

Tabular Display of Data

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What we're up against

Getting information from a table is like extracting sunlight from a cucumber.

Farquhar and Farquhar, 1891, p55

Perhaps not that bad, but a challenge.

Our examples from Ehrenberg (1977, **JRSSA**) and Wainer (1997, **JEBS**).

Eye on the ball

Most displays only do one thing well.

To build any effective display we must have a firm notion of purpose. We cannot know what the best answers are unless we know what the questions are. Thus we must first understand what questions will be asked of data. Any discussion of data display in the abstract is pointless.

*Wainer (1997 **JEBS**)*

We will concentrate on communication.

Back to communication

A display for communication should

- Target an audience
- Have a goal (tell a story)
- Make the story obvious
- Be uncluttered
- Cause no pain

It's a lot like oral communication!

Rules for Communication

Ehrenberg, Wainer, and many others give rules/advice.

We illustrate with examples from their papers.

Remember, we want to communicate, to show a story, which could be

- Big picture
- Trends
- Comparisons
- Typical values
- Atypical values

Ehrenberg's Criteria

Strong Criterion for Good Table

The patterns and exceptions in a table should be obvious at a glance.

Weak Criterion for Good Table

The patterns and exceptions in a table should be obvious at a glance once one has been told what they are.

Always meet the weak criterion.

UK Vessels (Ehrenberg, 1977)

UK Merchant Vessels over 500 tons in Service

| | 1962 | 1967 | 1973 |
|---------------------------------|--------|--------|--------|
| Number of vessels | | | |
| All vessels | 2,689 | 2,181 | 1,776 |
| Passenger | 242 | 173 | 122 |
| Dry cargo | 1,847 | 1,527 | 1,165 |
| Tankers | 600 | 481 | 489 |
| Deadweight in thousands of tons | | | |
| All vessels | 26,577 | 27,488 | 46,763 |
| Passenger | 1,467 | 919 | 349 |
| Dry cargo | 13,990 | 14,362 | 20,115 |
| Tankers | 11,120 | 12,167 | 26,299 |

UK Vessels – After

UK Merchant Vessels in Service

| Vessels over 500 tons | 1962 | 1967 | 1973 |
|-----------------------------|--------|--------|--------|
| Number | | | |
| Passenger | 240 | 170 | 120 |
| Tankers | 600 | 480 | 490 |
| Dry cargo | 1,800 | 1,500 | 1,200 |
| All vessels | 2,700 | 2,200 | 1,800 |
| Deadweight tons (thousands) | | | |
| Passenger | 1,500 | 920 | 350 |
| Tankers | 11,000 | 12,000 | 26,000 |
| Dry cargo | 14,000 | 14,000 | 20,000 |
| All vessels | 26,000 | 27,000 | 47,000 |

TV Correlations (Ehrenberg)

Correlation among TV audiences

| | | PrB | ThW | Tod | WoS | GrS | LnU | MoD | Pan | RgS | 24H |
|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ITV | PrB | 1.000 | 0.106 | 0.065 | 0.505 | 0.474 | 0.092 | 0.473 | 0.168 | 0.309 | 0.124 |
| " | ThW | 0.106 | 1.000 | 0.270 | 0.142 | 0.132 | 0.189 | 0.082 | 0.352 | 0.064 | 0.395 |
| " | Tod | 0.065 | 0.270 | 1.000 | 0.093 | 0.070 | 0.155 | 0.038 | 0.200 | 0.051 | 0.244 |
| " | WoS | 0.505 | 0.147 | 0.093 | 1.000 | 0.622 | 0.079 | 0.581 | 0.187 | 0.297 | 0.140 |
| BBC | GrS | 0.474 | 0.132 | 0.070 | 0.622 | 1.000 | 0.085 | 0.593 | 0.181 | 0.341 | 0.142 |
| " | LnU | 0.092 | 0.189 | 0.155 | 0.079 | 0.085 | 1.000 | 0.049 | 0.197 | 0.097 | 0.266 |
| " | MoD | 0.473 | 0.082 | 0.039 | 0.581 | 0.593 | 0.049 | 1.000 | 0.131 | 0.327 | 0.122 |
| " | Pan | 0.168 | 0.352 | 0.200 | 0.187 | 0.181 | 0.197 | 0.131 | 1.000 | 0.147 | 0.524 |
| " | RgS | 0.309 | 0.064 | 0.051 | 0.296 | 0.341 | 0.097 | 0.326 | 0.147 | 1.000 | 0.121 |
| " | 24H | 0.124 | 0.395 | 0.244 | 0.140 | 0.142 | 0.266 | 0.122 | 0.524 | 0.121 | 1.000 |

