Sept. 24, 1963

Tel: MIDland 8171

ALBANY HOTEL SMALLBROOK BIRMINGHAM 5

Dear Dr. A. Y. Wisner :—

I am a Professor of Human Engineering at Waseda University. I know the research work of your group through the magazine "Ergonomics". So I send the letter you, c/o Renoult Co. Today I visited Loughborough College of Tech. and met Mr. E Edwards and Mr. H. M. Cooke. Mr. Cooke taught me your new adress.

I appreciate very much if you allow me to visit your Laboratoire and reply some questions, on October 16, 1963. I'll stay at Commodore Hotel (tel PRO 93-00) of Paris.

I am now travelling around the world — U.S.A., England, Sweden, Denmark, Germany, Austria, Swiss, France, Italy.

looking foreward to see you.

yours truly,

Kazuo Tsubouchi

Professor of Waseda Univ.

(15, 4-chome Nishigahara,)

d'Albert Hotel
Tel: TRU 1332

MICHIO IKAI, M. D.
PROFESSOR OF PHYSIOLOGY, UNIVERSITY OF TOKYO

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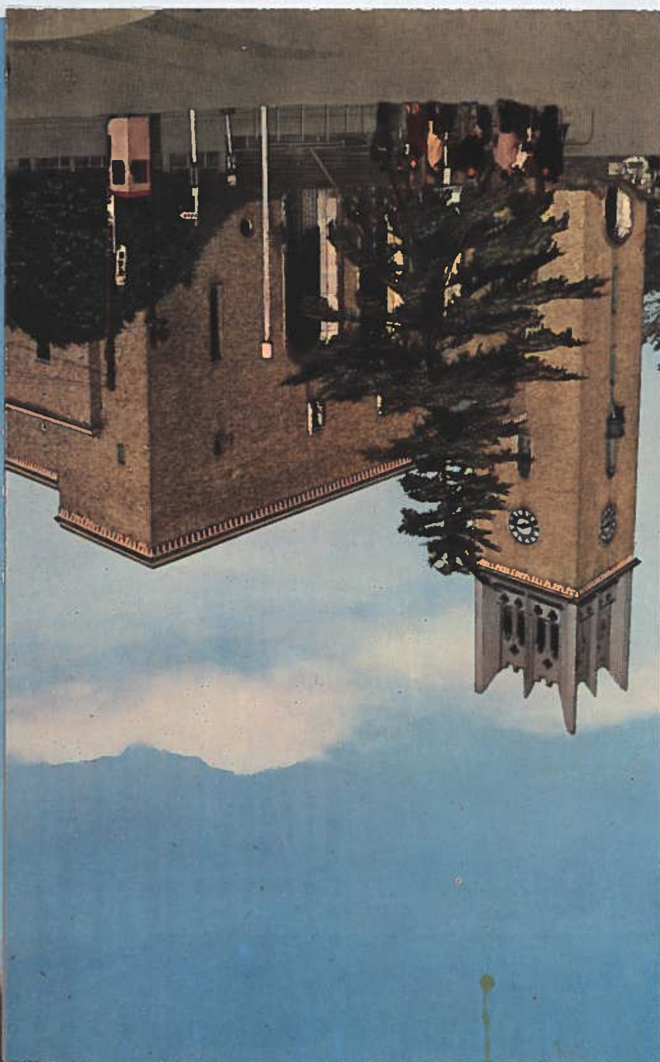
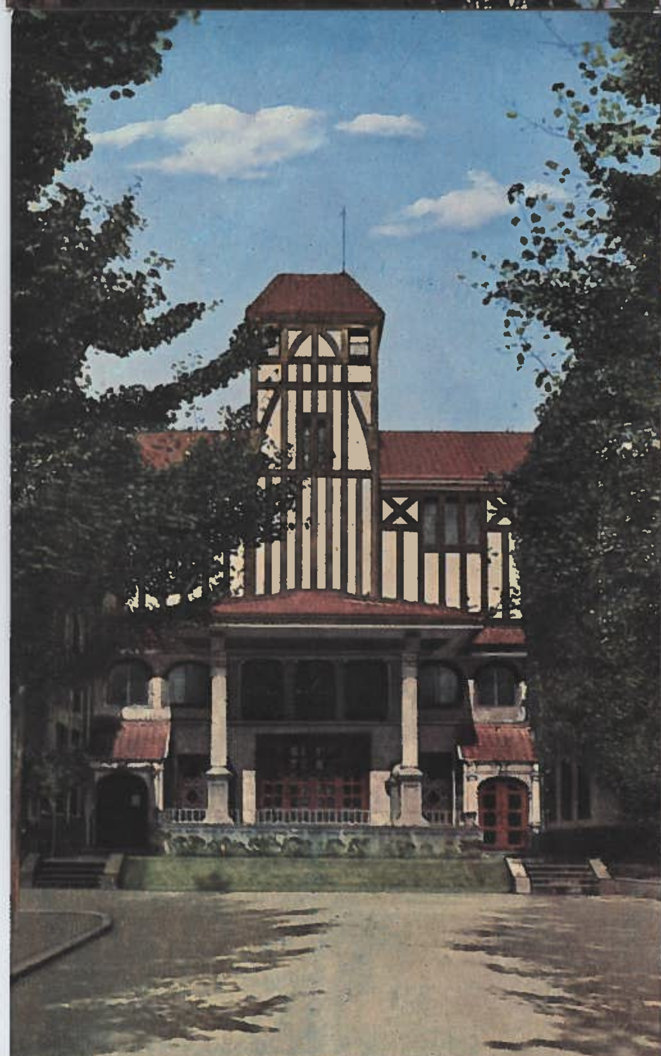


Laboratory of Physiology
School of Education
University of Tokyo
Motofuji-cho, Bunkyo-ku
Tokyo, Japan

July 26, 1963

Dear Dr. Wisner:

I had a nice time to see the activity of your laboratory of physiology in Paris during my visit to your country last month. Thank you very much for your kind treatment and introduction to other related institutions.

It was nice for me to find out Mr. Hiriartborde at Ecole Normale Superieure d'Education Physique de Chatenay-Malabry (SEINE) was my old friend. We enjoyed very much.

In London, Dr. R.J. Whitney of Medical Research Council Laboratory gave me a wonderful time to show their works and discuss strength and power as well as works with plethysmography. I had brought best wishes from yourself to himself, of course.

Hoping to see you again, with best regards to you,

sincerely yours,

Michio Ikai,M.D.
Professor of Physiology

Dr. A. Wisner
Laboratoire de Physiologie du
Travail du C.N.R.S.
41, Rue Gay-Lussac, Paris 5
France

Professor Kazuo Tsubouchi
15, 4-chome
Nishigahara
Kita-Ku
Tokyo
Japan

August 3, 1963
15, 4-chome,
Nishigahara,
Kita-Ku,
Tokyo,
Japan

Mr. A. Y. Wisner
Head of the Physiological Studies Unit
Regie Nationale des Usines Renault
Paris
France

Dear Mr. A. Y. Wisner ; -

I am studying the Ergonomics problems and teaching the Human Engineering at Waseda University. I am the member of committee of Human Engineering of S . A. E. of Japan. I had published the book named " Human Engineering " four years ago from Japanese bookstore. I wrote the many articles concerning with Ergonomics to many magazines. Japanese Industry (including automobile industry) have much interesting how apply the Human Engineering technique to their products design.

I'll appreciate very much if you allow me to visit your office on October 16, 1963 . I had read through the magazine and proceedings of " Ergonomics in Industry. I'd like to know thedetaile of this research , experimental equipment in your office and futher reseach items.

I'll leave Tokyo to New York on September 14 , 1963. I'll ~~leave~~ attend the CIOS International Management Congress at New York . I'll leave New York toEurope on September 20.

I hope God bless you.

Yours sincerely,

Kazuo Tsubouchi

Professor
of
Wase-da University

PARIS, le 12 Septembre 1963

Monsieur le Professeur KAZUO TSUBOUCHI

15, 4-CHOME
NISHIGAHARA
KITA-KU

TOKYO
(Japon)

Cher Monsieur,

Votre lettre du 3 Août m'a été transmise par le Dr.TARRIERE qui m'a succédé à la tête du laboratoire de Physiologie et de Biomécanique de la Régie Renault. Je me rejouis de vous voir le 16 Octobre dans mon nouveau laboratoire qui se trouve à l'adresse ci-dessus. Si vous désirez visiter le laboratoire de la Régie Renault, le Docteur TARRIERE est également à votre disposition.

Veuillez agréer, cher Monsieur, l'assurance de mes sentiments très distingués.

Dr. A. WISNER
Sous-Directeur

CNAM
MINISTERE DE L'EDUCATION NATIONALE
CONSERVATOIRE NATIONAL DES ARTS ET METIERS
ERGONOMIE ET NEUROSCIENCES DU TRAVAIL

Paris, 13th January 1992

Dr. Munehira AKITA,
26 Takezono-cho Kawashima
Nishikyo-ku
KYOTO 615
Japon

Dear Dr. Akita,

Mrs. Monnier and myself would like to join together to thank you for your Season's Greetings and send you our warm wishes for 1992, for yourself, your family and your research team.

We remember with much pleasure your kindness and availability during the preparation of the Congress and the Congress itself. It has been for both of us a most valuable and enriching experience.

With our best regards,

Alain WISNER

CNAM - LENET, 41 rue Gay-Lussac, 75005 Paris - Téls: (1) 43 54 18 27, (1) 43 54 18 34 - Fax : (1) 43 25 36 14

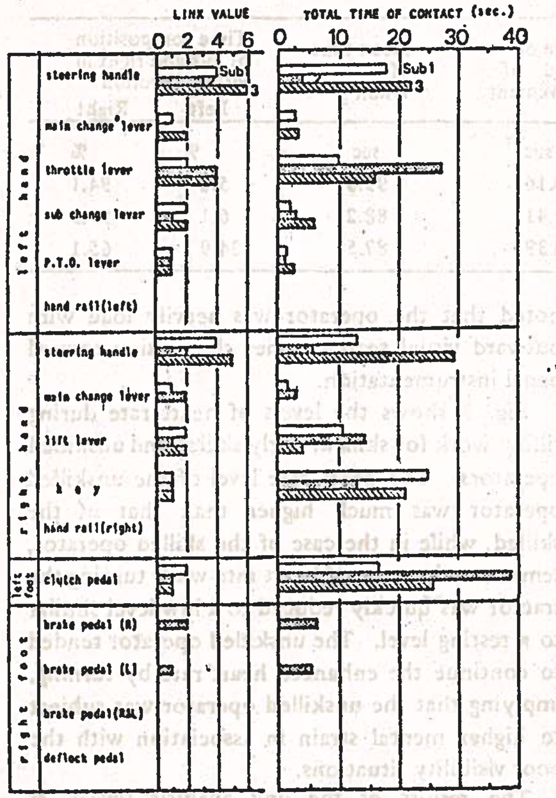

Fig. 4. Link analysis of tractor for starting operation.

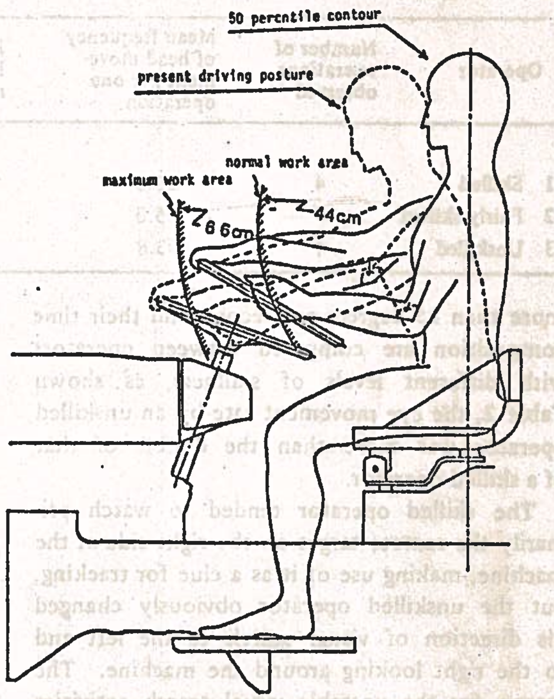

Fig. 5. Work area and hardwheel location.

both the left and right hands as well as for operating foot pedals. As a result, the total time of contacting controls was longer for the unskilled operator. The higher frequency and longer duration of contracting a control in case of an unskilled worker were especially dominant for the steering wheel operation. This was presumably related to the ergonomically poorly designed position of the steering wheel, as indicated in Figure 5.

The operator was forced to take a forward bending sitting posture to reach the wheel. This apparently disturbed the outward visibility, which otherwise would have been better from a natural sitting posture. Our results were suggestive of re-positioning the steering wheel about 20 cm near to the seat, so that the operator could maintain a more natural sitting posture.

Conclusion

In summarizing the results, an integrated approach to tractor design seems necessary, paying more attention to the effects of poor visibility toward the front view of such a machine. The techniques of measuring the range outward vision and analyzing the visual search activities need be developed on the basis of field studies.

Design of tractor and similar agricultural machines incorporating a control console within easy reach of the seated driver and a streamlined engine hood would greatly improve the operator's vision and performance.

According to our experiences, information gained from practical field studied seems indispensable in working up a new design of machines. An effective application of ergonomic principles should always be in situ analysis of the operator-machine interrelationship such as dependence of serial operations on the visibility-related over all machine structure.

Sadao HORINO: Department of Industrial Engineering, Faculty of Techonology, Kanagawa University, 3-27-1, Rokkakubashi, Kanagawa-ku, Yokohania-shi, 211, Japan

to Prof. A. Wisner
With best wishes,
Sadao Horino

Proceedings of
9th Asian Conference
on Occupational Health
Oct. 22-28, 1979
Seoul, Korea

Session 10.

