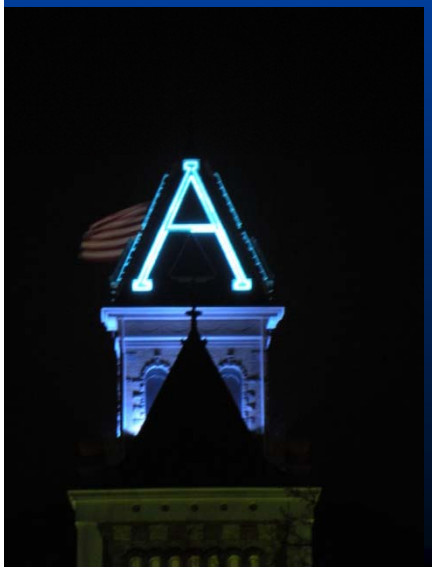
The Long Path from Static and Interactive Statistical Graphics to Journal-Quality Graphics, with Examples from the Medical Field

Jürgen Symanzik

Utah State University, Logan, UT, USA



***e-mail: symanzik@math.usu.edu**

WWW: http://www.math.usu.edu/~symanzik

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Definitions

- Static Graphic: Graphic created via user commands in a statistical software package (e.g., R, SAS, …)
- Interactive Graphics: Series of graphics manipulated via mouse and menu options via interactive statistical software (e.g., Mondrian, GGobi, …)
- Journal-Quality Graphic: High-quality graphic for publication purposes

Construction Principles for Good Graphics

- Early on, guide subject experts through exploratory interactive graphical sessions of new data sets
- For each facet of the data that should be displayed via graphics, first explore different possible graphical formats
- Once decided on a format, fine-tune each figure for print (grayscale), online (color), or presentation (poster or projection) format
- Adhere to special requests from the subject experts – they will have to understand a graphic (not we, the statisticians)

Carpal Tunnel Syndrome (CTS)

- Carpal tunnel syndrome is pressure on the median nerve -- the nerve in the wrist that supplies feeling and movement to parts of the hand. It can lead to numbness, tingling, weakness, or muscle damage in the hand and fingers.

from https://health.google.com/health/ref/Carpal+tunnel+syndrome

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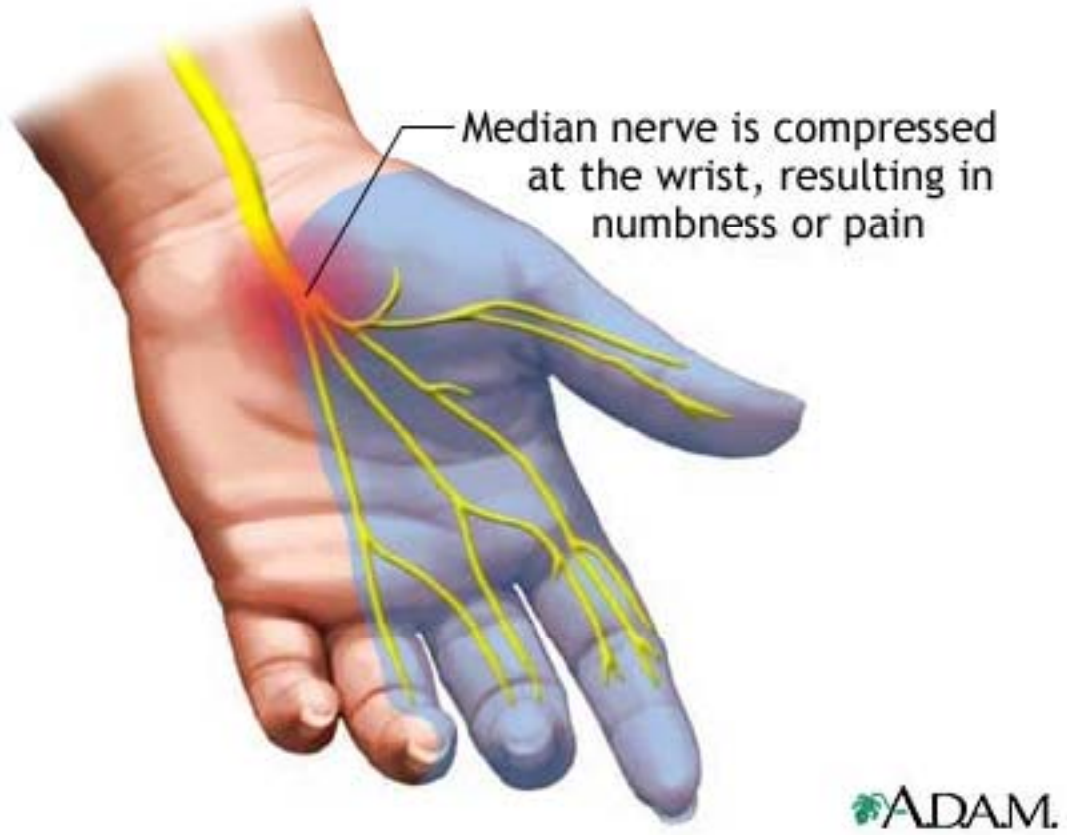
https://health.google.com/health/ref/graphic/1081



