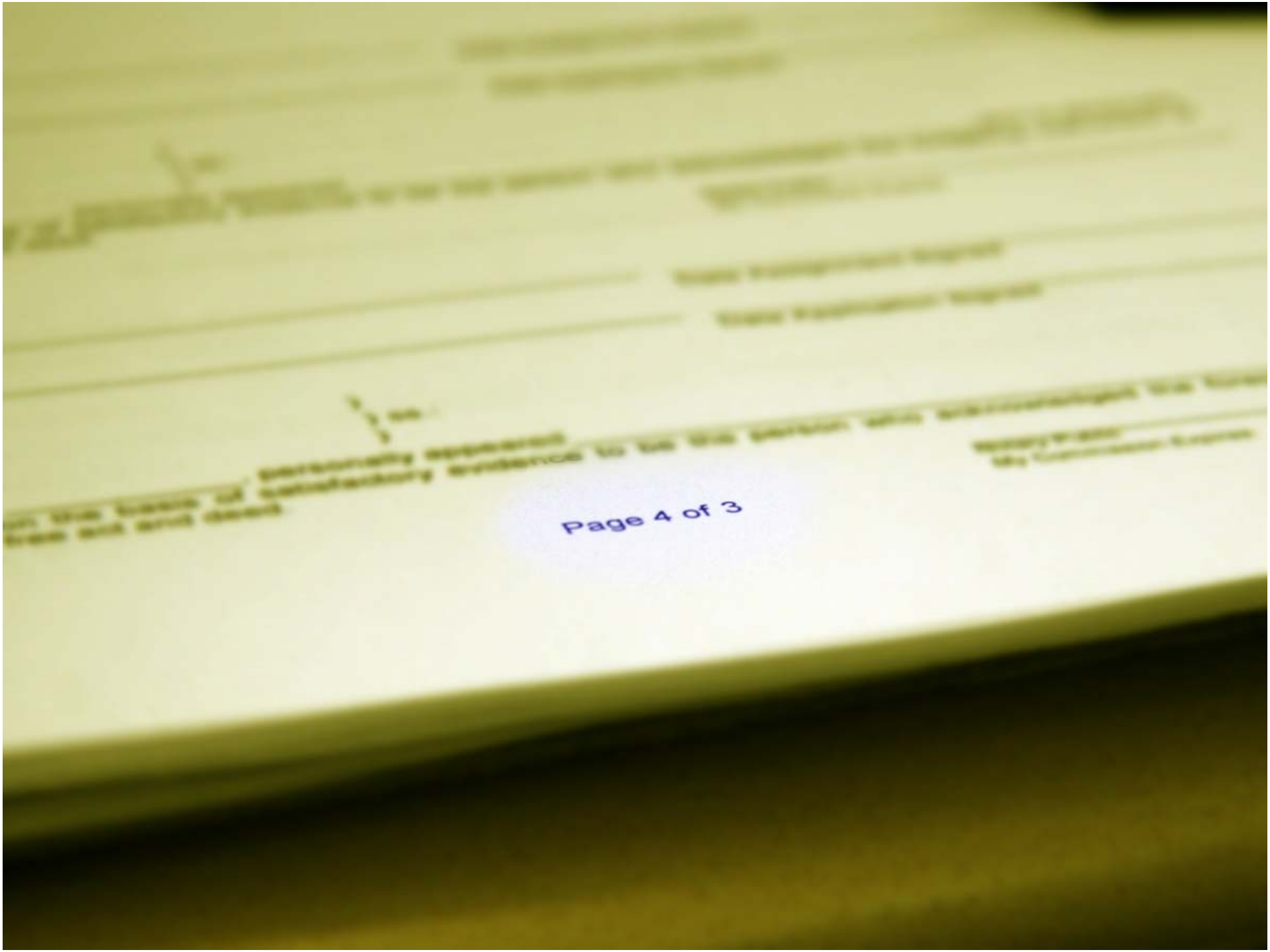
Nominal Scaling of Print Substrates

Nathan Moroney & Giordano Beretta

Hewlett-Packard Laboratories

17th IS&T/SID Color Imaging Conference

Pagination Humor?


