Analyses of sensory-relevance of adjective pairs frequently used in the semantic differential method

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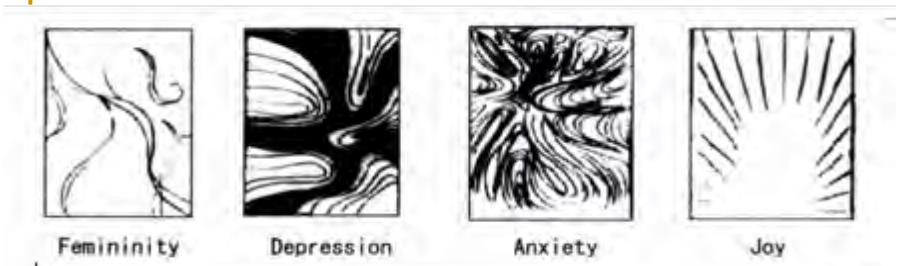
What is the semantic differential (SD) method?



femininity

	1 2 3 4 5 6 7	
pleasant	|-|-|-|-|-|-|-|	unpleasant
clear	|-|-|-|-|-|-|-|	cloudy
dynamic	|-|-|-|-|-|-|-|	static
gay	|-|-|-|-|-|-|-|	sober
soft	|-|-|-|-|-|-|-|	hard
likable	|-|-|-|-|-|-|-|	repugnant
active	|-|-|-|-|-|-|-|	passive
sharp	|-|-|-|-|-|-|-|	blunt
tense	|-|-|-|-|-|-|-|	relaxed
cheerful	|-|-|-|-|-|-|-|	gloomy

The SD method developed by C.E. Osgood (1957) has been widely used and found to be very useful for measuring the affective contents of various stimuli such as paintings or melodies. In this technique, participants rated the affective meanings or impressions of stimuli on scales of adjective pairs. As Osgood pointed out, the system generating responses for adjective scales in the SD method is assumed to be deeply based on synaesthetic processing.

FACTOR LOADINGS FOR EACH ADJECTIVE SCALE AFTER VARIMAX ROTATION

Adjective Pair	Factor 1 Evaluation	Factor 2 Activity	Factor 3 Potency
Pleasant–unpleasant	.86	–.02	.18
Clear–cloudy	.84	–.20	.00
Likable–repugnant	.82	–.01	.21
Beautiful–ugly	.81	–.16	.15
Cheerful–gloomy	.73	.30	.03
Light–heavy	.69	–.01	.09
Stable–unstable	.70	–.24	.02
Dry–wet	.47	.13	–.33
Dynamic–static	–.12	.84	–.08
Lively–quiet	–.03	.83	–.14
Gay–sober	.06	.78	–.16
Active–passive	.20	.70	–.30
Excited–calm	–.40	.69	–.37
Strong–weak	–.05	.68	–.26
Powerful–feeble	–.17	.63	–.25
Rugged–delicate	–.27	.54	–.32
Hard–soft	.20	–.23	.79
Rough–smooth	–.31	.41	.72
Sharp–blunt	–.16	–.39	.61
Tense–relaxed	–.38	.17	.54
Factor contribution	5.10	4.74	2.52
Variance explained, %	25.49	23.70	12.61
Accumulated variance explained, %	25.49	49.19	61.80

In most cases, three factors are extracted in the SD method.

representative adjective scale

Evaluation: pleasant-unpleasant

Activity: dynamic-static

Potency: hard-soft

These factors have been commonly found across different cultures and various stimulus domain.

The SD method is deeply based on synaesthetic processing of the contents implied by adjective pairs.