Carpal tunnel syndrome is becoming more frequently recognized and may be occurring more often. It may result from repetitive motion or the use of devices like computer keyboards. It affects the median nerve, the nerve that supplies feeling and movement to the thumb and "thumb-side" of the hand.

Internet 100%

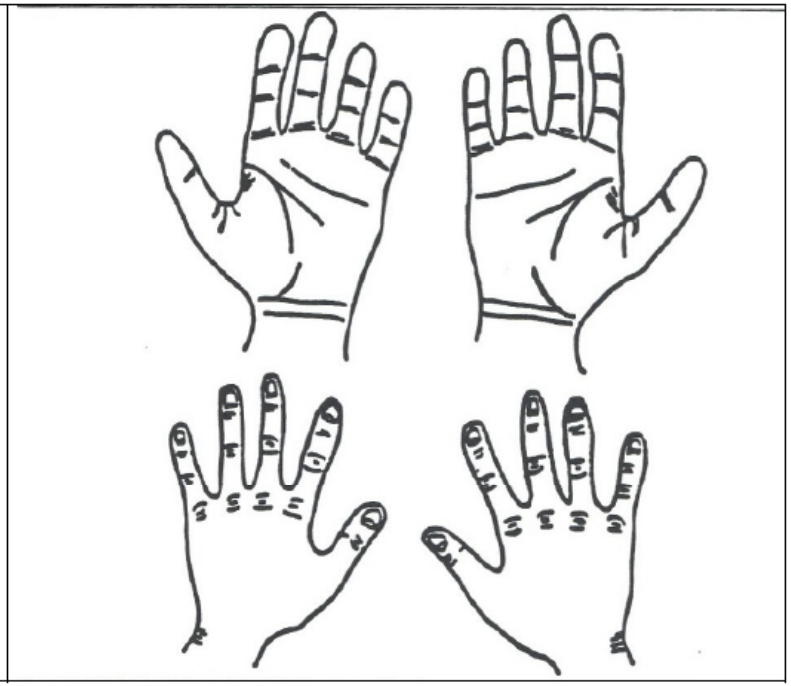
Study Background

- Subjects have to indicate where they experience what kind of "pain" on their fingers/hands
- Background:
  - 393 Subjects
  - 494 Hand Diagrams
- Expert raters assign values from 0 (unlikely) to 3 (classic), describing severity of CTS
- Interested in rating agreement among 3 expert raters

	RIGHT WRIST	LEFT WRIST	RIGHT HAND	LEFT HAND	RIGHT FINGERS	LEFT FINGERS
Burning/ Pain	O	O	O	O	O	O
Tightness/ Stiffness	O	O	O	O	O	O
Soreness/ Cramping/ Aching	O	O	O	O	O	O
Numbness/ Tingling	O	O	O	O	O	O

Please show on the diagram to the right where you have experienced numbness, tingling, burning, or pain by **shading in the problem area.**