TV Correlations – After

Correlation among TV audiences

| Programmes | | WoS | MoD | GrS | PrB | RgS | 24H | Pan | ThW | Tod | LnU |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| World of Sport | ITV | .6 | .6 | .5 | .3 | .1 | .2 | .1 | .1 | .1 | .1 |
| Match of the Day | BBC | .6 | .6 | .5 | .3 | .1 | .1 | .1 | .1 | .0 | .0 |
| Grandstand | BBC | .6 | .6 | .5 | .3 | .1 | .2 | .1 | .1 | .1 | .1 |
| Prof. Boxing | ITV | .5 | .5 | .5 | .3 | .1 | .2 | .1 | .1 | .1 | .1 |
| Rugby Special | BBC | .3 | .3 | .3 | .3 | .1 | .1 | .1 | .1 | .1 | .1 |
| 24 Hours | BBC | .1 | .1 | .1 | .1 | .1 | .5 | .4 | .2 | .2 | .2 |
| Panorama | BBC | .2 | .1 | .2 | .2 | .1 | .5 | .4 | .2 | .2 | .2 |
| This Week | ITV | .1 | .1 | .1 | .1 | .1 | .4 | .4 | .3 | .2 | .2 |
| Today | ITV | .1 | .0 | .1 | .1 | .1 | .2 | .2 | .3 | .2 | .2 |
| Line Up | BBC | .1 | .0 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 |

Unemployment (Ehrenberg)

Unemployment in Great Britain (thousands)

| | 1966 | 1968 | 1970 | 1973 |
|------------------|-------|-------|-------|-------|
| Total unemployed | 330.9 | 549.4 | 582.2 | 597.9 |
| Males | 259.6 | 460.7 | 495.3 | 499.4 |
| Females | 71.3 | 88.8 | 86.9 | 98.5 |

Unemployment – After

Unemployment in Great Britain (thousands)

| Year | Male | Female | Total |
|---------|------|--------|-------|
| 1966 | 260 | 71 | 330 |
| 1968 | 460 | 89 | 550 |
| 1970 | 500 | 87 | 580 |
| 1973 | 500 | 99 | 600 |
| Average | 430 | 86 | 520 |

Battery Life (Wainer)

Battery Life in Hours

| Battery Brand | Cassette Player | Radio | Flashlight | Portable Computer |
|-----------------|-----------------|-------|------------|-------------------|
| Constant Charge | 5 | 19 | 10 | 3 |
| Electro-Blaster | 10 | 26 | 15 | 4 |
| Never Die | 8 | 28 | 16 | 6 |
| PowerBat | 7 | 24 | 13 | 5 |
| Servo-Cell | 4 | 21 | 12 | 2 |

Battery Life – After

Battery Life in Hours

| Battery Brand | Radio | Flash. | Cass. Player | Port. Comp. | Brand Averages |
|-----------------------|-----------|-----------|--------------|-------------|----------------|
| Never Die | 28 | 16 | 8 | 6 | 15 |
| Electro-Blaster | 26 | 15 | 10 | 4 | 14 |
| PowerBat | 24 | 13 | 7 | 5 | 12 |
| Servo-Cell | 21 | 12 | 4 | 2 | 10 |
| Constant Charge | 19 | 10 | 5 | 3 | 9 |
| Usage averages | 24 | 13 | 7 | 4 | 12 |