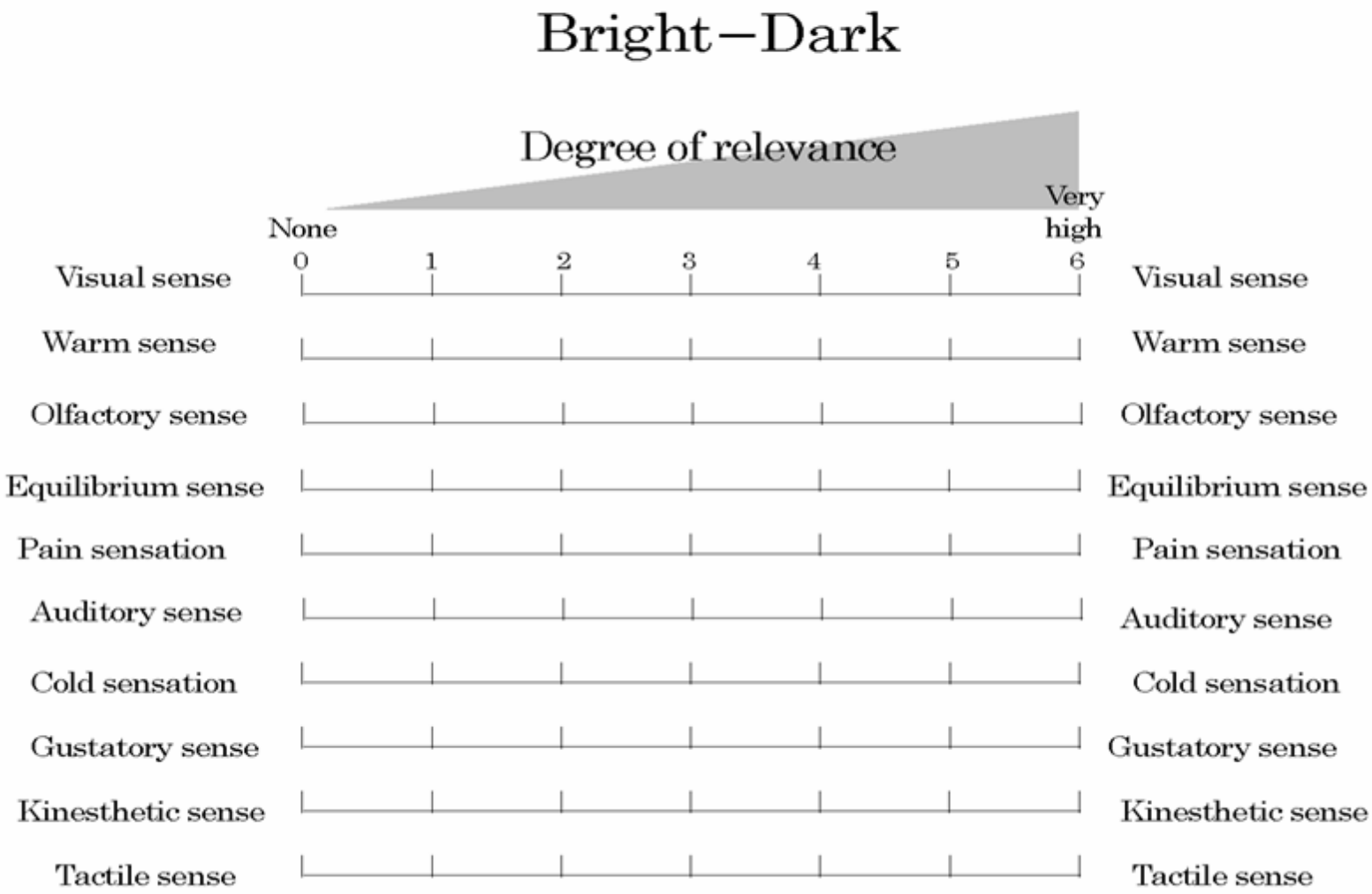
Purpose of the present study

- Although the SD method is deeply based on synaesthetic processing of the contents implied by adjectives, the synaesthetic properties related to the adjective pairs used in the SD method have not undergone precise quantitative analysis.

- We have devised a new technique called ‘Modality Differential (MD)’ method and measured the sensory-relevance of adjective pairs frequently used in the SD method.

Modality Differential (MD) method

Please rate the degree of sensory relevance of the adjective pair shown below to each modality by marking on the appropriate point.



