SUPPLEMENTAL FILES

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Part 1. Pilot Study

A pilot study was conducted prior to the experiment. Three university teachers (female, ages 34, 35, and 39) as Group A and four graduate students (female, ages 21, 22, 23, 24) as Group B, participated in it. Group A was mainly used to investigate the possible disturbances from everyday consumption habits. As consumers, teachers are more mature than students, so they were selected into Group A. Group B was mainly used to investigate a subject's tolerance limit for the electrical-power massage stimulus. Group B consisted of graduate students whose classmates would participate in experiments.

In Meas. 1, all subjects in Group A reported that they were somewhat hesitant for correctly looking for a proper fixed least starting point of the price estimate from their experiences of service market. Based on well-recognized customs in the service market, the subjects always thought that pay for the time of the massage should be priced above this fixed starting point. They all agreed this starting point ranging from ¥2.0 to ¥5.0. The experiment measures only the price for the duration of the massage but not the fixed starting price. To avoid such a mixing, the subjects were informed in experiments that a starting price of ¥3.0 has been considered, and only the money amount after this starting price needs to be reported. Choosing ¥3.0 is with such a consideration that students usually consume at lower price than teachers. Although it is impossible to set up a completely pure double-estimate condition in the experiment, this fixed starting price at least makes the condition purer.

In Group A, furthermore, two types of subjects' estimates were observed in Meas. 1 and 2. Two subjects assessed the money amount or duration based only on their intuitive estimates. And they kept so even Meas. 2 was repeated twice in sequence. This is in favor of the experimental purpose. However, one subject estimated them by a numerical counting in mind, and delivered almost linear data. She told the experimenter that she guessed the correct answers the experimenter would accept and made efforts to deliver a "correct" result in stead of the intuitive estimate. This is unfavorable to the experimental purpose.

Considering the results of Group A, an instruction was used in experiments to remind subjects: "There is neither 'correct' nor 'wrong' for the results you will report. It is very good as long as your reports are derived from your intuition but not from mechanically calculating the time in mind in parallel with the operating of the massage machine, e.g., rigidly counting seconds silently."

In the pilot study of Group B, all subjects showed evident boredom for the duration of massage above 75 seconds in Meas. 1, and partial subjects' showed boredom for the money amounts above ¥7.0 in Meas. 2. Therefore, the setting factors were finally determined as "Table 3" in the formal text.

The beginning instruction generally used for five simple experiments and Latin square experiment was as the following:

> *In the coming experiment you will experience a series of electrical-power massages with different durations. We want to know how you subjectively evaluate their prices according to their different durations.*
>
> *Usually there are two types of evaluating massages. One, basing on the degree of your comfortableness, namely, if you feel more comfortableness in a massage, you will evaluate a higher price, and if you fell little comfortableness, you will evaluate a very low price, without referring to the massage duration in time. This is not the evaluating type the experiment wants. Another evaluating type is basing on the massage duration in time. This is the evaluating type the experiment wants. You should price a presented massage by concentrating on the massage duration but not your comfortableness in the experiment. Just like in an electrical-power*

massage cure, the price is determined only by the massage duration but not one's comfortableness. We want to know that how you intuitively evaluate price only basing on the massage consumption quantity.

There is neither 'correct' nor 'wrong' for the results you will report. It is very good as long as your reports are derived from your intuition but not from mechanically calculating the time in mind in parallel with the operating of the massage machine, e.g., rigidly counting seconds silently.

In addition, a starting price of ¥3.0 for using the massage machine has been considered, and only the money amount for massage durations after this starting price needs to be reported.

Further more, to understand behavioral characteristics of subjects in experiments, after Meas. 1, 2, and 3 concluded, subjects received a sheet of Implemental Questionnaire Investigation on which they were asked to answer some questions showing their possible experiences involving market services of electrical-power massage and behavioral features in experiments. Sometimes, an additional oral inquiry was made by the experimenter to clear up some situations observed in the experiments. The information was used in appraising experimental data.

Part 2. Designs of Simple Experiments I~V

3.1 Method

3.1.1 Participants

85 graduate student volunteers were recruited from Jinan University as subjects in experiments. They were divided into five groups, labeled Groups I~V, with 17 subjects in each, respectively participated in five experiments, labeled Exps. I~V, which were differently designed in stimulus levels or stimulus presentation orders. To attract subjects, all participants were provided a free banquet or paid. Groups I, III, and V came from Management School, majored in management, and learned economics; Group II also from Management School, but majored in psychology or education, and never learned economics; and Group IV mainly from Literature School, majored in literature or history, and never learned economics. 5 subjects of Group II absented in the experiment. The actual participants in Group II were 12. Status of Groups I~VII are described in Table 3-1.

Table 3-1. Status of Groups I~V

	Subject	Male	Female	Age	Education Background
Group I	17	7	10	22-25	Learned economics, major in management
Group II	12	6	6	22-25	Never learned economics, major in psychology and education
Group III	17	8	9	22-26	Learned economics, major in management
Group IV	17	8	9	22-25	Never learned economics, major in literature or history
Group V	17	8	9	22-25	Learned economics, major in management

3.1.2 Measures

Each of Exps. I~V consists of three measurements, which investigates subjects' utility estimates respectively under three laboratory conditions of "quantity-price double estimate", "quantity single estimate", and "price single estimate".

Under the condition of quantity-price double estimate, labeled Meas. 1, subjects experience a sequence of consumptions, in which consuming quantities are unknown to them, and the prices are without existing recognized standards in practical markets. Subjects are asked to report money amounts they are willing to pay by estimating the consuming quantities through subjective assessments. This condition makes the utility scaling similar to one of Stevens' magnitude estimates in psychophysics, called cross-modality matching, a double estimate between the sensation scalings, for example, of handgrip and other physical stimuli such as loudness, brightness, visual length, vibration, electric shock, and so on.

Under the condition of quantity single estimate, labeled Meas. 2, money amounts are clearly assigned to subjects for their consumption, and they are asked to estimate consuming quantities they think "should be" to match the money amounts.

Under the condition of price single estimate, labeled Meas. 3, subjects are clearly told about quantities to be consumed and asked to estimate the prices they are willing to pay.

Meas. 2 and 3 are decompositions from Meas. 1.

Electrical-power massage is used as consumption in the experiment. It is conducted through a portable electrical-power massage machine, which is handy for the experimenter to control. The duration of the electrical-power massage is the consuming quantity and the money a subject is willing

to pay for such duration is the price chosen. Such an exact length of time is easily treated to be unknown to the subject. And, very importantly, till date in China, it is quite seldom to see commercial services of electrical-power massage, and stimulus of electrical-power massage has no recognized standard market price. These satisfy conditions required by the measurement of double-estimate utility. Subjects were not required to pay their estimates. It was a hypothetical test.

Taking Exp. I as an example, Meas. 1, 2, and 3 were specified as follows:

Meas. 1: A subject was given five stimuli of the massage on the waist of durations 15, 30, 45, 60, and 75 seconds, sequentially; the subject was not informed about durations of the stimuli. After one stimulus was completely presented, the subject was immediately asked to report orally a money mount he was willing to pay for the stimulus just experienced. And so on for next stimulus. When all five stimuli were given and five money amounts were reported, Meas. 1 concluded. With the same subject, the experiment proceeded to Meas. 2.

Meas. 2: The experimenter posed the following question to the subject: If you are asked to pay ¥1.0, what is duration of the massage you will demand? The experimenter began the massage on the subject's waist. The subject estimated the time for the money amount ¥1.0 and said an "OK" immediately when he felt that an appropriate length of time had passed. The experimenter recorded the time with a stopwatch. And so on for ¥2.0, ¥3.0, ¥4.0, and ¥5.0 sequentially. When all five lengths of time were reported, Meas. 2 concluded. With the same subject, the experiment proceeded to Meas. 3.

Meas. 3: The experimenter posed the following question to the subject: If you are given an electrical-power massage for 15 seconds, how much will you be willing to pay? The experimenter began the massage on the subject's waist for 15 seconds to acquaint him with such a time. After the subject reported on an answer sheet and the experimenter collected the answer sheet, the experimenter posed the second question to the subject: If you are given an electrical-power massage for 30 seconds, how much will you be willing to pay? And the subject reported on another answer sheet. If the subject asked, 30 seconds of the massage could be experienced by him (in fact, no subject did so in experiments). And so on until 45, 60, and 75 seconds were presented to the subject. Finally, the subject reported five money amounts respectively for 15, 30, 45, 60, and 75 seconds on five separate answer sheets. Meas. 1, 2, and 3 all concluded.

Setting factors of Exps. I~V are presented in Table 3. The setting factors were determined by referring to the pilot study (see Part 1).

Table 3-2. Setting factors of Exps. I~V

	Order of measures	Assigned duration and money					Estimate type	Subject's report	Participant
Exp. I	Meas. 1	15"	30"	45"	60"	75"	double	money	Group I (Learned economics)
	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time	
	Meas. 3	15"	30"	45"	60"	75"	single	money	
Exp. II	Meas. 1	10"	20"	30"	40"	50"	double	money	Group II (Never learned economics)
	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time	
	Meas. 3	10"	20"	30"	40"	50"	single	money	
Exp. III	Meas. 1	8"	16"	24"	32"	40"	double	money	Group III (Learned economics)
	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time	
	Meas. 3	8"	16"	24"	32"	40"	single	money	
Exp. IV	Meas. 1	30"	10"	50"	20"	40"	double	money	Group V (Learned

	Meas. 2	¥1.0	¥4.0	¥3.0	¥5.0	¥2.0	single	time	economics)
	Meas. 3	30"	10"	50"	20"	40"	single	money	
Exp. V	Meas. 1	30"	10"	50"	20"	40"	double	money	Group IV (Never
	Meas. 2	¥1.0	¥4.0	¥3.0	¥5.0	¥2.0	single	time	learned economics)
	Meas. 3	30"	10"	50"	20"	40"	single	money	

Designs in Table 3-1 provide three basic testing situations:

1) In Exps. I~III: massage durations monotonically increase in each of Meas. 1~3; beside of Meas. 2, duration levels in Meas. 1 and 3 totally decrease from Exp. I to III; money amounts and presentation orders in Meas. 2 are the same. They will provide tests at different stimulus levels for Meas. 1 and 3.