Multivariate (Wainer, 1997)

| PUBLIC SCHOOLS | Grade 8 - 1992 | | | | | | | | | |
|----------------|------------------------|---------------------|----------------------------------|---------------------|------------------------|---------------------|----------------------------|---------------------|------------------------|---------------------|
| | Graduated College | | Some Education After High School | | Graduated High School | | Did Not Finish High School | | I Don't Know | |
| | Percentage of Students | Average Proficiency | Percentage of Students | Average Proficiency | Percentage of Students | Average Proficiency | Percentage of Students | Average Proficiency | Percentage of Students | Average Proficiency |
| NATION | 40 (1.4) | 279 (1.4) | 18 (0.8) | 270 (1.2) | 25 (0.8) | 256 (1.4) | 8 (0.6) | 248 (1.8) | 9 (0.5) | 251 (1.7) |
| Northwest | 38 (3.1) | 282 (4.2) | 18 (1.1) | 267 (3.0) | 26 (2.2) | 259 (4.2) | 8 (0.9) | 248 (4.3) | 10 (1.2) | 250 (3.3) |
| Southeast | 35 (1.8) | 270 (1.9) | 17 (0.8) | 263 (2.0) | 28 (1.4) | 248 (1.9) | 12 (1.8) | 246 (4.2) | 8 (1.0) | 248 (4.3) |
| Central | 42 (2.7) | 283 (2.9) | 20 (1.4) | 273 (1.6) | 26 (1.7) | 264 (2.3) | 4 (0.7) | 244 (1.7) | 7 (0.8) | 258 (3.8) |
| West | 43 (2.9) | 279 (2.6) | 18 (1.2) | 274 (2.6) | 19 (1.5) | 252 (2.9) | 9 (1.1) | 246 (2.4) | 11 (0.9) | 248 (2.9) |
| STATES | 33 (1.8) | 261 (2.5) | 18 (0.7) | 258 (2.0) | 29 (1.1) | 244 (1.8) | 13 (0.9) | 238 (2.0) | 7 (0.8) | 237 (2.9) |
| Alabama | 36 (1.5) | 277 (1.5) | 22 (1.0) | 270 (1.5) | 21 (0.9) | 256 (1.8) | 10 (0.7) | 245 (2.5) | 12 (0.8) | 248 (2.7) |
| Arizona | 30 (1.1) | 264 (1.9) | 20 (0.8) | 264 (1.7) | 31 (1.1) | 248 (1.6) | 11 (0.7) | 246 (2.4) | 8 (0.8) | 245 (2.7) |
| California | 39 (1.8) | 275 (2.0) | 18 (1.0) | 268 (2.1) | 17 (0.9) | 251 (2.1) | 10 (0.9) | 241 (2.2) | 16 (1.1) | 240 (2.9) |
| Colorado | 46 (1.2) | 282 (1.3) | 19 (0.9) | 278 (1.6) | 21 (0.9) | 260 (1.5)> | 6 (0.6) | 250 (2.4) | 7 (0.5) | 252 (2.6) |
| Connecticut | 47 (1.3) | 288 (1.0)> | 16 (0.8) | 272 (1.8) | 22 (0.9) | 260 (1.8) | 6 (0.6) | 245 (3.3) | 9 (0.6) | 251 (2.4) |
| Delaware | 39 (1.2) | 274 (1.3) | 18 (1.0) | 268 (2.3) | 30 (1.0) | 251 (1.7) | 6 (0.5) | 248 (4.0) | 8 (0.9) | 248 (3.4) |