Page 4 of 3

xpedx
Ultra Digital
HPPP110CHM 19x13
Ultra Digital
Meadware
Meadware
N4186

Substrates

- Specialty Media Swatchbook
- 72 alphabetical samples

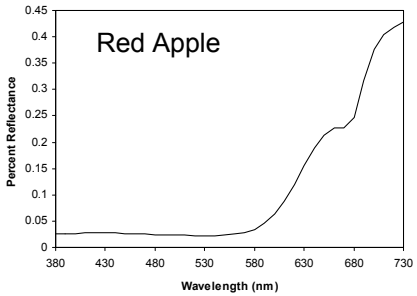
Metrology

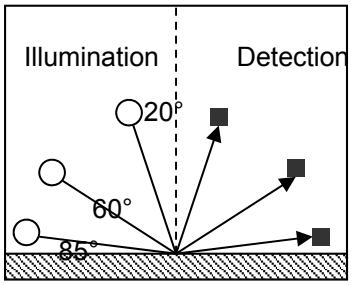
Spectrophotometer

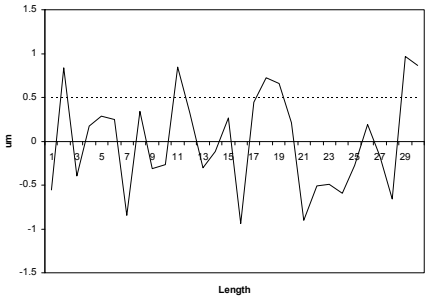
Glossmeter

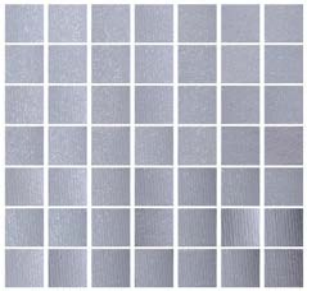
Profilometer

Multi-Angle Imaging







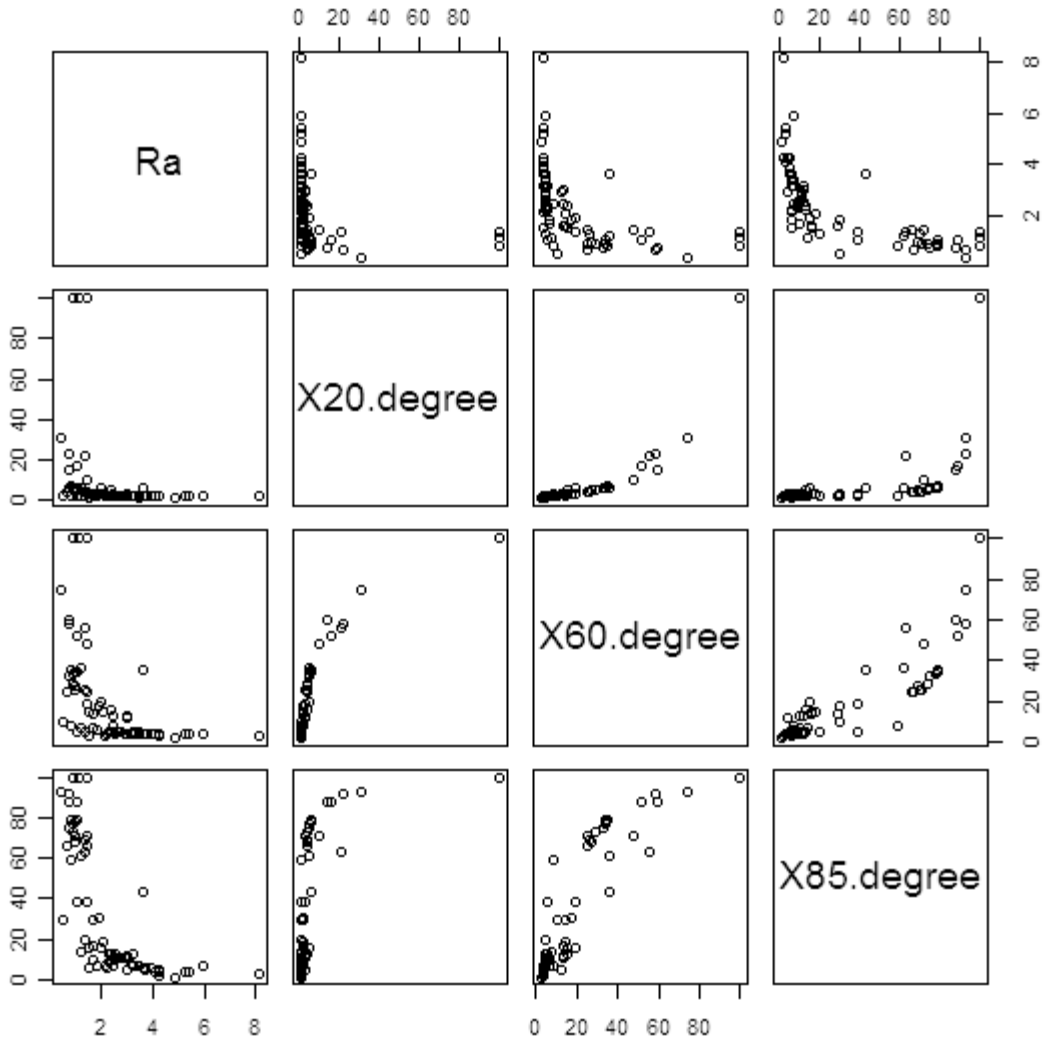


Thickness

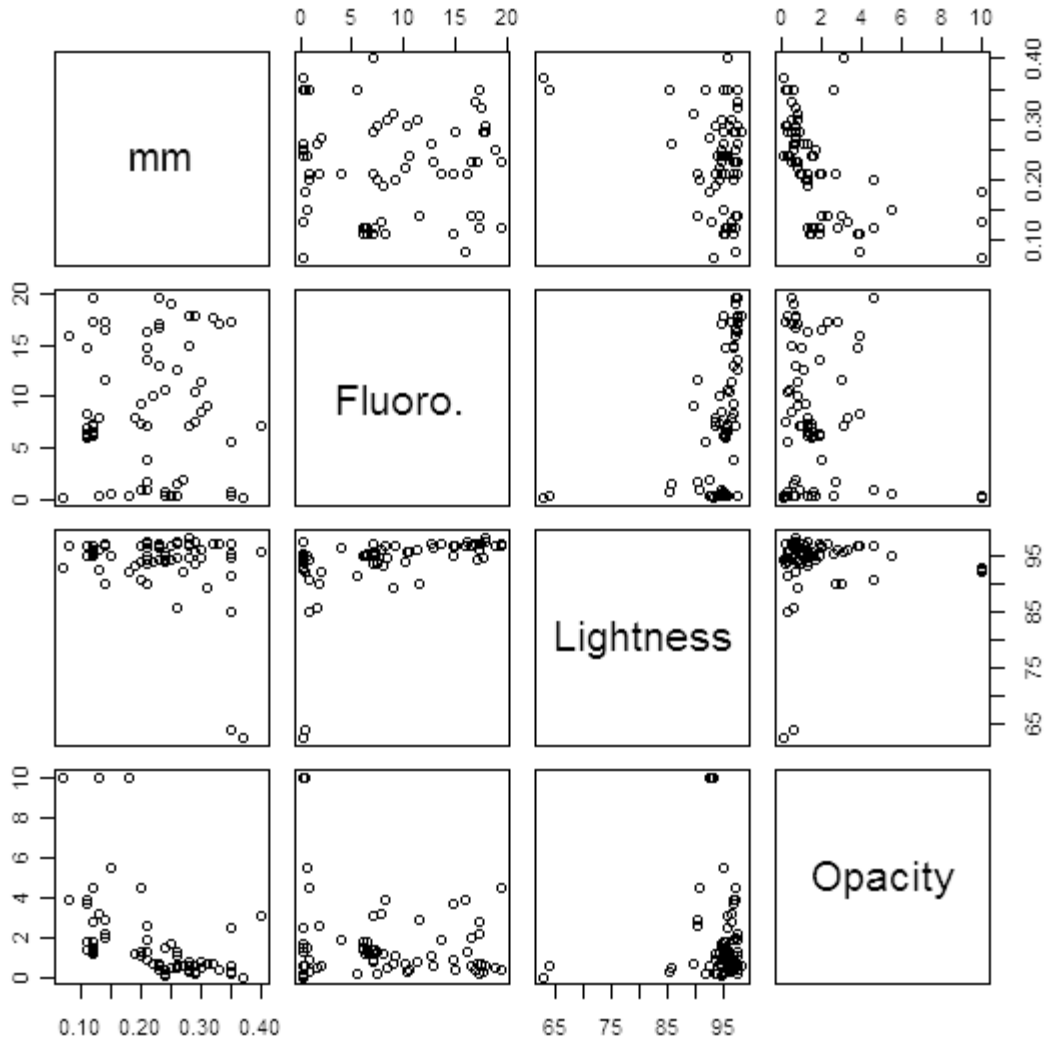
Fluoresence

Opacity

Roughness vs. Gloss



Thickness, Fluoresence, Lightness & Opacity



Are Ratio Scales Longer?

