to *E* and *T* were all observed in the *total* percentages of response. Those results seemed to show the difference of the signal relation between the tone of 1200 cps and the tone of 600 cps.

As we have seen in Table 6, the tone component in condition 1 and 2 was more discriminated by motor reports than by verbal reports and analogous difference between verbal and motor reports was not obtained in condition 3 and 4. Thus we were led to conclude that the signal nature of the tone of 1200 cps had the inherent property to the

first signal system activity and for that reason the signal nature was accurately reflected on the bulb pressing first signal system response. Though the bulb pressing response was directly controlled by the second signal system, it was important that the responding reaction was manifested in the *first signal system* (5).

The tone of 600 cps, on the contrary, had a different character. The signal nature to be inherent to the first signal system was indistinct and the signal peculiarities were observed in the interaction of the two signal systems.

iv) condition 4 (600-30): In condition 4, *Emotionally Stable* subjects tended to report "low tone and down line" more often than did *Emotionally Unstable* subjects in verbal and motor procedure. The fact that significant correlations to *E* factor was found only in totals of L-D response suggested that stimulus combinations of condition 4 had special significance in L-D response.

Stimulus compounds in condition 4 were stimuli rather to be judged "low and down" as compared with other four conditions, because L-D response was emphasized by the signal nature of stimulus compounds in condition 4. Thus judgements "low and down" should have been more stable than judgements of other combinations as compared with other four conditions.

Emotionally Unstable subjects were said to be unable to perceive the environment precisely and objectively and to seek the stable frame more strongly and to reestablish their judgements depending on the stable anchoring point, frame and criterion in the perceived objects. The present experimental findings showed that when the stimulus materials were stimuli to be rather judged "low and down," *Emotionally Unstable* subjects did not make their judgements according to the objectively (in respect to the framework of stimulus configuration) stable frame. It suggested that the association of judgement "low and down" was not a stable one in the activity of the first and the second signal system.

According to the experimental findings by conditioned reflex (6), the verbal judgement "low and down" had the similar inhibitory character to the inhibitory process of the first signal system. *Emotionally Unstable* subjects (partly analogous to the *high anxiety* normal subjects) are characterized by their weakness of the inhibitory process and for that reason totals of "low and down" response (both verbal and motor) in *Emotionally Unstable* subjects were less than those in *Emotionally Stable* subjects.

Table 8 Mean Scores of Y-G Test in Neurotic and Normal Group (Neurotic Group, N=10; Normal Group, N=20)

Personality Trait		S	T	D	C	I	N	O	R	G	A	Ag	Co
Neurosis	M	14.5	13.8	16.8	13.8	12.4	12.5	11.2	9.0	9.5	15.0	8.9	11.6
	SD	3.5	4.2	3.2	4.0	6.4	4.8	4.9	5.3	6.1	8.4	3.6	4.3
Normal	M	9.5	12.4	10.9	9.0	7.3	10.0	9.3	11.0	11.5	11.5	10.3	7.4
	SD	6.5	4.6	5.9	5.4	6.0	5.2	5.4	5.6	6.2	6.7	4.4	5.0

In correlations to *T* traits, *Thinking Extrovert* subjects tended to report "low and down" more often than did *Introvert* subjects in motor procedure and *Thinking Introvert* subjects tended to report "high and down" more often than did *Extrovert* subjects in motor pro-

cedure. As we mentioned previously, the verbal judgement "low and down" had an inhibitory character and required motor response "low and down" was not to press the bulb both to the sound and to the line.

As we saw in all four conditions, significant positive correlations to *T* trait were mainly observed in motor judgements "up," "high" and "high and up." It suggested that it was difficult for *Introvert* subjects to inhibit the first signal system activity controlled by the second signal system. What sort of response was selected by *Introvert* subjects, then?

The signal peculiarity of pitch discrimination which was a function of the interaction of two signal systems was functionally more similar (6) to the bulb pressing motor response than to the verbal response as compared with the signal function of the discrimination of inclination difference which was a function of the second signal system. Thus the bulb pressing response became to be connected with the sound component (see correlation to total of H-D). In verbal procedure, on the contrary, functionally similar line component became to be connected with the response (represented by the correlation to total of L-U).