| Dist. Columbia | 32 (1.0) | 244 (1.7) | 17 (0.8) | 240 (1.9) | 29 (0.8) | 224 (1.6) | 9 (0.7) | 225 (3.2) | 12 (0.8) | 229 (2.2) |
| Florida | 39 (1.5) | 268 (1.9) | 19 (0.7) | 266 (1.9) | 24 (1.1) | 251 (1.8) | 8 (0.7) | 244 (2.7) | 10 (0.7) | 244 (3.2) |
| Georgia | 35 (1.7) | 271 (2.1) | 18 (0.7) | 264 (1.7) | 30 (1.2) | 250 (1.3) | 11 (0.8) | 244 (2.2) | 8 (0.6) | 245 (2.6) |
| Hawaii | 36 (1.3) | 267 (1.5) | 15 (0.8)< | 266 (1.9) | 23 (1.0) | 246 (1.8) | 6 (0.5) | 242 (3.5) | 16 (0.8) | 246 (2.1)> |
| Idaho | 48 (1.2) | 281 (0.9) | 20 (0.8) | 278 (1.3) | 19 (0.9) | 288 (1.4)> | 7 (0.5) | 254 (2.3) | 6 (0.5) | 254 (2.8) |
| Indiana | 33 (1.5) | 283 (1.5) | 21 (0.9) | 275 (1.9) | 32 (1.1) | 260 (1.6) | 8 (0.6) | 250 (2.6) | 6 (0.5) | 249 (3.3) |
| Iowa | 44 (1.4) | 291 (1.2)> | 21 (0.8) | 285 (1.5) | 25 (1.1) | 273 (1.3) | 4 (0.4) | 262 (2.6) | 5 (0.4) | 268 (2.8) |
| Kentucky | 28 (1.4) | 278 (1.6)> | 19 (0.8) | 267 (1.6) | 32 (0.9) | 254 (1.6) | 16 (1.7) | 246 (1.7) | 6 (0.4) | 242 (2.8) |
| Louisiana | 32 (1.4) | 256 (2.5) | 20 (0.9) | 259 (1.8) | 30 (1.3) | 242 (1.6) | 10 (0.7) | 237 (2.4) | 7 (0.6) | 236 (3.7) |
| Maine | 40 (1.5) | 281 (1.4) | 22 (1.0) | 281 (1.5) | 28 (1.1) | 267 (1.1) | 6 (0.5) | 259 (2.7) | 5 (0.5) | 266 (2.6) |
| Maryland | 44 (1.7) | 278 (1.8) | 18 (0.9) | 268 (1.9) | 25 (1.2) | 250 (1.8) | 6 (0.8) | 240 (3.7) | 7 (0.5) | 245 (3.8) |
| Massachusetts | 48 (1.5) | 284 (1.3) | 17 (0.8) | 272 (1.8) | 21 (1.0) | 261 (1.4) | 7 (0.6) | 248 (3.2) | 7 (0.6) | 248 (2.6) |
| Michigan | 36 (1.6) | 277 (2.2) | 23 (0.9) | 271 (2.0) | 26 (0.9) | 257 (1.7) | 6 (0.5) | 249 (2.9) | 7 (0.6) | 248 (3.0) |
| Minnesota | 48 (1.3)> | 290 (1.0)> | 21 (0.9) | 284 (1.8) | 22 (0.9)< | 270 (1.8)> | 3 (0.4) | 256 (4.2) | 7 (0.8) | 268 (3.0) |
| Mississippi | 36 (1.7) | 254 (1.6) | 18 (0.7) | 256 (2.0) | 29 (1.4) | 239 (1.6) | 13 (0.8) | 234 (1.8) | 7 (0.6) | 231 (2.8) |
| Missouri | 36 (1.3) | 280 (1.7) | 22 (0.9) | 275 (1.5) | 29 (1.0) | 261 (1.5) | 8 (0.7) | 254 (2.4) | 8 (0.5) | 252 (2.9) |
| Nebraska | 46 (1.5) | 287 (1.2) | 20 (1.0) | 280 (1.6) | 24 (1.2) | 267 (1.7) | 4 (0.5) | 247 (3.3) | 6 (0.6) | 256 (3.8) |