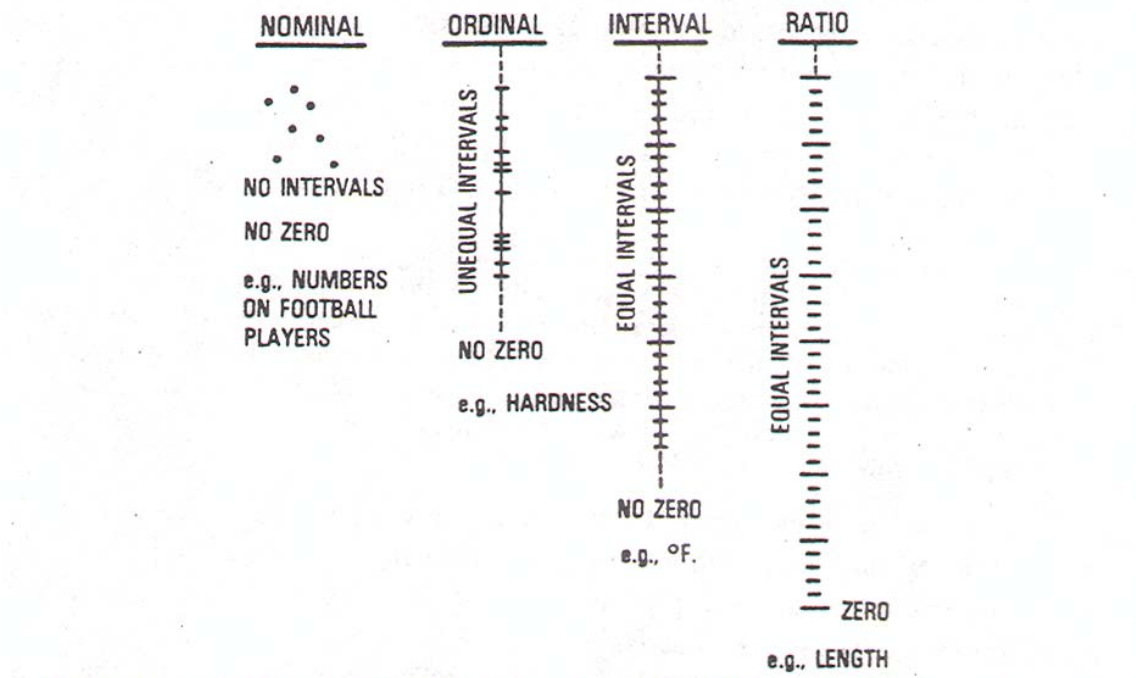
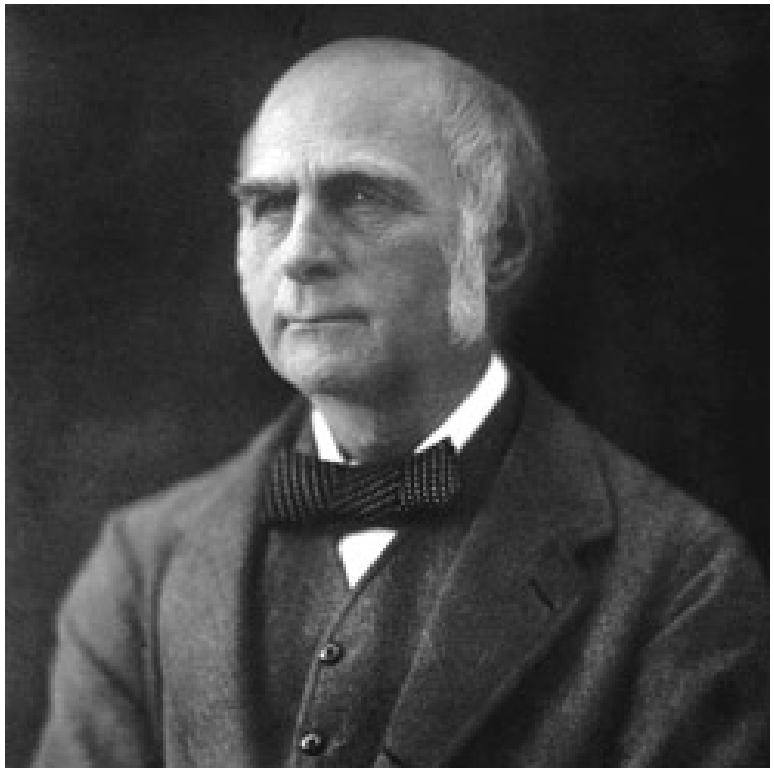


Fig. 2. Various measurement scales. A *nominal scale* merely uses numbers instead of names to distinguish among members of a group. An *ordinal scale* is derived from the operating of rank-ordering and gives no information about the meaning of distances along it. An *interval scale* is derived from the use of operations capable of specifying the equality of intervals and differences, so that equal distances anywhere along the scale have the same significance. A *ratio scale* is an interval scale with a zero point; equal ratios as well as equal intervals have the same meaning everywhere along this scale.

C.J. Bartleson and F. Grum eds., *Optical Radiation Measurements, Volume 5 Visual Measurements*, Academic Press, p. 341 (1984).

Nominal Scaling Undignified?

- "…until the phenomena of any branch of knowledge have been subjected to measurement and numbers, it cannot assume the status of dignity of a science"
  - Sir Francis Galton, *Psychometric Experiments*, (1875)



Father of σ and psychometric experiments

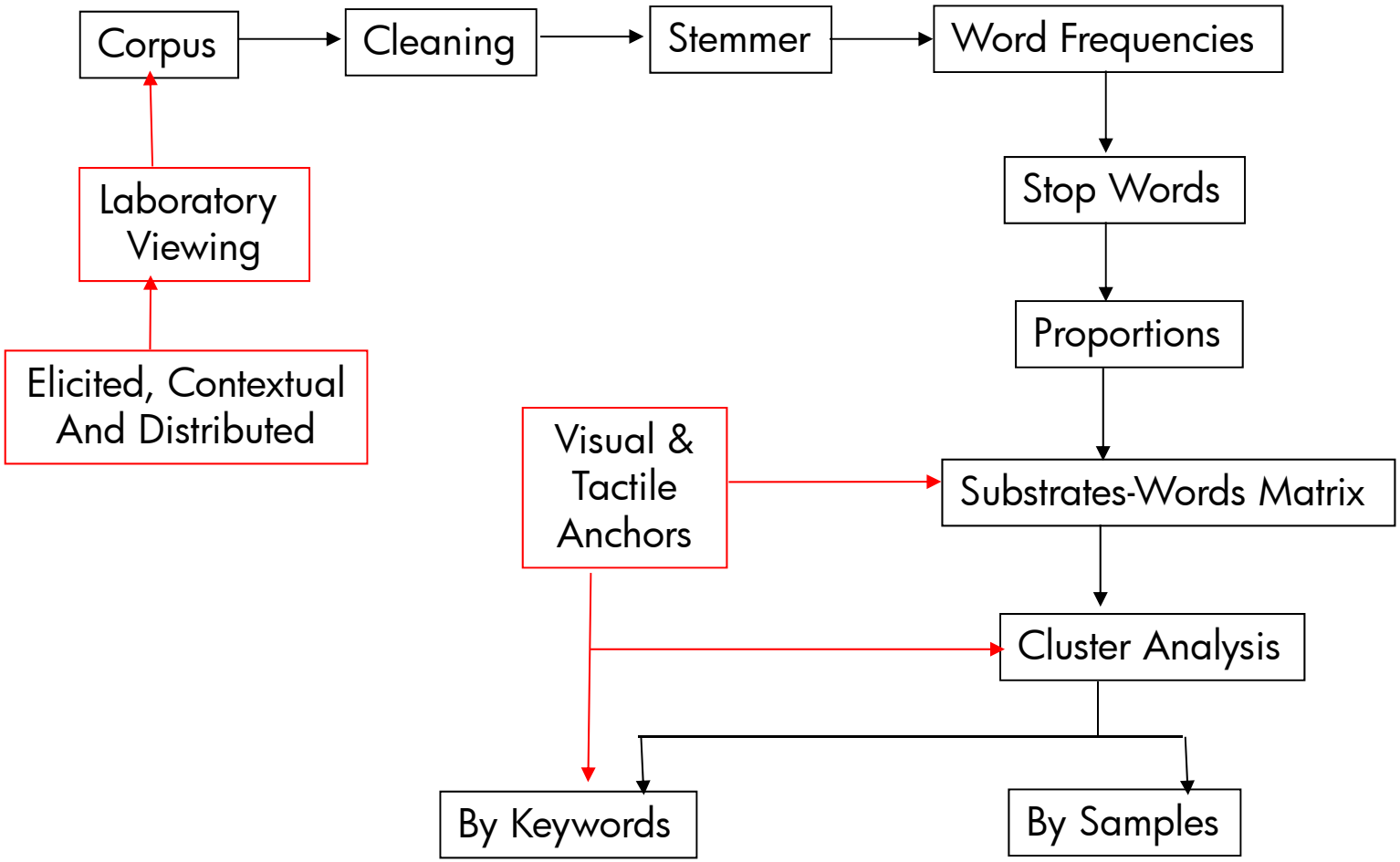
Media Corpus Experiment

Visual

Tactile

"…choose best words or phrases to describe the visual and tactile properties of the sample…"

