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TWIN STUDIES IN JAPAN

*JUKO ANDO**

The purpose of the present paper was to introduce the history, methodologies and findings of twin studies in Japan. At the initial stage, Japanese twin studies were strongly influenced by German psychology, especially its "strata theory" of personality. Uchimura et al.'s pioneer study and Inouye's eminent series of studies played an important leading role in establishing "the golden age of twin studies", during about one and a half decades beginning from late 1940s. In this period, a wide variety of studies were conducted mainly using the twin students of the high school attached to the University of Tokyo (Todai Fuzoku) and an interesting concept, "unconscious behavior (time)" was introduced by Takagi's, Kamitake's and Takuma's studies. Twinship and twin situations were another focus of twin research in Japan and Miki, Takuma and Amau have been conducting a series of studies on these issues. In Todai Fuzoku, there were several cotwin control studies, which are unknown but notable, in the educational settings. Some other interesting studies were also introduced and the future perspective is discussed.

It is well-known that the twin method is one of the most important methodologies in human behavioral genetics. A lot of large-scale twin projects are now going on in America, Australia, and some European countries, and the author has been introducing some of them (Ando and Watanabe, 1984; Ando, 1986, 1990, 1992a, 1994a 1994b). The methodological characteristics of recent twin studies are (1) big sample size, (2) longitudinal, and (3) multivariate. The modern twin studies look like a kind of "big science".

Compared to these trends, the methodology of twin studies in Japan has had quite a different picture. Unfortunately, the popu-

larity of twin study in psychology has already faded away and contributions to human behavior genetics are now minimal. We can find, however, "the golden age of twin studies" about forty years ago, in which a wide variety of twin studies were held in genetics, psychology, and education. The purpose of the present paper is to introduce the methodologies and the findings of Japanese twin studies in the psychological field (excluding psychopathology) and to compare them with those of modern behavioral genetics in foreign countries. Most studies introduced here are very old and classical.

The features of the Japanese twin studies are as follows.

(1) The theoretical background of psychogenetic studies stemmed originally from the theory of German personality psychology, the so called "strata theory of personality" or the perspective of "strata structure of psycho-physical person (Schichtenaufbau der psycho-physischen Person)" by K. Gottschaldt. The main method was natural observation of the twins' behavior in every-day life settings, such as in school or in summer camp, which only allowed small sample sizes.

(2) As for behavioral aspects, unconscious or involuntary processes of cognition and behavior were often focused upon. The

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reason was that these processes were assumed to be much more genetically-driven than voluntary processes.

(3) Researches of twinship (the relationship between twin siblings) were also common. In these researches, not only were cooperative factors examined, but also the factors which differentiate twin siblings.

(4) There was also a lot of research carried out in an educational setting. A special public high school attached to the University of Tokyo has been accumulating an adolescent twin sample selectively for over forty years, and has conducted a variety of unique twin researches through its educational activities. At the same time it has also provided twin samples for a lot of researchers who are interested in twin research. As a consequence, Japanese twin studies have been mainly of young adolescence and the number focussed on studies on other age groups (infant, childhood and adult) are small.

Historically, feature (1) has dominated the theoretical and methodological characteristics of Japanese twin studies. Until recently, Japanese twin researchers had used the German terminology, like EZ (Eineiige Zwillinge) and ZZ (Zweieiige Zwillings) instead of MZ (monozygotic twins) and DZ (dizygotic twins). Descriptive presentation of personality was sometimes preferred to a statistical one, and individual case studies which describe subjects' personality as a whole were popular. The fourth feature also affected our methodological limitation, that is the small sample size of DZ twins. Since 1963, both of the twin siblings have to pass the entrance examination of the high school independently. However, differences of academic abilities of twin siblings are on average larger for DZ than for MZ. Therefore it is difficult for DZs to enter this high school. Considering the low birth rate of DZ in Japan, this methodological problem is quite serious. In spite of these shortcomings, it is worth reviewing our classical twin studies, because they have the possibility to provide us with new methodological ideas which are difficult to find in recent behavioral genetics approaches.