Ergomics in Agriculture

APPLICATION OF ERGONOMICS IN AGRICULTURAL MACHINERY DESIGN

Sadao HORINO and Kazutaka KOGI, *Japan*

Introduction

In view of the fect that recent development of agricultural machinery has brought about higher frequencies of accidents and increased mental strain on the operators, a series of field studies were undertaken with the aim of illustrating how and in which aspects ergonomic principles should be applied to design of such machines. Attention was paid to compatibility between machines and operators, especially in terms of outward visibility of in operating the machines.

Methods

A series of field studies were carried out. They included application of a specially designed ergonomic checklist for evaluation of a combine harvester and a tractor, measurement of the outward visibility of tractor operators by means of fish-eye-lens phototechnique, eye movement analysis by film techniques during tilling work, and link analysis of the work dealing with a tractor. Continuous measurement of heart rate was done during the tilling work.

Results

The first field study was carried out for comparative evaluation of ergonomic aspects of a large combine harvester and a tractor. A corrective ergonomic checklist consisting of nine chapters and 339 items was used by 12 ergonomists to evaluate the two machines. Table 1 gives the number of items checked by more than 80% of the checkers or by 50% or more as required to be ergonomically countermeasured. The frequency of checked items was higher in the case of the combine harvester than in the case of the tractor, major areas where ergonomic countermeasures were considered to be taken were work space, controls, information displays, working environment and working posture. Major common items for both harvester and the tractor were foot steps for entrance, position of major controls within easy reach, control displacement of pedals and levers, visibility obstacles, adequate use of a mirror for visibility improvement, distinguishable coding of controls, installation of the driver cab to avoid uncomfortable environmental exposures to heat radiation, wind and dust, and lastly absorption of seat vibration and noise. Improvement of visibility included not only instrument panel visibility, but also tracking visibility for better tilling performance.

Since the combine harvester was designed for European population, all dimension of operating controls were too big for the Japanese population to handle, so that the operator was obliged to stand continuously to see the spot where crops are processed and the lane for tracking. However, since there was no enough space of standing between the fixed seat and the console for the operator, unnatural postures, occurred very often. Uncompatible control arrangement and counter pressure of pedals were also causing unnatural postures.

The visibility projection chart on the ground surface comfirms poor design of machine for tracking performance. Figure 1 shows a visibility characteristic in various driving position in the case of a tractor. The lower and more forward the driving position was taken, the wider the area of invisibility became, whereas the longer the lower visibility limit

Table 1. Number of items which were checked by 10 checkers or more (A;80% or more) and by 7 checkers or more (B;50% or more) of 12 checkers in combined harvester work and tractor work

Chapter	Number of items	Harvester A	Harvester B	Tractor A	Tractor B
1. Work space	22	2	15	0	3
2. Seat and foot rest	25	0	7	0	6
3. Controls	56	9	19	0	10
4. Information displays	37	9	17	0	9
5. Combination of displays and controls	37	3	12	0	6
6. Working environment	55	12	27	7	27
7. Posture and static work load	39	1	17	0	9
8. Dynamic work load	35	0	6	0	1
9. Hours of work and work performance	33	2	8	0	1
Over all	339	38	128	7	72

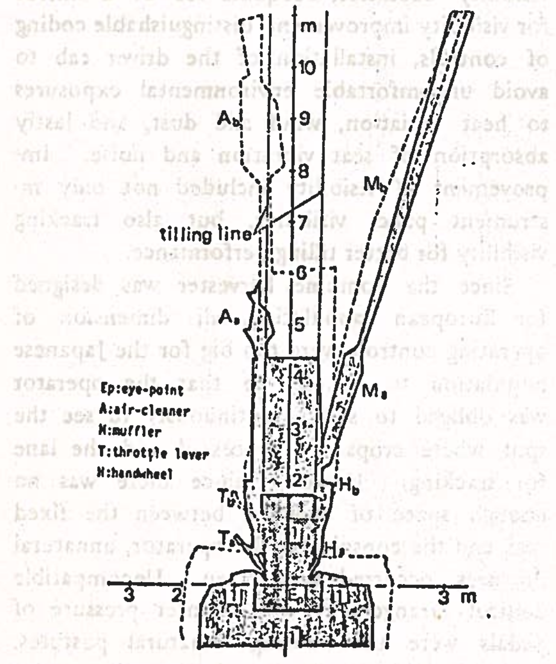

Fig. 1. Visibility projection chart on the ground surface of tractor by high-backward eye-position (a: ——) and low forward position (b: · · · ·) with vertical difference being 121mm, and frontal difference 247mm. Lower visibility limit (L) for a-position was 4.4m and 6.1m for b-position. Invisible projection area on the ground surface for a-position was 8.8m² and 14.9m² for b-position. Area □ shows direct projection of tractor on the ground.

became. The lower visibility limit was the distance from the operator's eye-level to a position of the tractor body which ground surface comes in sight. The lower visibility limit and the invisible area on the ground in case of higher and backward driving position were 4.4 m and 8.8 m^2 respectively, while they were 6.1 m and 14.9 m^2 respectively in case of low and forward driving position. So, it is clear that small difference in driving position in vertical and in frontal direction gives great difference in visibility. And it is also clear from the visibility projection chart that regardless of driving position, tilling lines which were the most important clue for the operator in driving the tractor straight forward are hidden by the main front portion of the tractor. This leads to the operator's unnatural forward and side bent leaning posture.

Figure 2 shows the eye movement pattern for 15 seconds in operating a tractor, the bold line indicating that of a skilled operator and the thin line indicating that of an unskilled operator. The unskilled operator showed more frequent and widely spreading movements of the eyes. This was due to the unskilled operator's visual search activities in getting proper clues for controlling properly the movement of the tractor.

If the mean rate of the eye movements of

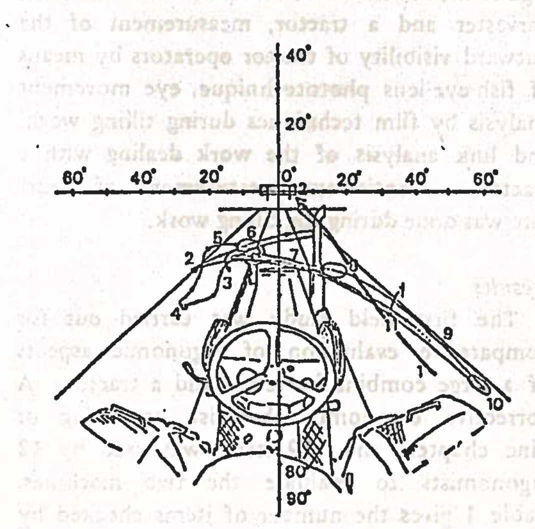

Fig. 2. Head movement frequency of skilled operator (—) and unskilled operator (—) in tilling work by tractor during first 15 seconds operation after start.

Table 2. Frequency and rate of head movement, and time composition of vision direction for three different operators

Operator	Number of operations observed	Mean frequency of head movement per one operation	Rate of head of movement	Mean time of vision	Time composition of left and right in vision direction: Left	Right
			sec^{-1}	sec	%	%
1 Skilled	4	16.0	0.16	99.6	5.8	94.1
2 Fairly skilled	2	36.0	0.41	88.2	6.1	93.9
3 Unskilled	4	33.8	0.39	87.5	34.9	65.1

more than 15 degrees per second and their time composition are compared between operators with different levels of skillness, as shown Table 2, the eye movement rate by an unskilled operator was more than the double of that of a skilled operator.

The skilled operator tended to watch primarily the remote target on the right side of the machine, making use of it as a clue for tracking, but the unskilled operator obviously changed his direction of visual search to the left and to the right looking around the machine. The reason for the unstable visual search activities of the unskilled would be the poor visibility of the operating part and the land being tilled. This kind of differences between the skill and unskilled operators in terms of eye movement rates was especially significant in case of turning the machine at the end of a lane. It should be noted that the operator was heavily load with outward visual search rather than vision toward penal instrumentation.

Fig. 3 shows the levels of heart rate during tilling work for skilled, fairly skilled and unskilled operators. The heart rate level of the unskilled operator was much higher than that of the skilled, while in the case of the skilled operator, temporary increase of heart rate while turning the tractor was quickly reduced to a low level similar to a resting level. The unskilled operator tended to continue the enhanced heart rate by turning, implying that the unskilled operator was subject to higher mental strain in association with the poor visibility situations.

The results of the link analysis reveal, as shown in figure 4, that the unskilled subject had generally higher link values, or higher frequencies of operating individual controls, for

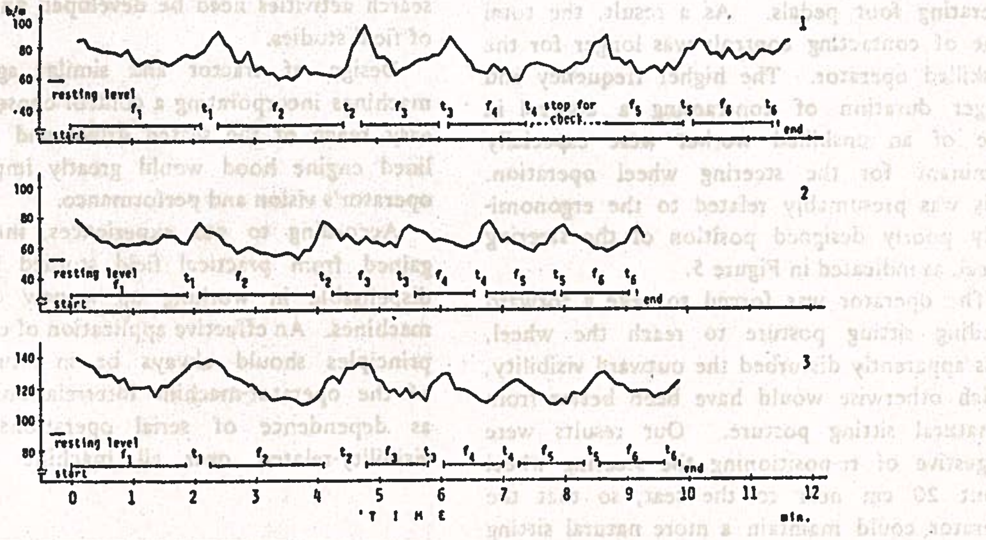

Fig. 3. Heart rate variation of skilled operator (1), fairly skilled operator (2) and unskilled operator (3) during tilling work. Forward processing operation is shown as f_1-f_6, while turning at the end of a field of shown as t_1-t_6.

fatal accidents caused by the tractors (bulldozer, tractor shovel and so on) are full of various meanings. That is, we know from the results that most of the fatal accidents are due to causes like 'drop downwards or falling down when forwarding and backwarding', 'pinched, clamped and rolled into', 'run over and be run over' and 'under convey'.

With regard to the factor of the machine, the safety-brake and so on are considered, as to the man-machine system, the operator's visual field and so on are considered and in the category of working environment, the edge of the road is very soft, sloping and so on.

Finally, I wish to record that these investigations were done with Prof Iguchi, M., Prof. Horino, S. and the members of the Security Board of Construction equipment.

REFERENCES

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2 The materials in the Ministry of Labour (Japan)
3 JIS
4 The annual of Industrial Security 1976
5 The Monthly Materials in Labour at construction business
6 ISO
7 Safety Regulations
8 Occupational Safety and Health Act, USA

to Prof. A. Wisner
with best wishes,
Sadao Horino

Proceedings of Regional Seminar on Ergonomic Application to Safety Control
Singapore (1978)

Accident Patterns and Safety Control in Foundry Tool Handling

Prof. Sadao Horino*

Summary

Various kinds of accidents in foundry workships in two factories were investigated. Materials were collected from accident reports of these factories for four years. Accidents in one of the factories occurred very frequently in working processes of moulding and finishing with use of hand tools. Other types of injuries like foreign bodies in the eyes and low back pains during direct operations in working processes were also commonly seen. This contrasted with accidents in another factory where transporting was a major source of accidents and the frequency rates of accidents was very low.

It is suggested that ergonomic factors such as work space arrangement and work method would be important key factors to prevent possible accidents in hand tool handling. The replacement of powered hand tools in moulding and finishing processes by other means would also be essential.

Introduction

Foundry work is often referred to as an industry of 'dirty work'. This simply describes how poor the working environment in the foundry is. It is generally seen that many foundry workers are working in noisy, dusty and dark working places, hot in summer and cold in winter. Silicosis and hearing loss are well known occupational diseases among them.

In addition to poor working environment, dangerous working conditions are another characteristic aspect of 'dirty work' in foundry. We must note that various kinds of accidents happen very frequently and commonly in foundry workshops.

Low back pain may be just one of outstanding health hazards among foundry men. More than half of the workers investigated in about ten different companies in Japan, according to my survey (1975), suffered from low back pain.

These health hazards, including injuries, are related to characteristic materials which are common to working processes in the foundry – sand, molten iron and steel and some organic chemical substances. Various kinds of hand tools such as air rammers, hammers, electric grinders and chipping machines are commonly used in handling those materials in different forms. And many accidents as well as low back pains are very much connected with using hand tools, probably being interacted with poor working environment, poor working postures and handling or lifting heavy materials.

This paper intends to analyse accident patterns in foundries, particularly in hand tool handling, in an attempt to find out useful countermeasures for these problems from ergonomic points of view.

Materials

Materials of the present study were collected from two foundry workshops of two different factories. Factory A was a medium-sized firm employing about 400 workers, of whom about 80 persons were working in foundry workshops. Accidents were occuring very frequently among them. Factory B was a large-scale firm consisting about 2000 workers, 470 workers being in the foundry section. This factory had an independent section on safety and health affairs with about ten full-time specialized staff. And the frequency rate of accidents was relatively much lower than in Factory A.

Accident reports of each factory were used for the analysis. The accident reports contained nearly the same items in the two factories: major items were date, time, place of accident, job and working shift of the injured, nature of injury, parts of body affected, accident type and situation, and number of days of absence. But Factory B kept more accurate records than Factory A on type and situation of each accident with a brief sketch attached.

Analysis was done for 138 accidents in foundry workshops out of a total of 259 accidents reported between 1974 and 1978 for factory A and 61 accidents in foundry workshops out of 288 accidents reported between 1971 and 1974 for Factory B.