Media Corpus Experiment



21 Participants

acetate	adhesive	angle	art	background	backing	beige	blue	board	bond
bone	bright	bristol	bronze	brown	bumpy	calandered	canvas	card	cardboard
cartridge	cast	cellophane	chalky	clear	cloth	coated	color	cream	cross
dark	decorative	deep	diffuse	dimples	dirty	dull	egg	eggshell	embossed
extra	fabric	film	fine	finish	flat	flexible	foil	frequency	friction
gloss	gold	good	grain	graininess	gray	green	grid	groove	heavier
heavy	heavy-weight	high	horizontal	imitation	irregular	ivory	laminate	light-weight	lightly
limp	linen	lines	little	machine	manila	marble	matte	maybe	medium
medium-weight	metallic	mottled	nylon	off-white	office	overtones	pale	paper	parallel
parchment	pattern	pearl	photo	plain	plastic	plasticized	printing	production	quality
random	ribbed	ridged	ridges	rigid	rough	satin	semi	semi-gloss	shallow
sheen	shiny	silver	slick	small	smooth	soft	sparkley	speckle	speed
sticky	stiff	stippled	stock	striations	stripes	surface	tan	tape	texture
thick	thickness	thin	tinge	transparency	transparent	ultra	uncoated	velvety	vertical
vinyl	waxy	weave	weft	weight	white	whiter	wove	yellow	yet

+450 tokens, +150 hapaxes, 20 keywords > 1% relative frequency

Substrates-Words Matrix

Substrates

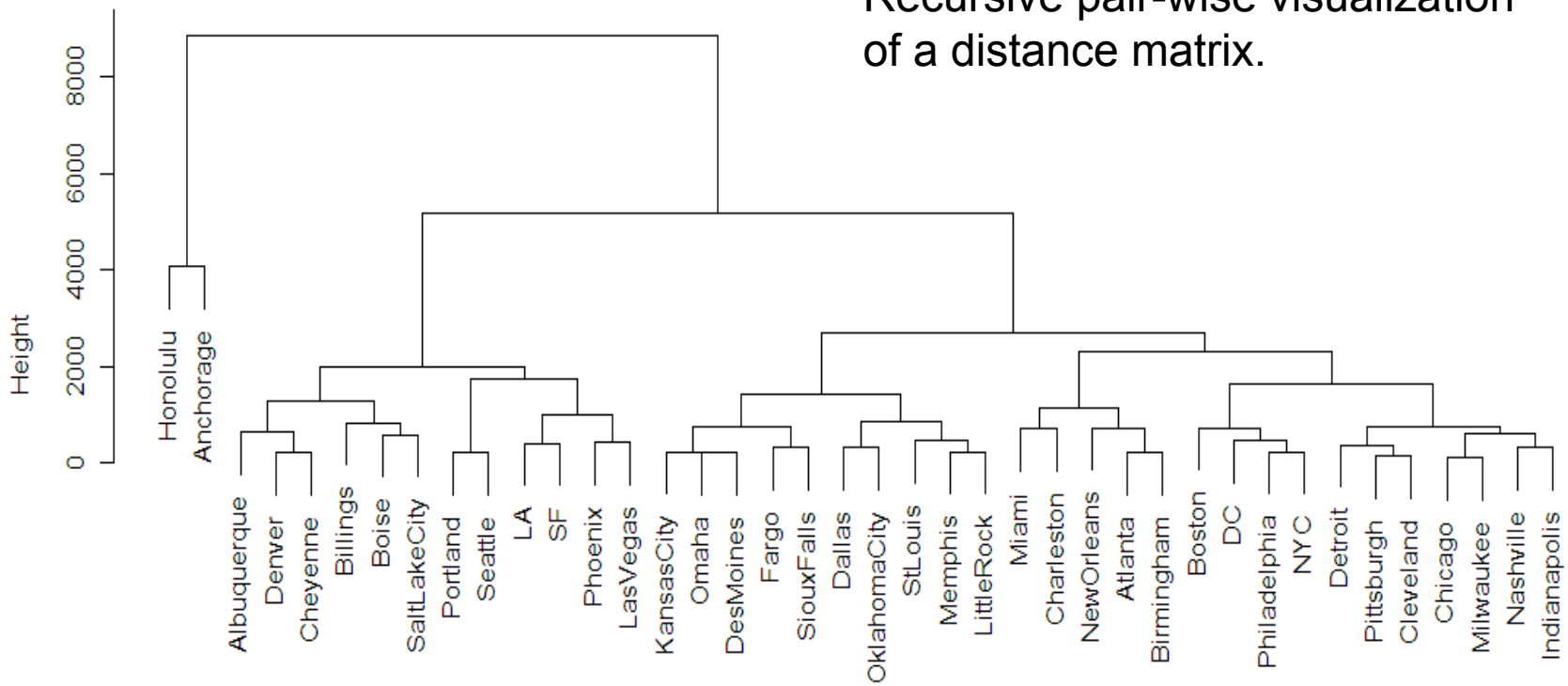
Words

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
smooth	17	16	8	11	13	4	4	7	7	13	1	15
white	11	13	5	11	12	9	7	10	0	3	12	2
matte	1	2	4	2	1	0	0	6	0	6	4	4
gloss	9	8	1	8	7	2	2	3	5	5	0	1
offwhite	5	3	4	5	5	2	2	4	0	1	4	1
texture	0	1	2	0	0	6	6	1	0	1	8	0
yellow	0	0	9	0	0	0	2	3	0	0	0	15
semi	4	3	4	3	3	3	1	2	1	4	0	1