Hard to see anything!
But perhaps useful for archival purposes.

Foods (Ehrenberg, 1978)

Consumers' (C) and Retailers' (R) ratings of the nutritional and economic values of different foods

| Foods | Nutritional | | Economic | |
|------------|-------------|----|----------|----|
| | C | R | C | R |
| Meat | 62 | 58 | 14 | 11 |
| Milk | 55 | 52 | 44 | 95 |
| Eggs | 49 | 48 | 85 | 61 |
| Cheese | 45 | 52 | 30 | 62 |
| Fresh Veg. | 42 | 24 | 25 | 18 |
| Fish | 33 | 52 | 20 | 10 |
| Chicken | 18 | 13 | 70 | 25 |
| Bread | 5 | 11 | 5 | 21 |

*In decreasing order of Consumers' Nutritional Ratings.

... hard to interpret without a verbal description
perhaps "Consumers and retailers agree quite well on nutritional ratings, but economic ratings differ from each other and from the nutritional ones."

Computer files

Computer files also need explanation.

```
# Number of hawks responding to the "alarm" call
# Variables are year (1999 or 2000), season (courtship,
# nestling, fledgling), distance in meters between the
# alarm call and the nest, number of hawks responding,
# and number of.
```

| year | season | distance | respond | trials |
|------|--------|----------|---------|--------|
| 1 | 1 | 100 | 1 | 4 |
| 1 | 1 | 150 | 2 | 4 |
| 1 | 1 | 225 | 1 | 4 |
| 1 | 1 | 325 | 2 | 2 |
| 2 | 1 | 100 | 6 | 8 |

...

Should be labeled and annotated.

Exceptions

Point out unusual values

| PUBLIC SCHOOLS | Graduated College | Some Education After High School | Graduated High School | Did Not Finish High School | I Don't Know | Mean |
|-----------------|-------------------|----------------------------------|-----------------------|----------------------------|--------------|------|
| Nation | 279 | 270 | 256 | 248 | 251 | 267 |
| States | | | | | | |
| 1 Iowa | 291 | 285 | 273 | 262 | 266 | 283 |
| 2 North Dakota | 289 | 283 | 271 | 259 | 272 | 283 |
| 3 Minnesota | 290 | 284 | 270 | 256 | 268 | 282 |
| 4 Maine | 288 | 281 | 267 | 259 | 266 | 278 |
| 5 Wisconsin | 287 | 282 | 270 | 254 | 255 | 278 |
| 6 New Hampshire | 287 | 280 | 267 | 259 | 262 | 278 |
| 7 Nebraska | 287 | 280 | 267 | 247 | 256 | 277 |
| 8 Idaho | 281 | 278 | 268 | 254 | 254 | 274 |
| 9 Wyoming | 281 | 278 | 266 | 258 | 260 | 274 |
| 10 Utah | 280 | 278 | 258 | 254 | 258 | 274 |
| 11 Connecticut | 288 | 272 | 260 | 245 | 251 | 273 |

Round Drastically

Use two significant figures where ever possible.

- Don't usually understand more than two digits
Budget is \$27,329,681 versus budget is 27 million dollars.
- Rarely justify more than two digits statistically
God gave us $1/\sqrt{n}$, but how big must n be for that third digit?
- We rarely care
Life expectancy 67.14 years; .01 year is about 4 days.
- Not for archival tables.

Order Rows/Columns Sensibly

Helps organize and facilitate comparison

- Alphabetical (Alabama first!) almost never correct
- Could be by size
- Could be a natural order, such as time
- By interest (rows or columns to compare should be adjacent)

Row/Column Summaries

Give a standard for comparison

- Could be mean/median/total/etc
- Give a visual focus
- Provide a standard of “usual”
- An overall summary can also help
- Can highlight for emphasis

Transpose

It's easier to compare numbers down columns.

- Numbers are closer
- Digits line up

Layout/Spacing

- Remove excess lines/boxing
- Use space to emphasize groups/gaps
- Excess space breaks adjacency

What is a stem and leaf plot, but a severely rounded table with meaningful spacing?

Avoid if you can

- Multidimensional tables
- Multivariate tables
- Too many rows or columns

Add

- Labels
- Good titles and explanatory text

The table with its labels, title, and accompanying text should stand alone and be comprehensible.

Also add emphasis to unusual values.

Summary

- Design for purpose and audience
- Round!
- Organize
- Simplify
- Add summaries
- Good title/labels
- Clean layout/proper spacing