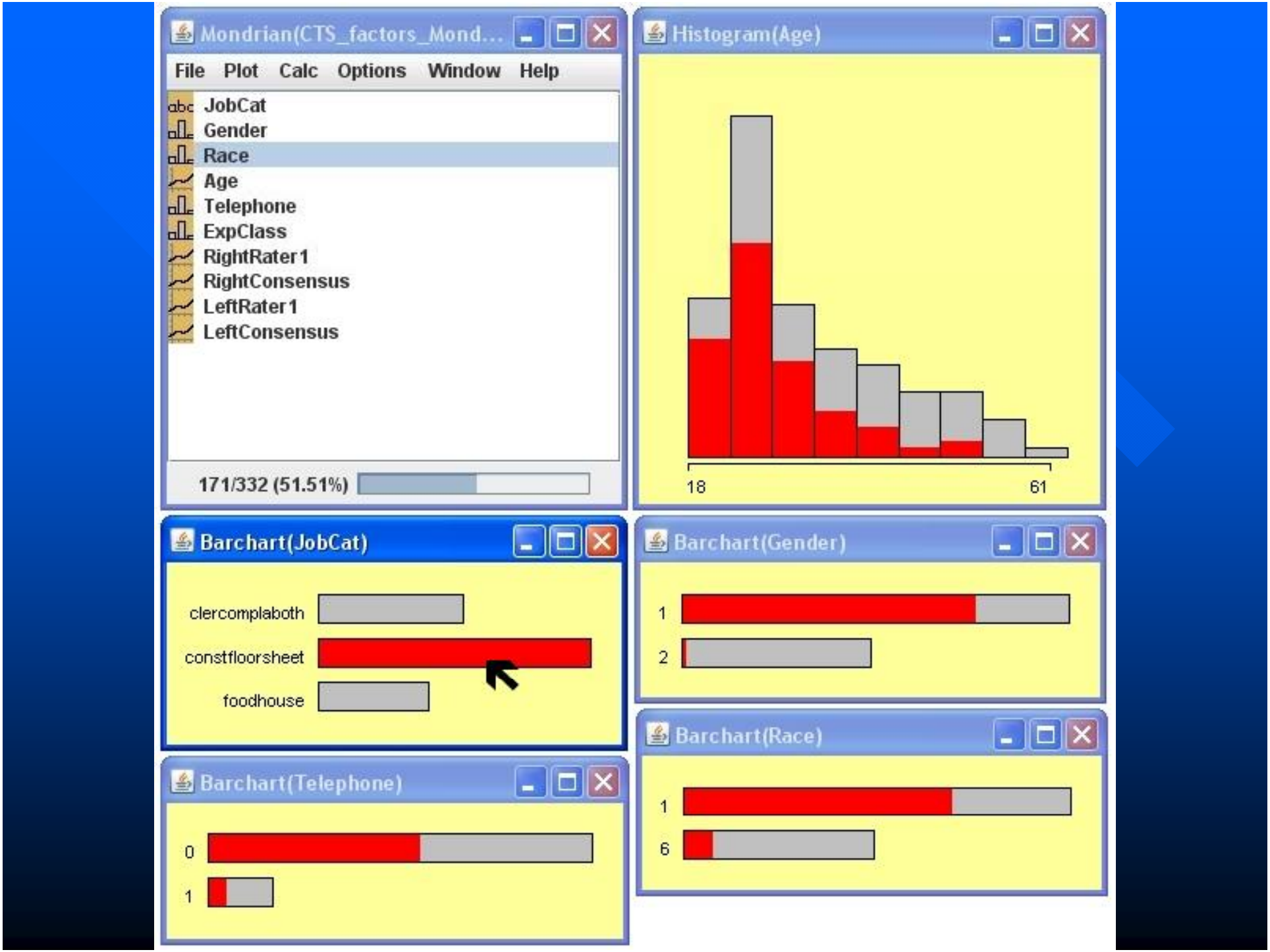
If you have not experienced these symptoms, please skip to the next question.