* *Ergonomics Laboratory, Department of Industrial Engineering, Faculty of Technology Kanagawa University, Yokohama, Japan.*

Results and Discussion

Overall frequency rates were compared between the two factories. Frequency rate was calculated by the following formula, in which F represents the frequency rates:

$$F = \frac{\text{number of injuries}}{\text{total man-hours of exposure}} \times 1{,}000{,}000$$

Frequency rate for the whole sections in factory A varied between 61.6 and 103.0 for three years between 1975 and 1977, while for the whole sections in factory B varied between 7.5 and 25.4 for eight years between 1970 and 1977. Similar tendencies were also seen in the frequency rate for foundry workshops.

The severity rate calculated in terms of time loss in days per thousand man-hours of exposure showed more clearly the difference between the two factories. It was between 0.77 and 1.09 for factory A but between 0.01 and 0.1 for factory B. It may be said that factory A was much behind factory B in terms of safety control.

Hourly distribution of the number of accidents in two factories is shown. There are peaks in the distribution, the first peak being around 10 am and the second peak around 2 pm for factory A and 4 pm for factory B. This indicates that the accident risk corresponded to production activities at the workshop level in both of these factories. (Fig. 1)

Monthly distribution of the number of accidents is shown. The figure deals only with factory A. Variation by month in the total incidents and the frequency rate for four years show that accidents occurred more frequently during the hot months, from May to September. (Fig. 2)

However, we can find no specific relationship between the severity rate and the season, one or two serious accidents resulting in a very high severity rate for the month.

When we look into the nature of accidents in relation to working processes, we can know that combination of handling goods in the process of sand preparation and moulding, flying objects in process of melting and pouring, use of hand tools in process of preparation and moulding and in the process of cleaning and finishing are the most prominent unsafe situations in factory A. (Table 1) These situations are mainly caused by handling or lifting heavy materials by hand, poor safeguard arrangement for dust flying from cupola and its way of handling of various powered hand tools.

In the case of factory B, on the other hand, the accident pattern differs very much from that of factory A. As shown, accidents occur most frequently in transporting operations, and overhead crane and its related facilities are major causes of injuries. (Table 2).

Ninety-seven cases out of 138 accidents happened in connection with direct operations in working processes in factory A with 34 out of a total of 61 accidents occurred during indirect operations in factory B. This difference would be much related to the difference in accident patterns between the two factories.

The plant management of factory B changed their moulding work processes intentionally around 1970 from the conventional system based on organic binders such as cement or bentnite binders. This elimination of hand tools from the moulding process contributed very successfully to the decrease in accidents.

Distribution of injuries by body parts affected is shown. Eye, hand and finger, and back and lower back are the prominent body parts injured in factory A, while hand, finger and foot are the most prominent body parts in factory B. (Table 3)

Focusing on injuries related to hand tools, more than one third of accidents in factory A occurred in dealing with hand tools while only 15% of accidents in factory B hand connection with hand tools. Eye, hand and lower back were the major body parts affected, and relatively speaking, this tendency was very much similar in two factories except for the lower back. Hand tools are very heavy, weighing around 7 kg in case of an air-rammer, thus causing low back pain, while vibration is seriously harmful to arms and shoulders, grinders in the finishing process often produce small iron pieces together with sand flying in the air, and in spite of eye protection, many workers suffered from foreign body injuries in the eyes.

Distribution of the number of absent days in factory A by body part injured shows that injuries around the back and the lower back cause long-day leaves of workers.

It may be helpful to illustrate a few typical examples of accidents occuring during operating hand tools.

Case 1: The injured person was a 36 year old male worker with under 20 years of employment, being engaged in the moulding section of a large box type product 1m by 1m by 1m. Four workers worked simultaneously in moulding one frame by using vertically long and heavy air-rammers to make sands harden inside a frame. It was 10.50am when the air-rammer operated by a worker by the side of the victim jumped and struck his hands, and broke a thumb bone. It took a month for him to recover from this injury.

This type of accident occurs very frequently. Partly because when it is very likely that the tools touch the body of other workers by chance in spite of paying much attention. And partly because an air-rammer itself is too heavy to handle freely.

So these problems may be solved by an interaction of better work space arrangement with ergonomic design of air-rammers for easy hand use.

Case 2: Mr. Y.I., who was 32 years old and under employment for 13 years was working in the finishing workshop making metal core frames for moulding. He usually used a portable electric disc grinder. The accident happened at 3.10pm on 26 September 1975. He got an electric shock just when he switched on the grinder to start the surface finishing work inside the metal frame of a large box type, and not being free from body movement, he was unable to switch off the grinder. Therefore the revolving grinder hurt the right chest. He got a narrow escape from death as his colleague switched off the electric source on hearing his painful screams for help.

He got a lacerated wound on the right chest and traumatic pneumothorax of the upper lung. He was in hospital for 33 days for medical treatment.

This accident was associated with combined ergonomic factors of narrow and enclosed working space, heavy weight of the tool and poor maintenance. This type of injury is a little bit unique and very severe, though the nature of the accident is not unusual.

Each accident was then categorized in terms of production means, namely tools, machines and facilities in relation to ergonomic factors such as work space, work load, work method, work organization and compatibility of information displays and controls which are considered to be key aspects of the interface with man and machines. Accident distribution by these production means in relation to ergonomic factors in factory A is shown. (Table 4)

The factor of work method was very frequently linked with accidents in tools, and the factors of work space and work method were related frequently to accidents on cupola and ladles.

The working position and the method of fixing materials could be improved in a proper way to avoid possible strikes by tools and treated materials.

Flying objects from cupolas and ladles could be restricted by enclosing the source of spilling small pieces in the air with safeguards and work space layout at the operation area in front of cupola could be improved to give more space.

The factor of work space in connection with accidents in transporting arises from the rough and insufficient surface of the aisles between and inside the workshops. Particularly, roll conveyor on the ground level caused frequent falls.

As we looked through the practical situation of accidents in two foundry factories, we can diminish accidents by hand tools first of all by properly designing the working processes and eliminating the use of such tools. Potentially, direct operation of powered hand tools is very harmful to workers if they remained just as tools of the conventional style. Air-rammers could be replaced by another completely different and safe way of moulding like using organic binder, a finishing grinder may be improved in terms of operation method. Some studies are being carried out to control grinding operations by the hydraulic remote-control system so that the worker can work away from the very dusty, noisy and dangerous working site.

However it is impossible to eliminate all hand tools from foundry work shops. Hand tools are fundamental in the foundry. Secondly, therefore, it will be most important to design tools ergonomically for easy handling by hands with reduced noise and vibration and to arrange work space for easy moving and for easy handling of materials and tools with better working posture. Some hand tools which produce much dust should be designed so as to collect the dust as soon as they are produced.

Lastly, it is suggested that accidents due to hand tools may be reduced by intensive and continuous safety control activities – such as establishing and improving safety rules, arranging work places in a proper way and promoting good house-keeping.

These preventive actions from ergonomic points of view dealing with different safety aspects of using hand tools should be taken and it seems important to review constantly the complex factors involved in hand tool work.

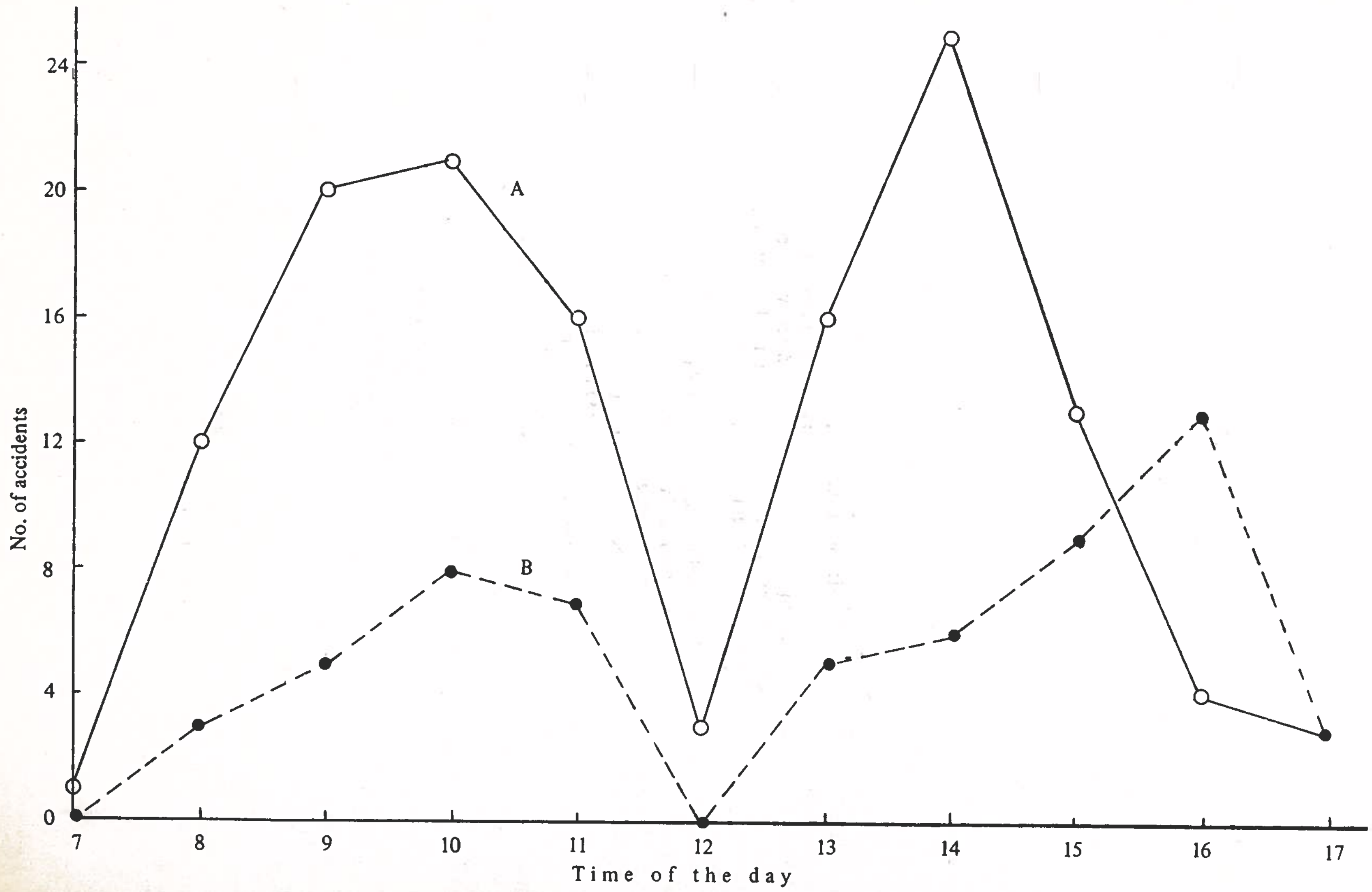

Fig.1: Distribution of Accidents by time of the day. (Factor A, 138 during 1974-77 and Factory B, 61 cases during 1971-74).

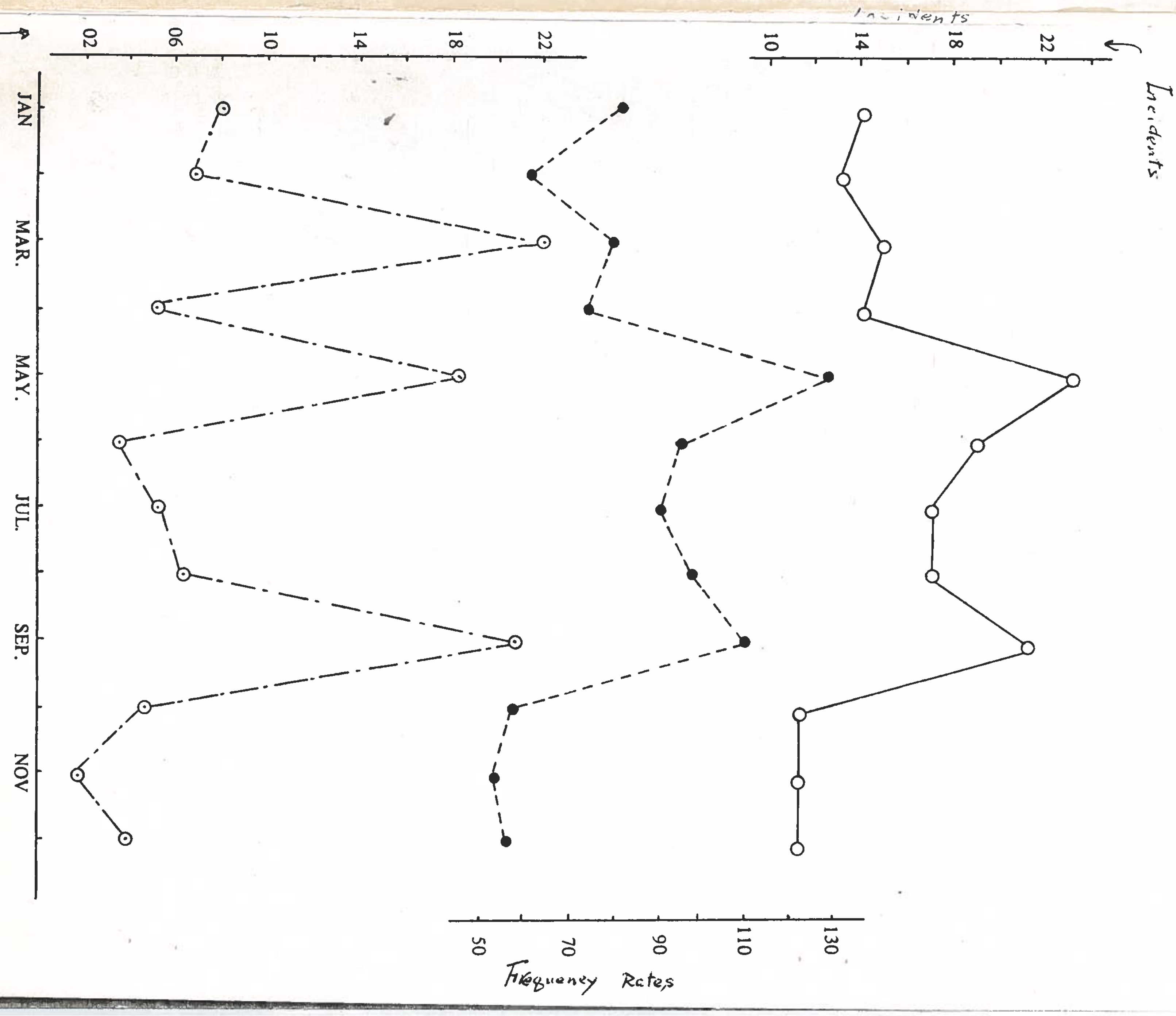

Fig. 2: Monthly distribution of accidents in Factory A (1975-77). Data covers foundry work shops and other work shops.