In the correct response percentage of H-U compounds, *T* trait was negatively correlated to motor report. Detailed analysis of the data showed that H-D motor response was positively correlated to *T* ($r = .656$) in H-U compound and together with the increase of H-D response by *Introverts* in L-D compound ($r = .566$), it resulted in the positive correlation in the total of H-D response.

EXPERIMENT III

Experiment I and II were conducted to investigate the relation of stimulus discrimination to personality trait in terms of signal systems in normal subjects. In one of the previous studies, the writer has investigated conditioning experiment in schizophrenic patients (4). In that experiment disturbance both in stimulus discrimination (by verbal report) and response differentiation (by conditioned motor response) were observed. Here, too, the writer was led to conclude that discrimination of pitch was closely connected with the interaction of two signal systems.

The purpose of Experiment III was to see if similar conclusions to those by method of conditioned reflex could be obtained by means of discrimination experiment mentioned above and secondly, to confirm writer's conclusions on signal natures of stimulus compounds in normals, by comparing signal peculiarities of discrimination in normals with those in schizophrenic and neurotic individuals.

Apparatus & Procedures

Apparatus and procedures were all the same as those of condition 1 (1200-60) in Experiment II.

Subjects: *Group 1* Ten patients (5 male, 5 female), 20 to 40 years old, diagnosed by psychiatrists as schizophrenia were used as a schizophrenic group. Those schizophrenic subjects were chosen from the patients in the Neuropsychiatric Ward in the Hospital of Kyoto University bearing the diagnosis of chronic schizophrenia whose case materials did not indicate cerebral organic involvements. Out of 10 subjects, 8 were diagnosed as the hebephrenic type, 2 as the paranoid type. *Group 2* Ten patients (5 male, 5 female) 19 to 35 years old, diagnosed as neurosis (anxiety neurosis and neurasthenia) were used as a neurotic group. They were chosen from the out-patients in the Neuropsychiatric Ward in the Hospital of Kyoto University. *Group 3* Data from condition 1 of Experiment II were utilized as a control group. Before the discrimination experiment Yatabe-Guilford Personality Inventory was tested by the neurotic group to measure per-

sonality traits of the subjects. Y-G Test can not be a tool to measure pathological peculiarities of schizophrenia and the test was not put in force for schizophrenic patients.

Results & Discussions

In Table 9 were shown minimal discriminable differences of visual and auditory stimuli in normal, neurotic and schizophrenic individuals. As was shown in Table 9, minimal discriminable differences of both visual and auditory stimuli were lower in abnormal groups than in normal group. Both in visual and auditory tasks, minimal discriminable differences were lower in schizophrenic group than in neurotic group.

Table 9 Minimal Discriminable Differences of Sound Pitch and Visual Inclination of Lines (Neurotic and Schizophrenic Group, N=10; Normal Group, N=20)

Group	Tone (cps)		Line (degree)	
	M	SD	M	SD
Normal	15.8	9.3	2.5	0.5
Neurosis	46.0	22.2	3.3	1.8
Schizophrenia	85.0	32.4	6.5	3.7

Pathological peculiarities of schizophrenic patients concerning the interaction of signal systems were characterized by those of the second signal system in its interaction with the first signal system. Here two signal systems interact in two directions: in the first place, first signal messages are transmitted to the second signal system and secondly, in the diverse direction, the first signal system activity is regulated by the controlling action of the second signal system. In schizophrenic patients above mentioned two modes of signal transmission were both disturbed and there is very good reason to suppose that disturbance in the signal transmission from the first to the second signal system is fundamental to the pathological peculiarities of schizophrenia.

In neurotic subjects, on the contrary, pathological peculiarities are mainly derived from the disturbance in the signal transmission from the first to the second signal system.

We shall proceed to the analysis of Table 10. In correct verbal response of H-U compound neurotic subjects showed lower responding rate than normal subjects, and in normals analogous phenomena were observed in *Emotionally Unstable* subjects (Table 7). In neurotic subjects the mean of *Emotional Unstability* factor was 66.7 (N = 10, SD = 17.9), while the mean of *E* factor in normals was 46.9. Thus the neuro-dynamic peculiarities in neurosis, characterized by the disturbance of the signal transmission from the first to the second signal system were confirmed both in Y-G scores of *E* and discrimination peculiarities in neurosis. The following results all supported above confirmation. That is, judgement by motor reports was more correct than that by verbal reports in H-U compound and in "high" sound component of stimulus compounds (they were characterized by *Emotionally Unstable* normal subjects).