● ● ●

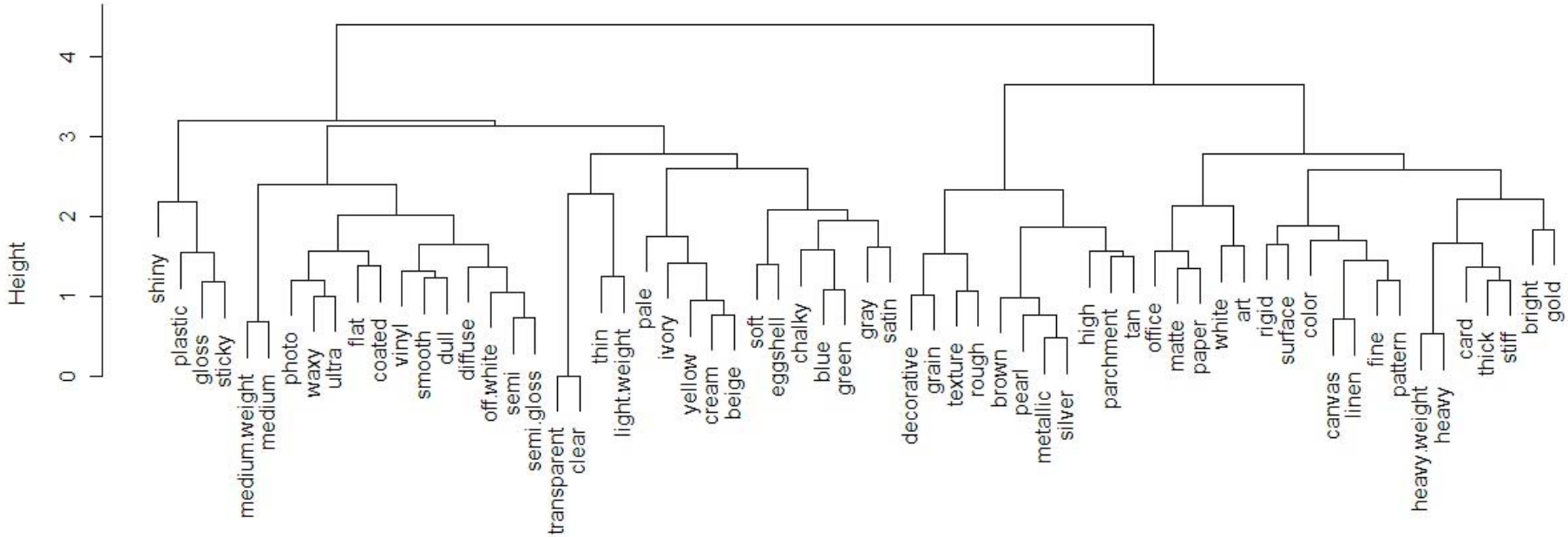
Dendrograms

Recursive pair-wise visualization of a distance matrix.



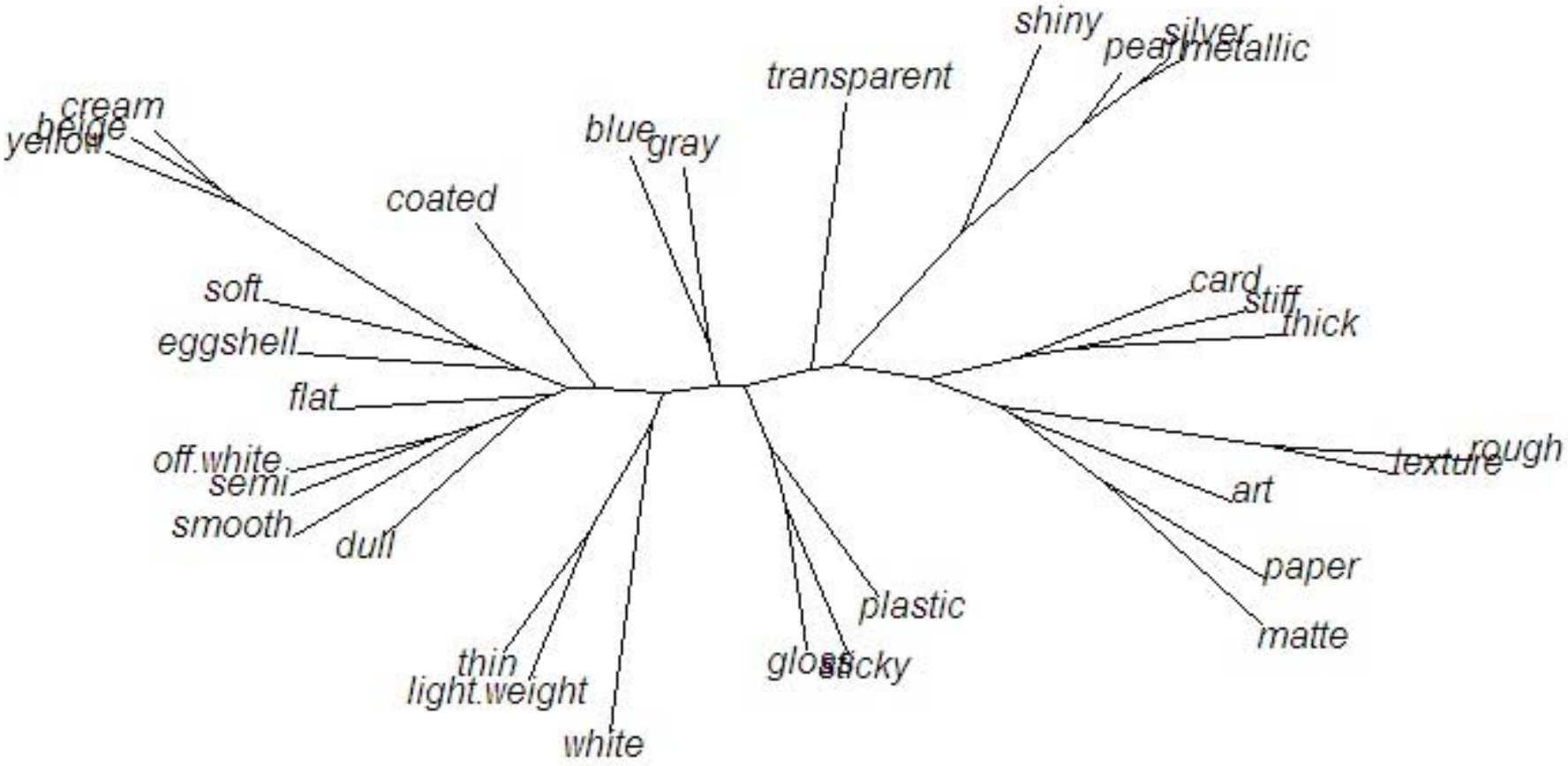
40 U.S. cities. Neighboring branches are closer.