Method

- **Investigated adjective pairs：** Based on the studies of Inoue & Kobayashi (1985) and Suzuki & Gyoba（2003）, the sensory-relevance of 74 adjective pairs was measured by the MD method.
- **Sensory modalities included in the MD method:** Visual, Auditory, Kinesthetic, Equilibrium, Olfactory, Gustatory, Tactile, Pain, Warm, & Cold sensations.
- **Participants:** Total 294 university students were participated. Each participant rated the sensory-relevance of 18±1 adjective pairs to the 10 modalities listed above.

Results: Principal factor analysis of MD data with varimax rotation.

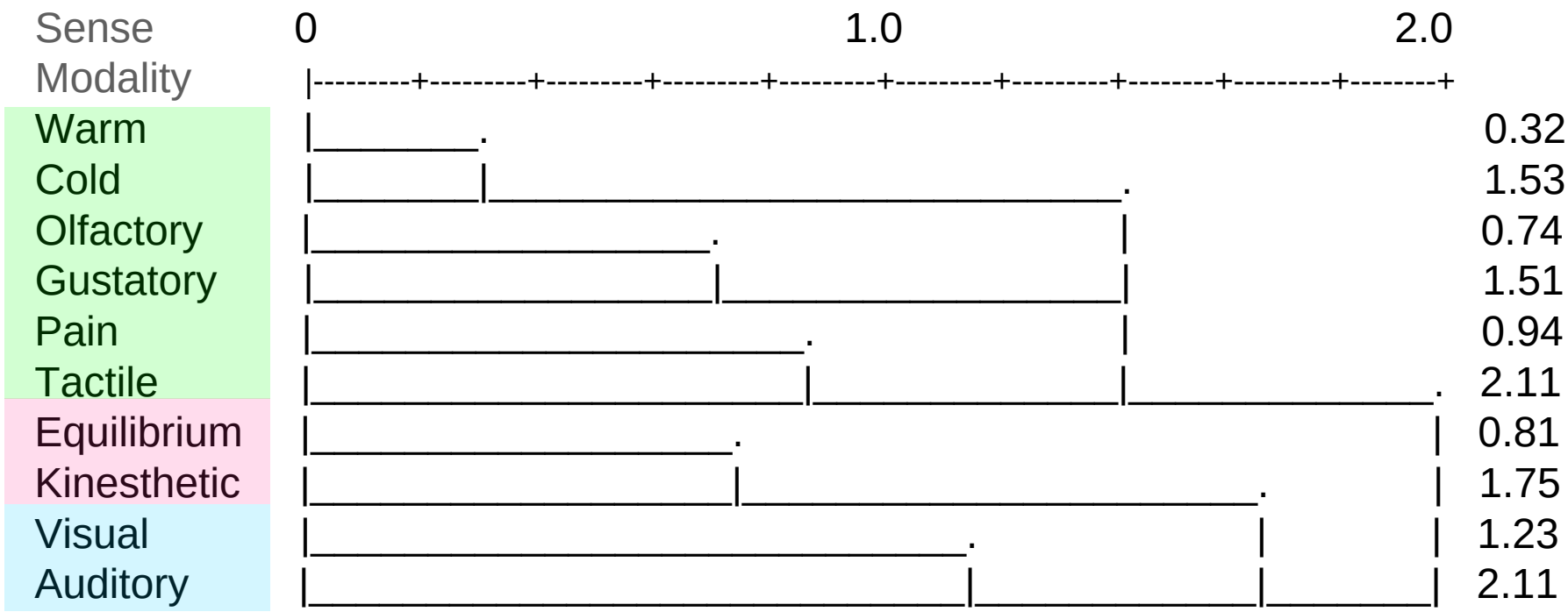
Sense Modality	Factor1 Proximal type	Factor2 Proprioceptive type	Factor3 Distal type
Cold	0.8753	-0.1037	-0.2069
Warm	0.7908	-0.1627	-0.1826
Gustatory	0.6999	-0.2774	0.3970
Pain	0.6838	0.4371	-0.0787
Tactile	0.5786	0.1317	0.1246
Equilibrium	0.0165	0.8637	0.0862
Kinesthetic	-0.0809	0.8898	-0.1431
Olfactory	0.4806	-0.2691	0.6968
Auditory	-0.0243	0.1895	0.5942
Visual	-0.2590	-0.1762	0.7333
Factor contribution	2.9891	1.9997	1.6597
Variance explained%	29.8911	19.9967	16.5972
Accumulated%	29.8911	49.8878	66.4850

Factor1 which explains the variance of the MD data most largely was found to be proximal- type senses.