There were observed some tendencies to report all the sound stimuli as "high" (both by verbal and motor) in neurotic subjects. Predominance of accuracy of judgement in H component over that in L component was accelerated in motor procedure.

In one of the previous studies by method of conditioned reflex (6), the writer obtained some results which suggested that in the second signal system (judgement by verbal report)

Table 10 Mean Verbal and Motor Reports on Simultaneous Stimulus Compounds in Normal and Abnormal Group.

Response Category		Normal (1200-60)		Neurosis (1200-60)		Schizophrenia (1200-60)	
		M	SD	M	SD	M	SD
Correct H-U	Verbal	61.3	18.1	47.5	15.4	55.8	18.7
	Motor	66.3	17.1	62.5	21.6	67.3	21.3
Correct L-U	Verbal	56.9	23.1	50.0	23.6	56.3	31.2
	Motor	63.8	22.2	56.3	15.9	68.8	23.0
Correct H-D	Verbal	56.9	14.4	58.9	21.6	47.4	25.5
	Motor	60.0	18.8	63.3	34.4	64.6	29.3
Correct L-D	Verbal	61.3	18.6	52.5	15.4	69.9	23.5
	Motor	60.0	23.5	55.0	19.3	49.5	31.4
Correct H	Verbal	76.9	12.7	75.4	13.8	73.9	27.6
	Motor	81.6	13.4	84.3	13.2	83.0	17.6
Correct L	Verbal	70.0	18.1	62.0	11.6	77.9	17.2
	Motor	75.9	17.4	63.9	14.7	73.0	26.7
Correct U	Verbal	82.8	11.8	73.9	16.2	73.1	23.3
	Motor	82.5	8.2	75.2	17.9	85.9	13.9
Correct D	Verbal	78.1	11.2	76.5	14.9	76.7	19.3
	Motor	77.2	12.1	82.6	25.9	74.9	25.7
Total H	Verbal	53.6	9.1	58.2	7.8	49.5	18.1
	Motor	53.3	11.3	60.3	9.8	55.9	19.5
Total U	Verbal	52.7	6.2	48.8	13.9	48.7	12.8
	Motor	52.5	9.2	46.4	17.3	55.6	15.7
Total H-U	Verbal	28.9	7.0	28.2	12.9	27.7	13.3
	Motor	27.8	7.2	27.9	17.2	23.7	15.0
Total L-U	Verbal	23.4	8.2	20.5	7.0	21.0	8.8
	Motor	24.7	9.8	18.6	4.9	26.9	14.1
Total H-D	Verbal	24.7	5.7	30.0	9.5	21.8	10.3
	Motor	25.5	9.0	32.4	13.3	27.2	13.2
Total L-D	Verbal	23.1	5.9	21.3	7.3	29.5	13.5
	Motor	22.0	7.0	21.2	7.3	17.2	8.6

(1) Neurotic Group

correct verbal H > correct verbal L $t=2.73$ $df=9$ $p<.05$ correct motor H > correct motor L $t=3.32$ $df=9$ $p<.01$ correct H-U, motor > verbal $t=2.62$ $df=9$ $p<.05$ total verbal H > expected value of response (50%) $t=3.29$ $df=9$ $p<.01$ total motor H > expected value of response $t=3.32$ $df=9$ $p<.01$

(2) Schizophrenic Group

correct H-U, motor > verbal $t=2.31$ $df=9$ $p<.05$ correct U, motor > verbal $t=2.20$ $p=.05$ correct L-D, verbal > motor $t=2.75$ $df=9$ $p<.05$ total motor L-D < expected value of response $t=2.87$ $df=9$ $p<.05$ total L-D, verbal > motor $t=2.72$ $df=9$ $p<.05$

(3) Neurotic vs. Schizophrenic Group

correct verbal L-D, schizophrenia > neurosis $t=1.95$ $df=18$ $p<.10$ correct verbal L, schizophrenia > neurosis $t=2.42$ $df=18$ $p<.05$

(4) Neurotic and Schizophrenic vs. Normal Group

correct verbal H-U, normal > neurosis $t=2.48$ $df=28$ $p<.05$

there might exist similar excitatory and inhibitory process to those of the first signal system activity (in respect to the effect on the first signal system activity), and when the excitatory and inhibitory process coincided in the two signal systems, both processes in two signal systems were reinforced each other, i. e., processes in the first signal system were reinforced by the second, and processes in the second signal system by the first.

