TABLE 4-1.

The Stevens Classification of Scales of Measurement

Scale	Basic Empirical Operations (1946)	Operations We Perform (1975)	Mathematical Group Structure (1946)	Permissible Transformations (1975)
N	Determination of equality	Identify and classify	Permutation group $x' = f(x)$ $f(x)$ means any one-to-one substitution	Substitution of any number for any other number
O	Determination of greater or less	Rank order	Isotonic group $x' = f(x)$ $f(x)$ means any monotonic increasing function	Any change that preserves order
I	Determination of equality of intervals or differences	Find distances or differences	General linear group $x' = ax + b$	Multiplication by a constant Addition of a constant
R	Determination of equality of ratios	Find ratios, fractions, or multiples	*Similarity group* $x' = ax$	Multiplication by a constant only

TABLE 4-2.

Examples of Scales of Measurement Given by Stevens

Scale	Example	Year Listed			
		1951	1959	1968b	1975
N	"Numbering" of football players	x	x	x	x
	Assignment of type or model numbers to classes	x	x	x	. . .
	Model numbers	. . .	. . .	. . .	x
O	Hardness of minerals	x	x	x	x
	Quality of leather, lumber, wool, etc.	x	. . .	. . .	. . .
	Grades of leather, lumber, wool, etc.	. . .	x	x	. . .
	Pleasantness of odors	x	. . .	. . .	. . .
	Street numbers	. . .	x	. . .	. . .
	Intelligence test raw scores	. . .	x	x	. . .
	Preference lists	. . .	. . .	. . .	x
	Rank lists	. . .	. . .	. . .	x
I	Temperature (Fahrenheit and centigrade)	x	. . .	. . .	. . .
	Temperature (Fahrenheit or Celsius)	. . .	x	x	x
	Energy	x	. . .	. . .	. . .
	Energy (potential)	. . .	x	x	. . .
	Calendar dates	x	. . .	. . .	. . .
	Time (calendar)	. . .	x	x	x
	"Standard scores" on achievement tests (?)	x	. . .	. . .	. . .
	Intelligence-test "standard-scores" (?)	. . .	x	x	. . .
	Standard scores	. . .	. . .	. . .	x
	Position	. . .	x	. . .	. . .
	Position on a line	. . .	. . .	x	. . .
R	Length, weight, density, resistance, etc.	x	. . .	. . .	. . .
	Length, density, work, time intervals, etc.	. . .	x	x	. . .
	Length, weight, numerosity, duration, and most physical scales	. . .	. . .	. . .	x
	Pitch scale (mels)	x	. . .	. . .	. . .
	Loudness scale (sones)	x	. . .	. . .	. . .
	Loudness (sones)	. . .	x	x	x
	Brightness (brils)	. . .	x	x	. . .
	Numerosity	. . .	x	x	. . .
	Temperature (Rankine or Kelvin)	. . .	x	x	x

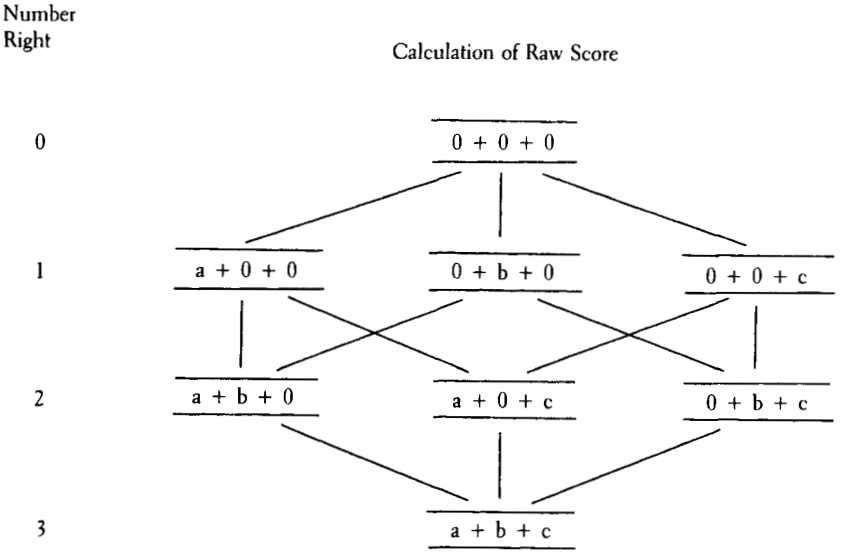

Figure 4-1

Response Patterns and Raw Scores on a 3-Item Test

TABLE 4-3.
Scale Types Proposed by Marks

Scale	Value of Constant			Power
	a	*b*	*c*	
Ordinal	+	+	+	0
Hyperordinal	0	+	+	1
Interval	+	0	+	1
Log interval	+	+	0	1
Difference	0	0	+	2
Power	0	+	0	2
Ratio	+	0	0	2
Absolute	0	0	0	3

TABLE 7-1.

Score Distribution and Scale Characteristics Computed from Correlation Analysis of Simulated Data (n = 2,500)

	Simulation						
	I	II	III	IV	V	VI	VII
Score							
4	1590	709	1272	188	829	34	4
3	589	534	182	422	333	213	65
2	252	431	114	588	201	472	252
1	65	358	387	730	329	585	589
0	4	468	545	572	808	1196	1590
Mean	3.48	2.26	2.50	1.57	2.02	0.92	0.52
Standard deviation	0.79	1.47	1.70	1.22	1.70	1.06	0.79
Item means							
A	.97	.74	.72	.64	.62	.42	.28
B	.88	.56	.61	.37	.50	.21	.11
C	.83	.50	.59	.30	.46	.16	.08
D	.80	.46	.57	.25	.44	.13	.06
Factor loadings							
A	.21	.65	.72	.48	.77	.66	.58
B	.38	.69	.87	.52	.83	.49	.41
C	.45	.67	.88	.50	.82	.42	.34
D	.47	.64	.88	.47	.81	.38	.30
Reliability	.39	.76	.91	.56	.88	.55	.43

TABLE 7-2.

Item Cross-Classifications, Simulation IV (n = 2,500)

Positive response to	Negative response to A	B	C	D	Total Positive	Item Parameter
A	...	855	992	1079	1603	9.6601
B	187	...	512	568	935	2.1170
C	139	327	...	441	750	1.3526
D	112	269	327	...	636	1.0
Total Negative	897	1565	1750	1864	...	...

Computed Ratios

$a/b = 4.57$	$a/c = 7.14$	$(a/b)(b/d) = 9.64$
$a/d = 9.63$	$b/c = 1.57$	$(a/c)(c/d) = 9.64$
$b/d = 2.11$	$c/d = 1.35$	$(b/c)(c/d) = 2.12$