Table 1

ACCIDENT SITUATIONS IN RELATION TO WORK PROCESS OF FOUNDRY SHOPS (FACTORY A, 1974-77)

	Sand Preparation And Molding	Melting & Pouring	Cleaning & Finishing	Others (Maintenance and Material Handling	Total
Handling Goods	21	6	5	4	36
Power Driven Machinery	5	0	1	0	6
Person Falling	8	4	2	2	4
Struck by Falling Body or Flying Objects	2	15	2	2	21
Hand Tools	19	1	15	7	42
Striking Against Objects	5	3	1	1	10
Miscellaneous	4	2	0	1	7
TOTAL	64	31	26	17	138

Table 2

ACCIDENT DISTRIBUTION RELATED TO PRODUCTION MEANS (FACTORY B, 1971–1974)

Production means related with accidents	No. of cases.
Air Grinder, Hammer, Plane and other Tools	7
Overhead Crane and its Facilities	14
Hand Carts, Forklift, Loader and other Transporting Machines	17
Melting, Pouring and Related Operations	15
Molding, Sand Preparation, Inspection of Goods and Others	8
TOTAL	61

Table 3

Distribution of Injuries by Part of Body affected, that focused in hand tools and that in relation to absent days in Factory A (1974-77) and B (1971-74)

Injured Part of the Body	Total No. of Injuries Factory A	Total No. of Injuries Factory B	No. of Injuries Caused by Hand Tools A	No. of Injuries Caused by Hand Tools B	Absent Days in Factory A 0	1-7	8-
Head	3	2	0	0	2	0	1
Face	6	6	4	0	2	2	2
Eye	26	5	17	3	19	5	2
Arm & Shoulder	15	6	3	1	7	1	7
Hand & Finger	34	19	12	3	22	5	7
Chest & Abdomen	13	1	3	0	5	0	8
Back & Waist	26	8	12	1	12	2	12
Lower Limb	7	2	2	0	1	3	3
Foot	14	15	3	2	8	3	3
Whole Body	1	0	0	0	0	0	0
Total	**145**	**64**	**56**	**10**	**78**	**21**	**46**

Table 4

ACCIDENT DISTRIBUTION BY PRODUCTION MEANS IN RELATION TO ERGONOMICAL FACTORS (FACTORY A, 1974-1977)

	Tools And Machines	Total No. of Accidents	Ergonomical Factors: Work Space	Work Load	Work Method	Work Organi-zation	Display & Controls
tools	Air Rammer	15	4	6	7	1	
	Hammer	14	3		13		
	Air Grinder	9	1		8	1	
	Scoop & Chisels	8	3	3	3		
machines	Electric Welder	4		2	2		
	Cupola & Ladles	25	11	6	13		2
facilities	Conveyer & Cart	27	17	5	6	1	2
	Hopper & Sand-Mills	20	4	10	2		2
	Miscellaneous	10	3	6	2		
	Total	**132**	**46**	**38**	**61**	**3**	**6**

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Department of Exercise Physiology
School of Health and Physical Education
Juntendo University
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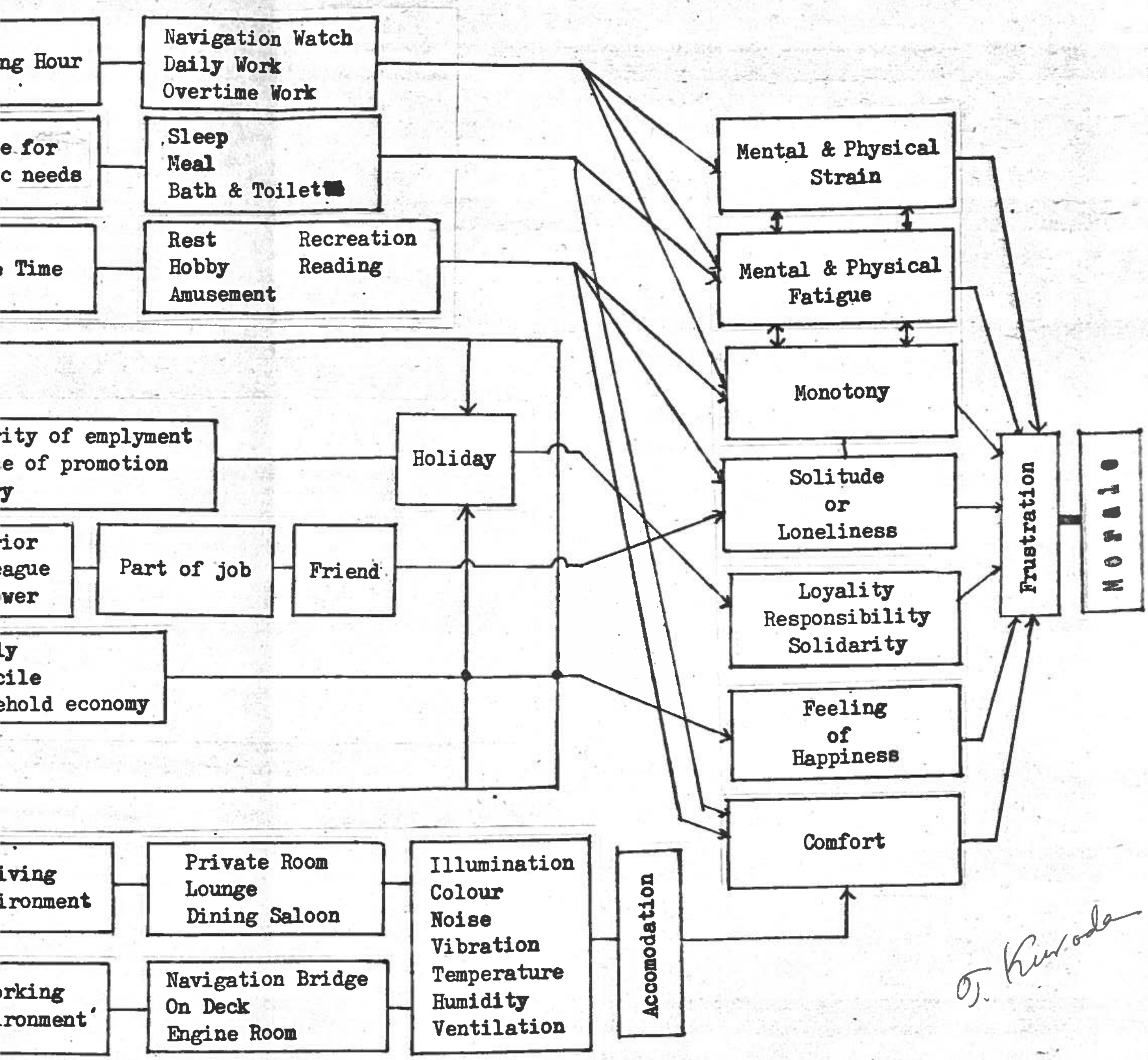

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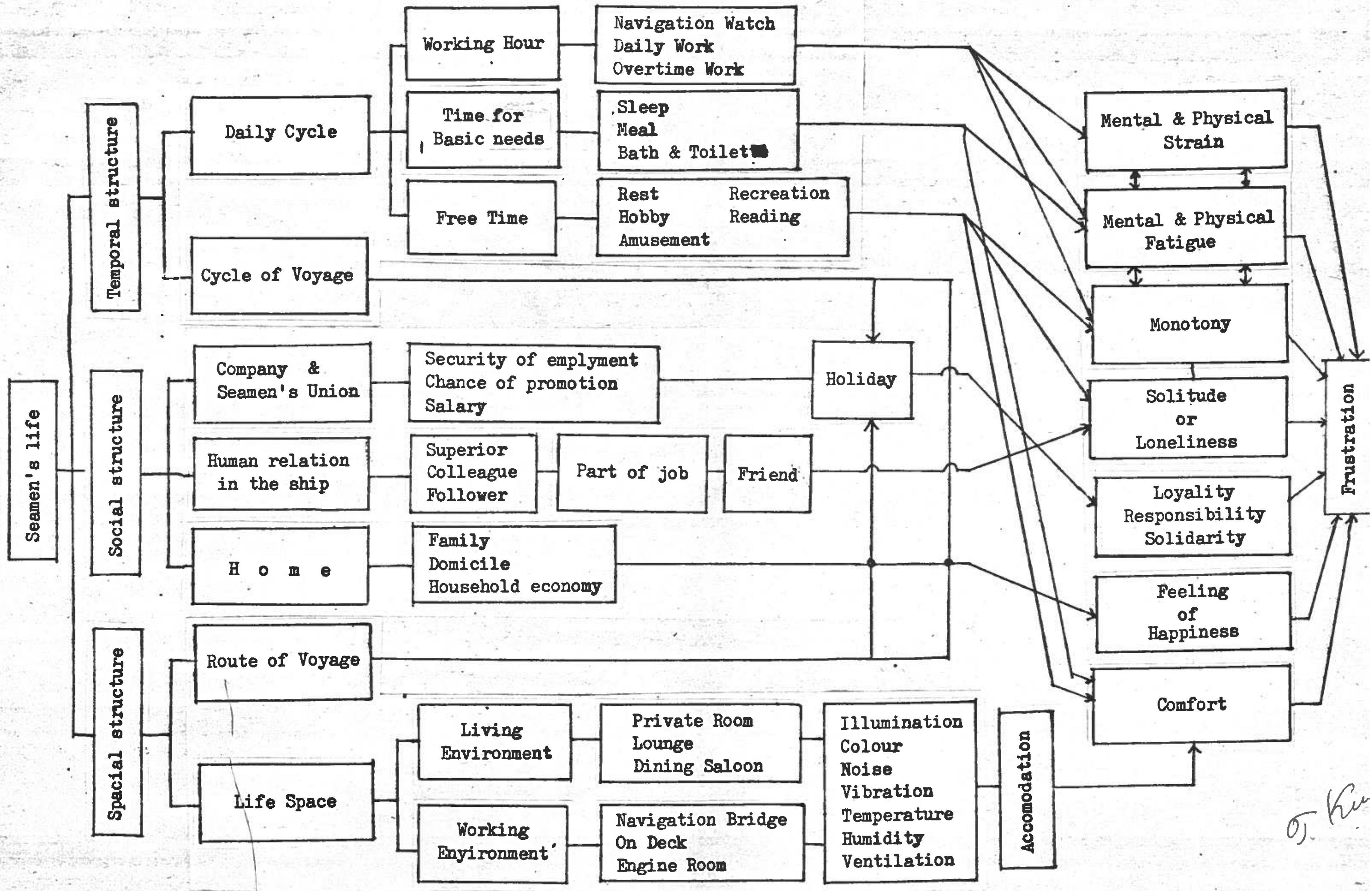

BIOCHEMICAL ASPECTS OF BRAIN UNDER SOME PHYSICAL ENVIRONMENTS.

CHIKARA SAKAGUCHI, HIROSHI SAKAMOTO, AND KIYOO MATSUI

We have studied the relation between the biological reaction and the noise exposure, and reported the changes in the function of endocrine and autonomic system. Thus, it seemed reasonable to assume that the noise causes the abnormality of anterior pituitary gland. Further, we think that the changes in endocrine system may be brought about by the effects of noise on higher center(Sakamoto, 1963).

Therfore, the biochemical investigation of brain was undertaken for clarifying the relation between adenohypophyseal dysfunction and higher center of brain in exposure to noise as compared with some physical environments.

The environmental conditions studied were noise, cold, and immobilization. For the noise condition, one hundred phon noise characterized by wide octave band spectrum was used, and the temperature in the cold was -10 ± 1°C.

The adult male rabbits were exposed to these environmental conditions. Thereafter, the brain was removed and separated into seven parts, that is, cerebrum, interbrain, upper and lower part of mesencephalon, cerebellum, pons and medulla oblongata. And then, the following biochemical observations in each of the parts were undertaken.

The first slide, please.

The ratio of lactic acid formation to oxygen consumption was calculated, and the difference in this value between the exposed animal and the control one was expressed as per cent of the control value. As the results shown in this slide, the noisy environment is characterized by the disturbance of glycolysis in interbrain and pons.

Next slide, please.

Besides, thiamine content in each of the parts was determined, but, no significant difference between the exposed animal and the cotrol one was observed.

Next slide, please.

And then, the water content in each of the parts of brain was measured by Hatschek's method. The difference in water content between the exposed animal and the control one was indicated as per cent of the control value. In the noisy environment, free water content decreased and bound water content increased in interbrain. Besides, bound water content increased in cerebrum and pons.

Next slide, please.

Sodium, potassium, and calcium were determined by flame photometry. The differences in the concentrations of these minerals between the exposed animal and the control one were indicated as per cent of the control value. The noisy

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environment is characterized by a decrease in calcium concentration of interbrain and lower-part of mesencephalon. Further, the changes in these minerals were not correlated with the changes in the water content in all the part of brain.

And also, the activities of monoamine oxidase and acetyl-cholinesterase were changed by the exposure to these environmental conditions, but the changes in these activities were not characteristic in each of the conditions.

Next slide, please.