2) In Exps. II, IV and V: stimulus levels assigned in Meas. 1, 2, and 3 of Exps. IV and V are the same to Exp. II, but with crossly disturbed presentation orders different from Exp. II. They will provide a comparison to reveal the possible difference between monotonically increasing presentation and crossly disturbed presentation.

3) Subjects participating in Exps. I, III, and V have the economics-study background, but those in Exps. II and IV not. It will provide a comparison to test the possible economics-study effect on experimental results.

Part 3. Original Data and Treatments for Simple Experiments I~V

In Meas. 3, some subjects delivered their single estimates in linear pattern, occupying about 35%, 42%, 35% in Exps. I~III. It is similar to the direct estimation for number, in which subjects apply a mathematical definition of linearity to numbers in any monotonically ascending or descending series, and deliver linear arithmetic result, regardless of the subjective scale of number (e.g., see Banks & Coleman, 1981). The analysis in Part 5 reveals that the linear pattern in Meas. 3 only reflect subjects' convenient matching to the assigned monotonically ascending consuming quantities but are not intuitive reports of utility scaling. The data with linear pattern in Meas. 3 are thus discarded.

1. Experiment I

17 graduate students participated in Exp. I. All 17 subjects' original data are collected in Table I-1. S_1~S_{10} are female, and S_{11}~S_{17} male. To ensure sound data, once subjects showed a sign of boredom, usually indicated by a reluctant, absent-minded, or unthinking performance, the experiment was paused right away, and the next measurement was carried out. Subjects' data were often incomplete.

1.1 Deletion of invalid data

In Table I-1, "bore" indicates a subject to be bored by the massage and the measurement to be stopped in this position; "none" indicates no data delivered in this position. The case of "none" merely appears in the data block of "Meas. 2" for S_7, because she estimated so low a series of money amounts—ranging ¥0.5~1.0—in Meas. 1 that money amounts ¥1.0~5.0 assigned in Meas. 2 were not suitable for her, and Meas. 2 had to be canceled for her.

Table I-1 Original Data

	Meas. 1					Meas. 2					Meas. 3				
Subject	15"	30"	45"	60"	75"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	15"	30"	45"	60"	75"
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	7	8.5	9.3	10	11.8	3.37	5.43	5.28	8.66	10.44	7.5	13	21	25	30
S_2	5	8	10	12	15	7.45	8.78	15.94	28.25	27.65	2	3	5	6	6
S_3	5	10	10	12	bore	7.56	12.34	19.28	29.97	37.32	***3***	***5***	***7***	***9***	***10***
S_4	***5***	***12***	***12***	bore	bore	***20***	***25.5***	***29.65***	bore	bore	3	8	12	20	25
S_5	***20***	***35***	***40***	bore	bore	***3.6***	***6.35***	***7.72***	bore	bore	5	8	10	15	20
S_6	10	13	18	20	20	7.25	15.15	20.72	25.88	34.75	***3***	***6***	***9***	***12***	***15***
S_7	0.5	0.8	1	1	bore	none	none	none	none	none	0.05	0.2	0.3	0.4	0.45
S_8	10	20	25	28	bore	***9***	***17.59***	***31.03***	***51.31***	***80***	1	3	4	4.5	5
S_9	***5***	***5***	***8***	***8***	bore	***4.16***	***5.5***	***5***	bore	bore	***2***	***4***	***6***	***8***	***9***
S_{10}	***5***	***7***	bore	bore	bore	***11.97***	***24.8***	bore	bore	bore	***6***	***7***	***8***	***9***	***10***
S_{11}	12	13	15	20	bore	13.15	15.47	22.84	25.84	bore	8	10	15	17	23
S_{12}	1	5	6	8	10	20.78	38.31	29.34	53.5	bore	2	5	6	6	7
S_{13}	***5***	***7***	bore	bore	bore	8.13	14.1	21.75	24.41	27.37	***2***	***4***	***6***	***8***	***9***

S_{14}	***5***	***6***	bore	bore	bore	8.41	11.97	25.21	30.75	bore	1	1.5	2	2.3	2.5
S_{15}	***10***	bore	bore	bore	bore	***11.54***	***25.25***	***36.34***	bore	bore	***1***	***2***	***3***	***4***	***5***
S_{16}	***15***	***15***	***25***	bore	bore	***18.62***	***18.54***	***34.57***	50.69	72.84	***2***	***2***	***3***	***5***	***5***
S_{17}	***3***	***5***	***10***	bore	bore	***11.85***	***20.09***	***29.85***	28.31	47.03	***2***	***3***	***5***	***7***	***10***

In Table I-1, the italic boldfaced numerals are discarded from analyses. The deletions follow

(i) If a subject only provides no more than three valid data in a measurement, his data will be deleted in this measurement, for they do not offer relatively complete information to illustrate a global curve.

(ii) In the results of Meas. 3, S_3, S_6, S_9, S_{10}, S_{13}, and S_{15} presented data in the linear pattern, in which mechanically permeating four or five positions a fixed interval of money amount was adopted between any two closest data. By comparing the results from Exps. IV and V, it is concluded that the linear pattern only reflect subjects' convenient matching to the monotonically increasing assigned consuming quantities, but are not intuitive reports of utility scaling (see the analysis in Part 4). They are thus discarded. The linear pattern occupies 35% in Meas. 3 of Exp. I.

(iii) In Meas. 1, S_9 reported that because of unknown reasons she used a double-numeral system to assess data and presented unnatural results, her data in Meas. 1 are therefore deleted.

(iv) In Meas. 2, S_8 reported that she made efforts to keep her reports as agreeable as possible as described in microeconomics—indeed she is successful!—so that no objective behavioral information was contributed. Her data in Meas. 2 are therefore discarded.

(v) S_{16} reported that he followed a rule combining microeconomics with his experience but did not use his intuition to judge, thus presenting artificial results; and S_{17} reported that he always used a complicated transformation, in which 1 minute or ¥5 was a boundary to divide regions of different prices, and below the boundary the prices slowly varied, but once above the boundary it drastically enlarged; his data therefore reflected nothing suitable for the study here. S_{16} and S_{17}'s data are all discarded.

1.2. Structural normalization of valid data

Implemental Questionnaire Investigation showed that among subjects nobody had a direct or indirect experience of paying for such an electrical-power massage. The condition for operating a double-estimate utility measurement was well satisfied in the experiment. Subjects had to select a money amount and duration mainly with their subjective estimates in Meas. 1. It brought about the divergence in data sizes. For example, in Meas. 1, the lowest individual average price is ¥0.83 presented by S_7, and the highest individual average price is ¥20.75 presented by S_8. Implemental Questionnaire Investigation showed that all subjects felt the assigned starting price ¥3.0 reasonable. Therefore, the divergences were mainly the result of individual distinctions.

The most interested here is the structural relations contained in experimental data rather than every subject's individual distinction. If the average is calculated directly, the structural relations of big data will be over weighted and those of small data will be under weighted. To reveal the structural relations clearly, it is feasible to introduce a structural normalization to compile the data into a numerical system to equalize every subject's contribution.

After discarding invalid data, there are only cases with four and five valid data to be considered. In a measurement, *First* and *Fifth* respectively denote the averages of the first and fifth data in the case with five valid data, and d_1, d_2, d_3, d_4, and d_5 denote the five valid data in this measurement for a subject.

1) Structural normalization in the cases with five valid data: All subjects' d_1 and d_5 in a measurement will commonly be changed into *First* and *Fifth*, and d_2, d_3, and d_4 of a subject in this measurement will be transformed into D_2, D_3, and D_4 by the formula

$$D_i = First+(Fifth–First)(d_i–d_1)/(d_5–d_1), \qquad i = 2,3,4.$$

For example, in Meas. 1, four subjects S_1, S_2, S_6, and S_{12} provide five valid data, their first data are 7, 5, 10, and 1 respectively (see Table I-1), and the average of these first data is *First*=(7+5+10+1)/4≈5.8, therefore, S_1's first datum d_1=7.0 becomes *First*= 5.8; and S_1, S_2, S_6, and S_{12}'s fifth data are 11.8, 15, 20, and 10 respectively (see Table I-1), and the average of these fifth data is *Fifth*=(11.8+15+20+10)/4≈14.2, therefore, S_1's fifth datum d_5=11.8 becomes *Fifth*=14.2; using the values of *First* and *Fifth* in the above formula, S_1's d_2=8.5, d_3=9.3, and d_4=10 (see Table I-1) respectively become D_2, D_3, and D_4 as following

D_2=5.8+(14.2-5.8)(8.5–7.0)/(11.8–7.0)≈8.4; D_3=5.8+(14.2-5.8)(9.3–7)/(11.8–7)≈9.8;

D_4=5.8+(14.2-5.8)(10–7)/(11.8–7)≈11.1.

For S_2, the first datum 5.0 becomes *First*=5.8, the fifth datum 15.0 becomes *Fifth*=14.2, and her d_2=8.0, d_3=10, and d_4=12 (see Table I-1) respectively become D_2, D_3, and D_4 as following

D_2=5.8+(14.2-5.8)(8.0–5.0)/(15.0–5.0)≈8.3; D_3=5.8+(14.2-5.8)(10–5.0)/(15–5.0)≈10;

D_4=5.8+(14.2-5.8)(12–5.0)/(15–5.0)≈11.7.

For S_6, the first datum 10.0 becomes *First*=5.8, the fifth datum 20.0 becomes *Fifth*=14.2, and her d_2=13, d_3=18, and d_4=20 respectively become D_2, D_3, and D_4 as following

D_2=5.8+(14.2-5.8)(13–10)/(20–10)≈8.3; D_3=5.8+(14.2-5.8)(18–10)/(20–10)≈12.5;

D_4=5.8+(14.2-5.8)(20–10)/(20–10)≈14.2.

For S_{12}, the first datum 1.0 becomes *First*=5.8, the fifth datum 10.0 becomes *Fifth*=14.2, and his d_2=5.0, d_3=6.0, and d_4=8.0 respectively become D_2, D_3, and D_4 as following

D_2=5.8+(14.2-5.8)(5.0–1.0)/(10–1.0)≈9.5; D_3=5.8+(14.2-5.8)(6.0–1.0)/(10–1.0)≈10.5;

D_4=5.8+(14.2-5.8)(8.0–1.0)/(10–1.0)≈12.3.