According to that, above mentioned response tendencies in neurotic subjects were interpreted as the following. Both in process of the signal transmission from the first to the second and in process of the signal transmission from the second to the first signal system, the excitatory process predominated over the inhibitory process.

In response percentages of the line component in neurotic subjects, there was no difference between normal and neurotic subjects. In neurotic subjects, the mean of *Thinking Introvert* personality trait was 13.8 ($N = 10$, $SD = 4.2$), while the mean of *T* trait in normals was 12.6. Thus the fact that in respect to *T* trait no difference between two groups was observed, supported the present result on response peculiarities of the line component.

Next we shall go on to the analysis of the results in schizophrenic patients. Schizophrenic patients responded more correctly in motor response than in verbal response in the discrimination of H-U compound and in H component of compounds. The results came from the disturbance of the process in the signal transmission from the first to the second signal system.

In the correct response of U component of stimulus compounds, patients responded more correctly in motor response than in verbal response and those tendencies were partly characterized by the *Thinking Introvert* normal subjects. The results suggested that in schizophrenic patients abnormal thinking introversion was observed, that is, *thinking introversion* was based on the disturbance of the second signal system activity and on the disturbance in the interaction of two signal system. The following phenomenon was worthy of note. In schizophrenic patients both correct and total responses of L-D compound were higher in verbal report than in motor report. Verbal report on L-D compound and also on L component of compounds was more correct in schizophrenic patients than in neurotic individuals. In normal subjects correlations of L-D response to personality traits were observed in condition 4 of Experiment II where L-D response was accentuated.

Thus the response peculiarities shown in L-D compound in schizophrenic patients led us to suppose that for the patients signal nature "low and down" was accentuated in the stimulus configurations.

According to the writer's theory on the excitatory and inhibitory processes of the second signal system activity, the connection "low and down" has the inhibitory character. Thus the writer was led to conclude that pathological peculiarities of schizophrenic patients were characterized by the predominance of the inhibitory process in the first and the second signal system and secondly, by the dissociation of the function of the first and the second signal system, which was represented by the disinhibition of the first signal system activity. In previous conditioning experiment in schizophrenia (4), some long-hospitalized patients tended to report all the tone stimuli as low sound when they were connected with line stimuli or unconditioned stimuli. It suggested that the predominance of inhibitory process

in the second signal system was accentuated when the perceptual world became complicated. In those cases paradoxical and ultra-paradoxical phases were observed in the first signal system activity, showing pathologically heightened inhibitory process of the first signal system.

GENERAL DISCUSSIONS

Though correlations of discrimination of visual and auditory stimuli to personality traits varied in different ways by the alteration of stimulus ranges (configurations) of two stimuli, signal peculiarities of visual and auditory stimuli remained fundamentally unvaried. That is, frequency discrimination of tones was a function of signal transmission from the first (direct) to the second (verbal) signal system, and in inclination discrimination of slant lines the second signal system was shown to play a predominant function over the first signal system.

In condition 1 where the tone component was 1200 cps and the line component was 60°, the difference of signal function between two components of stimulus compounds was directly shown by correlations to personality inventory and in other three conditions the difference of signal function between two components was partly covered with the specific properties of stimulus configurations.

The present experimental findings showed that signal peculiarities of stimulus discrimination were stressed when the signal nature of response coincided with that of personality traits in the signal system activity characteristics (to be of the same signal significance), i. e., stimulus discrimination was stressed when *Emotionally Unstable (Stable)* subjects responded by verbal responses, and when *Thinking Introvert (Extrovert)* subjects responded by motor responses. In the former, signal nature of response and personality trait were characterized by the signal transmission from the first to the second and in the latter, both were characterized by the predominant function of the second signal system over the first signal system.

