



Study 1

### Varimin Components: Underlying Figural Similarity

#### Source:

Künnapas, T. (1966). Visual Perception of Capital Letters. Multidimensional ratio scaling and multidimensional similarity. *Scandinavian Journal of Psychology*, 7, 189-196

#### Aim of Künnapas' study:

To find, by factor analysis, dimensions of judgments on similarity among nine capital letters of the alphabet.

#### Method:

Two methods of similarity assessment were used: Ratio scaling and similarity judgment. The author obtained equivalent results from the two procedures. With using similarity judgments, the results are somewhat more pronounced. Subjects' judge similarities of two paired capital letters by rating their similarity on a percent scale, 0 = no similarity, 100 = identity. All possible pairs of letters were presented (72 including alternating left-right positions).

#### Ss, procedures, data analysis:

For similarity judgments, 26 subjects were used. Different subject samples were used for ratio scaling; those results are not considered here. The author applied Thurstone's complete centroid method followed by Varimax rotation. The present re-analysis is conducted by PCA, which is followed in the Varimax and Varimin rotation.

Table 1

Data for factor analysis (Table 2 in the paper):

	I	J	L	F	E	U	O	S	A
I	.77	.72	.38	.30	.31	.08	.03	.08	
J		.50	.10	.12	.62	.40	.18	.06	
L			.36	.55	.29	.26	.08	.13	
F				.84	.08	.05	.21	.15	
E					.10	.10	.24	.19	
U						.77	.25	.07	
O							.34	.11	
S								.08	
A									

Eigenvalues:

3.39	1.82	1.34	0.94	0.70	...
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Varimax results

The present Varimax result does not differ noticeably from Künnapas' Varimax result. Künnapas distinguished three dimensions: roundedness (F1), rectangularity (F2), and vertical linearity (F3)

Table 2

Varimax loadings:

Stimulus	F1 Rounded- ness	F2 Rectan- gularity	F3 Vertical Linearity
I	.026	.227	.924
J	.441	-.044	.808
L	.109	.425	.739
F	-.013	.895	.168
E	.036	.926	.182
U	.831	-.048	.369
O	.900	.016	.112
S	.602	.368	-.204
A	.167	.341	-.048

Criticism:

Varimax F1 “roundedness”: The loadings of F1, even though similar to Varimin-factor “straight vs. rounded” (see Varimin-F2 below), do not show bipolarity, and thus, they do not indicate, by +/- sign, the opposing qualities of rounded (e.g. “O”) vs. straight (e.g. “I”) .

Varimax F2 “rectangularity”: The capitals “L,” “S,” “A,” and “I” have moderate F2 loadings. However, there is nothing rectangular in “S,” “A,” and “I,” the angles in “A” are not rectangular.

Varimax F3 “vertical linearity”: Two figural features are used in combination (vertical, linear) to establish one dimension. Dimensions should represent single features, not combinations of features. “U” has a moderate F3 loading (linearity) even though the dominant feature of “U” is that it is rounded which is the opposite of linearity.

Künnapas does not address problems of interpretation of his Varimax factors. Instead he summarises: *“The results...appear meaningful and easily interpretable ...”* .

Varimin results

Varimin F1 is a general factor with positive loadings only and low variance across variables. Its meaning can only be guessed. It cannot be revealed by comparing pairs of variables with large loading differences on F1. All differences are small. The most probable determinant of F1 is response set, which may be termed “similarity bias” (comparable to “acquiescence”). The Ss were requested to assess similarity, not oppositeness. They were probably led to overestimate figural similarities and to ignore opposing figural features. Thus some bias favoring positive intercorrelations has likely been introduced.

Table 3

Varimin loadings:

	F1 General factor	F2 Non-rounded (+) vs. rounded (-)	F3 Complex (+) vs. simple (-)
I	.574	.566	-.507
J	.633	.085	-.665
L	.662	.487	-.250
F	.603	.467	.497
E	.660	.451	.501
U	.687	-.438	-.405
O	.653	-.598	-.187
S	.524	-.402	-.320
A	.293	-.009	.247

Table 4

Minimal pairs:

	Bold numbers represent loadings of pairs of variables for one focal factor. Non-bold numbers represent loadings of the paired variables for non-focal factors	
	Non-rounded (+) rounded (-)	Complex (+) simple (-)
I	<b>.566</b>	-.507
U	<b>-.438</b>	-.405
L	<b>.487</b>	-.250
S	<b>-.402</b>	-.320
I	.566	<b>-.507</b>
E	.451	<b>.501</b>
L	<b>.487</b>	<b>-.250</b>
F	<b>.467</b>	<b>.497</b>

Results of minimal pair comparisons:

Varimin F2: Its bipolar meaning reveals itself by comparing “I” and “U”: the capital “I” is non-rounded, and straight, “U” is rounded. The same is true with “L” (non-rounded) and “S” (rounded).

Varimax F3: Again, minimal pair comparison helps find bipolar meanings. Capital “I” is simple (consists of only one element), and “E” (consists of four components) is complex. The difference regarding complexity is less conspicuous, but still noticeable for “L” (only one small line branching off from the vertical stem) and “F” (two lines).

In sum:

The Varimin solution outdoes the Varimax solution. The interpretation of its rotated factors is more convincing.