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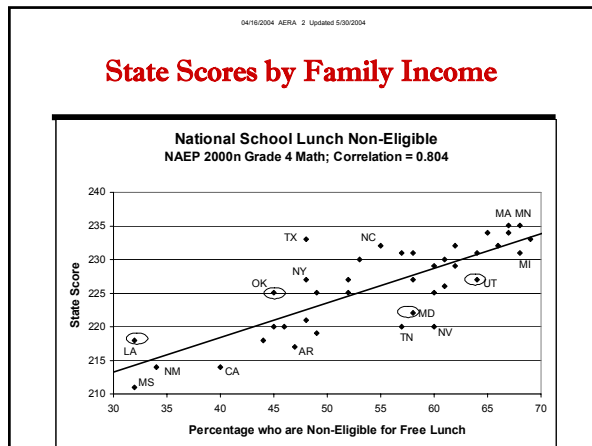
## Frequency of Simpson's Paradox in NAEP Data

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[www.StatLit.org/PDF/2004TerwilligerSchieldAERA.pdf](http://www.StatLit.org/PDF/2004TerwilligerSchieldAERA.pdf)



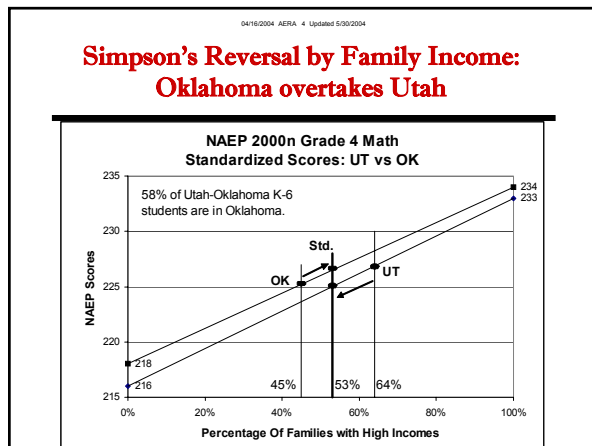
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### Simpson's Reversal by Family Income OK overtakes UT; LA overtakes MD

State	All	High \$	Low \$
UT	227	233	216
OK	↓225↓	↑234↑	↑218↑

State	All	High \$	Low \$
MD	222	233	207
LA	↓218↓	233	↑211↑



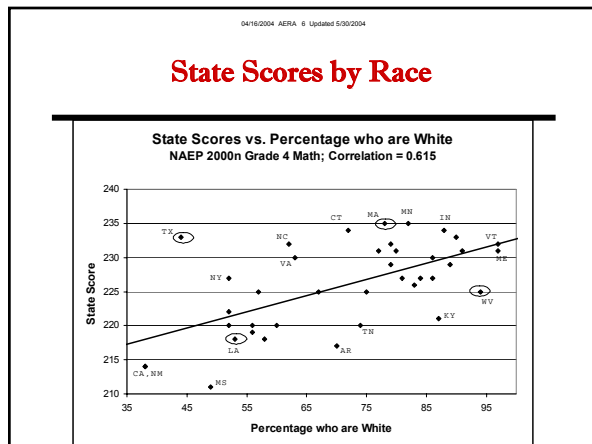
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### Simpson's Reversal by School Location: NY overtakes MO; TN overtakes GA

State	All	City	Non-City
MO	229	216	233
NY	↓227↓	216	↑236↑

State	All	City	Non-City
GA	220	208	222
TN	220	↑213↑	↑224↑



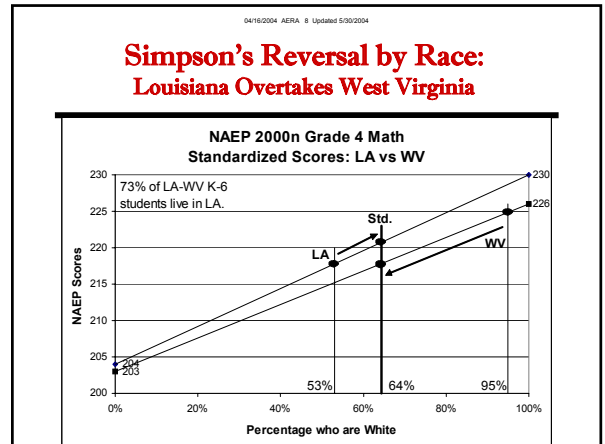
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### Simpson's Reversal by Race/Ethnicity: TX overtakes MA; LA overtakes WV

State	All	White	Black	Hispanic	Asian
MA	235	241	210	208	237
TX	↓233↓	↑243↑	↑220↑	↑224↑	↑247↑

State	All	White	Black
WV	225	226	203
LA	↓218↓	↑230↑	↑204↑



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### Conditions for Simpson's Reversal

'Simpson's reversal' occurs (state A overtakes B) if:

1. Overall score in state A is lower than in state B.
2. All subgroup scores in state A are at least as high as in state B.
3. At least one subgroup score in state A is higher than in state B.

A 'change' occurs when condition (1) is replaced by:

4. Overall score is no higher in State A than in B

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### 4% to 10% of Statistically Significant Differences are Reversed by Race

2002 Grade 8 Reading	Statistically Significant			
	Confounder	States	Pairs	Reverse %
School Lunch	40	505	1	0.2%
School Location	39		0	0%
Race/Ethnicity: All	40	505	52	10%
Race: White vs. Non	40	505	18	4%

52 reversals of statistically significant differences shows Simpson's Paradox is not a rare phenomena.

Statistical significance is obtained from the NAEP Data Tool.  
 \*Non-white\* includes blacks, Hispanics and Asians.  
 The 'all four groups' results are more disputable than the white/non-white.

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### Simpson's Paradox is not rare in NAEP data

NAEP 2002 Grade 8 Reading data:

- Absolute: 52 statistically significant differences are reversed by race
- Relative: 10% of statistically significant differences are reversed by race.

Some score differences are quite large:

- 14 points: California overtakes West Virginia

All Simpson's reversals are '**journalistically significant**'

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### Simpson's Paradox and NAEP: Recommendations

1. List state scores or ranks within relevant subgroups (e.g., school lunch, race/ethnicity)
2. Adjust state scores for non-school factors (other than race/ethnicity) such as student socio-economic status
3. Adjust state scores after controlling for the race/ethnicity of students
4. Increase sample sizes so a two point difference is statistically significant