The difference of the function in discrimination by motor report from that by verbal report shown in normal and abnormal subjects became of theoretical as well as practical importance in the field of perception especially in its relation to personality.

Avakyan (1, 2) has shown that eyelid reflexes could be used as indices of absolute and differential thresholds of tones as a substitute of verbal reports and in a certain condition absolute thresholds of tones were lower in eyelid reflex activities than in verbal reports (2). In many experiments to investigate signal relations between stimulus and response by Samsonova (5), it was found that in discrimination of distance (depth) difference of two horizontal lines, after repeated application of conditioning procedure two lines became discriminated more precisely by motor response than by verbal response. She concluded that distance discrimination of simple lines was a function of the first signal system, because discrimination was improved by the response of the first signal system motor response.

As the writer has pointed out (6,7), stimulus discrimination was determined by response characteristics related to signal natures of stimuli. Individual differences by conditioning (6) and also by the discrimination experiments in the present study showed that signal characteristics in discrimination were partly functions of the signal peculiarities of the subjects.

Those signal peculiarities were, as Pavlov pointed out in his classical schema, the strength, equilibration and mobility of the first and the second signal system and of their interactions.

In a traditional experimental method in perception, simple motor reactions were used as substitutes for verbal responses, in that simple motor reactions such as turning the key to the right or to the left, or pressing the key according to the preliminary verbal instruction were supposed to be functionally equivalent. The present experimental findings raise objections to those investigators' neglects of the "dynamic relation between the structure and the function (Pavlov)."

In preliminary experiment to determine minimal discriminable differences of visual and auditory stimuli separately, no correlation was found between minimal differences of two stimuli and personality traits. The fact that correlations were shown only when two stimuli were paired and presented randomly with differences of near threshold, may be explained in the following way. Discrimination of stimulus compound near threshold was more difficult than discrimination of single stimulus, and in the former two stimuli of different signal significances interacted each other, stressing individual peculiarities in the interaction of two signal systems.

Ivanov-Smolensky wrote in his *Essays on the patho-physiology of the higher nervous activity*:

"The concept of neurasthenia covers the three different pathological states described by Pavlov. As we have already known, on the basis of his clinical observations, Pavlov came to the conclusion that, on the one hand, there are neurasthenic states in which a weakening of the processes of internal inhibition (hyperasthenia) comes to the fore, and, on the other hand, states where the leading place is taken by phenomena of diffused inhibition, weakening of the excitatory process and diminution of cortical excitability (hyposthenia). But later, when describing the phenomena of pathological lability of the excitatory process, he frequently pointed out that in clinical neurology states of excitatory weakness correspond to these phenomena, i. e., states most peculiar precisely to neurasthenia. In the latter stage where the excitatory process begins to suffer, the cortex is exceedingly reactive, but susceptible to rapid exhaustion; the pathological lability of nervous excitation (easily emerging, but rapid dying down) is characterized clinically as "excitatory weakness," along with which a heightened tiredness is usually observed."

According to Pavlov's concept of neurasthenia mentioned above, the predominance of H response over L response may be considered as a result of the weakness of the process of internal inhibition and also of the pathological lability of the excitatory process. Here, H response corresponds to the excitatory process of the two signal systems and L response corresponds to the inhibitory process. Being characterized by the weakness of the process of internal inhibition and by the exceedingly reactive excitatory process, neurotic subjects judged the nature of tones as "high" more frequently and correctly. In discrimination each combination of stimulus compounds was presented only 8 trials in verbal and motor response procedure respectively and no practice effect was observed. It seemed that the discrimination did not suffer rapid exhaustion of excitatory process gained by phenomena of transmarginal inhibition.

Again, we will refer to the essays by Ivanov-Smolensky (3):

"According to Pavlov, the most specific properties of schizophrenia include heightened inhibibility of the cerebral cortex, phenomena of diffused inhibition the intensity and localization of which in the higher parts of the brain are changeable, and which is accompanied by various phenomena of liberation, disinhibition, positive induction of the evolutionary older, primitive and even rudimentary functions; another feature

consists in transitory, intermediate states between wakefulness and sleep closely connected this inhibition, now mainly of a general, now of a particular nature, in other words, the so-called hypnotic states."

