

SOME IMPORTANT SCENES IN THE HISTORY OF PSYCHOPHYSICS IN JAPAN

Tadasu Oyama

Department of Psychology, Nihon University, Sakurajosui, Setagayaku, Tokyo 156-8550, Japan

<oyama@gssc.nihon-u.ac.jp>

Abstract

In Japan, psychophysics began as early as 1888 with the first lecture on it given by Yujiro Motora at the University of Tokyo, following the completion of his Ph. D., at the laboratory of G. S. Hall. In 1910, the Photographic Album of Experimental Psychology was edited by the Department of Psychology of the University of Tokyo that included many photographs of psychophysical experiments. In 1933, Sadaji Takagi conducted the first experiment on animal psychophysics to investigate shape constancy in small birds. In 1949, the first experiment on infant psychophysics was conducted by Jyuji Misumi to study the early development of size constancy. And, in 1959, Tadasu Oyama proposed a new psychophysical technique, named the method of transposition to measure perceived size ratios without using numerical expressions. This method has been successfully applied to the measurement of illusions, figural after-effects, and size constancy. In 1960, Tarow Indow and his collaborators published their first systematic application of multidimensional scaling to color perception.

Beginnings of Psychophysics in Japan

Scientific psychology in Japan began as early as 1888 with Yujiro Motora's (1858–1912) lecture on "Psychophysics" at the University of Tokyo, which was conducted after he received his PhD at Johns Hopkins University (Oyama, Sato, & Suzuki, 2001). He also wrote a series of papers entitled "Psychophysics" in a Japanese academic journal called "Tetsugakukai Zasshi" (Journal of Philosophical Society). Motora defined "psychophysics" as the study of psychological phenomena from the physical side. According to him, the purpose of psychophysics was to investigate the relationship between physical phenomena such as rays or nerve impulses that are stimulated by them and sensory phenomena such as light. His papers included such topics as sensation, psychophysical measurement of sensory thresholds, Weber's law, Fechner's law, ideas, consciousness, attention, span of attention, reaction times, cyclic variation of attention level, rhythms in Japanese classical poems, and law of associations, obviously encompassing more areas than Fechner's original psychophysics. Motora pointed out that Weber's law is an experimental law, but that Fechner's law is a theoretical hypothesis. Motora's psychophysics was modern and scientific psychology, which contrasted with the mental philosophy and speculative psychology that had been taught in Japan before him (Oyama, 2001). Perhaps, Motora and Fechner shared strong theoretical interests on the relationship between the mind and the body, and between psychological and physical phenomena, as well as on the empirical basis of these relationships.

Establishment of Psychophysical Measurements as Laboratory Practice

A Photographic Album of Experimental Psychology, edited by the Department of Psychology of the University of Tokyo and published in 1910, illustrates the high level of instrumentation and methodology used in Japanese experimental psychology of the day (Osaka, 1999). The book contains 37 experiments including psychophysical measurement of the sensory threshold and the difference threshold using von Frey's hair aethesiometer, Zwaardemaker's olfactometer, Fechner's sound pendulum, and sonometer, among others. This book also has a brief explanation of psychophysical measurement techniques. By this period, leading Japanese psychologists who were students of Professor Matora, already had enough knowledge and instruments in classical psychophysical methods. They used these to conduct original experimental studies and to teach laboratory courses for students in newly founded universities and colleges.

In 1926, Koreshige Masuda (1883-1933), one of Matora's last students, wrote a book entitled "Introduction to Experimental Psychology," in which he discussed the methodology of psychology. Part of his book also contained manuals for laboratory practice that were intended for instructors and students. These included psychophysical measurements of the Müller-Lyer illusion, estimation of the middle point of a visually presented line, stimulus threshold for sound, discrimination threshold of tonal pitch, among others.

In the same year, the *Japanese Journal of Psychology* was launched, at first by a small group of psychologists, to be taken over in 1927 by the Japanese Psychological Association as its official scientific journal and it has been published continuously until today. In the early volumes of this journal, many important contributions have been published on geometrical-optical illusions, the moon illusion, size constancy, and other perceptual phenomena that were investigated by using psychophysical measurements (Oyama & Goto, 2007; Oyama, Torii, & Mochizuki, 2005)..

First Experiments in Animal Psychophysics

In 1933, the first experiments in animal psychophysics were conducted by Sadaji Takagi (1893-1875) who investigated shape constancy in small birds (Takagi, 1933), based on the hypothesis that it was important for birds, as well as humans, to make similar responses to objects of the identical shape, independently of the viewing direction.