Uchimura, Suwa and Okada's Study (1949)—the Dawn of Japanese Twin Study

It is surprising that we can find a notable twin study in the very first volume of *The Japanese Journal of Psychology* published in 1926. The author, Torao Obonai, collected over a hundred pairs of twins living in Tokyo City and reported the similarities of physical traits, intelligence and some learning abilities, that were expressed as correlation coefficients (Obonai, 1926). Although the distinction between MZ and DZ was not well-established in those days, he demonstrated the existence of these two kinds of twins statistically, selected 68 pairs of MZ-like twins by their facial features, and calculated the correlation coefficients of these "MZs" to be strikingly high (.98 for height and .86 for intelligence). He also studied the relationship between mirror-imaging and physical development of twins (Obonai and Kitawaki 1932). [Note 1]

One of the pioneer researchers who conducted empirical twin researches in its initial stage was Yushi Uchimura, a professor at the medical school of the University of Tokyo, who majored in brain science. He had been studying in München, Germany, in the middle of 1920s and was strongly influenced by Lange's and Gottschaldt's works on twins. After returning to Japan, he conducted "twin camp research" (in 1942 and 1943), imitating Gottschaldt's method, in which investigators spent a couple of weeks with twin subjects in summer camps and made natural observation of their everyday behavior from getting up to going to bed, or even in bed, with various psychological experiments. The focus of his research was the transactional processes between heredity and environment in shaping one's personality. His major findings were reported on a medical journal, entitled "*the Study of Character and Twin Research*" (1949) by his colleagues, Nozomi Suwa and Keizo Okada. Interestingly enough, the researchers who were interested in psycho-genetical (ie. behavioral genetical) issues in Japan were, and still are, mostly medical researchers, not psychologists.

In their report, after introducing several personality theories of famous philosophers

and psychologists, such as Spanger, Klages, Jung, and Kretschmer, Suwa and Okada discussed the history and findings of European twin research in detail. Then they studied Gottschaldt's summer camp method and his personality theory. Finally their own twin study was introduced.

Their twin study consisted of detailed case reports and experimental results of 11 male MZ pairs and 10 male DZ pairs of 11 to 16 years old. The subjects' photographs were also included in the report. The following is an example of the descriptions.

Twelve years old, fifth graders. First and second born male children. Their father studied at a certain university in America, had worked as a government official for long years, and died at 49. The father's character was honest, frank, active, and realistic. . . .

Both A and B [Note 2] were reared by their parents. Both parents did not treat twin siblings differently at all, but sometimes reproved A, saying "because you are the elder. . ." There was nothing abnormal during pregnancy, but B was in a state of suspended animation at birth, and showed slightly delayed development afterwards. . . .

They are quite similar identical twins, both mentally and physically. Highly similar behavioral patterns were observed in everyday life. Compared to the similarity shown in most part of their characters, differences between them are so trivial that such differences have no influences on their personality as a whole. The differences are following; A plays a leading part to B, and has responsible feeling towards his duty. He is also self-regulated and modest. On the other hand, B is compliant to A, lacking in independence, and selfish. The origin of such differences is thought to be the fact that A grew up being restricted as the elder and that B grew up freely as the younger, so these differences were shaped entirely by the environment.

Through these case observations, the au-

thors concluded that heredity plays an important role for forming one's personality and that physical and physiological factors, such as prenatal conditions and trauma at birth, and social factors, such as birth order and school training, might have caused the differences between twin siblings. They found that the more different physical conditions MZ cotwins have the more different psychologically they are. They also reported the results of several psychological tests (Intelligence, Rorschach, Kraepelin), some psychological experiments (eg. assessing one's own mental tempo by tapping), and works of drawing and clay sculpture. Although the results of these tests and experiments were analysed statistically, they were still anecdotal because of the small sample size.

In Uchimura, Suwa and Okada's study, we can find the typical methodological features in Japanese twin study, especially feature (1) and (3) mentioned above. Emphasized were observations under natural settings, effects of twin relationship, and personality as a whole, which are sometimes neglected in recent twin methodology. Nevertheless their interpretation of the data were intuitive, anecdotal and not theory-oriented. These shortcomings were overcome by Inoue's studies introduced next.

Inoue's Studies

Eiji Inoue is the most eminent behavioral geneticist in Japan and he used to be the president of both the Japanese Association of Human Genetics and the Japan Society for Twin Studies. He was a professor in the Institute of Brain Research, School of Medicine, the University of Tokyo. The institute was the main research center during "the golden age of twin studies". His works range from basic methodological discussion on twin method to heritabilities of mental disorders, EEG, and others. However his most important study worth introducing here is the genetic studies of personality. He provided an overview of Japanese twin studies, which were mostly his and his colleagues' studies, in the article entitled "Twin

Table 1. Relative Concordance and Discordance of MZ Twins in Behavior and Personality (Inouye, 1970).