Factor2 corresponds to proprioceptive type of senses.

Factor3 can be considered as distal type of senses whose contribution was almost a half of that of Factor1

Results of Cluster analysis (Ward method)



The results of the cluster analysis was almost in line with those of factor analysis. The sense modalities were first divided into two groups, proximal type and non-proximal type. The latter type of senses were further grouped into distal type or proprioceptive type. The proximal type of senses were subdivided into groups of tactile & pain, olfactory & gustatory, or cold & warm. These results nicely correspond to psychological classification of sense modalities, while the participants were merely asked to judge synaesthetic properties of adjectives.

The general tendency of MD profile of each modality

Adjective pair	Warm	Cold	Olfa	Gus	Pain	Tact	Equi	Kine	Audi	Visu	Ave.	SD
Pleasant − Unpleasant	4.13	3.73	4.78	4.43	4.16	4.67	2.51	3.30	5.04	4.95	4.17	0.76
Comfortable - Uncomfortable	4.03	3.38	4.59	3.95	3.28	5.28	3.59	2.95	4.28	5.21	4.05	0.75
Likable – Dislikable	3.28	2.85	4.68	5.03	3.07	4.41	1.93	3.59	4.72	5.16	3.87	1.03
Good – Bad	2.92	2.24	3.95	4.65	2.78	4.00	3.30	3.86	4.43	4.95	3.71	0.83
Agreeable - Disagreeable	3.15	2.79	3.69	3.64	3.79	4.10	2.41	3.13	4.97	5.18	3.69	0.84
….	…	…	…	…	…	…	…	…	…	…	…	…
….	…	…	…	…	…	…	…	…	…	…	…	…
Bright - Dark	3.11	2.41	0.92	0.65	1.16	1.57	2.05	2.22	1.95	5.62	2.16	1.35
Quiet - Noisy	1.30	1.00	0.97	0.84	1.70	1.62	1.54	3.00	5.65	3.86	2.15	1.48
Clear - Unclear	1.49	1.06	2.66	2.52	0.88	1.40	0.90	0.83	3.36	5.70	2.08	1.46
Passive - Active	1.48	1.16	1.15	1.28	1.41	1.72	1.72	4.16	2.28	3.67	2.00	1.01
Average	2.27	1.89	2.14	2.19	2.18	3.39	2.17	3.39	3.44	4.87		
Standard Deviation	0.91	0.85	1.13	1.15	1.01	1.19	0.83	1.07	1.03	0.63		
Coefficient of Variation	39.96	44.95	52.95	52.73	46.18	35.05	38.32	31.65	29.85	12.99		

Senses belonging to the proximal type have generally low average MD scores, while they have larger variances. In contrast, the distal type senses, especially visual sense has a very high average MD score, while its variance is very small. These results suggest that visual sensation has high relevance to all adjectives with small variation. The opposite is true for the senses such as olfactory or pain sensation.

The adjective pairs which show high MD scores to multiple senses

Adjective pair	Warm	Cold	Olfa	Gus	Pain	Tact	Equi	Kine	Audi	Visu	Ave.
Pleasant − Unpleasant	4.13	3.73	4.78	4.43	4.16	4.67	2.51	3.30	5.04	4.95	4.17
Comfortable - Uncomfortable	4.03	3.38	4.59	3.95	3.28	5.28	3.59	2.95	4.28	5.21	4.05
Likable – Dislikable	3.28	2.85	4.68	5.03	3.07	4.41	1.93	3.59	4.72	5.16	3.87
Sensitive – Insensitive	3.14	3.44	3.44	3.89	4.19	4.22	3.92	4.83	4.28	4.25	3.96
Good – Bad	2.92	2.24	3.95	4.65	2.78	4.00	3.30	3.86	4.43	4.95	3.71
Agreeable - Disagreeable	3.15	2.79	3.69	3.64	3.79	4.10	2.41	3.13	4.97	5.18	3.69
Easy – Uneasy	3.32	2.70	2.86	2.89	4.24	3.32	2.95	4.68	4.46	4.76	3.62
….	…	…	…	…	…	…	…	…	…	…	…
….	…	…	…	…	…	…	…	…	…	…	…

- The adjective pairs which have the highest average MD scores can be regarded as representative adjective scales of Evaluation factor.