2) Structural normalization in the cases with four valid data: Denoting *fourth* as the average of all subjects' D_4 in the case of five valid data in a measurement. In the case of four valid data, all subjects' first and fourth data d_1 and d_4 in this measurement will commonly be changed into *First* and *fourth*, their d_2 and d_3 will be transformed to D_2 and D_3 by the formula

$$D_i = First+(fourth–First)(d_i–d_1)/(d_4–d_1), \qquad i = 2,3.$$

For example, in Meas. 1, S_3, S_7, S_8, and S_{11} provide four valid data (see Table I-1), S_3's first datum "5.0" becomes *First*=5.8, and using the values of D_4 of S_1, S_2, S_6, and S_{12} are 11.1, 11.7, 14.2, and 12.3 respectively (see the result in above "1)"), S_3's fourth datum "12.0" becomes

fourth=(11.1+11.7+14.2+12.3)/4≈12.3;

her d_2=10 and d_3=10 become D_2 and D_3

D_2=5.8+(12.3–5.8)(10–5.0)/(12–5.0)≈10.4; D_3=5.8+(12.3–5.8)(10–5.0)/(12–5.0)≈10.4.

For S_7, her first datum "0.5" becomes *First*=5.8, and the fourth datum "1.0" becomes *fourth*=12.3; her d_2=0.8 and d_3=1.0 become D_2 and D_3:

D_2=5.8+(12.3–5.8)(0.8–0.5)/(1.0–0.5)=9.7; D_3=5.8+(12.3–5.8)(1.0–0.5)/(1.0–0.5)=12.3.

For S_8, first datum "10.0" becomes *First*=5.8, and the fourth datum "28.0" becomes *fourth*=12.3; her d_2=20 and d_3=25 become D_2 and D_3:

D_2=5.8+(12.3–5.8)(20–10)/(28–10)≈9.4; D_3=5.8+(12.3–5.8)(25–10)/(28–10)≈11.2.

For S_{11}, his first datum "12.0" becomes *First*=5.8, and the fourth datum "20.0" becomes *fourth*=12.3; his d_2=13 and d_3=15 become D_2 and D_3:

D_2=5.8+(12.3–5.8)(13–12)/(20–12)≈6.6; D_3=5.8+(12.3–5.8)(15–12)/(20–12)≈8.2.

The gist of the above normalization is to construct a structure by changing the systems of four valid data into the system of five valid data, as the system with five valid data occupies the largest proportion in all experimental data. Meanwhile, the values of *First* and *Fifth* reflect the general levels of the estimation size.

The normalized results of all valid data in Meas. 1, 2, and 3 are collected in Table I-2. Every normalized datum is calculated to one decimal place. Compared with original data, normalized data obviously equalizes all subjects' contributions to the structural relations. In Table I-2, the results of "Mean" are used in curve estimations.

Table I-2 Structural Normalization of Valid Data

	Meas. 1					Meas. 2					Meas. 3				
Subject	15"	30"	45"	60"	75"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	15"	30"	45"	60"	75"
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	5.8	8.4	9.8	11.1	14.2	6.8	12.8	12.4	22.3	27.5	3.3	5.7	9.2	11	13.2
S_2	5.8	8.3	10	11.7	14.2	6.8	8.2	15.5	28.1	27.5	3.3	5.8	10.7	13.2	13.2
S_3	5.8	10.4	10.4	12.3		6.8	10.1	15	22.4	27.5					
S_4											3.3	5.6	7.4	11	13.2
S_5											3.3	5.3	6.6	9.9	13.2
S_6	5.8	8.3	12.5	14.2	14.2	6.8	12.8	17	20.8	27.5					
S_7	5.8	9.7	12.3	12.3							3.3	7	9.5	12	13.2
S_8	5.8	9.4	11.2	12.3							3.3	4.6	7.9	9.2	13.2
S_{11}	5.8	6.6	8.2	12.3		6.8	9.9	19.6	23.6		3.3	6.6	9.9	11.9	13.2
S_{12}	5.8	9.5	10.5	12.3	14.2	6.8	15.8	11.2	23.6		3.3	9.2	11.2	11.2	13.2
S_{13}						6.8	13.2	21.5	24.3	27.5					
S_{14}						6.8	9.5	19.4	23.6		3.3	6.6	9.9	11.9	13.2
Mean	**5.8**	**8.8**	**10.6**	**12.3**	**14.2**	**6.8**	**11.5**	**16.5**	**23.6**	**27.5**	**3.3**	**6.3**	**9.2**	**11.3**	**13.2**

By the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Exp. I as following

$m=0.77(q+60)^{0.704}-10$;

$S_2=68.9\ln(m+10)-159.1$;

$S_3=17\ln(m+60)-70$.

2. Experiment II

12 graduate students participated in Exp. II. Four of them did not provide valid information (valid data are not more than three in each of three measurements). Their data have been discarded. All Four deleted subjects delivered linear pattern in Meas. 3. S_6's fourth datum in Meas. 2 is "none" for the experimenter's operation error. Nine subjects' delivered complete or partial valid data summarized in Table II-1. In Exp. II, there totally are 5 subjects of delivering data in linear pattern in Meas. 3. They occupy a proportion of 42%.

Table II-1 Original Data of Exp. II

	Meas. 1					Meas. 2					Meas. 3				
Subject	10”	20”	30”	40”	50”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10”	20”	30”	40”	50”
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	3	7	7	7.5	8.5	***18.9***	***29.8***	***34.84***	bore	bore	0.5	1	2	2.5	3
S_2	5	6	8	9	12	10.97	20.72	21.28	24.87	31.62	2	3	4	6	8
S_3	1	3	4	6	6	4.75	10.9	14.72	21.217	25.15	***1***	***2***	***3***	***4***	***5***
S_4	4	5	6	6	7	***20.03***	***31.9***	***39.5***	bore	bore	2	3	4	4.5	5
S_5	5	6	8	10	10	***11.29***	***19.97***	***22.53***	bore	bore	3	5	6	8	10
S_6	7	10	12	15	18	8.22	11.03	13.5	none	17.97	5	10	12	15	18
S_7	2	5	7	8	bore	5.13	10.4	13.19	24.56	25.97	2	3	5	6	7
S_8	***12***	***20***	***25***	bore	bore	***14***	***16.15***	***16.15***	bore	bore	10	12	15	20	20

Following the same structural normalization treatment in Exp. I, the structural normalization results are presented in Table IV-2, in which invalid data have been deleted following the same regulations for Exp. I. The data of “Mean” are used in curve estimations.

Table II-2 Structural Normalization of Valid Data in Exp. II

	Meas. 1					Meas. 2					Meas. 3				
Subject	10”	20”	30”	40”	50”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10”	20”	30”	40”	50”
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	4.1	8	8	9.2	10.3						3.5	4.8	7.5	8.8	10.1
S_2	4.1	5	6.8	7.6	10.3	8.7	15.8	16.2	19.3	25.2	3.5	4.6	5.7	7.9	10.1
S_3	4.1	6.6	7.8	10.3	10.3	8.7	12.7	16.1	21.7	25.2					
S_4	4.1	6.2	6.2	8.2	10.3						3.5	5.7	7.9	9	10.1
S_5	4.1	5.3	7.8	10.3	10.3						3.5	5.4	6.3	8.2	10.1
S_6	4.1	5.8	6.9	7.9	10.3	8.7	12.5	17	none	25.2	3.5	4.8	7.5	8.8	10.1
S_7	4.1	6.5	8.1	8.9		8.7	11.8	14.2	24	25.2	3.5	7	9.5	12	10.1
S_8											3.5	4.8	6.8	10.1	10.1
Mean	**4.1**	**6.2**	**7.3**	**8.9**	**10.3**	**8.7**	**13.5**	**15.9**	**21.2**	**25.2**	**3.5**	**5.3**	**7.3**	**9.3**	**10.1**

By the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Exp. II as following

m=0,51(q+60)$^{0.786}$−10;

S_2=52.4ln(m+10) −117.1;

S_3=15.3ln(m+60) −61.5.

3. Experiment III

17 graduate students participated in Exp. III. Three of them provided no valid information (valid data are not more than thee in each of three measurements). Their data have been deleted. All three deleted subjects delivered linear pattern in Meas. 3. Table III-3 presents the remaining 14 subjects’ original data. Only two subjects S_1 and S_2 gave five valid data in Meas. 1. Its structure does not represent most of the data in this measurement. And this is impossibly reasonable to normalize other data into their structure. The normalization in Meas. 1 is based on the structure of four valid data

system of $S_3 \sim S_9$. In Meas. 2 and 3, the normalizations are similar to those in Exps. I. In Exp. III, there totally are 6 subjects of delivering data in linear pattern in Meas. 3. They occupy a proportion of 35%.

Table III-1 Original Data of Exp. III

	Meas. 1					Meas. 2					Meas. 3				
Subject	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	7	10	20	20	23	6.18	7.72	13.9	18.47	18.97	5	10	10	15	15
S_2	10	18	23	28	30	3.78	5.56	11.2	13.34	bore	***10***	***15***	***20***	***25***	***30***
S_3	5	8	11	13	bore	3.62	8.25	10.32	12.38	16.28	4	11	19	25	30
S_4	3	3.5	4	4	bore	8.22	19	23.91	31.75	42.22	1	1.5	3	4	4
S_5	3	5	6.5	6.5	bore	4.97	11.84	15.09	20.44	28.75	2	4	5.5	6.5	6.5
S_6	1	1.5	1.5	2	bore	23.31	53.56	70.31	78.1	bore	0.5	1.3	1.8	2.4	3
S_7	2	4	5	5	bore	***11.6***	***31.25***	none	none	none	0.8	1	1	1.5	1.5
S_8	7	8	9	9	bore	***16.25***	***22***	none	none	none	***1***	***3***	***4***	***5***	***6***
S_9	5	15	20	25	bore	***2.57***	***5.25***	none	none	none	1.5	3	4	5	5
S_{10}	***10***	***15***	***20***	bore	bore	10.87	17.6	24	26.78	bore	5	8	15	18	20
S_{11}	***2***	***3***	***3***	bore	bore	***13.25***	***32.81***	***44.09***	bore	bore	0.5	0.8	1.2	1.5	1.7
S_{12}	***5***	***8***	bore	bore	bore	***4.75***	***9.29***	none	none	none	3	5	10	13	15
S_{13}	***5***	***8***	bore	bore	bore	***3.25***	***6.04***	none	none	none	2	4	5	6	6
S_{14}	***5***	***6***	bore	bore	bore	8.16	11.19	15.53	25.66	25.6	***2***	***3***	***4***	***5***	***6***

The structural normalization results are presented in Table III-2, in which invalid data have been deleted following the same regulations for Exp. I. The data of “Mean” are used in curve estimations.