	← Concordant	Discordant →
Behavior Level	Bodily Motion Facial Expression Personality Level	Situation-dependent Behavior Social Behavior Activity Temperament Emotion Will Ego-feeling
Strata Theory	← Deep Structure	Superficial Structure →

studies and human behavioral genetics” (1970). He introduced four major fields of human behavioral genetics in Japan; genetic studies of normal human behavior (including Uchi-mura, Okada and Suwa’s), studies of heredity and environmental influences on intellectual development, genetic studies of mental disorders, and an experimental study of a behavioral change by co-twin control. Thus he has already used the term “human behavioral genetics”.

His study on personality (Inouye, 1953) was also based upon the data of a twin camp. The subjects were eight identical twins in early adolescence, both male and female, including five pairs reared apart. He reported a detailed description of the subjects’ personality in the same way as the former researchers’, but it should be noted that he also analyzed the data in terms of German strata theory. His conclusion is summerized in Table 1 which suggested that “personality is seen to have a strata structure, and heredity plays an important role in the formation of ‘deep’ structure as activity, while environment plays an important role in that of ‘superficial’ structure as ego-feeling”. (Inouye, 1970) This perspective seems to be very suggestive, because most personality studies conducted in modern behavioral genetics are done in terms of self-reported questionnaire which could have mainly assessed superficial structures.

Inouye and his colleagues also conducted some interesting experiments on twins. He examined genetic mechanisms of tongue, finger, and other gymnastics, indicating that three types of tongue gymnastics (rolling, furling up and twisting) were seen as pleiotropic phenotype and independent to clover-leaf tongue, and that tongue rolling, clover-

leaf rougue and turning lower lip inside out were simple dominant traits with incomplete penetrance. On the other hand, freely flexible terminal joints of fingers was a simple recessive trait with incomplete penetrance, by means of the method that he had originated to estimate penetrance and gene frequency from data of concordance in MZ twins (Inouye, 1960). In another study (Inouye, 1966), he and his colleagues investigated the effect of bovine brain hydate on mentally retarded children by cotwin control with double blind method.

These studies were not Inouye’s only contributions to Japanese behavioral genetics. He has played an important leading role in Japanese twin studies. He facilitated new research ideas, constructed large-scale twin registries, and affected a lot of twin investigators, such as Kamitake, Takagi, Amau and Takuma, whom will be introduced next. The most fascinating idea he brought to the scene was “not to analyze similarities of twins on some specific traits predetermined, but to search what aspect of behavior is similar especially between MZ siblings (Inouye, 1980)”, which was termed “a Copernican change in twin method” by the author (Ando, (1993). It is a very important perspective because heredity never anticipates any psychological testing nor any specific culture which produces psychological aspects that we assess in tests. This research agenda has led us to various researches on the attractive concept, unconscious behavior, which is thought to be the most fruitful outcome in the golden age of twin studies.

Three Volumes of “Studies on Twins”—the Golden Age of Twin Studies

In 1948, the Department of Education of the

Faculty of Letters in the University of Tokyo (Faculty of Education was non-existent at that time) instituted a special junior and senior high school in which a certain number of twins (around 20 pairs each year) were given priority to enter for experimental studies of education. For the first three years, only MZ twins were allowed to enter, and an informal research team (which consisted of researchers of medicine as well as of

education with Prof. Kaigo as the leader) were involved in twin studies. In 1951, "the Twin Study Group" was established, financially supported by Grant-in-Aid from the Ministry of Education, Culture and Science. Other universities also participated in the research, and from then a wide variety of twin studies were conducted until the early 1960s. We can call this period "The Golden Age of Twin Studies" in Japan. [Note 3]

Table 2. Reports Published in Three Volumes of "*Studies of Twins*".