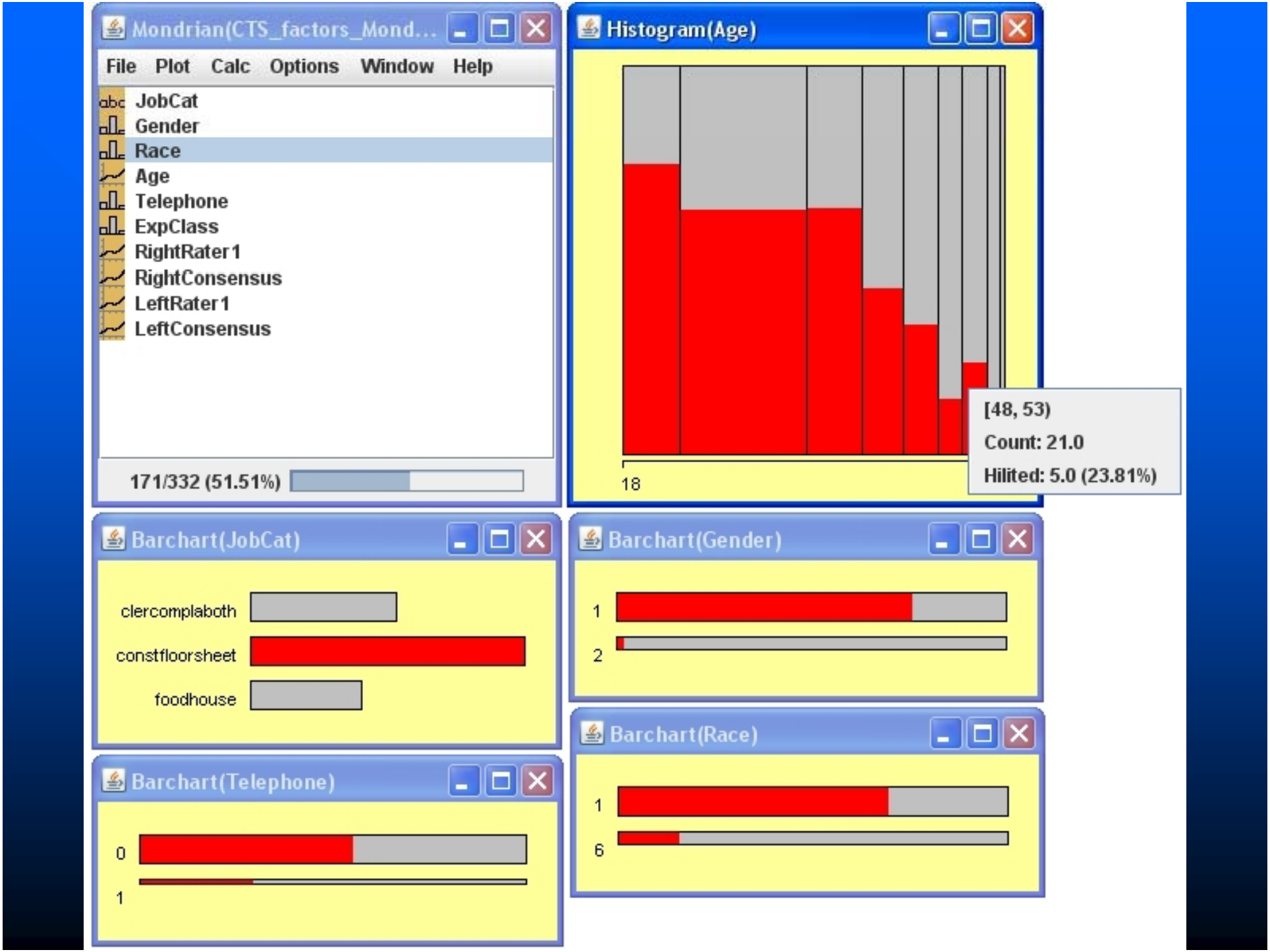


Live Demo of Interactive Graphics

-  Mondrian

- *http://www.rosuda.org/Mondrian/*
- Visualization of categorical and geographic data
- Main Developer: Martin Theus