As the writer has pointed out, together with the disturbance of the function of the signal transmission from the first to the second signal system and of the abstracting action of the second signal system, in the second signal system the inhibitory process was predominant and in the first signal system disinhibition phenomena were observed.

On account of heightened inhibibility of the first signal system and of the pathological relation between two signal systems, inhibitory message of the second signal system disinhibited the first signal system in state of heightened inhibibility. In L-D condition required motor response was to inhibit the bulb pressing twice and motor response was to be in state of more heightened inhibibility. Here the inhibitory signal message not to press the bulb twice was transmitted in two ways, i. e., message was transmitted by the controlling action of the second signal system and in some cases inhibited first component of double motor responses disinhibited the response of the second component.

The writer's previous conclusions on signal nature of stimuli by method of conditioned reflex in normals and schizophrenic patients were confirmed by the discrimination experiment related to personality inventory in normals and also by that related to pathological peculiarities in neurotic and schizophrenic individuals. It aimed to extend the theory and method of conditioned reflex to the field of perception as well as to the field of personality.

It seemed for the writer that the theory and method of conditioned reflex will embrace broader sphere of psychology than the current trends of psychology did. The concept of signal systems is of great importance in the theory of conditioned reflex. As Ivanov-Smolensky stated (3), "A specific feature of human subject is the indispensable role played by that extremely important addition, possessed by human nervous activity in contradistinction to that of animals, in other words, by the second signal system and its interrelation with the first signal system." Thus, it is the concept of signal systems that really makes the theory of conditioned reflexes psychologically significant.*

SUMMARY

(1) In normal subjects, discrimination experiments were conducted to the simultaneous stimulus compounds of visual and auditory stimuli with the minimal discriminable difference between each stimulus component. In the auditory task, (i) frequency discrimination of tones near 1200 cps and (ii) discrimination of tones near 600 cps were used. In the visual task, inclination discrimination of slant lines (i) near 60° and (ii) near 30° were used. Verbal and bulb pressing motor response was used as the measure of judgement of the subject.

Correlation coefficients of each score in discrimination to the *Emotional Unstability* factor and to the *Thinking Introvert* trait in Yatabe-Guilford Personality Inventory were measured. Significant correlations to verbal responses were mainly obtained in *E* factor and correlations to motor responses were largely obtained in *T* trait. It supported the hypothesis that *Emotional Unstability* factor was a function of the signal transmission from the first to the second signal system and that *Thinking Introvert* trait was largely concerned with

* As the writer has pointed out previously (6), in USSR, investigations on signal systems have been usually carried out as their interaction without separating the first from the second, on account of emphasis on the structural relations between two systems, while American psychologists' attitudes are to treat them either separately or equi-functionally. It is possible to unify classifications "classical conditioning," "instrumental conditioning" and "verbal conditioning" by the concept of signal systems (7).

a predominant function of the second signal system over the first. Though correlations of discrimination of visual and auditory stimuli to personality traits varied in different ways by the alteration of stimulus ranges (configurations) of two stimuli, signal peculiarities of visual and auditory stimuli remained fundamentally unvaried. That is, frequency discrimination of tones was a function of signal transmission from the first to the second signal system, and in inclination discrimination of slant lines the second signal system was shown to play a predominant function over the first signal system. Both in correlations to personality traits and in the mean responding rates of each stimulus combination clear distinction of the function of motor response from that of verbal response.

(2) The same discrimination experiments were conducted to neurotic (anxiety neurosis and neurasthenia) and schizophrenic (hebephrenic and paranoid type) patients, in which the tone component was near 1200 cps and the line component was near 60°.

Application of the conclusion on signal nature of two stimuli mentioned above to the discrimination characteristics in neurotic and schizophrenic patients supported pathological signal peculiarities of those patients. In neurotic patients were observed the disturbance of signal transmission from the first to the second signal system and pathological reactivity of the excitatory process. Discrimination peculiarities of schizophrenic patients were characterized by the disturbance of the signal transmission from the first to the second, by the disturbance of the generalizing action of the second signal system and by heightened inhibitability of the process of the first and the second signal system.

Here, too, clear distinction of the function of motor response from that of verbal response was observed.

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