Volume 1 (edited by Uchimura in 1953)		
Kamitake	G.S.R.	10 MZs 8 DZs (junior high school students)
Kamitake, Tatsuno	sensory-motor learning	10 MZs 8 DZs (students)
Nakamura, Nakajima	Kraepelin-Uchida test	21 MZs 19 DZs (applicants=12 yrs)
Nakamura, Nakajima	Rorschach test	21 MZs 10 non twins (applicants)
Inouye, Miyazawa	intelligence	90 MZs 19 DZs (applicants)
Volume 2 (edited by Uchimura in 1956)		
Kondo	voice pitch	37 MZs 15 DZs (8-17 yrs)
Mizuno	a build, muscular strength, athletics	15 MZs 27-30 non twin pairs (students)
Kamitake	mirror-image of MZ	21 MZs 19 DZs (applicants)
Kamitake, Tatsuno	memory, guess	7 MZs 7 DZs (11-15 yrs) [memory] 20 MZs 17 DZs (9-17 yrs) [guess 1] 53 MZs 22 DZs (12 yrs) [guess 2]
Kamitake, Nagasawa	language ability	10 MZs 20 DZs (10-18 yrs)
Kamitake, Naruse	hypnosis	47 MZs 33 DZs (10-17 yrs)
Sagara, Takuma, Morikawa	intelligence	53 MZs 13 DZs (applicants) [Koga] 30 MZs 11 DZs (applicants) [WISC]
Iwashita	scholastic achievement	141 MZs 60 DZs (applicants)
Takagi	unconscious time	8 MZs (11-14 yrs)*
	Muller-Lyer illusion	16 MZs (11-13 yrs)
	level of aspiration	8 MZs (11-14 yrs)*
Miki, Amau	personality difference between twin siblings	32 MZs 15 DZs 1 UK (students)
Okada	personality development (case study)	11 MZs
Volume 3 (edited by Fujita in 1963)		
Kamitake	eye blinking	40 MZs 24 DZs (applicants)
Takuma	intelligence	62 MZs 14 DZs (applicants)
Sawada	intelligence development	12-30 twins (students)
Takagi	drawing, eye blinking	10 MZs 6 DZs (applicants)
	mental tempo	[drawing, eye blinking] 8 MZs 2 DZs 2 UKs (students) [mental tempo]
Kawashiro, Sekiya, Nakada	class atmosphere	12 MZs (1 st) 18 MZs (2 nd) (students)
Mizuno, Tanaka	nap	9 MZs (students)
Okada	personality development (case study)	3 MZs 1 DZ (infants)

* They had been participants of twin camps conducted by Uchimura and others.

Most research outcomes were published in three volumes of “*Studies on Twins*” (Volume 1 edited by Uchimura, 1953; Vol. 2 by Uchimura, 1956; Vol. 3 by Fujita, 1963) [Note 4]. There were 29 studies in Volume 1, 28 in Vol. 2, and 26 in Vol. 3, ranging from zygoty diagnosis, physical constitution, physiological conditions to psychological, psychopathological and educational issues. The psychological and educational studies are listed in Table 2.

Takagi’s and Kamitake’s series of studies might have been influenced by Gottschaldt’s strata theory and Inouye’s agenda. Takagi (1956) reported high heritability of “unconscious behavior”. In his experiment the subjects were asked to put together some stripes of five different comics (A to E) into an order to construct each story. Fig. 1 shows the order of choice, time of performance and time taken to tell the story, of eight pairs of MZ. As indicated in this figure, the order and the time spent for each test were dissimilar, but the total performance time was strikingly similar ($r=.98$). It is obvious that the subjects’ attention was focused entirely upon their performance, not upon the time spent, which led us to the concept of “unconscious behavior” or “unconscious time”. A similar phenomenon was reported by Takuma (unpublished, see Inouye, 1970). In Takuma’s experiments, there was no external standard to measure the time span and the subjects had to measure retrospectively the time spent in some mental tasks in terms of their internal sense of time which they had ignored while performing the tasks.

Kamitake (1963) counted the number of eye blinking under three different conditions. Under condition 1, subjects were asked to stare at a ball which was positioned just one meter away in front. Correlation coefficients of the number of blinking per minute between twin sibs were .10 for MZs and $-.04$ for DZs. Under condition 2 they were asked not to blink while staring at the ball, Correlation coefficients were .33 for MZs and .27 for DZs. Under these two conditions, no heritabilities were observed. However, under condition 3, the number of blinking were

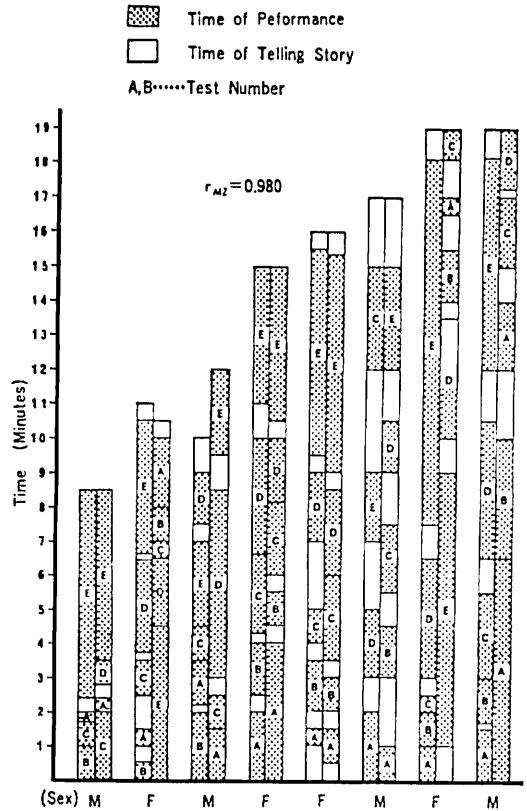


Figure 1. Unconscious performance time of monozygotic twins (Takagi, 1956).