Clustering by Word



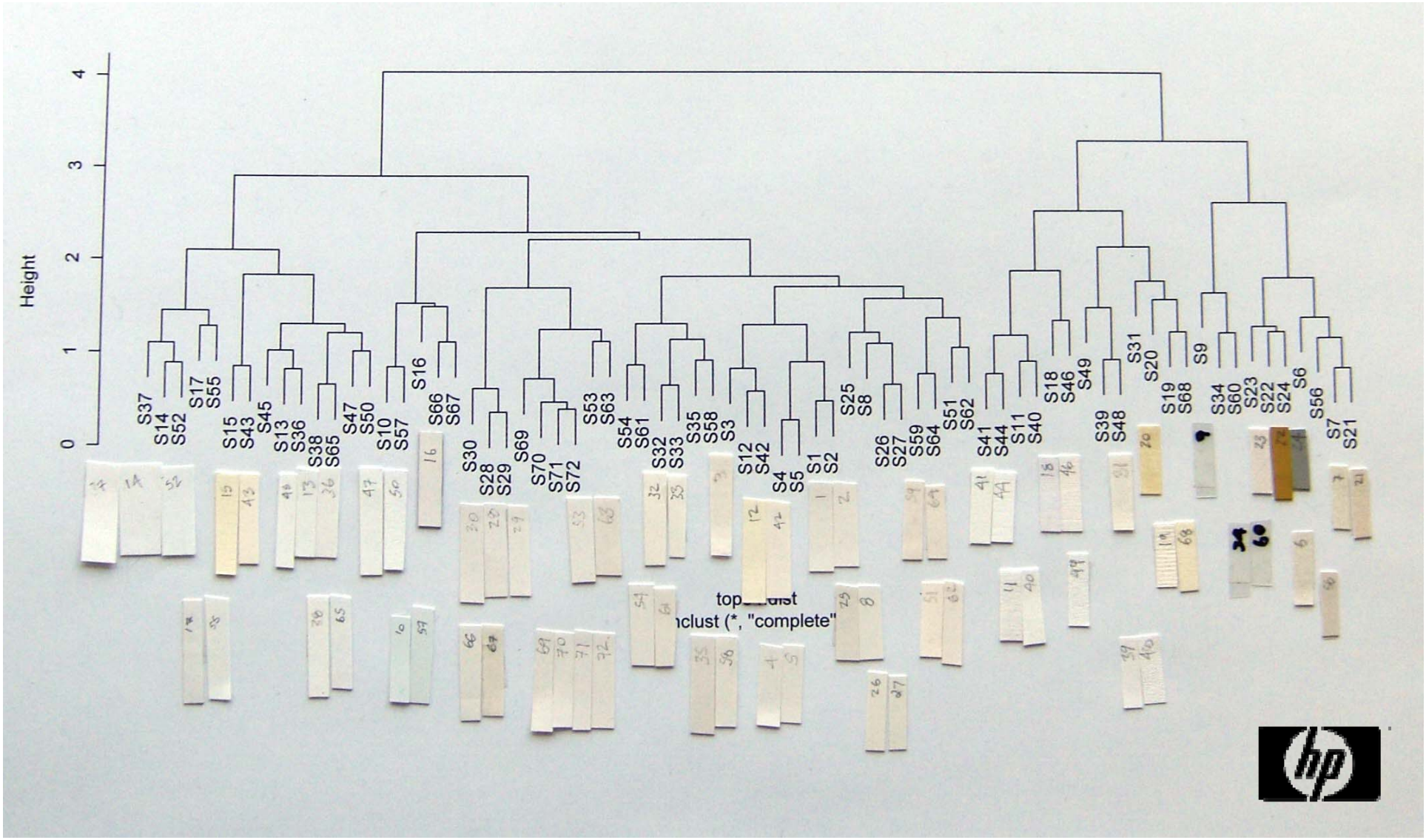
Top 64 words agglomeratively clustered using Kendall's tau for the correlation matrix.

Unrooted Phylogentic Tree

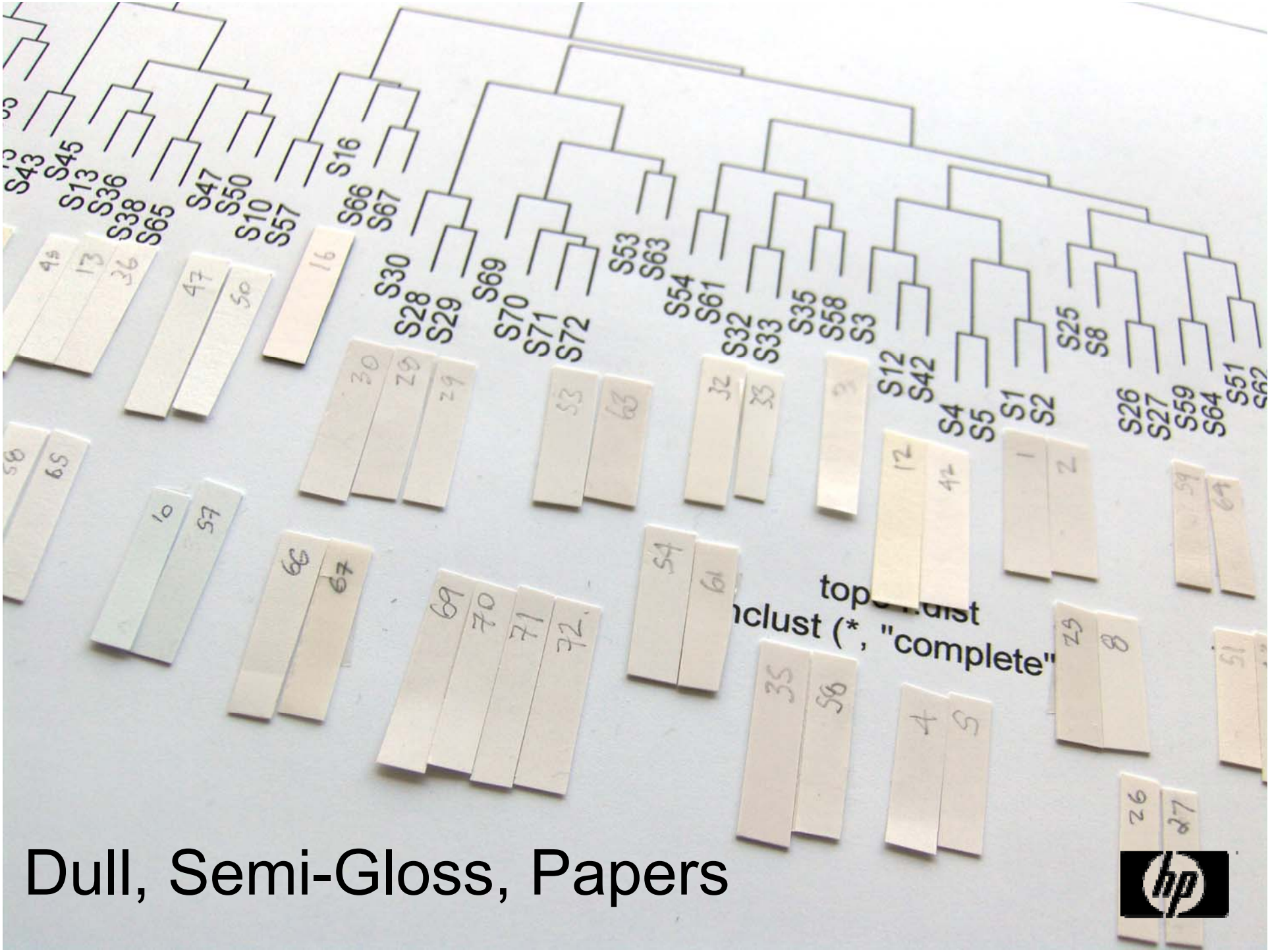


Minimize the length of the branches.
Top 32 Keywords, 25% also in online color naming experiment.