Mondrian(CTS_factors_Mond...
File Plot Calc Options Window Help
JobCat
Gender
Race
Age
Telephone
ExpClass
RightRater1
RightConsensus
LeftRater1
LeftConsensus
171/332 (51.51%)
Histogram(Age)
18
61
Barchart(JobCat)
clercomplaboth
constfloorsheet
foodhouse
Barchart(Gender)
1
2
Barchart(Telephone)
0
1
Barchart(Race)
1
6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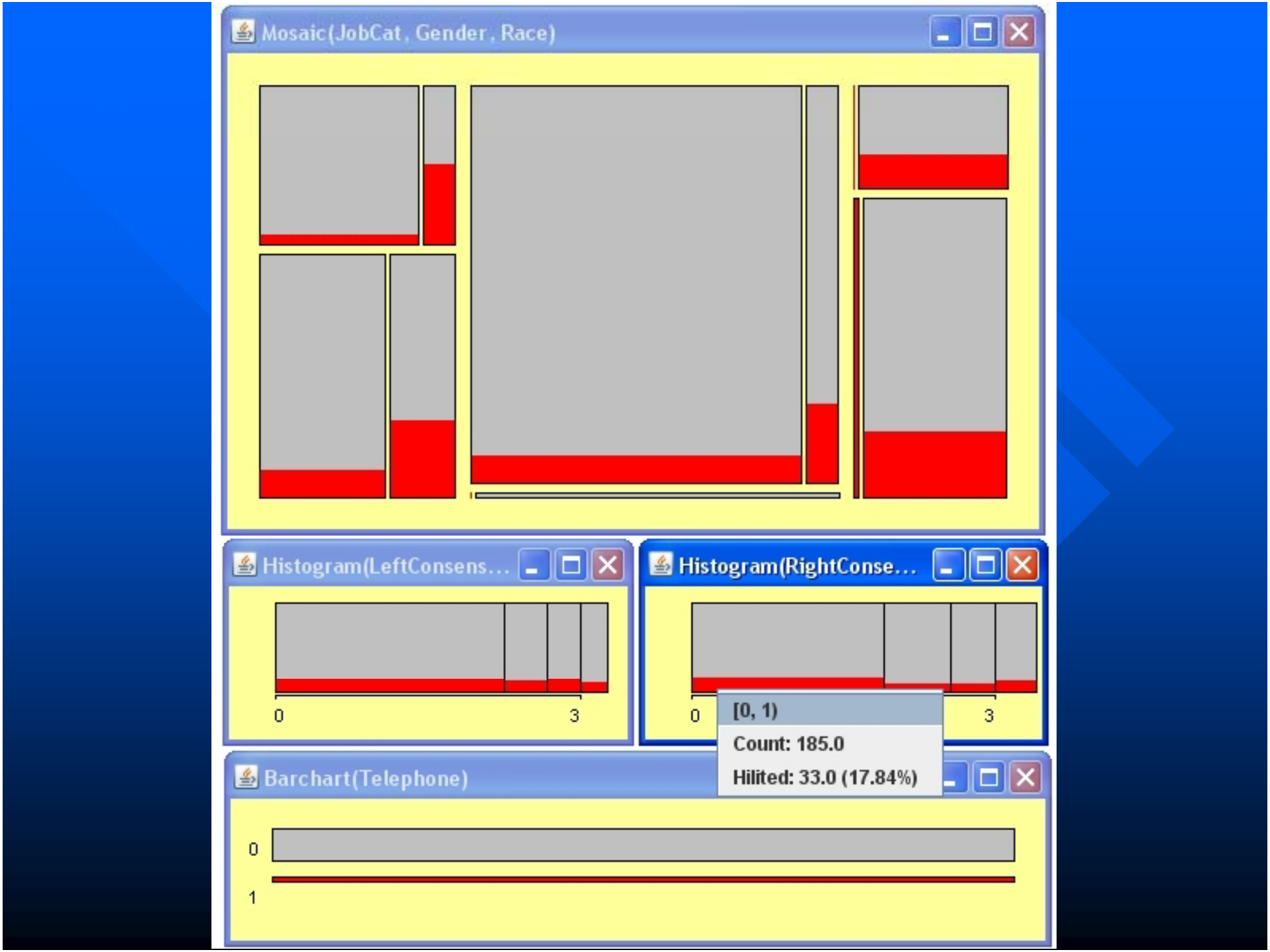
JobCat
Gender
Race
Age
Telephone
ExpClass
RightRater1
RightConsensus
LeftRater1
LeftConsensus
171/332 (51.51%)
Histogram(Age)
18
[48, 53)
Count: 21.0
Hilited: 5.0 (23.81%)
Barchart(JobCat)
clercomplaboth
constfloorsheet
foodhouse
Barchart(Gender)
1
2
Barchart(Race)
1
6
Barchart(Telephone)
0
1


Mosaic(JobCat, Gender, Race)
Histogram(LeftConsens...
0
3
Histogram(RightConse...
0
3
[0, 1)
Count: 185.0
Hilited: 33.0 (17.84%)
Barchart(Telephone)
0
1