counted while subjects were taking psychological test like intelligence test. The results were that $r(MZ)$ was .94 while $r(DZ)$ was -0.4 , indicating high heritability or emergence in Lykken’s terminology (1992). This result was replicated again in Takagi (1963).

Both Takagi’s and Kamitake’s studies showed high heritability of unconscious behavior which was hypothesized to be located in the deep structure of personality strata in Gottschaldt’s theory. Kamitake conducted a series of twin experiments (including those listed in Table 2) to investigate genetic structure of mental functioning, and offered the assumption that unconscious-physical functioning is more heritable than conscious-intellectual functioning and that conscious-intellectual functioning corresponds to the upper stratum of brain (cerebrum cortex) whereas unconscious-physical functioning cor-

responds to lower stratum (medulla oblongata or cerebellum) (Kamitake, 1971). This assumption needs to be verified by larger samples.

Okada (1956) conducted a follow-up study of his previous twin subjects. The study continued for more than ten years since the first and second twin camp mentioned earlier. Unfortunately World War II occurred during this period, and the social and family circumstances of the twins changed dramatically. These had made his longitudinal case study really interesting and valuable even though it might have been anecdotal. His study indicated that even identical twins who shared the same genetical dispositions sometimes took different courses in life or played different roles in society, even though their basic personality structure was maintained. Okada also tried to investigate personality development in infant and childhood in the same method (Okada, 1956).

As for intelligence, there were three studies (Inouye and Miyazawa, 1953; Sagara, Takuma, and Morikawa, 1956; Takuma, 1962). Inouye and Miyazawa did not find any significant genetic effects on intelligence measured by a kind of group test called Noken Test, but Sagara et al. and Takuma reported significant heritabilities of intelligence in different kinds of test: Koga (group test) and WISC (individual test) in Sagara et al; and Tanaka B and Ushijima Test (group) in Takuma. These results indicated that heritability depends on the kind of intelligence test that is used. It was noted in retrospect that Noken Test was originally designed to screen mental defectives (Inouye, 1970). Takuma (1968) added other kinds of intelligence data and confirmed significant genetic effects on intelligence in Japanese population. He also found a significant relation between intellectual development and perinatal factors such as low birth weight (Takuma, 1966).

Iwashita (1956) reported genetic and environmental influence on academic achievement using paired discrepancy scores. In comparison to Frischeisen-Kohler (1930), his results suggested lower heritability in the area of arithmetic and mathematics and possible

genetic effect on musical ability, which were the replicated results of Frischeisen-Kohler's. He also reported smaller discrepancy scores between MZ twins of girls than those of boys.

Miki et al's and Kawashiro et al's study were also interesting and they will be introduced in the following sections.

Above is a brief introduction of a series of "*Studies on Twins*". Although there were various kinds of studies and some of them seemed to be theoretically important, the sample sizes were small and most studies have never been replicated nor verified afterwards, except for intelligence. The fact that no study on personality by means of questionnaire was conducted is very strange. But the strangest thing is that no trend of behavioral genetic research took place in the psychological field in spite of such a fever of twin studies. Psychologists were interested in twin relationship rather than behavioral genetics.

Studies on Differences between Twin Sibs, Twin Relationship and Twin Situation

Although Miki was one of the contributors in a series of "*Studies on Twins*", the interest of his research was different from the others. He and his coinvestigators were not so interested in the genetic aspects of behavior but in differences between twin sibs which can be called "non-shared environment" in modern terminology. In Uchimura, Suwa and Okada's pioneer study, they reported systematic personality differences between the first born and the second born twin, which might bear relationship to traditional child rearing custom in Japan. The first born (or elder) child tended to be careful, self-controlled, directive, optimistic, but weak-willed and tend to avoid responsibility whereas the second born (or younger) tended to be introspective and modest but passive, riotous, selfish, complaining, crooked.