Table III-2 Structural Normalization of Valid Data in Exp. III

	Meas. 1					Meas. 2					Meas. 3				
Subject	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	3.7	5	9.2	9.2	10.5	6.2	8.6	18.4	25.6	26.4	2.3	6.1	6.1	9.8	9.8
S_2	3.7	6.1	7.7	9.2	9.8	6.2	9.2	18.7	22.3						
S_3	3.7	5.8	7.8	9.2		6.2	13.6	16.9	20.2	26.4	2.3	4.3	6.7	8.4	9.8
S_4	3.7	6.5	9.2	9.2		6.2	12.6	15.5	20.2	26.4	2.3	3.6	7.3	8.4	9.8
S_5	3.7	6.8	9.2	9.2		6.2	12	14.8	19.3	26.4	2.3	5.6	6.5	9.8	9.8
S_6	3.7	6.5	6.5	9.2		6.2	14.9	19.8	22.3		2.3	4.7	6.2	8	9.8
S_7	3.7	7.4	9.2	9.2							2.3	4.4	4.4	9.8	9.8
S_8	3.7	6.5	9.2	9.2											
S_9	3.7	6.5	7.8	9.2							2.3	5.5	7.7	9.8	9.8
S_{10}						6.2	13	19.5	22.3		2.3	3.8	7.3	8.8	9.8
S_{11}											2.3	4.2	5.8	8.6	9.8
S_{12}											2.3	3.6	6.7	8.6	9.8
S_{13}											2.3	6.1	7.9	9.8	9.8
S_{14}						6.2	9.7	14.7	26.5	26.4					
Mean	**3.7**	**6.3**	**8.4**	**9.2**	**10.2**	**6.2**	**11.7**	**17.3**	**22.3**	**26.4**	**2.3**	**4.7**	**6.6**	**9.1**	**9.8**

By the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Exp. III as following

$m=0.26(q+60)^{0.950}-10$;

$S_2=65.9\ln(m+10)-151.8$;

$S_3=19.2\ln(q+60)-78.5$.

4. Experiment IV

17 graduate students participated in Exp. V. Eight of them did not provide valid information (valid data are not more than thee in each of three measurements). Their data have been deleted. Five of the deleted subjects behaved out of ordinary: one reported that he only made two judgments ¥3.0 and ¥5.0 for all stimuli; one judged stimuli only by their order but not durations; one persisted to estimate prices of stimuli by transforming the electrical power massage to hand massage; one persisted to judge the massage duration by rigidly counting seconds; and one reported that he could not determine his estimates exactly without a objective market standard and always delivered two or three prices for a stimulus. 9 subjects' valid data are summarized in Table IV-1. In Tables IV-1 and IV-2, for the convenience of reading, data are ordered in monotonically ascending stimuli but not in the crossly disturbed presentation as they were assigned in the experiment. In Exp. IV, only one subject (S_7) delivered linear-pattern data in Meas. 3, occupying a proportion of 6%. Comparing with Exps. I~III, the linear pattern almost disappears. S_3's "none" was resulted by experimenter's operation error.

Table IV-1 Original Data of Exp. IV

	Meas. 1					Meas. 2					Meas. 3				
Subject	10"	20"	30"	40"	50"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10"	20"	30"	40"	50"
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	15	20	25	25	30	3.81	5.04	12.75	16.97	24.9	6	12	15	23	30
S_2	5	10	15	15	18	7.72	12.32	21.69	19	25.31	4	5	7	12	13
S_3	5	8	none	13	10	10.15	8.35	16	24	24.66	2	4	5	7	8
S_4	***5***	bore	***20***	bore	bore	4	6.69	8.63	10.56	16.03	4	10	8	12	15
S_5	1	3	3	5	5	bore	***22.47***	***41.41***	***48.16***	bore	1	2	2	3	3
S_6	1	2	3	4	5	bore	***34.72***	***55.78***	***68.1***	bore	1	1.5	3	4	4
S_7	1	1	3	3	4	24.34	28.61	34.62	43.78	61.25	***1***	***2***	***3***	***4***	***5***
S_8	1	3	3	bore	5	bore	bore	***42.37***	bore	bore	0.5	1	1.2	1.5	1.5
S_9	***10***	bore	***3***	bore	bore	1.88	3.03	6.56	7.56	12.19	bore	***3***	bore	bore	bore

The structural normalization results are presented in Table IV-2, in which invalid data have been deleted following the same regulations for Exp. I. The data of "Mean" are used in curve estimations.

Table IV-2 Structural Normalization of Valid Data in Exp. IV

	Meas. 1					Meas. 2					Meas. 3				
Subject	10"	20"	30"	40"	50"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10"	20"	30"	40"	50"
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	4..8	6.9	8.9	8.9	11	8.6	9.7	16.6	20.3	27.4	2.6	4.6	5.6	8.6	10.6

S_2	4.8	7.2	9.6	9.6	11	8.6	13.5	22	20.7	27.4	2.6	3.5	5.3	9.7	10.6
S_3	4.8	8.5		14.7	11	8.6	6.3	16.2	26.5	27.4	2.6	5.3	6.6	9.3	10.6
S_4						8.6	12.8	15.8	18.9	27.4	2.6	6.7	5.5	8.4	10.6
S_5	4..8	7.9	7.9	11	11						2.6	6.6	6.6	10.6	10.6
S_6	4.8	6.4	7.9	9.5	11						2.6	3.9	7.9	10.6	10.6
S_7	4.8	4.8	8.9	8.9	11	8.6	10.8	13.8	18.5	27.4					
S_8	4.8	7.9	7.9		11						2.6	6.6	8.2	10.6	10.6
S_9						8.6	13.3	26.9	26.9	27.4					
Mean	**4.8**	**7.1**	**8.5**	**10.4**	**11**	**8.6**	**10.6**	**14.2**	**20.6**	**27.4**	**2.6**	**5.3**	**6.5**	**9.7**	**10.6**

By the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Exp. IV as following

$m=0.54(q+60)^{0.758}-10$;

$S_2=60.7\ln(m+10)-139.1$;

$S_3=18.1\ln(q+60)-74.3$.

5. Experiment V

17 graduate students participated in Exp. V. Three of them did not provide valid information (valid data are not more than thee in each of three measurements). Their data have been deleted. Two of the deleted subjects behaved out of ordinary: one reported that he only made two judgments, comfortable and uncomfortable, and gave ¥10.0 for the former but ¥2.0 for the latter; and another claimed that she could not decide how to act in a hypothetical test and reported a constant number for all estimates. 14 subjects' valid data are summarized in Table V-1. In Tables V-1 and V-2, for the convenience of reading, data are ordered with monotonically ascending stimuli but not in the crossly disturbed presentation as they were assigned in the experiment. In Exp. V, only one subject (S_9) delivered linear-pattern data in Meas. 3, occupying a proportion of 6%.

Table V-1 Original Data of Exp. V

	Meas. 1					Meas. 2					Meas. 3				
Subject	10"	20"	30"	40"	50"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10"	20"	30"	40"	50"'
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	0.5	1	1	2.5	2	18.19	23.4	31.03	53.25	60.02	1	3	2.5	3.5	4.5
S_2	10	8	15	20	17	3.9	5.78	9.5	10.25	14.75	3	8	10	17	20
S_3	2	2	3	3	5	24.3	36.66	50.84	48.5	60.3	1	2	2	4	3
S_4	6	6	10	12	12	7.81	10.38	19.66	21.4	28.18	2	3	5	7	8
S_5	4	4	6	8	8	5.57	11.88	15.63	21.4	28.18	2	3	5	6	7
S_6	20	25	25	bore	28	4.71	3.56	5.81	7.43	11.19	10	12	15	20	25
S_7	5	6	5	bore	8	10.78	12.63	18.25	24.16	28.25	2	4	5	6	8
S_8	10	5	10	bore	15	13.5	10.94	27.79	30.53	35.88	2	3	4	6	6
S_9	2	2	6	6	9	12.66	18.75	45.31	45.29	60.08	***2***	***4***	***6***	***8***	***9***
S_{10}	1	2	3	4	4	bore	***43.25***	bore	***120.11***	bore	0.5	2	3	4	4.5
S_{11}	4	4	5	6	8	bore	***9.19***	***14.63***	***18.31***	bore	2	3	4	4	5
S_{12}	***10***	bore	***20***	bore	bore	7.12	6.72	15.53	20.69	27.03	5	10	20	20	30

S_{13}	***5***	bore	***10***	bore	bore	8.13	3.74	3.53	5.94	18.95	bore	bore	***10***	bore	bore
S_{14}	bore	bore	***0.5***	bore	bore	8.41	***22.6***	bore	bore	bore	0.5	2	3	4	4.5

The structural normalization results are presented in Table V-2, in which invalid data have been deleted following the same regulations for Exp. I. The data of "Mean" are used in curve estimations.

Table V-2 Structural Normalization of Valid Data in Exp. V

	Meas. 1					Meas. 2					Meas. 3				
Subject	10"	20"	30"	40"	50"	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	10"	20"	30"	40"	50"
	(Money, ¥)					(Time, second)					(Money, ¥)				
S_1	5.9	7.5	7.5	12.2	10.6	10.2	13.2	17.6	30.5	34.4	2.6	5.4	6	8.3	10.5
S_2	5.9	4.6	9.3	12.6	10.6	10.2	14.4	22.6	24.4	34.4	2.6	4.9	5.9	9.2	10.5
S_3	5.9	5.9	7.5	7.5	10.6	10.2	18.5	28	26.5	34.4	2.6	6.6	6.6	14.5	10.5
S_4	5.9	5.9	9	10.6	10.6	10.2	13.3	24.3	26.3	34.4	2.6	3.9	6.6	9.2	10.5
S_5	5.9	5.9	8.3	10.6	10.6	10.2	15.6	18.8	23.9	34.4	2.6	4.1	7.3	9	10.5
S_6	5.9	8.8	8.8		10.6	10.2	5.9	14.3	20.4	34.4	2.6	3.6	5.2	6.6	10.5
S_7	5.9	7.5	5.9		10.6	10.2	12.8	20.5	28.6	34.4	2.6	5.2	6.6	7.9	10.5
S_8	5.9	1.2	5.9		10.6	10.2	7.9	25.7	28.6	34.4	2.6	4.6	8.6	10.5	10.5
S_9	5.9	1.2	8.6	8.6	10.6	10.2	13.3	26.9	26.9	34.4					
S_{10}	5.9	7	9	10.6	10.6						2.6	5.6	7.5	9.6	10.5
S_{11}	5.9	13	7.1	8.3	10.6						2.6	5.2	7.9	9.6	10.5
S_{12}						10.2	9.7	20.4	26.7	34.4	2.6	4.1	7.3	7.3	10.5
S_{13}						10.2	9.9	13.7	20.7	34.4					
S_{14}											2.6	5.6	5.6	9	10.5
Mean	**5.9**	**6.1**	**7.9**	**10.1**	**10.6**	**10.2**	**12.2**	**21.2**	**25.8**	**34.4**	**2.6**	**4.9**	**7.5**	**9**	**10.5**

By the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Exp. V as following

$m=0.97(q+60)^{0.651}-10$;

$S_2=79.4\ln(m+10)-182.5$;

$S_3=17.7\ln(q+60)-72.6$.