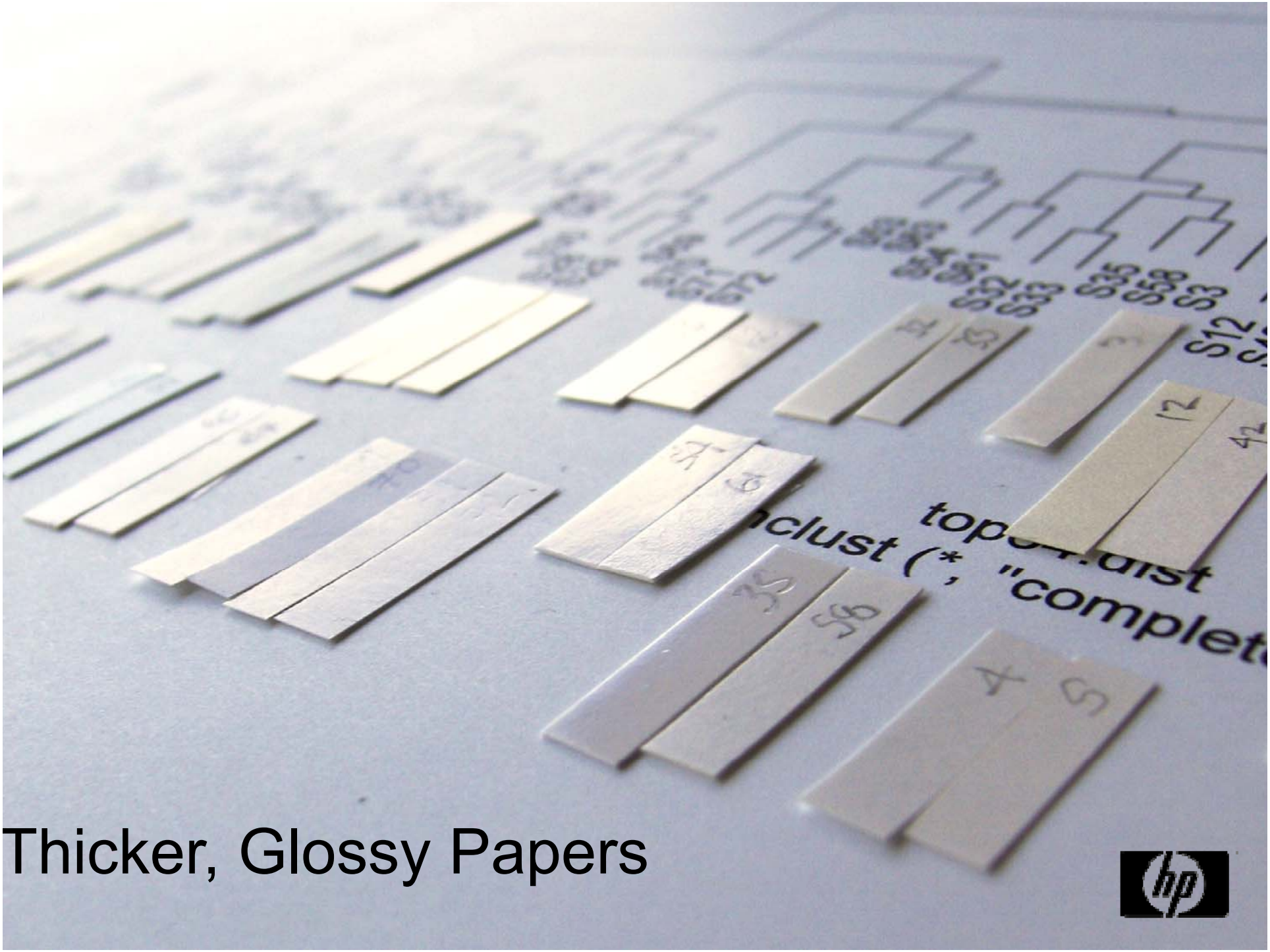
Clustering by Substrate



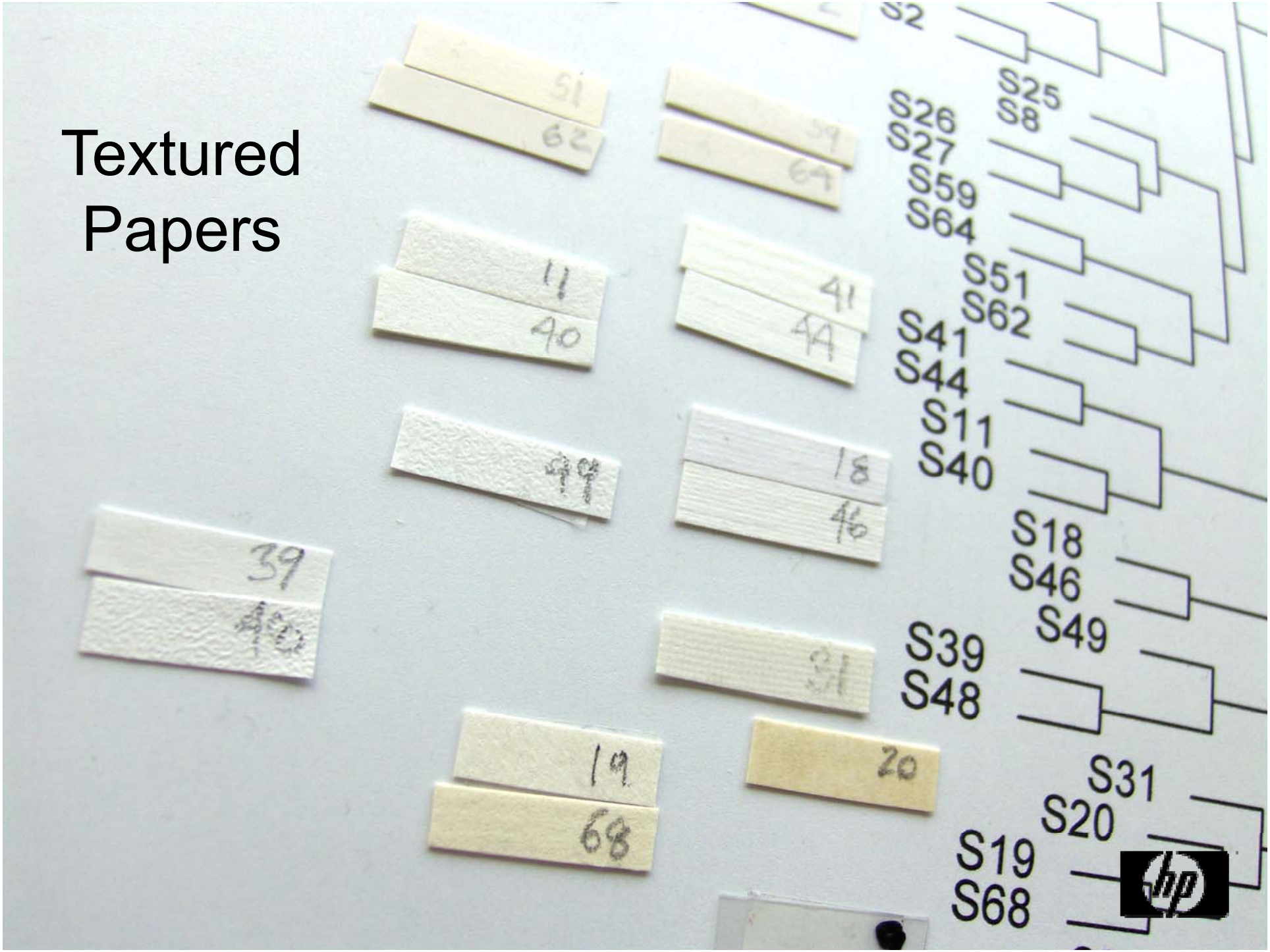
Thinner, Plain Papers

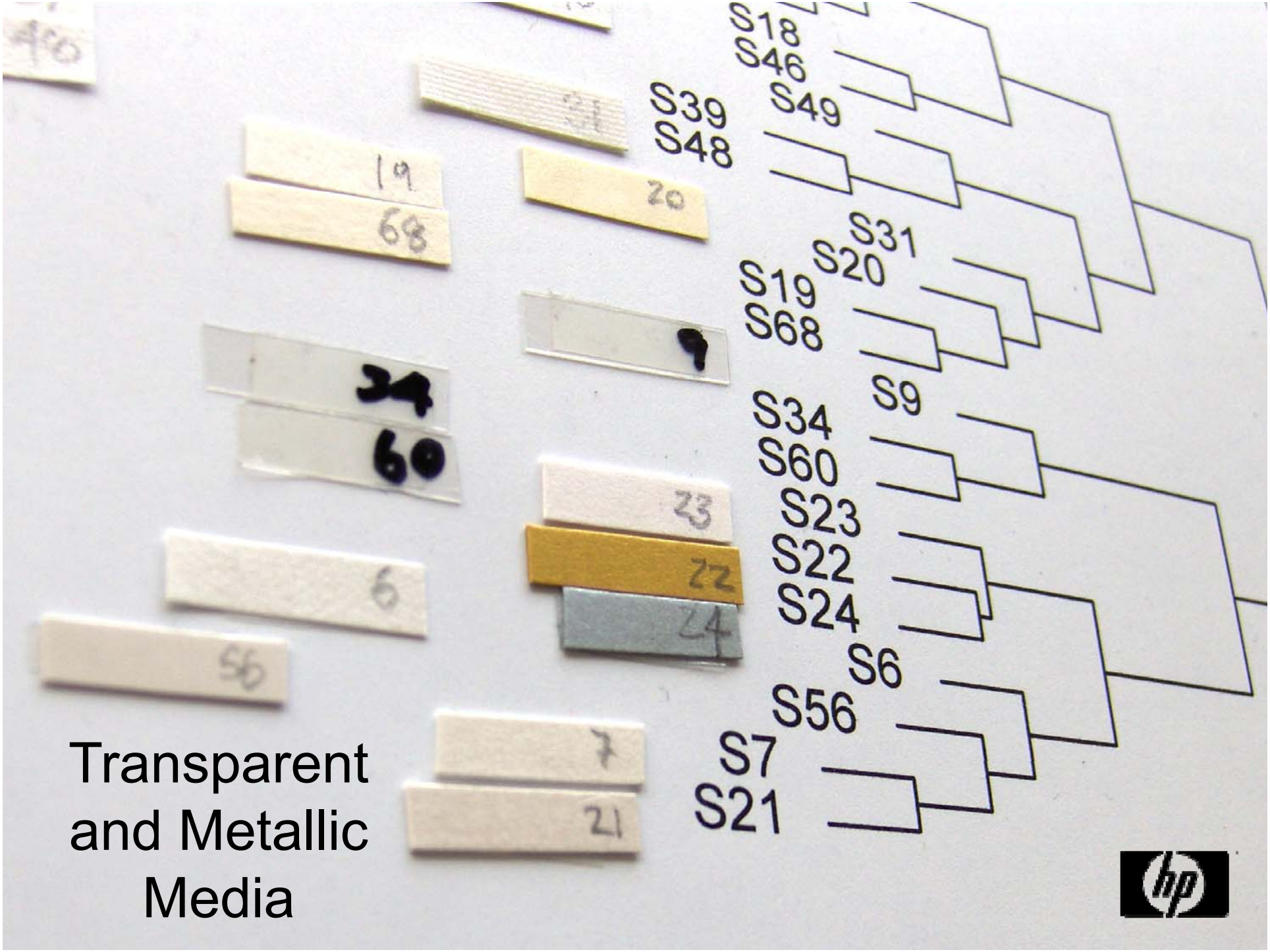


Dull, Semi-Gloss, Papers


Thicker, Glossy Papers

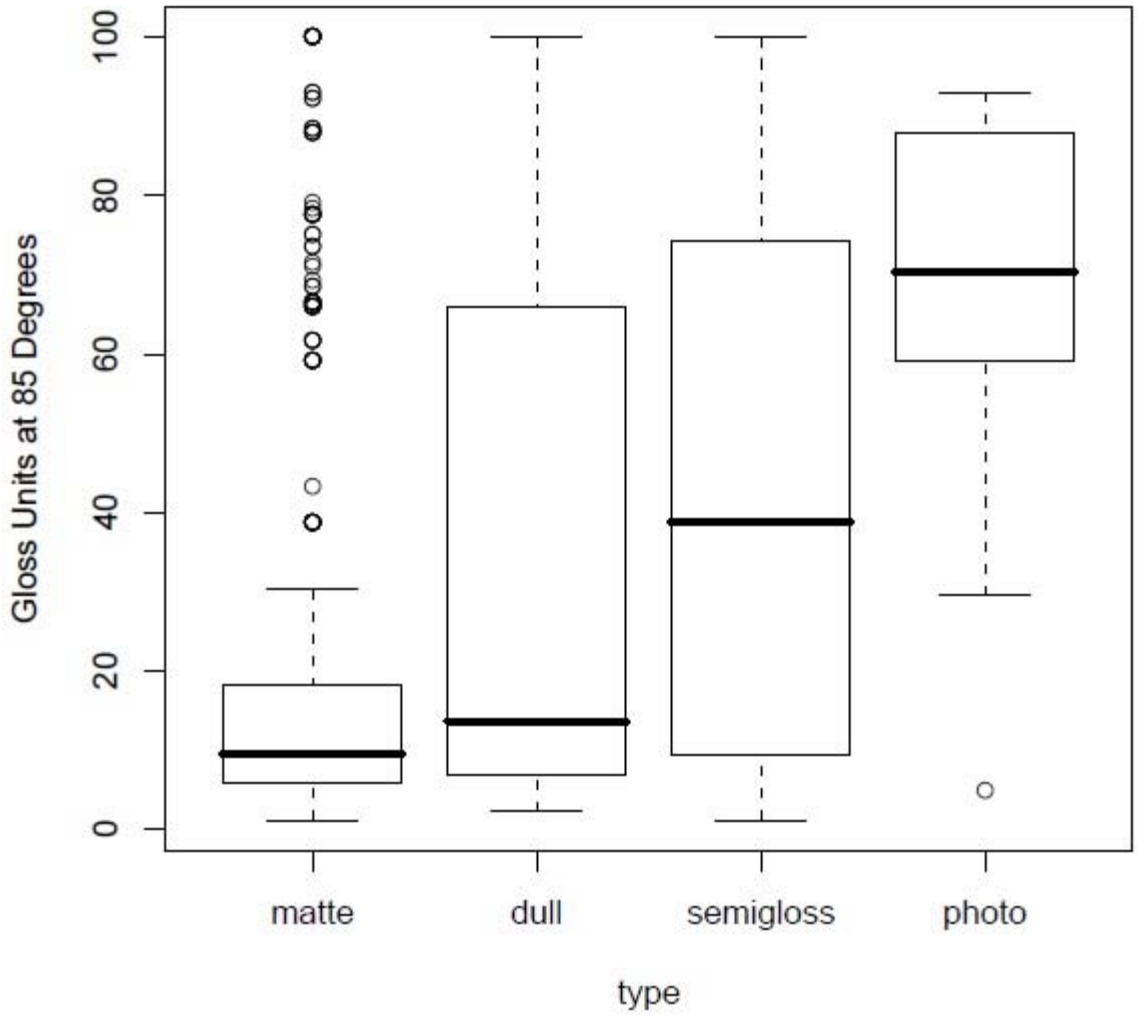
Textured Papers





Transparent and Metallic Media

Words vs. Measurements



Summary

- Anchored elicitation of unconstrained natural language descriptions of the visual and tactile perceptual properties of print substrates can be used to create a clustering of samples by word and vice versa.
- Consider the rehabilitation of nominal scales?
- Slides posted to http://mostlycolor.ch