Miki and Kimura (1954) constructed a scale to measure such personality differences and verified the existence of these difference in identical twins. Miki and Amau (Kimura's married name) (1954) examined the correlational relationship between these differences

Table 3. Relation between Personality Differences and Treatment in the Family.
(Miki & Amau, 1953)

personality difference	treatment in the family		total
	different	not different	
large	6	2	8
small	12	11	23
nil	1	6	7
total	19	19	38

in personality and the discrepancy of treatment by their parents. In general parents did not treat their twins differently but in some situations, for example, when twin sibs are called or introduced to others, the elder tends to have a priority to the younger. Table 3 presents the contingency table between personality differences and treatment differences for boys which indicates a significant relationship. These studies were very important in the history of Japanese twin studies. They called upon twin researchers to distinguish the elder from the younger. Even now we still have the custom of calling the elder "child A" and the younger "child B". Furuhashi (1954) further investigated on the relationship among personality differences parents' treatment and interrelationship between twin sibs. His study was based upon systematic case reports of 12 MZs and 6 DZs including experimental situations, and it was difficult to generalize his result. But his study was the first empirical one to examine the issue of twin relationship (twinship).

About ten years later, Miki and his colleagues conducted another series of researches concerning twinship or "twin situation" in their term (Miki et al., 1963; Miki et al., 1964; Miki et al., 1969). In Miki et al. (1963), consciousness as a twin, consciousness as a friend and consciousness as a sibling were assessed in terms of the following aspects: feeling of indifferenciation, sympathy, willingness to participate together, willingness to defend a partner, and feeling of being half of a twin. They found that consciousness as a twin was the strongest among the three

especially for the female, suggesting that interpersonal relations of twins are different from those of non twins. Their next study (Miki, et al., 1964) focused upon this issue. A questionnaire was used to find out the level of independence from their mother. There was another questionnaire on their advisor on voluntary decision making behaviour, interviews, and still another questionnaire on the consciousness as a twin. Although independence from parents did not differ between twins and non-twins, twins tended to choose their twin sib, rather than their friends, as an advisor. It further suggested a possibility to interfere the development of friendship relations in twins. Miki et al.'s (1969) results on this issue were as follows: (1) Friendship relations of adolescent twins were neither intimate nor important as in non-twins, and this tendency was clearer among females than males. (2) Development of friendships with the second best friend as well as with the best friend underdeveloped. (3) There were two types of twins whose friendship was retarded. In one of the two types, the role of a friend was not clear and was not differentiated from that of the sibling. In this type the twin partner could be a friend as well as a sibling. In the other type interpersonal relations were cool and superficial in general. One of the co-authors, Takahashi, studied dependency of female twins later (Takahashi, 1973).

Miki's studies overemphasized the speciality of twin situations. His study gave us a negative impression that the study of twins seems to be a peculiar problem, and reduced the credibility of twin studies upon the issue of nature/nurture problem. This impression might have been one of the reasons why twin studies had declined afterwards. Actually one of his co-investigator Giyoo Hatano, who became a famous cognitive psychologist later, made the following comment on this nature/nurture controversy (Hatano, 1891);

In my opinion, such discussion as to what percentage heredity bears and what percentage environment bears proves absolutely fruitless. As frequently pointed out, both heredity and environment are

indispensable, and . . . the most important question is how much we can boost intelligence by environmental enrichment. . . . It is not always necessary to ask how much our basic abilities and conceptions are regulated by heredity.

We can find a typical "interactionalistic" view in his statement which might be the most popular in Japan today. Miki's last study was, in the author's opinion, a symbol of the end of the twin age.

The emphasis on twin situations mentioned above, however, had a great value in a practical sense, especially for twin mothers. The knowledge about twinship and twin situations can inform mothers of twins of a positive attitude on child rearing. Amau (Miki's first co-investigator) got married and, to her surprise, had twin children! She established the Japanese Association of Twin Mothers and has been the president of the association, as Mother of twin mothers. As a psychologist, her interest focused upon the differences between twin siblings and twin situations. In Amau (1988), there were a lot of empirical and anecdotal reports, together with scientific investigations, on twinship and twin situations which are valuable for mothers rearing twin children.