References

Banks, W. P. & Coleman, M. J., (1981). "Two subjective scales of numbers". *Perception & Psychophysics*, *29*, 95–105.

Part 4. Analyses on Simple Experiments I~V

Fitting the power law in means of structural-normalized data of Meas. 1 and the logarithmic laws in means of structural-normalized data of Meas. 2 and 3, experimental values of a_2, c_2, C_2, a_3, c_3, C_3, α, and β are acquired. They are collected in Table 4-1. Fig. 4-1 plots curve estimations of Exps. I~V.

Table 4-1. Experimental and theoretical parameter values in five experiments

	a_2	c_2	C_2	a_3	c_3	C_3	b	α		β	
								Theory	Experiment	Theory	Experiment
Exp. I	10	68.9	-159.1	60	17.0	-70.0	2.6	0.641	0.704	0.72	0.77
Exp. II	10	52.4	-117.1	60	15.3	-61.5	2.5	0.730	0.786	0.50	0.51
Exp. III	10	65.9	-151.8	60	19.2	-78.5	3.1	0.903	0.950	0.25	0.26
Exp. IV	10	60.7	-139.1	60	18.1	-74.3	2.4	0.716	0.785	0.52	0.54
Exp. V	10	79.4	-182.5	60	17.7	-72.6	2.7	0.602	0.651	0.84	0.97

In Fig. 4-1, under distinguished experimental circumstances, the utility scaling totally shows a regular, identical, and measurable psychological response: five plots for Exps. I~V are very similar in their principal features. Meas. 1 approves the power function, and Meas. 2 and 3 the logarithmic function. Especially, in Meas. 3, the values of R_3^2 are 1.0, 0.99, 0.99, 0.98, and 1.0 respectively for Exps. I~V, evidently support that the single estimate follows the logarithmic law. In Meas. 1, the values of R_1^2 are 1.0, 0.99, 0.96, 0.98, and 0.93, while, in Meas. 2, the values of R_2^2 0.99, 0.99, 1.0, 0.93, and 0.96, respectively for Exps. I~V. They also do well in most of cases.

In addition, Fig. 2 shows that Exps. IV and V with disordered stimulus presentations deliver more disordered data than Exps. I~III, especially for S_2. In the curve estimations, the curve type of S_2 in Exps. IV and V are mainly determined by referring to their partners in Exps. I~III. This should be feasible because the curve shape of S_2 in Exps. I~III is clear and the differences between Exps. IV and V and Exps. I~III are totally insignificant statistically (see below).

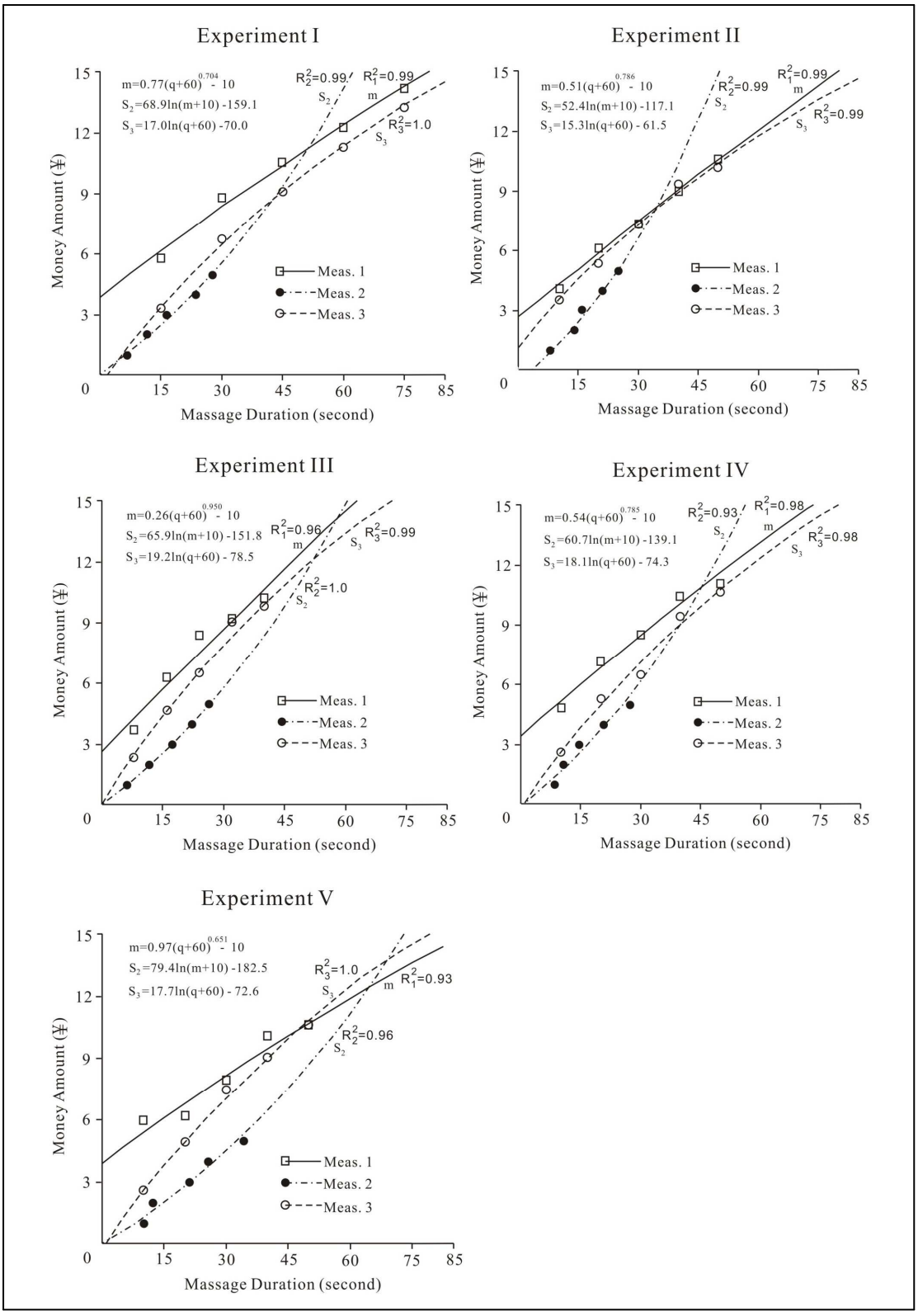

Fig. 4-1. Curve estimations of Meas. 1, 2, and 3 in Exps. I~V. Their principal features are similar.

4.1 Relations between single and double estimates

In Exps. I~V, massage durations and presentation orders of Meas. 1 and 3 in an experiment are the same, and the distinction between Meas. 1 and 3 in an experiment is only that the former is a double estimate but the latter a single estimate. To examine the distinction between single and double estimates,

and taking into account that fitting data for each measurement are small sample (n=5), Wilcoxon test is selected as an examination tool. For Exps. I~V, Meas. 1 and 3 in an experiment are paired in the Wilcoxon test. Table 4-2 presents the testing results.

Table 4-2. Wilcoxon tests on paired Meas. 1 and 3 in Exps. I~V (n=5 in each)

Exp. I	Exp. II	Exp. III	Exp. IV	Exp. V
Z=2.041	Z=1.095	Z=2.023	Z=2.023	Z=2.023
p=0.041	p=***0.273***	p=0.043	p=0.043	p=0.043

Table 4-2 shows the difference between paired Meas. 1 and 3 significant in four of five experiments ($p<0.05$), and only Exp. II ($p=0.273$) is insignificant. That is, single and double estimates are generally different, they deliver two distinguished subjective measures.

Respectively for Exps. I~V, substituting the experimental values of c_2, C_2, c_3, and C_3 from Table 4-1 and taking b=2.6, 2.5, 3.1, 2.4, and 2.7 in (10) and (11), obtain the theoretical values of α and β as shown in Table 4. For example, taking b=2.6 for Exp. I, theoretical values of α and β for Exp. I are derived as follows

$$\alpha = \frac{bc_3}{c_2} = \frac{2.6\times 17}{68.9} \approx 0.641 ;$$

$$\beta = \exp\left(\frac{bC_3 - C_2}{c_2}\right) = \exp\left(\frac{-2.6\times 70 + 159.1}{68.9}\right) \approx e^{-0.332} \approx 0.72 .$$

Table 4-1 shows the theoretical values of α and β agreeing with their experimental values with an average relative error [(Experimental−Theoretical) /Experimental] of 6.4% for all five experiments. Ekman relations (10) and (11) hold at this error level. They reveal relationships between single- and double-estimate utility scales.

In addition, Table 4-1 shows a systematic deviation between theoretical and experimental values of α and β, where the theoretical values are identically less than the experimental ones. If the experimental values multiply a revision coefficient of 0.92, their agreements would greatly be improved as shown in Table 4-3.

Table 4-3. Revised experimental values of α and β

	α		β	
	Theoretical	Revised experimental	Theoretical	Revised experimental
Exp. I	0.641	0.704×0.92≈0.648	0.72	0.77×0.92≈0.71
Exp. II	0.730	0.786×0.92≈0.723	0.50	0.51×0.92≈0.47
Exp. III	0.903	0.950×0.92≈0.874	0.25	0.26×0.92≈0.24
Exp. IV	0.716	0.785×0.92≈0.722	0.52	0.54×0.92≈0.50
Exp. IV	0.602	0.651×0.92≈0.599	0.84	0.97×0.92≈0.89

The deviation may be resulted from constant errors occurring in measurements. For example, in the estimates of massage durations in Meas. 2, whatever subjects' immediate oral reports by saying "OK" or experimenters' manual records by pressing a stop watch tend to enlarge the massage durations but never to shorten them. It might be evident one of causes for constant errors. Table 4-3 indicates the revision coefficient for those constant errors is about 0.92. To prevent those errors, using real payoff

and non-temporal test may be helpful.