Results in Paper

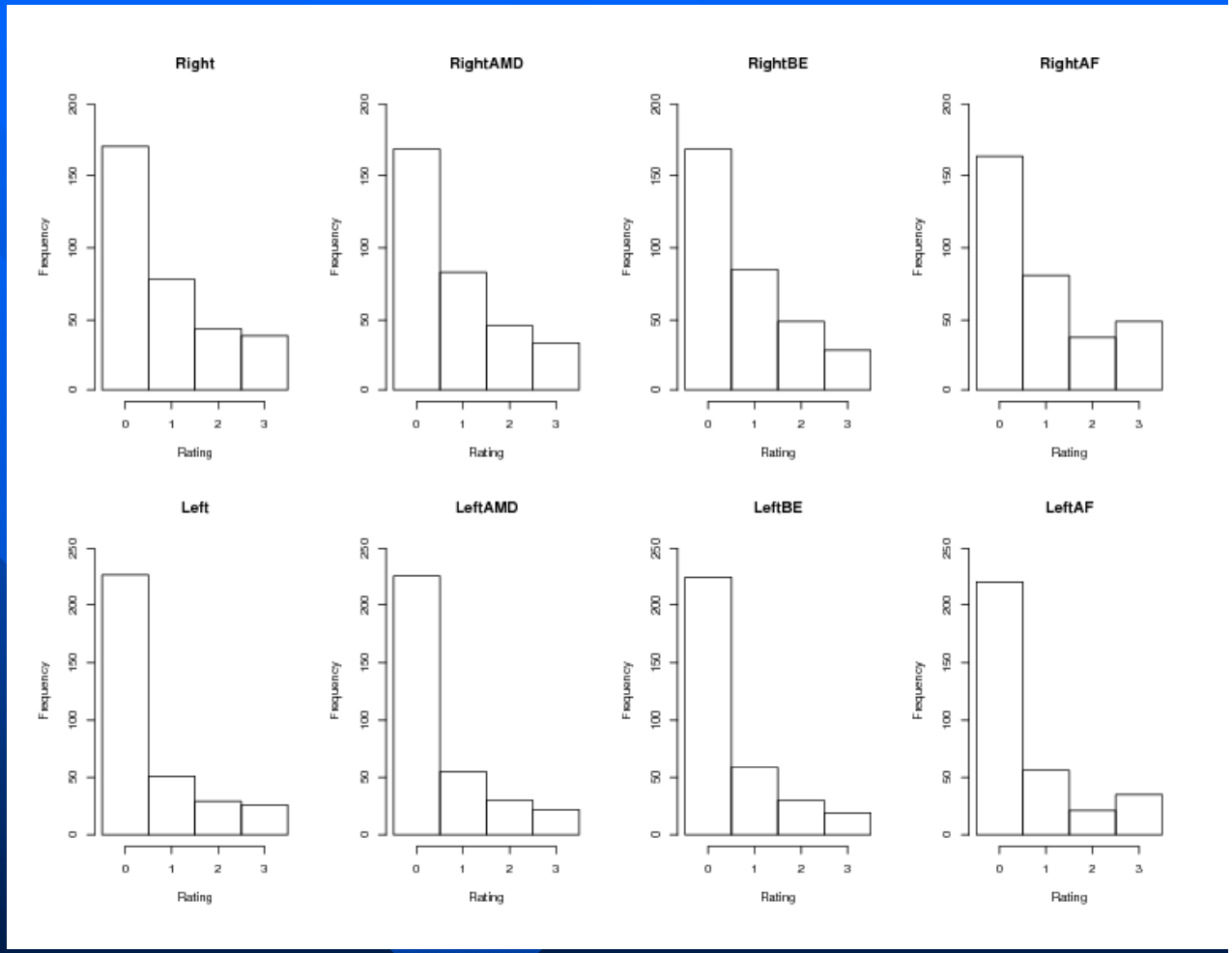
- Graphical observations complemented by numerous logistic regression analyses. Overall result:

Personal Factors as Predictors of Disagreement

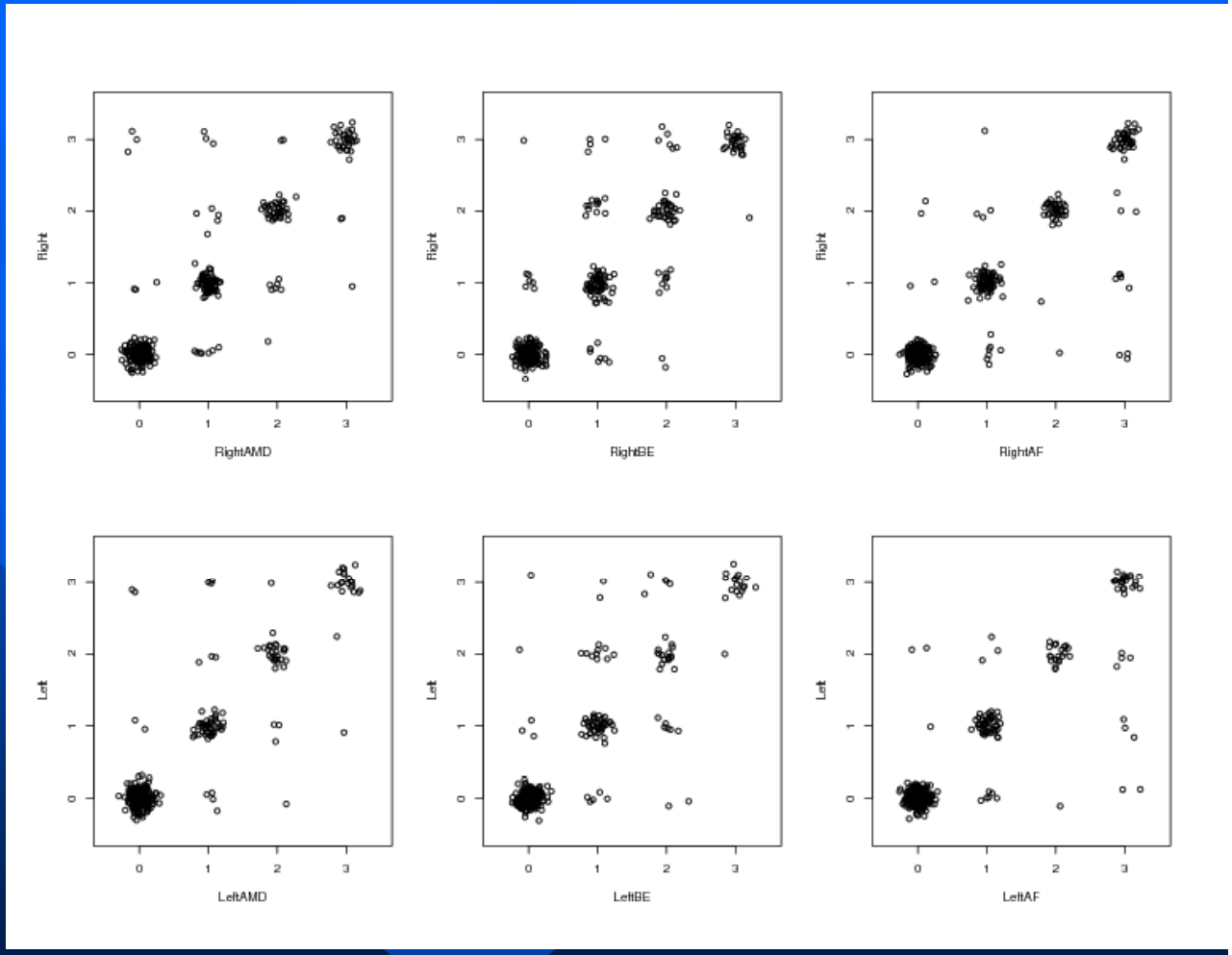
In order to determine whether subjects' personal factors contributed to systematic misclassification of our diagnostic outcome, we ran logistic regression analyses to predict disagreement among the raters. This analysis was restricted to the first hand diagram completed by self-administered questionnaire for each subject ($n = 288$). The outcome for this analysis was complete agreement among raters versus at least one rater with a different score. Agreement among raters was not predicted by the subjects' age, sex, job category, race, the presence of other neck/shoulder or elbow/forearm symptoms, or other diseases including diabetes and arthritis.