Takuma and Amau recently conducted a series of follow-up studies, together with the teachers of Todai Fuzoku high school, concerning twin relationship in late adolescence and adulthood (Takuma, et al., 1990, 1991, 1992). In their 1990 study, the research target was the students of this high school. The research indicated that females were higher than the males in their consciousness as a twin. Twins who were treated equally by their parents had a slightly higher consciousness than those who were not, and MZs were higher than DZ. Female twins tended to choose their twin partner as an advisor, suggesting that female twins were dependent on each other. Rebellious age range and personal anxiety level were reported to be more similar in MZs than in DZs. In the 1992 study, subjects were the graduates of the same high school, aging from 21 to 57 years old. A total of 164 pairs and 413

individuals participated (that means for 85 individuals their twin siblings did not participate). They found that there was a stable tendency of intimacy between twin siblings from late adolescence to middle and old age. Moreover, consciousness as twins substantially related to various aspects of personal relations. Whether such peculiarities of twin situation will bias the twin method is an important issue. Takuma and Takeuchi had conducted a similar research in 1983 (Takuma and Takeuchi, 1983). [Note 5]

Twin Studies in Educational Settings

Twin studies introduced above are not all the research done at Todai Fuzoku high school. There were a lot of other twin studies conducted in this school which are not well-known but worth introducing here. Because of the controversial issue of "heredity and education" which is at the core of the nature/nurture problem, twin studies in educational situation are highly valued.

There were about two dozen reports of twin studies published on the bulletin of this school (*Todai Fuzoku Ronshu*) since 1955. Among them the most fascinating studies were those using the cotwin control method. It is the most powerful method to examine environmental effects because investigators are able to manipulate or control environmental conditions directly, without any genetical variations. We can only find less than two dozens of this type world-wide, most of which did not contain more than three pairs of twins (Ando, 1993a).

There were three cotwin control studies: Nakada, Kawashiro, et al. and Fukue (Ibara). Nakada conducted a two-year comparative study between the method focusing upon students' own experience (the empirical method) and one that focuses upon objective sequences of the materials and rules (the curriculum method) in mathematics (Nakada, 1955, 1956). He found no significant differences between these two methods. However he found an interesting interaction pattern. For upper ability students, the curriculum method was beneficial whereas the empirical method was more suitable for lower ability

students. These results are quite similar to the authors's recent studies (Ando, 1992b, 1993), in which the communicative approach (CA) and the grammatical approach (GA) in teaching English were compared. CA was found to be beneficial for lower intelligent learners and GA for upper intelligent learners. These results indicate a typical disordinal ATI (Aptitude Treatment Interaction) pattern implying that experience-oriented instructions compensate for and curriculum-oriented instructions capitalize on intellectual aptitude. More interestingly, these results show a kind of genotype-environment interaction indirectly.

Kawashiro, Sekiya and Nakada (1957) investigated the effect of classroom atmosphere upon personality development. It was not a controlled experiment but a natural experiment because they happened to find two classrooms having very different atmospheres, one being active and talkative and the other being passive and quiet. Eight identical twins underwent a personality inventory, and the results imply a strong influence of these atmosphere differences in classroom upon personality change.

Fukue (married name of Ibara) conducted probably the longest longitudinal cotwin control experiments that have ever done in the world (Ibara, 1966, 1968; Fukue, 1970, 1971). They were also "natural" experiment. There was a general tendency that students in cultural clubs were emotionally stable and active while those in sport clubs took around the mean value (commonplace) in emotional stability and activity dimensions. She compared personality profiles of identical twins on Yatabe-Guilford Personality Inventory (YG test), and indicated that this tendency could be clearly observed even at an individual level.

There were also many studies on scholastic achievement and intelligence. An interesting finding was that there were several types of longitudinal changing patterns of scholastic achievement (Case Study Group, 1973). One example is "parallel type" in which twin siblings were completely different across all subjects, and another one is "counterbalance type" in which scores were different accord-

ing to subjects although the total scores were almost equivalent. Kasuya (1979) analyzed intelligence and achievement scores from a behavioral genetical point of view. Heritability of intelligence increased from seventh grade to tenth grade, which was a parallel conclusion of the author's recent analysis of this high school's data (Ando, 1993c). Kasuya also found that heritabilities of Japanese language and Science were substantial and mathematics was not heritable.

The results of twin studies conducted in Todai Fuzoku high school were published in a compact book in 1978 (The junior and senior high school attached to the University of Tokyo, 1978).

Other Topics

Although the research introduced above formed the main stream of twin studies in Japan, there were other studies that were conducted independently.

Ohira (1953, 1954, 1955, 1956, 1958) conducted a series of twin studies. He reported substantial genetic influences on intelligence, Japanese language, a degree of physical maturation, personality. Ohira also investigated the issue of genotype-environment correlation. Sawa (1957, 1958) reported correlations of intelligence between identical twins reared together, being around .90. Sawa also hypothesized a structure of intelligence according to these correlations, suggesting that linguistic factors such as knowledge, words, arithmetic were not affected by emotional disturbance but spatial, comprehension and figure arrangement were easily affected and therefore subject to change.