By the way, could we classify psychophysical measures also by single and double estimates? It is certainly not a problem for Stevens' cross-modality matching, which is obviously the double estimate. If a handgrip-loudness cross matching is described in a two-dimensional coordinate with a horizontal axis of loudness intensity and a vertical axis of handgrip intensity, to decompose the single estimates from such a handgrip-loudness cross matching, Meas. 2 requires us to inform the objective intensity of handgrip to a subject and ask him to report subjective loudness scale matched to the handgrip, while, Meas. 3 requires us to inform the objective intensity of loudness to a subject and ask him to report subjective handgrip scale matched to the loudness. In this way we can transplant the double estimate and its two decomposed single estimates from the utility scaling to the psychophysical scaling. Would logarithmic laws be observed in the two decomposed single estimates in this transplant? It may be another worthy attempt implied in this paper. A merit of the single- and double-estimate category is a possibility of testing Ekman relations experimentally. It could clarify the relationship between logarithmic law and power law in psychophysical measures.

4.2 Comparison between subjects with and without economics-study backgrounds

Participants in Exps. I, III, and V have economics-study background, and those in Exps. II and IV no economics-study background. Among them, experimental setting factors of Meas. 2 are the same in Exps. I~III, Wilcoxon tests for the data of Meas. 2 paired between Exp. II and Exps. I, III can reveal the possible distinction between the two kinds of subjects. Similarly, experimental setting factors of Meas. 1~3 are the same in Exps. IV and V (see Table 3), Wilcoxon tests for the data of Meas. 1~3 paired between Exp. IV and V can also reveal the possible distinction between the two kinds of subjects. Their results are presented in Table 4-4.

Table 4-4. Wilcoxon tests for two kinds of subjects (n=5 in each)

Between	Meas. 1	Meas. 2	Meas. 3
Exps. II and I		Z=0.674, p=0.500	
Exps. II and III		Z=0.405, p=0.686	
Exps. IV and V	Z=0.674, p=0.500	Z=2.041, p=***0.041***	Z=0.73, p=0.465

In Table 4-4, except of Meas. 2 between Exps. IV and V (p=0.041), four of five results are insignificant (p>0.05). It is therefore concluded that there totally is no significant difference between subjects with and without economics-study backgrounds in their performances. Subjects' behaviors observed in valid data have no reliance on the specialized knowledge in economics.

3.3.3 Measures to the effects of two presentation patterns

Taking into account the comparison results between subjects with and without economics study background, data from the above two kinds of subjects can be compared to test the effects of monotonically increasing and crossly disturbed presentation orders. Assigned stimulus values of Meas. 1~3 are the same in Exps. II, IV, and V, but they monotonically increase and contain increasing expectation in Exp. II, while, are crossly disturbed and contain no increasing expectation in Exp. IV and V. Wilcoxon tests on Meas. 1~3 pared between Exps. II and V and between Exps. II and IV can reveal the possible differences. Similarly, Money amounts of Meas. 2 in Exps. I, III, IV, and V are the same, but Exps. I and III contain increasing expectation, while, Exps. IV and V not. To compare the

possible differences of Meas. 2 between Exps. I, III and Exps. IV, V, Wilcoxon tests were also performed on them. Table 4-5 presents the results.

Table 4-5. Wilcoxon tests for presentation effects (n=5 in each)

Between	Meas. 1	Meas. 2	Meas. 3
Exps. II and IV	Z=2.032, p=***0.042***	Z=0.944, p=0.345	Z=0.730, p=0.465
Exps. II and V	Z=1.753, p=0.080	Z=1.753, p=0.080	Z=1.214, p=0.225
Exps. I and IV		Z=1.214, p=0.225	
Exps. I and V		Z=2.203, p=***0.043***	
Exps. III and IV		Z=0.674, p=0.500	
Exps. III and V		Z=2.203, p=***0.043***	

In Table 4-5, except of Meas. 1 between Exps. II and IV (p=0.042) and Meas. 2 between Exps. I and V (p=0.043) and between Exps. III and V (p=0.043), seven of ten results are insignificant (p>0.05). They reveal that totally the increasing expectation has no evident impact on the global distribution of utility scaling results. However, from Fig. 4-1, the increasing expectation diminishes the deviation of data from the regression curve: average values of R^2 are 0.99, 0.99, and 0.98 for Exps. I, II, and III, but less to 0.96 respectively for Exps. IV and V, showing the increasing expectation to enhance the consensus of subjects' estimates. Exps. IV and V present more disordered data than Exps. I~III. It indicates that order effects exist in five simple experiments, and it is necessary to conduct Latin square experiment so that high-quality data can be obtained.

By the way, basing on the above testing results, we are able to further test the possible difference between subjects major in psychology or education (Exp. II) and in literature or history (Exp. IV) by comparing Exp. II with Exp. IV also through Wilcoxson tests. The testing results indicate that they totally have no significant difference: Z=2.032, 0.944, 0.703, and p=***0.042***, 0.345, 0.465, for Meas. 1~3 between Exps. II and IV, namely, two of three testing results are insignificant between Exps. II and IV.

Furthermore, proportions of linear pattern in Meas. 3 are 35%, 42%, and 35% for Exps. I, II, and III, but merely 6% respectively for Exps. IV and V. The linear pattern in Meas. 3 almost disappears in measurements with the crossly disturbed presentation. The linear pattern is resulted by the increasing expectation, and is not the essential attribute of utility scaling.

In the close-ended numerical scaling, there are two response patterns, the logarithmic pattern for American immature subjects (e.g. second-grade children) and the linear pattern for American mature subjects (e.g. sixth-grade children and adults) (Siegler & Opfer, 2003). To the Mundurucu subjects coming from Amazonian indigene group with a reduced numerical lexicon and little or no formal education, an experimental study reveals at all ages subjects presenting a logarithmic scale in number-space mappings (Dehaene, et al., 2008). Combining the results from Siegler and Opfer with the results from Dehaene, et al., it has been concluded that the logarithmic pattern is followed by initial intuition scaling and the linear pattern is a cultural invention in formal education (Dehaene, et al., 2008). In the single estimate for Meas. 3 in Exps. I~III, with monotonically increased stimulus presentation order, there is also a linear pattern occupying a substantial proportion in the economic scaling. Nonetheless, in Exps. IV and V, with crossly disturbed stimulus presentation order, the linear pattern almost disappears in the utility scaling. The linear pattern in utility scaling is only resulted from the order effect but is not an essential attribute. Though the utility scaling seems to be a kind of the numeric scaling, they are different substantially.

References

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Part 5. Latin Square Experiment

1. Experimental design

There are two kinds of order effects taken into account in Latin square designs. The first is the order effect between Meas. 1~3, called inter-Meas order effect, and the second between five stimuli (numbered 1, 2, 3, 4, and 5 in Table 5-2) assigned in each of Meas. 1~3, called inner-Meas order effect. Table 5-1 is the Latin square design for the former, and Table 5-2 for the latter.

Table 5-1. Latin square design for inter-Meas order effect

	Order of measures	Presented duration and money					Estimate type	Subject's report
Group I	Meas. 1	8"	16"	24"	32"	40"	double	money
	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time
	Meas. 3	8"	16"	24"	32"	40"	single	money
Group II	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time
	Meas. 3	8"	16"	24"	32"	40"	single	money
	Meas. 1	8"	16"	24"	32"	40"	double	money
Group III	Meas. 3	8"	16"	24"	32"	40"	single	money
	Meas. 1	8"	16"	24"	32"	40"	double	money
	Meas. 2	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	single	time

Table 5-2. Latin square design for inner-Meas order effect

Subgroup	Stimulus order				
i	1	2	3	4	5
ii	2	1	5	3	4
iii	3	4	1	5	2
iv	4	5	2	1	3
v	5	3	4	2	1

In the designs of Table 5-1, each of Groups I~III contains 3 measurements (Meas. 1~3), with different presentation orders. The design of Table 5-2 is used in each of Meas. 1~3. Each of Groups I~III contains 5 subgroups i, ii, iii, iv, and v with different stimulus presentation orders as shown in Table 5-2. There are 5 subgroups for everyone of Groups I~III, and 15 subgroups in total for Groups I~III. In the experiment, every subgroup contains 4 valid subjects (male 2, female 2). The total number of valid subjects is 60. In each of Groups I~III, every subgroup participated in one of stimulus sets shown in Table 5-2. For example, in Group I, for Meas. 1, Subgroup i was presented the stimulus set "1, 2, 3, 4, 5", Subgroup ii "2, 1, 5, 3, 4", Subgroup iii "3, 4, 1, 5, 2", and so on. Repeat the same design respectively for Meas. 2 and Meas. 3 in Group I. And so on for Group II and Group III, until all 15 subgroups have been contained. Combining Tables 5-1 and 5-2, the complete designs for Groups I~III are specified as Tables 5-3, 5-4, and 5-5.

For example, in Table 5-3, subject code "Ii1" means that Group I, Subgroup i, and subject No. 1; "Ii2" Group I, Subgroup i, and subject No. 2; "Iii1" Group I, Subgroup ii, and subject No. 1; and "Iii2"

Group I, Subgroup ii, and subject No. 2. And so on for the rest parts of Table 5-3 and for Tables 5-4 and 5-5.