Further, the studies were carried out to investigate the changes in the ammonia content of the brain, liver, and blood. In this study, the adult male rats were exposed to noise for three hours, or to cold for three hours, or were immobilized for two hours. Thereafter, the animals were killed by two different methods; the one was decapitated at room temperature and the other was dropped into the mixture of solid carbon dioxide and acetone. The determination of ammonia was made by Conway's method using Seligson-Hirata's apparatus.

As shown in this slide, under the noise condition, the ammonia content was elevated significantly in the brain, liver, and blood, but not under the other conditions.

On the basis of these experimental observations, it may be concluded that the noise acts not as metabolic stimuli, but as neurotropic stimuli with a peculiar nature.

Next slide, please.

And then, we investigated the question whether the increase in the ammonia content under the noise condition was brought about by the acceleration in the productive mechanism or the disturbance in the disposal system.

The brain and liver of the exposed rat was homogenized in Tris buffer(pH 7.4), and these homogenates were added to the following substrats. These reaction mixtures were incubated for one hour at 37°C.

For the productive mechanism, two kinds of substrat were used; the one was the boiled homogenate of the brain or liver of the unconditioned rat, and the other was 2 mMol glutathione solution. Thus, the ammonia content in the reaction mixture was measured. As the results, the production of the ammonia did not change between the noise and the control group.

For the disposal system, 2 mMol ammonium chloride was used as the substrat. The ammonia content remaining in the reaction mixture was measured. As the results, the disposal ability for the ammonia in the noise group was reduced more than in the control group.

Thus, it may be concluded that the increase of the ammonia content in the brain and liver under the noise condition was brought about mainly by the disturbance in the disposal system.

Turn off the slide, please.

On the basis of these findings on the metabolism in the brain, we cannot understand each of the physical environmental factors as the same strain.

When the workers in the different workshops are exposed to noise, abnormal thermal condition, unnatural posture and etc., they often become weary. And we are apt to make mistakes that these worker's states are usually diagnosed as the fatigue in the same category on the biological response. But, we think that the different changes in the metabolism of the brain are brought about by each of the physical environmental factors.

Thus, these problems will be made clear in the near future.

Thank you.

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Mie Medical Journal,
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ENDOCRINE DYSFUNCTION IN NOISY ENVIRONMENT

REPORT I

HIROSHI SAKAMOTO

From the Department of Hygiene,
Mie Prefectural University School of Medicine, Tsu
(Director : Prof. A. Kawahata)

(Received for publication, May 30, 1959)

About 30 years after Fosbrake had reported on the hardness of hearing prevalent among blacksmiths[1]), Helmholtz advanced acoustic theory, that is, resonance theory[2]) in 1863. Subsequently, a systematic change in the auditory organ of the hardness of hearing by noise was first discovered in 1907[3]). This problem was fairly minutely studied at the time and degeneration of Corti's organ and nerve fibre in the region commensurate to the frequency of stimulating pure sound was observed[4-7]). In audiogram of the hardness of hearing by noise C^5 dip was found characteristic[8]). As differential diagnosis DL test[9]), Onchi's test[10]), Fowler's balance test[11]), etc. were applied, and examination of the actual status of hardness of hearing in various noisy workshops or yards, not to speak of shipbuilding. were carried out in a wide scope.

On the other hand, there has been a progress made in the studies of the method for prevention of noise[27-32]) and earplug[33-47]), and especially conspicuous of late are investigations on the standard for noise tolerance causing hardness of hearing[48-51]).

However, from the view point that noise is acting on the living body, these achievements are restricted only to the action of noise giving to the auditory organ. In the event of our being actually exposed to noise, even if it is not an exposure for long years as to give rise to the growth of hardness of hearing, we are sure to become complaining of various bodily symptoms in a short time. Actually it has been made clear that psychological disturbance, such as emotional disturbance[52-55]), sleeping disturbance[56]) and lowering in working capacity[57-61]) have been appearing. These symptoms are not only of sensory affairs of on excretion of 17-KS in urine were observed.

Thorn's test was carried out after operations when lowering was caused in the rate of eosinophyls by injection of Epinephrine as previously mentioned. As a result, as shown in table IV, by injection of ACTH eosinophyls were found well decreased, showing a normal decrease rate. Unlike in the case of Epinephrine injection, the decrease of eosinophyls by injection of ACTH was due, by acting on adrenal cortex itself[84)-88)], to secretion of glucocorticoid having been promoted[88)]. That is, adrenal cortex sufficienty retained reserval function[88)].

By using guinea pig as experimental animal histchemical observation was made on ascorbic acid by Giroud-Leblond method[89)], and by carrying out haematoxylin eosion staining at the same time, histological observation was also made (Photos I, II, III and IV), exposure to noise being 95 - 100 phons (0 - 10,000 cycles). As compared to control specimen, atrophy of Zona fasciculata and hypertrophy of Zona glomerulosa and Zona reticularis were observed in specimen exposed to noise. When the boundary between Zona fasciculata and Zona reticularis was enlarged, atrophy of the cells of Zona faciculate was noted after exposure to noise.

On the contrary, ascorbic acid granules in adrenal cortex, as compared to the control specimen, were found existing in a great number after exposure to noise. These findings are quite contrary to those on adrenal cortex at the time of administration of ACTH[90)]. These are findings to be seen at the time of pituitarectomy[91,92)]. That is to say, adrenal cortex, while becoming inactivated atrophy, still retains reserval fufnction, suggesting that innervation of ACTH from anterior pituitary gland is weakened. On further observation on ketosteroid in adrenal cortex by using Seligman-Ashbel method[93-99)], a strong positive reaction on Zona fasciculata appeared in the control specimen, but when exposure to noise was carried out the positive reaction of Zona glomerulosa and Zona reticularis became stronger than that of Zona fasciculata. This fact is considered to be further supporting the above results.

The fact that a decrease in excretion of 17-KS. in urine is caused was previously stated, but as various steroids are contained in 17-KS, an attempt was made to find out the status of the original organs by segregative measuring of different steroid constituting 17-KS. Thus, 17-KS. in urine was allowed to be isolated in different steroids by colum chromatography with the improved system of Edward's method[100)]. The method of dissolving was as shown in table V, by which 8 fractions were obtained. Steroid ingredient of each fraction is as the table VI. shows. Looking at the figure of 17-KS. in urine at value means the more the index inclines to sympathicotonic[114-116], by exposure to noise, the sympathicotony comes to occur. Sympathicotony by this noise exposure is recognized in reports by various investigators, who used other methods[63,64]. The results of the change of adrenaline contained in circulating blood, measured by Boor's method[117], are given in the figure 3. The amount of adrenaline contained in blood gets increased. From this it is clearly known that sympatho-adrenal system presents emergency reaction by noise. To return again, at such a time as emergency reaction occurs G.A.S. reaction is usually brought about[118-120], but in case of exposure to noise being carried out, there is a contradiction exsting that no G.A.S. reaction is caused to occur.

III. Pituitary Gonadal System.

As repeatedly stated, noise, while causing excitment to sympathoadrenal system, on one hand, it is bringing about lowering of activity on pituitary adrenocortical system, on the contrary, wherein, it is wondered, speciality of noise probably lies.

In the statemtent under the chapter I, are given 2 experimcntal results relative to the function of pituitary gonadal system. One is the finding on chromatography of 17-KS. in urine, that is, dehydroisoandrosterone and isoandrosterone cause an increase in secretion, but androsterone, etiochlanolone and 11-oxy-17-KS. induce a decrease in the secretion. While this is supporting the findings on atrophy of Zona fasciculata and hypertrophy of Zona reticularis in adrenal cortex, the decrease in the secretion of androsterone and etiocholanolone suggests of gonadal functional lowering at the same time, which is a matter worth noticing. The other is the findings on Azan staining of adenohypophysis by exposure to noise. It is considered almost certain that gonadotropin to be secreted from pituitary gland is produced from basophyls of adenohypophysis [121-130], but on Azan stained specimen after exposure to noise, disappearance of granules in cell-nucleus of basophyls is observed. It is not clear as to what influence of the basophyls function has on this finding, but at least it can not be taken as a state of hyperfunction.

From the reason as above described, I have decided to make observations more closely on the influence of noise against adenohypophysis-gonadal system.

As it is necessary first of all to ascertain the significance of the disappearance of granules in basophyl cell-nuclues, by utilizing PAS reaction of McManns[131] and Hotchkiss[132], trichrome-PAS staining[133,134] was carried out. (Photos V. and VI.)

Rabbits were used for experimental animals. The nucleuses stained deep bluish violet after exposure are basophyls, but PAS reaction of protoplasma being almost negativized, A-F positive cells are increased by exposure to noise, according to the consideration that PAS reaction indicates positive reaction on gonadotropin or at least on FSH[139, 144-147], cannot be recognized. Therefore, it might be better to interpret that PAS reactive substance principally would be gonadotropin.

Granting that an increase in secretion of thyrotropic hormone from the anterior lobe occurs, naturally functional formative change should also occur in thyroid gland by exposure to noise and, therefore, the tissue of thyroid gland has been observed by Mallory's colloid staining. As compared with the control specimen, the wall cells in the specimen after exposure have been found became taller, the colour in the follicle assumed a tinge of red, thyroxin content became less, showing the figure after having been released in the blood. Thus, thyroid function is caused to accelerate by exposure to noise[148],[149] (photos, X and XI.).

On observation of what influence the exposure to noise has on basal metabolic rate, a rise of metabolic rate has been noted, as the fig. 4. shows. This rise of basal metabolic rate cannot be attributed solely to hyperthyroidism but at least there is no contradiction.

V. Higher Center:

It has already been stated that anterior pituitary gland causes functional abnormality by exposure to noise, that is, ACTH and gonadotropic hormone bring about a decrease and thyrotrophic hormone an increase in secretion. Also as stated under chapter III, when trichrome PAS reaction on adenohypophysis is carried out, acidophyls, which stains Orange G, does not turn yellow by exposure to noise (photos V and VI). That is, it is to show some other aspect different to normal acidophyls and can easily be conjectured that some secretory abnormality is caused to the hormone to be secreted from acidophyls. Regarding the secretory abnormality of hormone from acidophyls, it is now under investigations, and will be reported on other occasion. But this means that both the cells, acidphyls and basophyls, are caused a functional change, which I think it more appropriate to interpret as an influence from the higher center innervating pituitary gland[150-159] rather than to consider that noise directly changes adenohypophysis. As regards what secretory mechanism adenohypophysis performs, however, opinions differ among investigators[102,158-160], being left still unsolved. Consequently, it is difficult to pass a decision even on the relation with the higher center, which causes functional change of anterior pituitary by noise, but the finding of neurosecrate in diencephalon may serve as an important data in interpreting the innervation of anterior pituitary gland[161-168]. On neurosecrate dynamics by exposure to noise, Arizono, etc.[169]

Table II The Effects of Time on the Changes in Amount of Urinary 17k.s. Excreted

Subjects	Time of works	No. of ★ Urine	Amount of Urine (c.c.)	Total 17k.s. excreted (mg)	17k.s. mg/8 hours
1	Early	I	350	4.6	4.6
		II	95	2.1	1.7
		III	175	1.9	2.5
2	Eerly	I	130	1.7	1.7
		II	160	2.7	2.2
		III	200	2.0	2.6
3	Eerly	I	50	1.2	1.2
		II	140	1.6	1.3
		III	95	1.2	1.6
4	Late	I	155	1.7	2.7
		II	210	3.1	2.5
		III	420	2.6	2.2
5	Late	I	110	1.8	2.9
		II	165	3.5	2.8
		III	245	2.7	2.4
6	Late	I	60	2.4	3.8
		II	225	4.0	3.2
		III	200	3.1	2.7

★Early
- I p.m. 8.00~a.m. 4.00 (8 Hours, Sleeping)
- II a.m. 4.00~p.m. 2.00 (10 Hours, Labour)
- III p. m. 2.00~p.m. 8.00 (6 Hours, After Labour)

Late
- I a.m. 8.00~p.m. 1.00 (5 Hours, Before Labour)
- II p.m. 1.00~p.m. 10.30 (9.5 Hours, Labour)
- III p.m. 10.30~a.m. 8.00 (9.5 Hours, After Labour)

Table III Effects of Labour in Spinning Industries on Epinephrine

Subj No.	Conditions	Eosinophile Count/mm³ Prior Injection	Eosinophile Count/mm³ Posterior Injection	Ratio of Decrease (%)	Mean Ratio of Decrease (%)
1	Before Labour	324	244	−25	−56
2		321	183	−43	
3		202	74	−63	
4		174	47	−73	
5		355	152	−57	
6		225	72	−68	
7		373	194	−48	
8		616	191	−69	
9	After Labour	216	152	−30	−19
10		299	252	−16	
11		70	91	+30	
12		108	58	−46	
13		138	127	−07	
14		188	183	−03	
15		638	527	−17	
16		160	141	−13	
17		83	27	−67	

Table VI 17 k.s. Fraction

F.I : non-alcholic steroid

F.II : 3:5-cycloandrostan-6-ol-17on, non Ketonic Fraction

F.III : β-K.S., isoandrosterone, dehydroisoandrosterone

F.IV : androsterone

F.V : etiocholan - 3α-ol-17-one

F.VI : }11-oxy-17-k.s.
F.VII :

F.VIII : unknown sterocd, non Ketonic Fraction

Fig. I Urinary 17k.s. Fraction view by exposure to noise.