Soejima (1972a, b) analyzed scholastic achievement data out of the largest twin sample, from 6 to 14 years old, in Saga prefecture. In 1972a study, cross-sectional data of 594 pairs of twins (318 MZs, 147 DZs and 129 OZs) were analyzed and in 1972b study, longitudinal data of 158 pairs (80 MZs, 49 DZs and 20 OZs) were analyzed. Both studies offered the same conclusion that school marks were influenced by heredity in primary and junior high school level and mathematics was the most affected by environment in junior

high school level. Asaka (1978) also reported lower heritability of mathematics from the data of Todai Fuzoku students in 1971 and 1972. These two results were equivalent to Iwashita's conclusion mentioned before. Interestingly, a Swedish sample (Husén, 1959) showed a reversed result indicating high heritability in mathematics.

Abe, et al. (1993) presented higher concordance in the following behaviors in infant and early childhood: reaction to sudden noises, absence of stranger anxiety, abundant salivary drooling in infancy, and ability to sleep alone, clinging to the mother, motion sickness, constipation, perspiration, bedwetting, night terrors at 3 years old. Ooki and Asaka (1993) also reported the genetic influence on motor and language development in infancy by twins in Todai Fuzoku.

As introduced above, the author conducted the cotwin controlled studies to compare two different methods in teaching English (Ando, 1992b, 1993b). He also studied the similarities of MZs' semantic spaces expressed by means of multi-dimensional scaling (Ando and Watanabe, 1984).

The last three studies which are introduced next are somewhat unique. Ooki and Asaka (1990) investigated the attitude of twin mothers toward zygosity diagnosis. More than half of the mothers wanted to know about children's zygosity and mothers of identical twins were sometimes informed of children's zygosity as fraternal twin. Both Ooki and Asaka are the experts of zygosity diagnosis and they have conducted a lot of studies on it. Nagano and Imaizumi (1933) collected folklore data on twin birth. According to their article, seven percent of twin mothers heard of stories such as having animal-like babies and 1.3% heard that twins were reincarnation of a couple who committed double suicide. Fujinaga, et al. (1985, 1986, 1987) reported an interesting case study in which one pair of opposite-sex twin was reared by a family that was extremely feministic in its child rearing policy and also emphasized the acquisition of androgynous gender roles. Because of the influence of their grandmother (this is these authors' *ad hoc* explanation),

this policy was not consistent and, as a result, each cotwins acquired his/her typical gender role respectively although slight influences of the family policy could be seen.

Hayakawa (1933) recently edited a health handbook for twin mothers, nurse and those who have something to do with rearing twins. With the spread of ovulation induction drug, birth rate of twins is increasing and, therefore, a book like this might be useful. Hayakawa is a public hygienist who has a large-scale twin registry of middle and advanced ages in Kansai (western part of Japan) area.

Conclusion

Are the quality and quantity of Japanese twin studies presented in this paper sufficient? The answer is *yes* and *no*. As we have seen, there was a large variety of twin studies in Japan. The past investigators tried many kinds of methods and tested fascinating ideas. However, twin studies in Japan were still insufficient. Lack of replications, lack of researchers, small sample size of DZs, lack of studies of infant, childhood, adulthood and old ages, and lack of future perspectives. Why has the popularity of twin studies faded away? Is it because the nature/nurture problem has been solved by interactionalism? No, not yet. There are a number of unsolved problems: are there significant genotype-environment correlation and interaction? How about genetic structure of cognitive abilities and personality? How do these psychological traits develop as a result of heredity/environment interaction? Furthermore, the most important question is how a person's genetic predisposition blossoms by means of education. The twin method is one of the most fascinating methods in psychology, although it is one of the most difficult methods to conduct.

Note

1. In Ikemi's papers (1937a, 1937b), he presented a family study on personality. In the 7th volume of Japanese Journal of Psychology, E. Stern's article entitled "Beitrag zur Psychologie der Begabung von Zwillingen (Psychological

contribution on disposition of twins)" was introduced.

2. In Japan, a first born offspring tend to be respected because of a tradition of patriarcy and sometimes treated as the elder sibling even though he/she is one of the twin.
3. The author referred to Kawasaki (1957)'s report, when introducing the historical review presented here.
4. The first volume of Bulletin of the Faculty of Education, University of Tokyo was a special issue on twin studies, which contained six papers.
5. Takuma wrote an interesting essay on his experience of twin studies (Takuma, 1991).

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