Takagi trained four Japanese tomtits (*Sittiparus varius varius*) with the simultaneous discrimination method in the situation shown in Figure 1 (a). The bird had to fly from the perch and pick up food covered by one of two thin white plates of the same area that were placed side by side, perpendicularly to the line of sight from the perch. One cover was a circle and the other was an ellipse. The positive stimulus was the circle for two of the birds, whereas it was the ellipse for the other two. After the training in shape discrimination was completed, two of the birds were tested in two situations, in which the circular and ellipsoidal covers were tilted 45° and 60° to the line of sight. In the 45° test, the birds chose the positive stimuli in 60% and 65% of trials. This meant that the birds that were trained to choose the circle, continued to choose the circle more frequently than the ellipse; whereas the birds trained with the ellipse, continued to choose the ellipse rather than the circle, despite the fact that

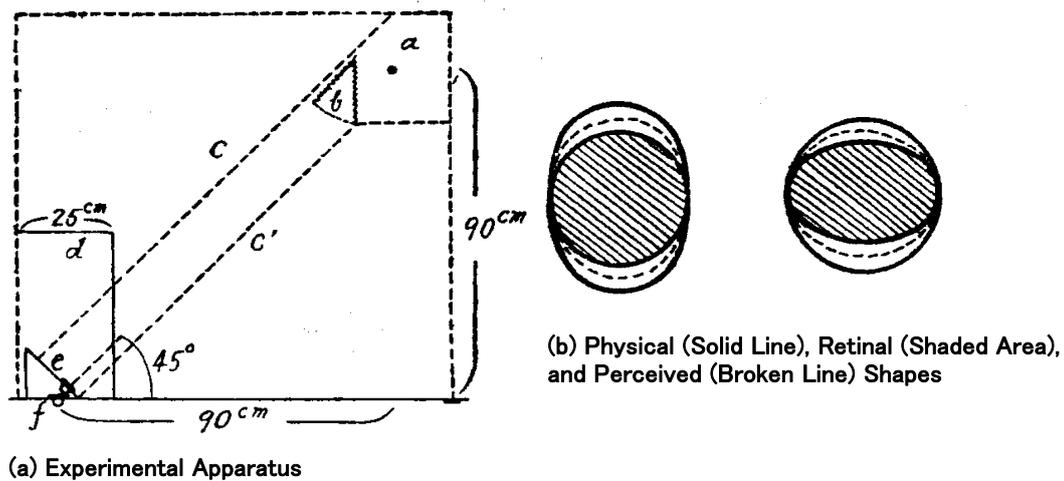


Figure 1. Experiment on size constancy in small birds (Takagi, 1933)

the retinal images of the circular and ellipsoidal covers were changed to an ellipse and a circle, respectively, as shown in Figure 1 (b).

This result clearly demonstrated shape constancy in birds. However, in the 60° test, the birds chose the wrong stimulus more frequently than the right one, suggesting that shape constancy in birds was not fully developed. Takagi was careful to conduct control experiments with the same birds, to demonstrate that their shape discrimination was mostly independent of size and orientation (in the perpendicular plane to the line of sight) of the stimuli. It is particularly interesting that he confirmed shape constancy in birds, which are known to use only monocular depth cues. In this experiment, psychophysical measures, such as the point of subjective equality were not obtained and only the frequencies of the discrimination responses by the birds were analyzed. Yet it can be said that these experiments heralded the beginnings of animal psychophysics in Japan.

First Experiments on Infant Psychophysics

In 1949, Jyuji Misumi (1924-2002) who later found fame as a social psychologist, in his young days conducted the first experiments on infant psychophysics to study early development of size constancy (Misumi, 1949). The participants in his studies were over 400 normal infants who visited the Medical Center of the Kyusyu University for physical examinations. More than 10 infants served as participants for each age group in each experiment.

