Psychology

The leading aim of our department is to explore the psychophysiological mechanisms underlying human stress reaction by adopting the current methodology of cardiovascular psychophysiology. Our basic research, especially on developing new non-invasive measures for cardiovascular hemodynamics, autonomic regulation, and vascular health, has stimulated application studies focused on human mind-body interaction and health promotion.

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1. Development of a normalized pulse volume (NPV) measurement device

Normalized pulse volume (NPV) is expressed as PGac/PGdc. Here, PGac and PGdc are the alternate and direct current components of the photo-plethysmogram (PG), respectively. Using a theoretical pressure-volume curve, it was confirmed that NPV was directly proportional to the pulsating component of arterial blood volume. Notably, as a stress marker, NPV was predicted to be more sensitive than the other two PG indices when exploring the effects of increases in vascular resistance and elevations of blood pressure on these PG indices during rest and mental stress.

Based on the NPV measurement, new devices have been developed as follows:

2. Development of a new non-invasive blood pressure monitoring device

In collaboration with biomedical device manufacturers, we developed a new volume-clamp device, MUB101 (Medisens, Tokyo), and more recently, a mobile continuous blood pressure solution, viewPhii CBP (Socionext, Kanagawa). This most recently developed device can achieve a reliable measurement of non-invasive, beat-by-beat finger blood pressure (BP) with two novel techniques: 1) a partially open cuff-unit is employed to prevent blood from pooling at the fingertip, and 2) an appropriate cuff position permitting the least involvement of the finger tissue segment under the cuff can be checked by observing the alterations of a finger photo-plethysmographic signal along with a gradual increase in cuff pressure.

3. Development of a new device for measuring baroreflex-based parasympathetic and vascular sympathetic autonomic activities

Blood pressure is an important vital sign. When it excessively rises or falls, our brain attempts to keep it within a normal range. This mechanism is called baroreflex. A new device can measure 1) neurogenic baroreflex sensitivity (parasympathetic activity) by calculating the slope of a regression line representing the correlation between the NPV and the pulse interval in a baroreflex series, and 2) vascular autonomic activity by calculating the deviation of NPV in that series (2, 3).

The challenge ahead of us is to explore the psychological and behavioral factors that mediate progress in stress-related diseases and the promotion of health. Using various measures, including the new device and indexes explained above, we are continuing our behavioral epidemiological studies.

Additionally, we obtained a patent for our newly developed hardware, namely an ear-cuff-type wearable device for measuring various types of biological information. The biological information measuring device is equipped with a clip that attaches to the boat-shaped fossa of the auricle so as to be sandwiched from both sides and a part of the clip, and the clip is provided on the boat of the auricle. It is also equipped with a pulse wave sensor that does not press the helix when attached to the auricle and measures biological information from an artery running through the helix. The pulse wave sensor is a non-contact-type sensor that measures biological information using transmitted light, and the clip is such that it sandwiches the boat-shaped fossa of the auricle from both sides. The pulse wave sensor may be configured so as not to come into contact with the helix when worn in such a manner.

4. Japanese Children's Temperament from Early to Middle Childhood

The purpose of this research is to examine the applicability and the factor structure of the Temperament in Middle Childhood Questionnaire (TMCQ) and to explore the development of temperament from early to middle childhood with a longitudinal Japanese sample.

The TMCQ, consisting of 157 items designed to measure 17 subscales of temperament of middle childhood, were directly translated into Japanese, and was sent by post to 927 parents who participated in an early childhood temperament study in 2012. Although 217 were not delivered due to unknown address, 272 parents agreed to participate in the research and responded to the questionnaire (return rate of 38.4%). Because the targeted age range for TMCQ is 7 to 10 years old, we excluded data for children over the age of 11 and analyzed the remaining 190 responses (101 boys and 89 girls; 13 of whom were 8 years old, 84 of whom were 9 years old, and 93 of whom were 10 years old).

The results showed satisfactory high reliability coefficients (Cronbach's alpha) for all subscales except the one for Low-Intensity Pleasure. To examine the structure of the subscale, factor analysis was performed only on subscales included in the three factors of the Children's Behavior Questionnaire (CBQ). Although three factors (Negative Affectivity, Surgency/Extraversion, and Effortful Control) were obtained from the factor loading pattern, the loading pattern of some subscales differed from those of the CBQ obtained in the previous study and the reliability coefficients of Effortful Control were low. ANOVA with two factors (age × sex) for each of the three-factor scales calculated similarly to those of the CBQ was performed. A significant sex difference was found in the following factor scores: the score for boys was significantly higher than the score for girls for Surgency/Extraversion (F (1, 184) = 6.93, $p < .01$), and the score for girls was higher than the score for boys for Effortful Control (F (1, 184) = 5.82, $p < .05$). There was no interaction between age and sex, and no age differences for the three-factor scale scores. The magnitude of correlations of the same factor scale score between the CBQ and the TMCQ were moderate (Table 1).

Table 1 Reliability and exploratoy factor analysis of the TMCQ scale scores

		Rotated Factor Loadings		
Scale	σ	F 1 (NA)	F 2 (EC)	F 3 (ES)
Activation Control	.68			
Activity Level	.88	-.05	.07	**.65**
Affiliation	.72			
Anger/Furustration	.74	**.55**	-.29	.04
Assertiveness/Dominance	.71			
Attention	.89	-.15	.76	.00
Discomfort	.68	**.78**	.05	.01
Fantasy/Openness	.70			
Fear	.74	**.65**	.07	-.19
High Intesity Pleasure	.76	-.06	-.20	**.74**
Impulsivity	.78	.19	**-.72**	.26
Inhibitory Control	.76	.14	.90	.05
Low Intesity Preasure	.16	**.43**	.12	12
Perceptual Sensitivity	.71	.38	**.45**	**.46**
Sadness	.78	**.71**	-.17	-.18
Shyness	.75	.32	.20	-.34
Soothability/Falling Reactivity	.71	**-.69**	.12	.02
Extraversion/Surgency (ES)	.66			
Negative Affectivity (NA)	.82			
Effortful Control (EC)	.55			
Eigenvalues		3.71	2.87	1.53
% of variance		28.50	22.05	11.79

Extraction Method: Principal Axis Factoring

We concluded that the TMCQ is applicable to Japanese school-age children with the exception of the Low-Intensity Pleasure scale. While the temperament of Japanese children was moderately stable from early to middle childhood, we consider further study of the structure of the TMCQ necessary due to the low reliability of the Effortful Control scale.

Keywords: Development of measurement device, Temperament

List of Main Publications and Patents from 2019 to 2022

1) Kato Y. Baroreflex Vascular Sympathetic Nervous Activity Detection Device, Baroreflex Vascular Sympathetic Nervous Activity Detection Program, and Baroreflex Vascular Sympathetic Nervous Activity Detection Method. Patent JP7081831B2. 2022-6-07. US11517207B2, 2022-12-06. EP3603495A4, 2021-0106.
2) Kato Y. Biological information measuring device. Patent JP7261491B2. 2023-4-20.

See 2D Barcodes below