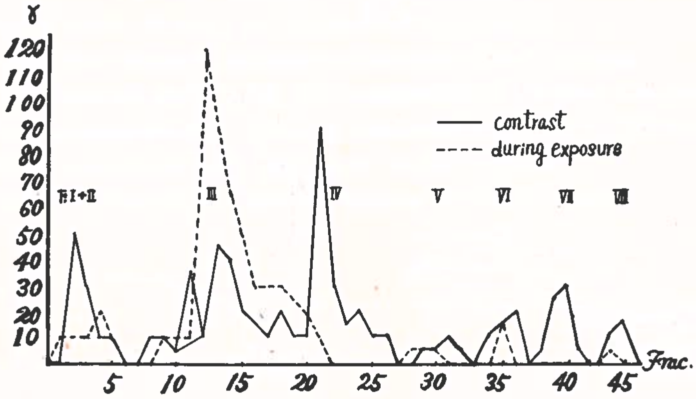


Table VII Fraction retio of Urinary 17 k.s. during exposure to noise

	III+IV+V/VI+VII			IV+V/III			VI+VII/III		
	Before expasure	After expasure	Differ-ence	Before expasure	After expasure	Differ-ence	Before expasure	After expasure	Differ-ence
1	2.4	5.3	+ 2.9	122.0	0.9	−121.1	51.0	0.4	− 0.56
2	4.0	3.3	− 0.7	3.8	0.9	− 2.9	1.2	0.6	− 0.6
3	4.1	10.0	+ 5.9	8.6	0.9	− 7.7	2.2	0.2	− 2.0
4	53.0	68.0	+15.0	2.1	2.1	± 0	0.05	0.04	− 0.01
5	1.1	7.0	+ 5.9	0.6	0.07	− 0.53	1.0	0.15	− 0.85
6	6.6	8.4	+ 1.8	0.4	0.17	− 0.23	0.2	0.15	− 0.06
7	3.9	35.0	+31.1	1.3	0.07	− 0.23	0.6	0.03	− 0.57

Photos

I : Normal adrenal cortex. Staining after Giroud-Leblond and Haematoxylin-Eosin. Low magnification.

II : Adrenal cortex after exposure. Staining after Giroud-Leblond and Haematoxylin-Eosin. Low magnification.

III : Normal adrenal cortex. The transitional portion of two zona, glomerulosa and fasciculata. High magnification.

IV : Adrenal cortex after exposure. The transitional portion of two zona, glomerulosa and fasciculata. High magnification.

V : Trichrome PAS reaction in normal adenohypophysis.

VI : Trichrome PAS reaction in adenohypophysis after exposure.

VII : Testis after exposure. Staining Haematoxylin-Eosin.

VIII : Normal testis. Staining by Seligman-Ashbel's method.

IX : Testis after exposure. Staining by Seligman-Ashbel's method.

X : Normal thyroid. Staining by Mallory's method.

XI : Thyroid after exposure. Staining by Mallory's method.

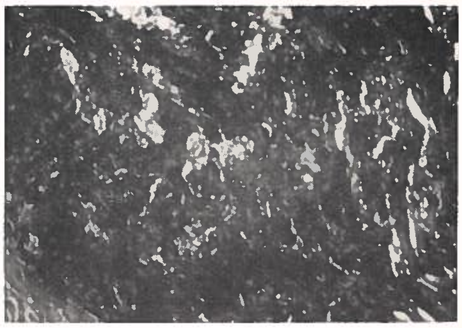
XII : Normal neurohypophysis. Staining by Halmi's method.

XIII : Neurohypophysis after exposure. Staining by Halmi's method.




Photos

IX



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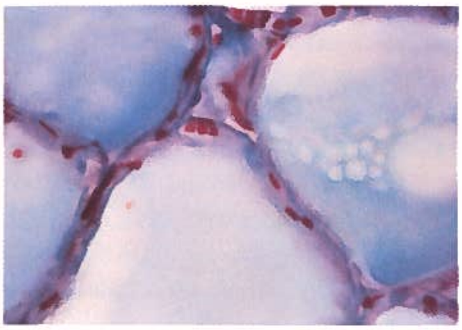
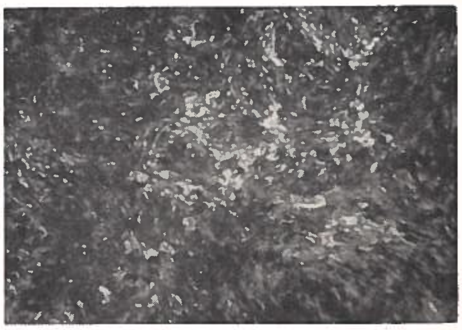


X



XIII

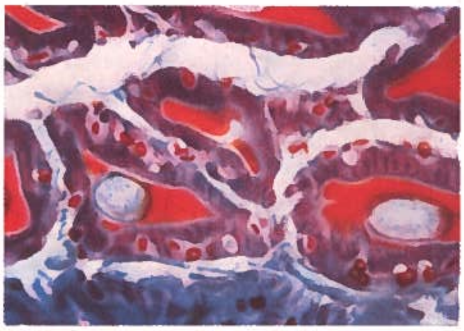


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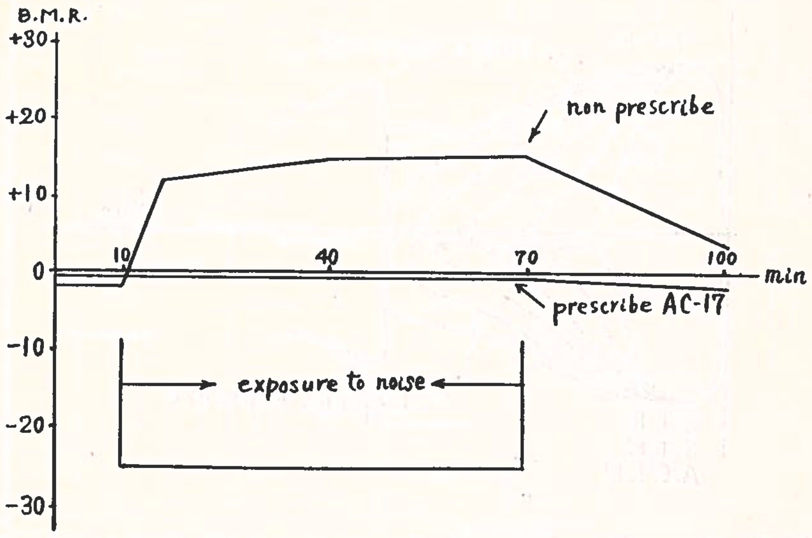
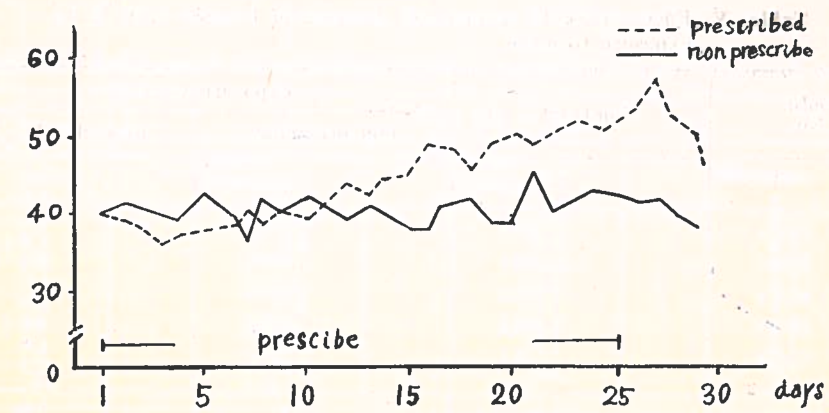
Fig. 8 Effects of noise on B. M. R.



AC-17 is prescribed oraly 30mg. daily for 2 days and 10mg. intramusculary preor experiment.

Fig. 9 Effects of AC-17 prescription to 1~3-old hens.

Number of eggs laid per 100hens daily.



AC-17 is prescribed oraly 30mg daily

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ENDOCRINE DYSFUNCTION IN NOISY ENVIRONMENT

Report II

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(Received for publication, May 30, 1959)

It is summarized in Report I. how endocrine balance in a living organism is disturbed by exposure to noise. But it remains to clarify the nature and threshold of the noise to which an organism is exposed, progress of recovery from the endocrine disturbance, various other problems that should come out on the place where the noise is actually produced, and prophylaxis for endocrine disturbance due to noise. The present report, in continuation to the previous one, will deal with these points. As attention is drawn in the introduction of the previous report, statement is limited also in this report to a summarized observation, and another report will be published on detailed results of different specific experiments which readers will please refer to.

I. Threshold and Octave Band Specificity of Noise:

Changes in endocrine function which are discussed in the previous report appear upon exposure for 4 hours to a noise of 100 phons having such frequency construction as shown in Fig. I In consequence, when intensity and specific octave band of the noise liable for these changes were examined, the following results were obtained.

When any noise affects a living organism, its intensity is not only to be expressed by the instantaneous one in terms of phons but also subject to the influence of the duration of exposure to it. In other words, intensity of any noise affecting a human body can be expressed within a certain limit by the formula: phons times by the duration of exposure. Particularly the duration of exposure is involved to a great extent in case the phon value is near the threshold. However, this does not mean that endocrine balance is disturbed as soon as intensity of noise has reached a specific level, but biological reaction time should intervene here. Although it is difficult to specify exactly how long a living organism should be exposed to noise to give rise to endocrine reaction, it can be said that exposure to any noise in the intensity of at least 100 phons for 1 hour is liable for the various changes which are dealt with in the previous report. In another case where the duration of exposure is fixed at 4 hours, endocrine changes are produced by any noise of the intensity of at least 80 phons. This can be examined also by means of histological and histochemical methods applied to animal experiments, and can be detected also from reaction of decrease in urinary 17-ketosteroid in a human body (Table I.). In order to find out the specific octave band capable of causing the endocrine changes caused by the noises of the frequency constitution as shown in Fig. I, we made examination after having classifed them by the different octave bands in which their peaks are situated, as shown in Fig. 2. and 3. and, in addition, separated those of Fig. 3. as shown in Fig. 4. and 5. When the amount of 17-ketosteroid excreted in urine is used as the indicator, it was found that the reaction of decrease in excretion of 17-ketosteroid can be caused by noise having its peak near 100 c/s, as shown in Table II. Observation of this finding on the histological changes of the different endocrinous glands which are mentioned in the previous report discloses that there is an obvious difference in the histological changes between the case of the noise of Fig. 2. and that of Fig. 4. More exactly, PAS-reaction of the anterior lobe of the pituitary gland and findings on A-Fstaining (Photos I, and II) are remarkably changed by the noise of Fig. 4. which has its peak around 1,000 c/s. This may be confirmed by the fact that steroid secretion is found to be decreased on ketosteroid staining in the testicle. On the other hand, decrease in steroid secretion in the zona fasciculata of the adrenal cortex and its acceleration in the zona reticularis as well as hypertrophy of the zona glomerulosa are caused by a noise having its peak just at 1,000 c/s. It is deduced therefore that the main influence on endocrine disturbance due to noise derives from that having its peak around 1,000 c/s. However, Hale[170] who regarded noise as stress in his experiment states that adrenocortical function in rats is lowered by a noise of a low frequency of 50 - 400 c/s, and it seems that there would remain still some questions in lower octave bands than 1,000 c/s on which my experiments were made. But it may be probable that this would be attributed to difference in sensibility of animals experimented. In my own experiments which were made on a noise having its peak in a lower octave band as shown in Fig. 6. it was found that steroid secretion in the testicle is rather accelerated on the contrary and PAS-reaction in the an-

terior lobe of the pituitary gland is never made negative. Moreover, if it is judged from the fact that the amount of excretion of 17-ketosteroid in urine is not decreased in a human body (Table III.), it is hardly conceivable that any noise of a low frequency as shown in Fig. 6 should give rise at least to such endocrine disturbance as was examined. But Yamakawa states in his study of the influence of noise upon a living body by electromyographic observation[171] that the lower is the frequency, the greater is the influence, and the problem is to be further examined.

II. Recovery and Long-run Exposure:

It is to clarify through what course the endocrine disturbance caused chiefly at the anterior lobe of the pituitary gland is recovered after exposure to noise or whether it is not recovered. Therefore, the disturbance was put under observation on trophic hormone of the anterior lobe of the pituitary gland, where the distiurbance is most pronounced, immediately, 1½, 3 and 6 hours after exposure. By means of PAS-reaction of the anterior lobe as the indicator, it was found that the disturbance was almost recovered after 3 hours and the effect at the 6th hour showed no difference from the normal one. But after 1½ hour only acidophils which are stained in yellow, by Orange G showing a sign of recovery, it can be said that the recovery appears only after 3 hours. This finding means that recovery from the disturbance due to exposure to noise progresses fairly quickly just as the disturbance is caused quickly.

The progress of recovery stated above is observed on the PAS-reaction of the anterior lobe in case of a single exposure to noise for 4 hours. The disturbance caused by expossure to the noise of 100 phons for 1 hour, too, is recovered through the similar course as far as a single exposure concerns. Is this also the case for long-run exposure to noise? Ishibashi[63], who examined the influence of long-run exposure to noise upon the autonomic nervous system, states that the phenomenon of habituation is involved so that the sympathetic nerves finally are not tensioned even if a living organism is exposed to noise. So examination was made to find out whether the endocrine system under observation is also subject to such phenomenon of habituation after long-run exposure. Rats were exposed to the noise of 100 phons as shown in Fig. I for 4 - 5 hours every day, and PAS-reaction of the anterior lobe of their pituitary gland was examined. It was found that the longer is the period of exposure, the more prolonged is the recovery time, no sign of recovery being observed even in 6 and 24 hours in case of long-run exposure for 1 week and 1 month, respectively, and the recovery being seen only in 48 hours in case of long-run exposure for 3 months. This gives us an impression that endocrine disturbance in the anterior lobe of the pituitary gland remains settled for long hours. On the other hand, examination by means of A-Fstaining disclosed that recovery from the positive effect which is strengthened after a single exposure takes also a longer time, and it seems that the disturbance becomes gradually settled. This disturbance of secretion of trophic hormone in the anterior lobe of the pituitary gland gives rise to similar disturbance of its peripheral endocrine glands, which can be observed in parallel in the gonad, adrenal cortex and thyroid, respectively. As shown in Fig. 7. which illustrates the progress of recovery and the influence of long-run exposure stated in the foregoing, whereas the disturbance almost recovers in 3 hours in case of a single exposure. it takes an almost settled shape in case of long-run exposure, recovery time being gradually prolonged, no recovery being observed in case of exposure on the following day and further the disturbance still remains even 2 days after.