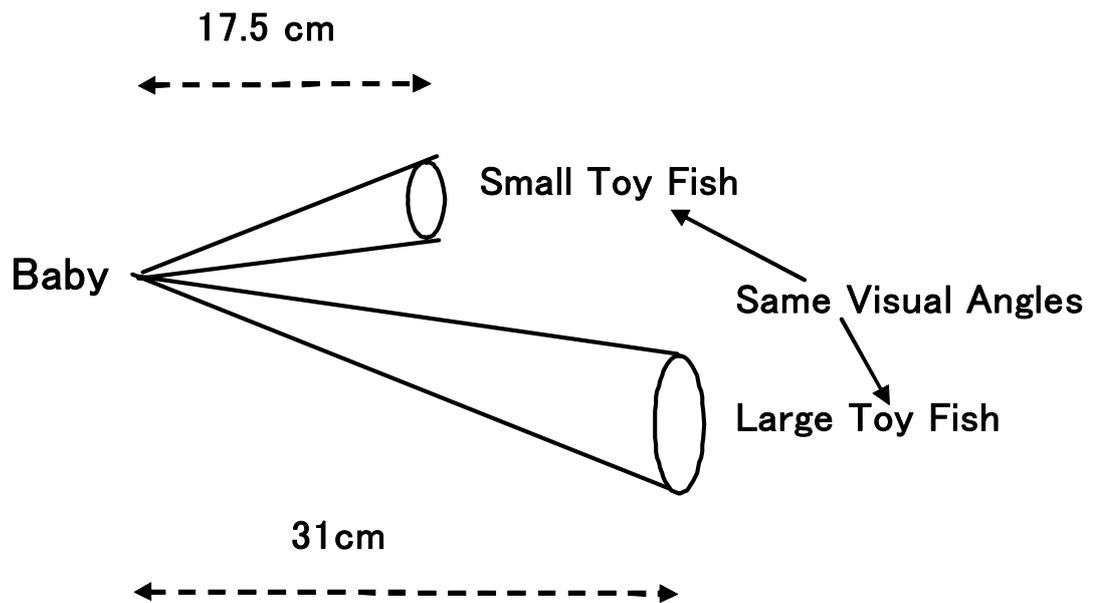


Figure 2. Size constancy in infants (Misumi, 1949)

His investigations confirmed that infants older than the 5 months preferred larger object to smaller ones, when these objects were presented at the same distance from the infant. When a large and a small goldfish toys were presented at different distances in such a way that the two objects had the same visual angle as shown in Figure 2, infants older than approximately 30 weeks indicated a weak tendency of size constancy in their reaching behavior. Some of them chose the far, but physically larger of two objects that presented identical sizes on the retina, whereas in a control experiment, infants chose the near object 100% of the time, when objects had the same physical size.

From these and other experiments, Misumi concluded that infants show size constancy after they are approximately 8-months old. Misumi's investigation was a pioneering study on infant perception and it would be worthwhile to re-examine his results using modern techniques.

A New Psychophysical Method: Method of Transposition

In 1959, Tadasu Oyama (the author) proposed a new psychophysical method, *the method of transposition*, in which the perceived size ratios are measured without any numerical expression by the observer (Oyama, 1959). The name was derived from the Gestaltist's concept of *transposition*, and it involves a type of ratio matching. However, it was quite different from Stevens' (1957) ratio-estimation, or ratio-production methods, because the method of transposition did not use verbal responses or numerical concepts.

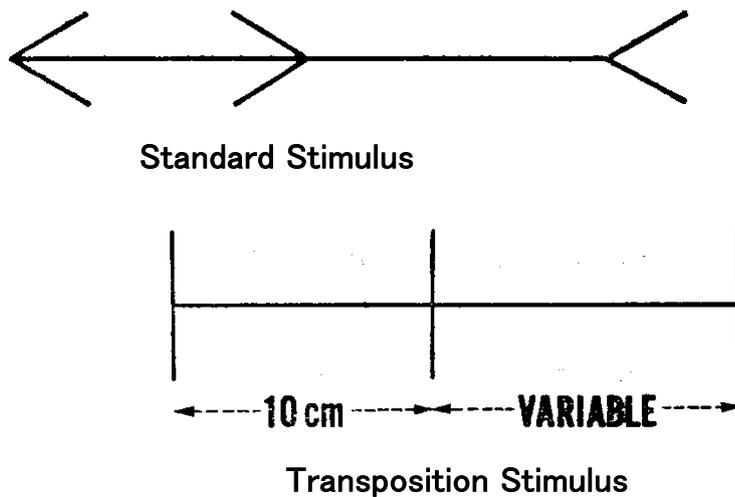


Figure 3. Method of transposition (Oyama, 1959)

In the *method of transposition*, the experimenter usually uses two pairs of objects; the standard pair of objects whose apparent size-ratio is being investigated in relation to some perceptual phenomena, such as an illusion, a figural after-effect, or constancy, and the comparison pair of objects that are presented in a neutral place and physical size-ratio is systematically varied. The observers are asked to compare apparent size ratios or relations between the two pairs and to match the comparison pair to the standard pair. In the case of the Müller-Lyer illusion shown in Figure 3, the observer matches the perceived length-ratio between the right and left parts of the transposition (comparison) stimulus to the ratio between those in the standard stimulus (illusion figure), adjusting the variable part of the former. In other words, observers transpose the perceived relationship between the standard pairs to that between the comparison pairs. This method has successfully been applied to the measurement of illusions, figural after-effects, and size constancy, among others. (Oyama & Ichihara, 1973; Oyama & Sato, 1967).

Multi-Dimensional Scaling

In 1960, Tarow Indow and his collaborators published their first systematic application of multidimensional scaling to color perception. They produced three-dimensional configurations of colors, very similar to the Munsell color system, but deviating somewhat from the Munsell system, particularly in the spacing of hues (Indow & Kanazawa, 1960). Indow has continued systematic studies on this topic until recently (Indow, 1988).

Concluding Remarks

In Japan, there is a long history of psychophysics, going back over 120 years. I have reviewed some relatively early and important contributions of Japanese investigations in this field. These studies form the background to the investigations in psychophysics currently being conducted in Japan.

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