The adjective pairs which show high MD scores to Auditory & Kinesthetic senses

Adjective pair	Warm	Cold	Olfa	Gus	Pain	Tact	Equi	Kine	Audi	Visu
Quiet - Noisy	2.23	1.88	1.40	1.18	1.85	2.23	2.13	3.53	5.78	4.38
Static - Dynamic	1.98	1.60	1.18	1.06	2.11	2.97	3.63	5.20	3.71	5.19
Free – Busy	1.94	1.42	1.06	0.94	1.31	1.89	2.22	4.94	3.89	4.64
Calm - Turbulent	2.67	2.02	2.25	1.70	3.27	2.60	2.01	4.54	4.28	4.69
Slow - Fast	1.54	1.28	1.31	1.10	1.82	2.44	2.97	4.59	4.03	5.31
Inactive − Active	1.92	1.19	1.00	0.89	1.38	2.68	2.68	5.16	3.30	4.51
Lonely - Cheerful	2.73	2.18	1.65	1.68	1.65	2.38	1.58	3.08	5.28	5.33
…..	…	…	…	…	…	…	…	…	…	…
…..	…	…	…	…	…	…	…	…	…	…

The adjective pairs which have the high MD scores to Auditory and Kinesthetic senses can be regarded as representative adjective scales of Activity factor.

The adjective pairs which show high MD scores to Tactile sense

Adjective pair	Warm	Cold	Olfa	Gus	Pain	Tact	Equi	Kine	Audi	Visu
Smooth - Rough	1.38	1.25	1.45	3.80	3.05	5.90	1.13	2.55	2.48	4.88
Soft - Hard	2.01	1.87	1.15	2.84	4.13	5.79	1.68	3.76	2.36	3.96
Blunt - Sharp	1.58	1.58	1.80	2.82	4.59	5.69	1.85	2.73	2.54	5.09
Round – Square	1.58	1.45	0.98	1.65	2.88	5.65	1.90	2.93	1.90	5.48
Gentle - Rough	1.51	1.17	1.79	2.77	2.56	5.03	2.15	3.24	3.48	4.83
Warm - Cold	5.67	5.53	1.25	3.67	3.39	5.03	1.11	2.42	1.61	3.33
Small - Big	1.54	1.49	1.26	1.72	2.67	4.69	2.41	3.05	3.82	5.49
Feminine -masculine	2.49	1.56	4.15	1.85	1.41	4.62	1.59	4.23	3.77	5.49
.....	…	…	…	…	…	…	…	…	…	…
.....	…	…	…	…	…	…	…	…	…	…

The adjective pairs which have the high MD scores to Tactile sensation can be regarded as representative adjective scales of Potency factor.

Neural bases for the three main factors in the SD method revealed by Neuro-imaging studies

- Suzuki, Gyoba, and Sakuta (2004, 2005)

Using 24-channel near-infrared spectroscopy (NIRS), the brain activities were measured while the participants rated the line drawings using semantic differential scales.

Evaluation Specific activities were not observed. (May be due to the multisensory properties contained in the adjective scales of evaluation.)

Activity The right superior temporal gyrus was activated. (The auditory association area where auditory information converges.)

Potency The post central gyrus was activated. (This implies that somatosensory processing area is related to potency.)

The present results obtained by the MD method are well in line with those obtained the neuro-imaging studies.

Conclusion & Future study

- The present study and our previous studies using neuro-imaging clearly indicate that the Semantic Differential (SD) method is really based on synaesthetic processing.

- The present study also indicates that the participants can reliably conduct Modality Differential (MD).

- In future study, we have a plan to utilize the versatility of the MD method for measuring sensory-relevance of several materials, such as various types of arts, sports, or industrial products.

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