Table 5-3. Latin square design for Group I

Subject code	Sex	Meas. 1					Meas. 2					Meas. 3				
Ii1	M	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Ii2	M	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Ii3	F	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Ii4	F	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Iii1	M	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”
Iii2	M	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”
Iii3	F	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”
Iii4	F	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”
Iiii1	M	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”
Iiii2	M	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”
Iiii3	F	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”
Iiii4	F	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”
Iiv1	M	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”
Iiv2	M	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”
Iiv3	F	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”
Iiv4	F	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”
Iv1	M	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”
Iv2	M	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”
Iv3	F	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”
Iv4	F	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”

Table 5-4. Latin square design for Group II

Subject code	Sex	Meas. 2					Meas. 3					Meas. 1				
IIi1	M	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”
IIi2	M	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”
IIi3	F	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”
IIi4	F	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”
IIii1	M	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”
IIii2	M	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”
IIii3	F	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”
IIii4	F	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”
IIiii1	M	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”
IIiii2	M	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”
IIiii3	F	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”
IIiii4	F	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”
IIiv1	M	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”
IIiv2	M	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”

IIiv3	F	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”
IIiv4	F	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”
IIv1	M	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”
IIv2	M	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”
IIv3	F	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”
IIv4	F	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”

Table 5-5. Latin square design for Group III

Subject code	Sex	Meas. 3					Meas. 1					Meas. 2				
IIIi1	M	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0
IIIi2	M	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0
IIIi3	F	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0
IIIi4	F	8”	16”	24”	32”	40”	8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0
IIIii1	M	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0
IIIii2	M	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0
IIIii3	F	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0
IIIii4	F	16”	8”	40”	24”	32”	16”	8”	40”	24”	32”	¥2.0	¥1.0	¥5.0	¥3.0	¥4.0
IIIiii1	M	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0
IIIiii2	M	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0
IIIiii3	F	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0
IIIiii4	F	24”	32”	8”	40”	16”	24”	32”	8”	40”	16”	¥3.0	¥4.0	¥1.0	¥5.0	¥2.0
IIIiv1	M	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0
IIIiv2	M	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0
IIIiv3	F	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0
IIIiv4	F	32”	40”	16”	8”	24”	32”	40”	16”	8”	24”	¥4.0	¥5.0	¥2.0	¥1.0	¥3.0
IIIv1	M	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0
IIIv2	M	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0
IIIv3	F	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0
IIIv4	F	40”	24”	32”	16”	8”	40”	24”	32”	16”	8”	¥5.0	¥3.0	¥4.0	¥2.0	¥1.0

2. Original data and their treatments

60 valid subjects’ original data are collected in Table 5-6. For reading convenience, the data of all 15 subgroups are recorded with monotonically increasing stimulus presentation orders consecutively in Meas. 1~3. Table 5-7 is the structural normalized data collection for Groups I~III.

Table 5-6. Original data collection for Groups I~III

Subject code	Sex	Meas. 1					Meas. 2					Meas. 3				
		8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Ii1	M	3	5	7	10	12	3.00	8.63	11.59	13.12	13.87	1.5	2	3	3	4
Ii2	M	2	5	6	5	5	15.32	26.00	35.22	40.72	46.00	0.5	1.2	1.5	2	2.4
Ii3	F	3	5	7	10	10	3.50	6.78	9.62	12.00	13.41	3	5	8	10	12
Ii4	F	6	8	8	10	10	8.25	27.63	27.63	44.63	53.72	0.5	1.5	2	2.5	2.5
Iii1	M	3	5	5	6	10	8.56	9.97	12.73	21.22	22.03	4	5	8	8	12

Iii2	M	1	3	5	5	7	5.94	17.09	31.91	44.88	51.35	1	2	3	3.5	4
Iii3	F	2	4	3	4	6	8.31	8.06	27.47	27.97	31.91	1	3	3.5	4.5	5
Iii4	F	3	5	8	5	10	12.66	20.69	31.72	39.65	42.81	3	5	6	7	10
Iiii1	M	5	11	15	20	20	4.25	6.65	8.31	8.90	12.40	7	11	15	20	25
Iiii2	M	2	3	4	5	5	9.53	26.12	20.06	33.19	47.85	2	4	4	6	6
Iiii3	F	2	6	3	6	10	11.44	15.41	12.87	20.65	30.56	1	3	5	8	11
Iiii4	F	7	11	15	20	23	1.88	5.69	5.91	7.31	11.06	5	9	15	18	22
Iiv1	M	1	1.5	2	2	2.5	5.84	6.28	18.60	22.37	25.34	1.5	2	3	4	5
Iiv2	M	1	3	3	5	8	5.00	9.07	17.16	24.00	31.09	1	2	3	6	6
Iiv3	F	0.5	1	2	2	2.5	17.94	23.59	33.19	57.43	54.15	1	2	3	4	4.5
Iiv4	F	5	8	10	10	15	2.11	4.51	6.03	9.09	8.18	6	18	15	20	28
Iv1	M	7	10	15	15	20	1.90	2.78	7.22	9.68	6.13	3	8	10	12	15
Iv2	M	2	2.5	2.5	3	4	11.00	22.57	49.40	55.00	67.75	0.7	1	2	2.5	3
Iv3	F	4	6	8	12	10	7.84	9.66	9.47	14.50	14.69	3	8	10	15	17
Iv4	F	8	12	15	15	20	1.50	2.31	3.85	4.72	8.33	8	13	18	20	22
IIi1	M	1	1.5	2	3	3	21.41	41.25	54.68	74.53	84.53	0.7	1.5	2	3	3.5
IIi2	M	1.5	2.5	3	5	6	5.94	11.13	13.53	20.01	20.91	1.5	3	4.5	5.5	7
IIi3	F	1.5	2.5	4	5	5	50.57	97.00	116.91	144.66	158.06	1.5	3	4	5	6.5
IIi4	F	0.5	1	1.3	1.5	1.8	14.15	34.25	54.31	84.91	96.28	0.5	1.1	1.5	2	2.1
IIii1	M	1.9	2.2	2.7	3.3	3.9	28.47	38.72	45.53	51.00	62.09	5	6	6.7	7.2	7.8
IIii2	M	28	40	55	70	70	2.29	4.60	3.41	2.82	4.96	7	18	27	33	40
IIii3	F	3	5	8	10	12	7.50	23.28	13.56	15.43	20.81	3	4	8	10	12
IIii4	F	2	4	5	7	7	4.97	8.93	11.04	10.94	13.78	1	3	4	5	7
IIiii1	M	4	4.5	5.8	7.5	8	2.38	10.00	7.59	11.28	17.78	5	6	6.7	7.2	7.8
IIiii2	M	2	3	4	6	6	7.31	4.50	7.56	10.44	18.29	4	5	7	8	8.5
IIiii3	F	2	4	6	7	7	6.22	9.94	11.28	16.12	24.16	2	4	5	7	10
IIiii4	F	1	4	3	7	8	8.9	8.84	18.93	20.78	24.38	1	2.5	3	4	4.5
IIiv1	M	0.7	1	1.5	2	3	24.94	43.44	64.32	54.22	62.91	2	3	4	4	5
IIiv2	M	2	5	5	5	7	10.25	11.34	16.29	16.81	16.94	0	1	2.5	3	4.5
IIiv3	F	10	15	12	13	18	3.19	5.00	7.97	10.00	13.56	5	10	12	15	20
IIiv4	F	0.8	2	2	3.5	3.5	21.63	30.40	50.31	68.47	69.13	0.8	1.5	2	3	3.5
IIv1	M	0.8	1.5	2.5	3.0	3.5	12.71	27.1	42.3	57.2	71.64	0.8	1.5	2.5	3.0	3.5
IIv2	M	0.5	1	2	2.5	3	13.56	15.11	18.77	20.21	23.48	0.2	1	1.5	2	2.8
IIv3	F	2	3	3	4	4	7.06	9.40	8.06	9.12	9.25	0	2	3	4	4
IIv4	F	0.5	1	2	2	3	14.15	29.35	33.34	45.31	49.03	1	1.5	2	2	2.5
IIIi1	M	2	5	8	10	13	5.00	10.41	12.78	22.03	19.08	3	5	10	13	15
IIIi2	M	5	7	10	10	12	1.59	3.44	5.47	8.66	10.41	3	5	7	10	12
IIIi3	F	3	7	10	12	15	4.16	8.68	10.44	13.84	16.66	2	4	5	6	6
IIIi4	F	2	3	5	7	8	4.10	8.00	12.69	14.19	18.40	3	5	6	8	8
IIIii1	M	1	2	2.9	2.5	2.8	7.47	14.44	17.06	23.53	29.69	0.5	2	2.2	2.4	2.8
IIIii2	M	2	3	10	11	12	2.94	5.25	10.81	15.40	11.85	2	5	10	11	12
IIIii3	F	2	3	4	6	5	5.72	11.69	11.91	14.97	26.50	1.5	2	3	5	6
IIIii4	F	1.5	3	2	3	5	10.78	14.84	48.35	49.47	64.66	1	2	2.5	3	4
IIIiii1	M	3	5	6	8	8	7.75	12.82	14.18	17.15	20.38	3	4	5	7	8

IIIiii2	M	20	45	40	45	60	1.00	1.78	2.84	2.78	4.19	5	15	20	25	25
IIIiii3	F	3	8	10	12	15	7.57	16.88	16.78	19.72	26.15	3	12	20	24	30
IIIiii4	F	3	5	5	7	9	4.03	12.27	18.13	30.34	31.16	2	4	5	7	9
IIIiv1	M	0.8	2	2.2	2.4	3	11.41	23.94	23.97	60.85	52.85	1.6	2	2.1	2.5	2.7
IIIiv2	M	3	4	6	8	7	1.53	4.66	12.94	10.06	12.06	3	4	6	8	8
IIIiv3	F	5	22	10	25	26	1.91	2.90	3.97	3.34	7.19	10	15	18	20	22
IIIiv4	F	2	5	8	7	10	10.72	14.37	20.22	21.56	22.22	1	4	5.5	7	9
IIIv1	M	5	8	13	20	20	2.12	3.37	3.78	5.72	6.56	2	5	10	12	17
IIIv2	M	0.3	0.6	0.7	0.8	1.2	32.53	54.04	74.22	66.50	106.06	0.4	0.6	0.8	1.2	2
IIIv3	F	7	32	45	47	42	1.53	1.71	2.65	3.12	4.78	5	16	20	30	37
IIIv4	F	5	6	13	16	20	4.40	5.47	7.62	9.78	11.10	4	5	8	10	15