III. Problems in Actual Life:

I have reported in the foregoing on the influence of noise which could be experimentally confirmed. Further attempt was made to disclose the disturbance of endocrine balance which has been dealt with so far at the place where noise is remarkably intense.

According to an investigation conducted in a village in the neighbourhood of a certain airfield for jet planes, more than half of all the inhabitants complained as physical symptoms due to noise of susceptibility to fatigue by working, lowering of working efficiency headache, palpitation, stiff shoulder, loss in body weight, sleeplessness and unconfortable feeling at getting up. Situated at the end of a runway of the airfield, this village is exposed practically uninterruptedly to roars of jet planes, and the villagers are annoyed by the noise exceeding 130 phons when a jet plane passes over them. Moreover, it is not contrary to the endocrinological findings previously stated that in the investigation on their sexual life, though psychological factors are involved therein to a great extent, the greater part of the answers complained of decrease in frequency of sexual intercourse. On the other hand, when poultry farming in this village before jet planes had begun to use the airfield was compared with that of today, it was found as shown in Table IV. that decrease in number of 3-years-old hens is particularly remarkable. This is because the 3-years-old hens stop to lay eggs on account of premature aging. Yet, when the number of eggs laid per 100 hens was examined, it was found that the total number was reduced notwithstanding the decrease in number of 3-years-old hens. This fact just confirms the endocrine disturbance. In order to demonstrate that this diminished egg-laying is owing to decrease in secretion of gonad stimulating hormone from the anterior lobe of the pituitary gland, their anterior lobe was stained with PAS, and it was found that PAS-reaction was evidently made negative in the hens in the neighbourhood of the jet plane airfield.

Not only in the village around a jet plane airfield but also in the places where noise is remarkably intense, investigation discloses that workers in such places complain of lowering of their working efficiency, headache, palpitation, etc. stated above and also reduced sexual appetite.

IV. Prophylaxis and Remedies for Endocrine Disturbance:

I have reported that in experiment as well as in actual life, noise is liable to disturb endocrine balance to interfere with smooth operation of the regulating system in a living organism. The prophylactic measure for avoiding such disturbance and the treatment thereof will be dealt with in this section.

The principle of the prophylaxis, just as that for infectious diseases, consists in devising some engineering measures which will enable the source of noise not to produce any noise or to weaken the noise produced, and at the same time, other measures in connection with individual sensibility. The measures in connection with the source of noise and transmission of noise are not dealt with in this paper, but only those in connection with sensibility. However, this constitutes a very difficult problem in view of the fact that the essential of endocrine disturbance due to noise does not originate from the peripheral endocrine glands but is that of the pan-regulating system with the diencephalon as the centre and that no detail of the diencephalic function is clarified at the present time. Consequently, it is thought that the measures for the prophylaxis and treatment will be improved as the disturbance of the diencephalic function has been further studied in future. In addition, the problem is made all the more difficult as there are very few drugs which are considered might affect the diencephalic function. I have known that among these few drugs, adrenochrome[172-180] which have been used as a hemostatic and vascular reinforcing agent is capable of preventing and treating endocrine disturbance due to noise. Really adrenochrome is not considered to be of a central effect but to have actions on the vascular system[181-182] and various metabolisms[185-186]. It has been once considered that adrenochrome is of an action stimulating the pituitary - adrenocortical system[187-194] but this stimulating action is to be attributed to that of salicylic acid which is used as a solubilizing agent in making an aqueous solution of adrenochrome hardly soluble in water, and it is now generally understood that such an action is difficult to be found in adrenochrome itself[195-196]. However, adrenochrome has the so-called antistress action[197-200], mechanism of which remains unknown, and many reports have been published. I also have observed the effect of adrenochrome in examining the reaction of a living organism to stimulation due to cold. In the course of the experiments, I encountered some phenomena which could not be interpreted as being due to the action of adrenochrome on the vascular system or the enzyme system, and I presumed that adrenochrome might affect the diencephalic function[201]. If disturbance in endocrine balance due to noise really originates from the disorder of the diencephalic function, it is considered that adrenochrome may exercise some influence on the endocrine disturbance. Adrenochrome being hardly soluble in water, possible influence of salicylic acid, used as a solubilizer, is unavoidable when a large quantity of adrenochrome should be used. Therefore, refrained from using hardly soluble adrenochrome monosemicarbazone but used of sodium dl-l-methyl-2,3,5,6-tetrahydro-5-semicarbazono-6-oxoindole 3-sulfonate (AC-17) which is easily soluble and in the solution of which no salicylic acid is contained at all. Moreover, AC-17 is found to be most suitable for endocrine disturbance for which a solution of a high concentration is necessary.

AC-17 had been preliminarily administered orally for 3 days to rabbits and 15 mg. of it were injected intramuscularly before the experiment. After having exposed them to noise just as reported previously, their endocrinous organs were examined. PAS-staining and A-F-staining effects of the anterior lobe of their pituitary gland are shown in Photos III and IV. Both effeects present almost no change due to exposure to noise and present the normal pictures. Normal pictures were obtained in case of the thyroid and testicle steroid-staining effect as well as Ashbel - Seligman staining of the adrenal-cortex, which shows that no endocrine disturbance was caused. In human also, the amount of excretion of 17-ketosteroid was not decreased by exposure to noise (Table V.), and basal metabolism which should be accelerated by exposure to noise as shown in Fig. 8. was not accelerated even by the exposure thanks to the preliminary treatment with AC-17.

When AC-17 mixed with feed was given to the hens which have been laying less eggs in the neighbourhood of an airfield for jet planes, reported above, they came to lay more eggs obviously from around the 15th day after administration, as shown in Fig. 9. It was reported above that rabbits exposed to noise of 100 phons for 4 hours takes 3 hours for recovery from endocrine disturbance in case of a single exposure. When 10 mg. of AC-17 is injected intravenously to rabbits after they have been exposed to noise, a sign of recovery can be obviously confirmed as early as in 30 minutes. (Photo V.) These findings show that administration of AC-17 can prevent endocrine balance

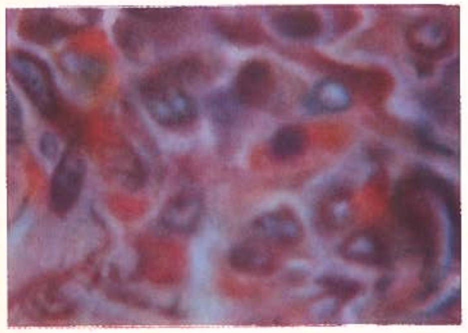
from being disturbed by noise and at the same time is effective for recovery from the endocrine disturbance caused by noise.

Conclusion:

Exposure to noise gives rise to dysfunction of the diencephalon-pituitary system, disturbance in balance of the peripheral endocrinous glands with the anterior lobe of the pituitary gland as the centre, thyroidal hyperfunction and lowering of function of the zona fasciculata of the adrenalcortex and the gonads. Functions of the zona glomerulosa and zona reticularis of the adrenalcortex are accelerated. These phenomena are due to decrease or increase in secretion of trophic hormone for every endocrinous gland from the pituitary gland.

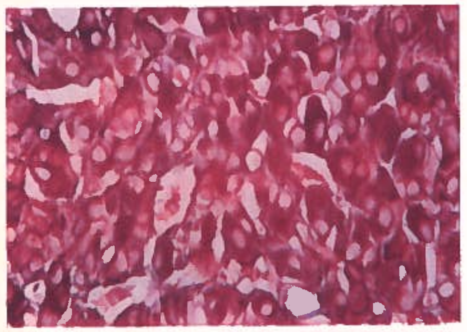
On the other hand, the autonomic nervous system shows a tendency to be sympatheticotonic and adrenaline secretion from adrenal medulla is increased. This disturbance of endocrine balance is reversible, being recovered in approximately 3 hours after exposure to noise is stopped. But repeated exposures entails prolongation of recovering time and the disturbance tends to be gradually settled. Such a state gives rise to different complaints in men and other animals living in any places of intense noise. Particularly, hens come to lay obviously less eggs. For the prevention and treatment of this endocrine disturbance, watersoluble adrenochrome, AC-17, is effective.

Photos



I

IV



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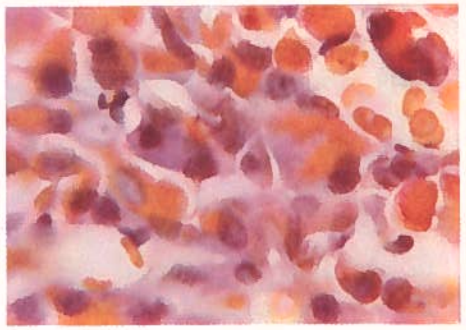
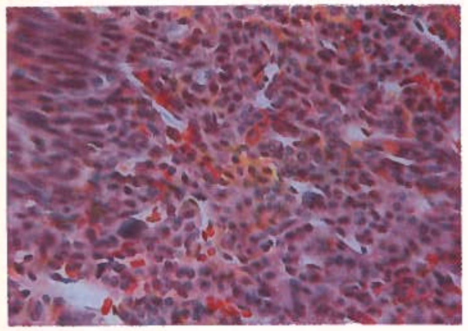


V



III

Photos

I : Trichrome PAS reaction in adenohypophysis after exposure to noise of Fig. IV.
II : A-F-staining in adenohypophysis after exposure to noise of Fig. IV.
III : Trichrome PAS reaction of AC-17 prescribed adenohypophysis after exposure.
IV : A-F staining of AC-17 prescribed adenohypophysis after exposure.
V : Trichrome PAS reaction of adenohypophysis treated AC-17 in ½ hour after exposure.

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Fig. 1

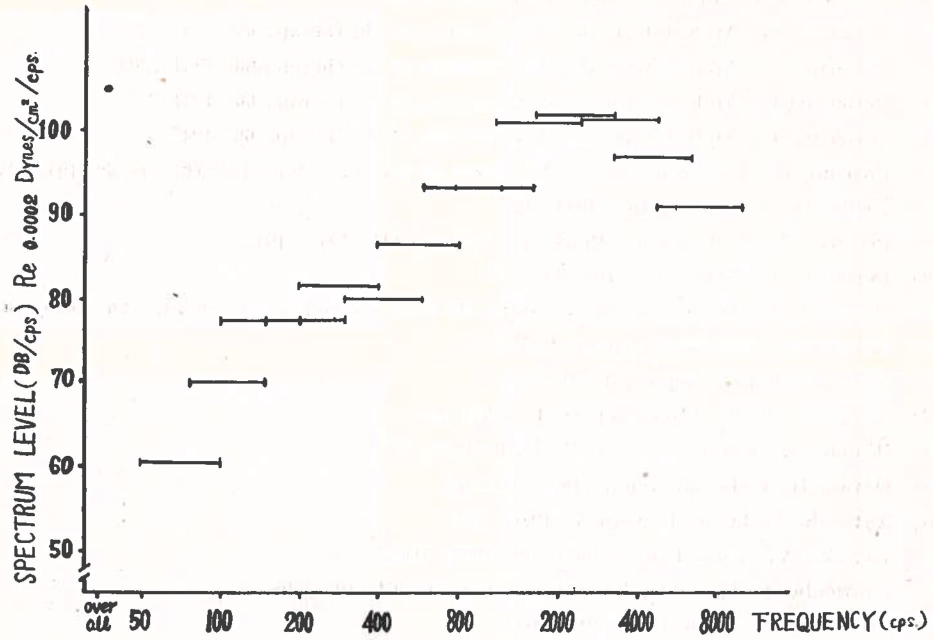

Table I Decrease of Urinary 17k.s. excretion by exposure to variable phon

Phon	90			80			70		
Subj. No.	Before expousre	After expousre	Difference	Before expousre	After exposure	Difference	Before expousre	After exposure	Difference
1	3.22	2.41	−0.81	3.09	2.00	−1.09	2.97	2.53	−0.44
2	3.08	2.30	−0.78	3.06	2.92	−0.14	3.22	2.95	−0.27
3	2.53	1.84	−0.69	3.21	2.43	−0.78	2.76	2.84	+0.08
4	4.04	3.67	−0.37	3.88	3.94	+0.06	2.88	2.76	−0.12
5	4.20	3.02	−1.18	4.10	3.62	−0.48	3.65	3.12	−0.53
6	3.86	2.97	−0.89	2.78	2.62	−0.16	3.28	3.28	± 0
7	1.95	1.66	−0.29	2.66	2.96	+0.30	3.36	3.42	+0.06
8	2.73	1.69	−1.04	3.41	2.98	−0.43	2.54	2.40	−0.14
	3.20	2.44	−0.76	3.27	2.93	−0.34	3.08	2.91	−0.17

Fig. 2

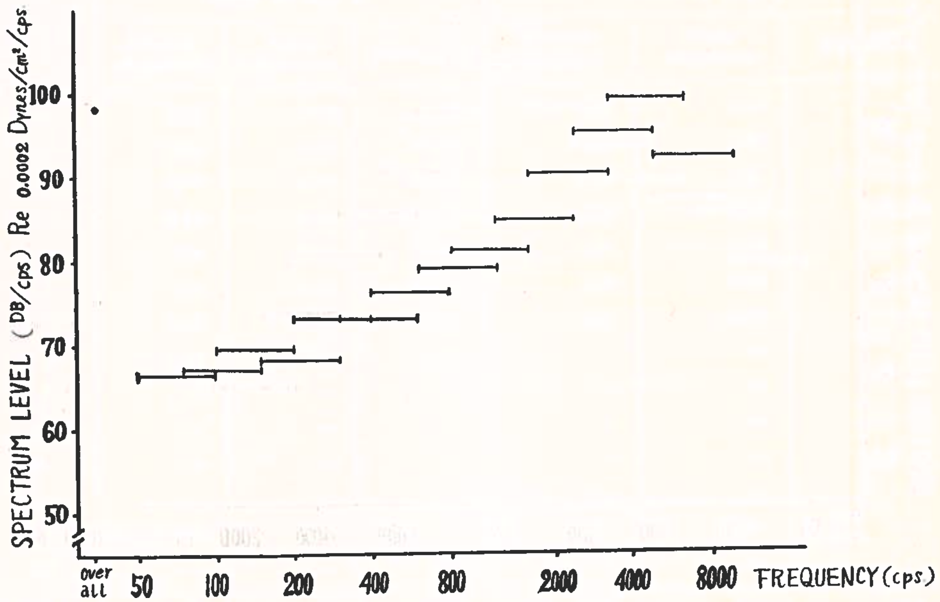

Fig. 3

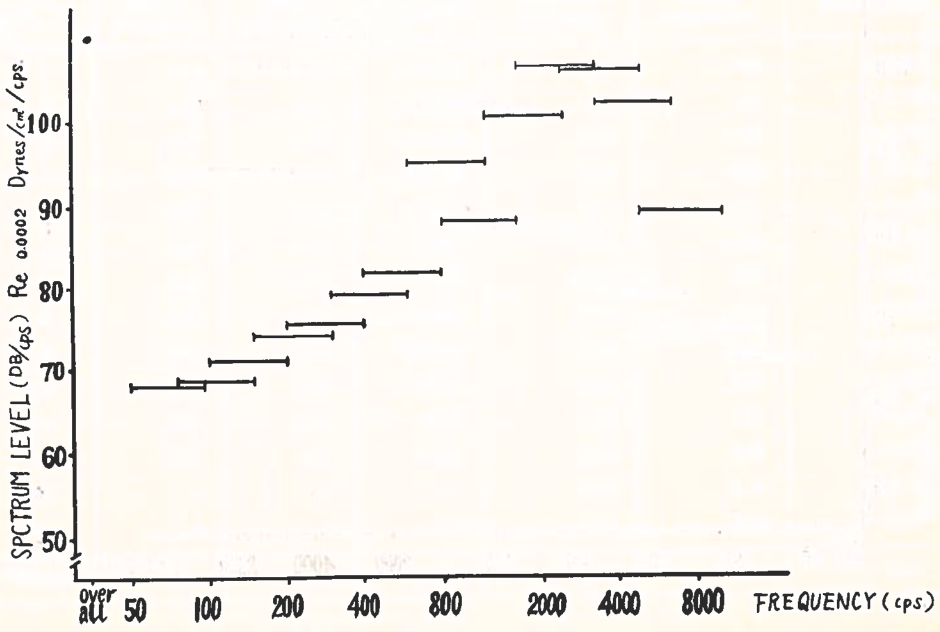

Fig. 4

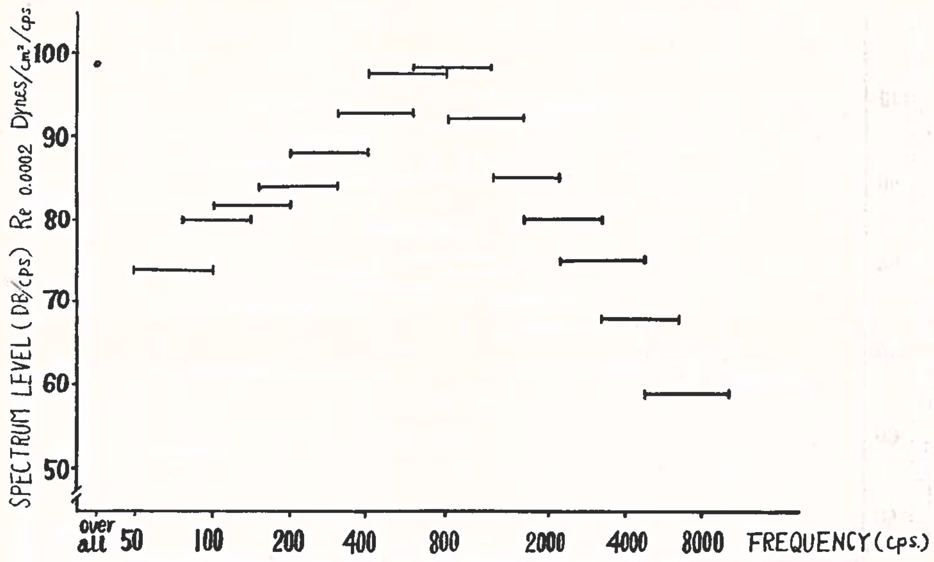

Fig. 5

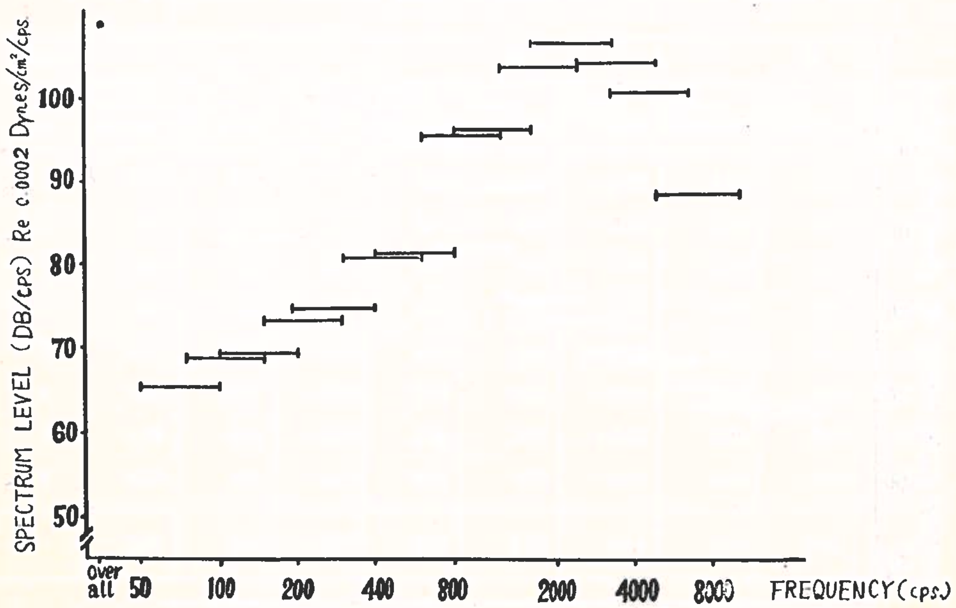

Table II Decrease of Urinary 17K.S. excretion by exposure to variable cycles.

Subj. No.	Noise in Fig. 2			Noise in Fig. 3		
	Before exposure	After exposure	Difference	Before exposure	After exposure	Difference
1	5.43	4.54	−0.89	3.57	2.31	−1.26
2	2.66	2.63	−0.03	3.01	2.84	−0.17
3	3.99	3.69	−0.30	2.37	2.21	−0.16
4	3.52	3.45	−0.07	3.03	3.02	−0.01
5	2.08	1.58	−0.50	4.95	3.40	−1.55
6	1.71	1.61	−0.10	4.48	2.35	−2.13
7	3.20	2.94	−0.26	3.47	3.29	−0.18
8	2.55	2.45	−0.10	—	—	—
9	—	—	—	—	—	—
10	—	—	—	—	—	—
11	—	—	—	—	—	—
12	—	—	—	—	—	—
13	—	—	—	—	—	—
14	—	—	—	—	—	—
Mean	3.14	2.86	−0.28	3.55	2.77	−0.78

Subj. No.	Noise in Fig. 4			Noise in Fig. 5		
	Before exposure	After exposure	Difference	Before exposure	After exposure	Difference
1	1.14	1.04	−0.10	1.66	1.63	−0.03
2	1.50	1.11	−0.39	1.40	1.63	+0.23
3	2.27	1.08	−1.19	1.61	1.43	−0.18
4	4.08	2.10	−1.98	2.85	2.08	−0.77
5	2.80	2.08	−0.72	1.53	1.11	−0.42
6	1.97	1.80	−0.17	1.95	1.45	−0.50
7	2.84	2.32	−0.52	1.52	1.50	−0.02
8	2.18	1.61	−0.57	0.98	1.58	+0.60
9	3.68	3.21	−0.47	3.11	3.40	+0.29
10	2.18	1.82	−0.36	2.25	2.05	−0.20
11	2.50	2.47	−0.03	2.08	1.71	−0.37
12	2.27	1.97	−0.30	2.98	2.89	−0.09
13	—	—	—	3.64	2.18	−1.46
14	—	—	—	2.47	2.46	−0.01
Mean	2.45	1.88	−0.57	2.15	1.94	−0.21

Fig. 6

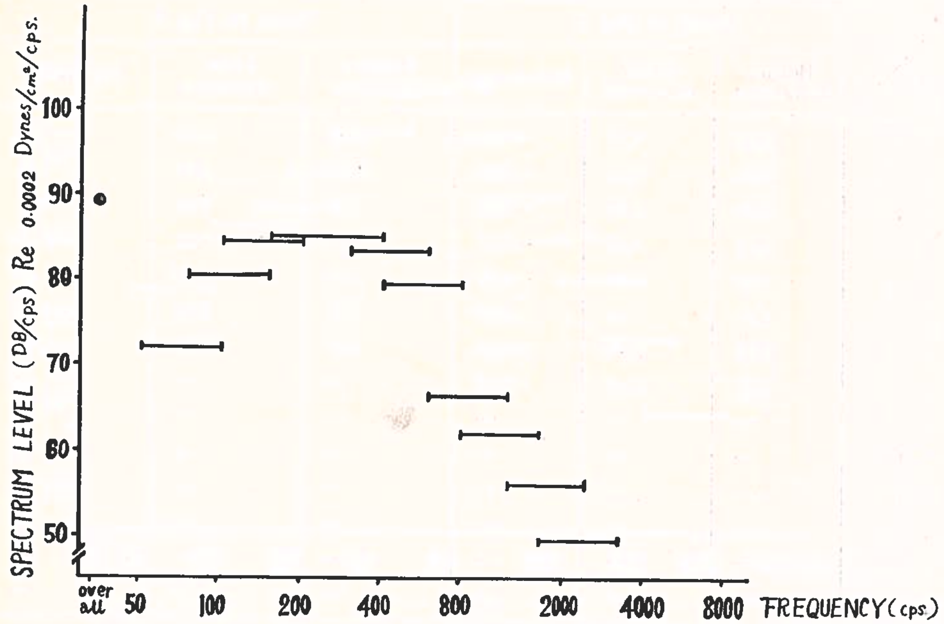

Table III Exchange of Urinary 17k.s. excretion by exposure to low frequency noise

	0 ～ 700 ∾		
	Before exposure	After exposure	Difference
1	1.68	1.89	+0.21
2	2.56	1.63	−0.93
3	2.90	3.24	+0.34
4	2.08	2.21	+0·13
5	1.63	1.76	+0.13
6	1.82	1.58	−0.24
Mean	2.11	1.05	−0.06

Fig. 7 Recovering viewes of adeno-hypophysis by long run exposure. secretion activity

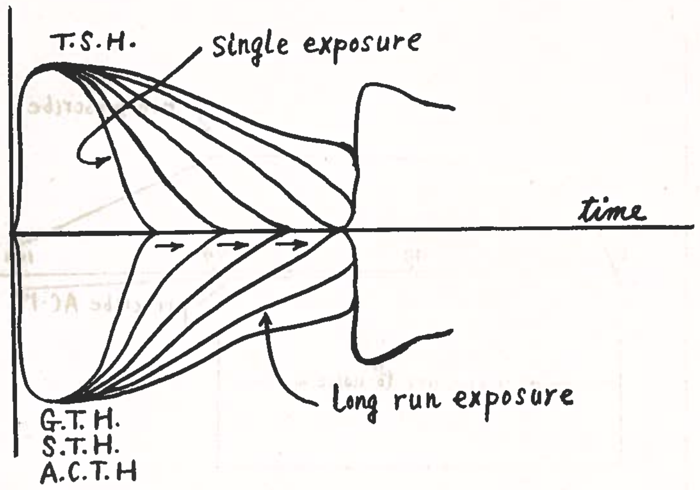

Table. IV Changes in total number of hens and eggs in the village around a airfield.

Stadium	Before	Initial stadium by exposure to jet.	Long run exposure to jet.
1-year-old hens	40	55	53
2-year-old hens	96	115	88
3-year-old hens	68	37	31
Total	204	207	172
Number of eggs laid per 100 hens daily	76	56	40

Table V Effect of AC-17 against the decrease of Urinary 17 K. S. by exposure to noise

Subj. No.	Contrast	exposure to noise	
		non prescribe	prescribe AC-17
1	1.9	1.2	2.0
2	2.4	1.3	2.0
3	1.9	1.5	1.9
4	1.0	0.8	1.2
5	2.2	1.8	2.0
6	1.5	1.2	1.7
7	1.9	1.7	2.0
8	2.2	1.2	1.9
9	1.7	1.0	1.9
10	2.3	0.9	2.0
Mean	1.90	1.31	1.86

AC-17 is prescribed oraly 30 mg. daily for 2 days.

governing the activity of the pituitary gland, and also that the changes in endocrine system may be brought about by the effects of the noise on higher centres.

Some metabolic changes in the brains of rabbits were observed. The brains were separated into 7 parts, cerebrum, cerebellum, interbrain, uper part and lower part of mesencephalon, pons, and medulla oblongata.

As a result of measuring the QO_2, lactic acid formation and glucose consumption in homogenates of each part, it has become known that disturbance of glycolysis of the interbrain was caused by exposure to noise. This phenomenon could not be seen by exposure to any other stimuli.

Next Na, K, and Ca in each part of brain were determined by flame photometry. The concentration of K decreased in the pons, and increased in the interbrain and cerebellum. But, the changes in concentration of K were not characteristic of the noise. However, the concentration of Na decreased in the lower part of the mesencephalon and pons, and the concentration of Ca decreased in the pons, lower part of mesencephalon and interbrain. These metabolic changes were characteristic of the noise.

On the other hand, the water metabolism in each part of brain was measured by Hatschek's method. The free water decreased in the interbrain, and the bound water increased in the cerebrum, lower part of mesencephalon, interbrain, pons, and medulla oblongata, but in the upper part of the mesencephalon, the bound water decreased.

I am not able to explain the relationship between these metabolic changes and the function of the higher centre, but I consider that this problem will be solved in the near future.

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