Table 5-7. Structural normalized data collection for Groups I~III

Subject code	Sex	Meas. 1					Meas. 2					Meas. 3				
		8”	16”	24”	32”	40”	¥1.0	¥2.0	¥3.0	¥4.0	¥5.0	8”	16”	24”	32”	40”
Ii1	M	3.48	5.25	7.02	9.67	11.45	9.03	21.07	27.40	30.67	32.27	2.53	4.12	7.31	7.31	10.49
Ii2	M	3.48	11.45	14.11	11.45	11.45	9.03	17.12	24.10	28.27	32.27	2.53	5.46	6.72	8.81	10.49
Ii3	F	3.48	5.76	8.03	11.45	11.45	9.03	16.72	23.38	28.96	32.27	2.53	4.30	6.95	8.72	10.49
Ii4	F	3.48	7.47	7.47	11.45	11.45	9.03	14.48	18.94	27.62	32.27	2.53	6.51	8.50	10.49	10.49
Iii1	M	3.48	5.76	5.76	6.90	11.45	9.03	11.46	16.22	30.87	32.27	2.53	3.53	6.51	6.51	10.49
Iii2	M	3.48	6.14	8.79	8.79	11.45	9.03	14.72	22.32	28.96	32.27	2.53	5.18	7.84	9.16	10.49
Iii3	F	3.48	7.47	5.47	7.47	11.45	9.03	8.78	27.90	28.39	32.27	2.53	6.51	7.51	9.50	10.49
Iii4	F	3.48	5.76	9.17	5.76	11.45	9.03	15.22	23.72	29.83	32.27	2.53	4.80	5.94	7.08	10.49
Iiii1	M	3.48	6.67	8.79	11.45	11.45	9.03	15.87	20.61	22.28	32.27	2.53	4.30	6.07	8.28	10.49
Iiii2	M	3.48	6.14	8.79	11.45	11.45	9.03	19.09	15.42	23.38	32.27	2.53	6.51	6.51	10.49	10.49
Iiii3	F	3.48	7.47	4.48	7.47	11.45	9.03	13.86	10.77	20.22	32.27	2.53	4.12	5.71	8.10	10.49
Iiii4	F	3.48	5.47	7.47	9.96	11.45	9.03	18.68	19.23	22.78	32.27	2.53	4.65	7.84	9.43	10.49
Iiv1	M	3.48	9.46	8.79	8.79	11.45	9.03	9.55	24.24	28.73	32.27	2.53	3.67	5.94	8.22	10.49
Iiv2	M	3.48	5.76	5.76	8.03	11.45	9.03	12.66	19.86	25.95	32.27	2.53	4.12	5.71	10.49	10.49
Iiv3	F	3.48	5.47	9.46	9.46	11.45	9.03	12.66	18.82	34.38	32.27	2.53	4.80	7.08	9.43	10.49
Iiv4	F	3.48	5.87	7.47	7.47	11.45	9.03	18.22	24.04	35.75	32.27	2.53	6.87	5.79	7.60	10.49
Iv1	M	3.48	5.32	8.38	8.38	11.45	9.03	13.86	38.24	51.77	32.27	2.53	5.85	7.17	8.50	10.49
Iv2	M	3.48	5.47	5.47	7.47	11.45	9.03	13.76	24.76	27.05	32.27	2.53	3.57	7.03	8.76	10.49
Iv3	F	3.48	6.14	8.79	14.12	11.45	9.03	15.00	14.56	31.63	32.27	2.53	5.37	6.51	9.35	10.49
Iv4	F	3.48	6.14	8.13	8.13	11.45	9.03	11.76	17.03	19.99	32.27	2.53	5.37	8.22	9.35	10.49
IIi1	M	3.48	5.47	7.47	11.45	11.45	9.03	16.33	21.28	28.59	32.27	2.53	4.80	6.23	9.07	10.49
IIi2	M	3.48	5.25	6.14	9.68	11.45	9.03	17.12	20.08	30.96	32.27	2.53	4.70	6.87	9.77	10.49
IIi3	F	3.48	5.76	9.17	11.45	11.45	9.03	19.07	23.37	29.37	32.27	2.53	4.92	6.51	8.10	10.49
IIi4	F	3.48	6.55	8.39	9.61	11.45	9.03	14.72	20.39	29.05	32.27	2.53	5.52	7.51	8.76	10.49
IIii1	M	3.48	4.57	8.26	9.06	11.45	9.03	16.12	20.82	24.60	32.27	2.53	5.37	7.36	8.78	10.49
IIii2	M	3.48	5.76	8.60	11.45	11.45	9.03	29.14	18.77	13.64	32.27	2.53	5.18	7.35	8.80	10.49
IIii3	F	3.48	5.25	7.91	9.68	11.45	9.03	36.58	19.61	22.88	32.27	2.53	3.41	6.95	8.72	10.49
IIii4	F	3.48	6.67	8.26	11.45	11.45	9.03	19.48	25.04	24.78	32.27	2.53	5.18	6.51	7.84	10.49
IIiii1	M	3.48	6.47	7.07	10.45	11.45	9.03	20.53	16.89	22.46	32.27	2.53	5.37	7.36	8.78	10.49

IIiii2	M	3.48	5.47	7.47	11.45	11.45	9.03	3.08	9.56	15.65	32.27	2.53	4.30	7.84	9.61	10.49
IIiii3	F	3.48	6.67	9.86	11.45	11.45	9.03	13.85	15.58	21.85	32.27	2.53	4.03	5.52	7.51	10.49
IIiii4	F	3.48	6.90	5.76	10.31	11.45	9.03	8.94	24.09	26.87	32.27	2.53	5.94	7.08	9.35	10.49
IIiv1	M	3.48	4.52	6.25	7.99	11.45	9.03	20.33	33.13	26.95	32.27	2.53	5.18	7.84	9.61	10.49
IIiv2	M	3.48	8.26	8.26	8.26	11.45	9.03	12.85	30.01	31.81	32.27	2.53	4.30	6.95	7.84	10.49
IIiv3	F	3.48	8.46	5.47	6.47	11.45	9.03	13.09	19.74	24.29	32.27	2.53	5.18	6.24	7.84	10.49
IIiv4	F	3.48	7.02	7.02	11.45	11.45	9.03	13.32	23.06	31.94	32.27	2.53	4.95	6.07	9.02	10.49
IIv1	M	3.48	5.55	8.50	9.97	11.45	9.03	14.70	20.70	26.58	32.27	2.53	4.59	7.54	9.02	10.49
IIv2	M	3.48	5.07	8.26	9.86	11.45	9.03	12.66	21.36	24.61	32.27	2.53	4.98	6.51	8.04	10.49
IIv3	F	3.48	7.47	7.47	11.45	11.45	9.03	33.86	19.64	30.89	32.27	2.53	6.51	8.50	10.49	10.49
IIv4	F	3.48	5.07	8.26	8.26	11.45	9.03	19.16	21.82	29.79	32.27	2.53	5.18	7.60	7.60	10.49
IIIi1	M	3.48	5.56	7.83	9.28	11.45	9.03	17.96	21.87	37.14	32.27	2.53	3.85	7.17	9.16	10.49
IIIi2	M	3.48	5.76	9.17	9.17	11.45	9.03	13.90	19.25	27.66	32.27	2.53	4.30	6.07	8.72	10.49
IIIi3	F	3.48	6.14	8.13	9.46	11.45	9.03	17.43	20.71	27.03	32.27	2.53	6.51	8.50	10.49	10.49
IIIi4	F	3.48	4.81	7.47	10.12	11.45	9.03	15.37	22.99	25.43	32.27	2.53	5.71	7.31	10.49	10.49
IIIii1	M	3.48	7.91	11.89	10.12	11.45	9.03	16.32	19.06	25.83	32.27	2.53	7.72	8.41	9.11	10.49
IIIii2	M	3.48	4.28	9.86	10.65	11.45	9.03	15.06	29.56	41.53	32.27	2.53	4.92	8.90	9.69	10.49
IIIii3	F	3.48	6.14	8.79	14.11	11.45	9.03	15.71	15.95	19.37	32.27	2.53	3.41	5.18	8.72	10.49
IIIii4	F	3.48	6.90	4.62	6.90	11.45	9.03	10.78	25.24	25.72	32.27	2.53	5.18	6.51	7.84	10.49
IIIiii1	M	3.48	6.67	8.26	11.45	11.45	9.03	18.36	20.86	26.33	32.27	2.53	4.12	5.71	8.90	10.49
IIIiii2	M	3.48	8.46	7.47	8.46	11.45	9.03	14.71	22.43	22.00	32.27	2.53	6.51	8.50	10.49	10.49
IIIiii3	F	3.48	6.80	8.13	9.46	11.45	9.03	20.68	20.55	24.23	32.27	2.53	5.18	7.54	8.72	10.49
IIIiii4	F	3.48	6.14	6.14	8.79	11.45	9.03	16.09	21.11	31.57	32.27	2.53	4.80	5.94	8.22	10.49
IIIiv1	M	3.48	7.83	8.55	9.28	11.45	9.03	16.06	16.07	36.76	32.27	2.53	5.42	6.15	9.04	10.49
IIIiv2	M	3.48	5.47	9.46	13.44	11.45	9.03	15.94	34.21	27.86	32.27	2.53	4.12	7.31	10.49	10.49
IIIiv3	F	3.48	9.93	5.38	11.07	11.45	9.03	13.39	18.10	15.32	32.27	2.53	5.85	7.84	9.16	10.49
IIIiv4	F	3.48	6.47	9.46	8.46	11.45	9.03	16.41	28.23	30.94	32.27	2.53	5.52	7.01	8.50	10.49
IIIv1	M	3.48	5.07	7.73	11.45	11.45	9.03	15.57	17.72	27.87	32.27	2.53	4.12	6.78	7.84	10.49
IIIv2	M	3.48	6.14	7.02	7.91	11.45	9.03	15.83	22.21	19.77	32.27	2.53	3.53	4.52	6.51	10.49
IIIv3	F	3.48	9.17	12.13	12.59	11.45	9.03	10.32	17.04	20.40	32.27	2.53	5.27	6.26	8.75	10.49
IIIv4	F	3.48	4.01	7.73	9.32	11.45	9.03	12.74	20.20	27.69	32.27	2.53	3.25	5.42	6.87	10.49
Mean		**3.48**	**6.37**	**7.94**	**9.80**	**11.45**	**9.03**	**15.96**	**21.50**	**27.26**	**32.27**	**2.53**	**4.98**	**6.90**	**8.80**	**10.49**

Using the values of means presented in the bottom of Table 5-7, by the curve regression in SPSS, finally obtain the power and logarithmic laws for Meas. 1~3 in Latin square experiment as the following

$m=1.88(q+20)^{0.596}-10$;

$S_2=74.6\ln(m+10)-169.8$;

$S_3=10.4\ln(q+20)-32.2$.