Graphical Results: Development Sequence (1) - Histograms

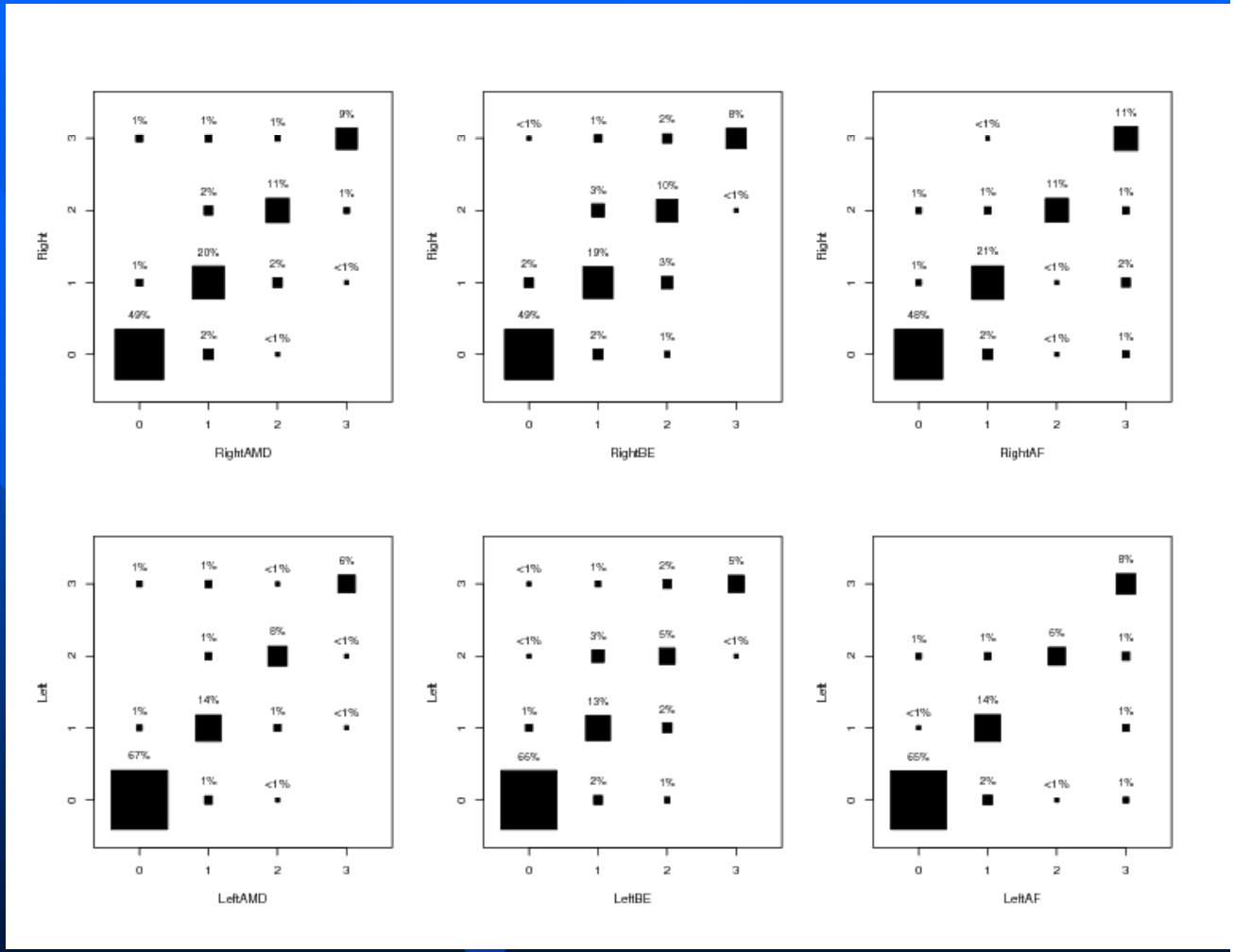
- Comparison of Rating Consensus Scores of 3 Raters, Compared to the Raters' Individual Scores



Graphical Results: Development Sequence (2) – Jittered Scatterplots



Graphical Results: Development Sequence (3) – Boxes



Graphical Results: Development Sequence (4) – 2007 Conference Poster Version (1 Rater only)

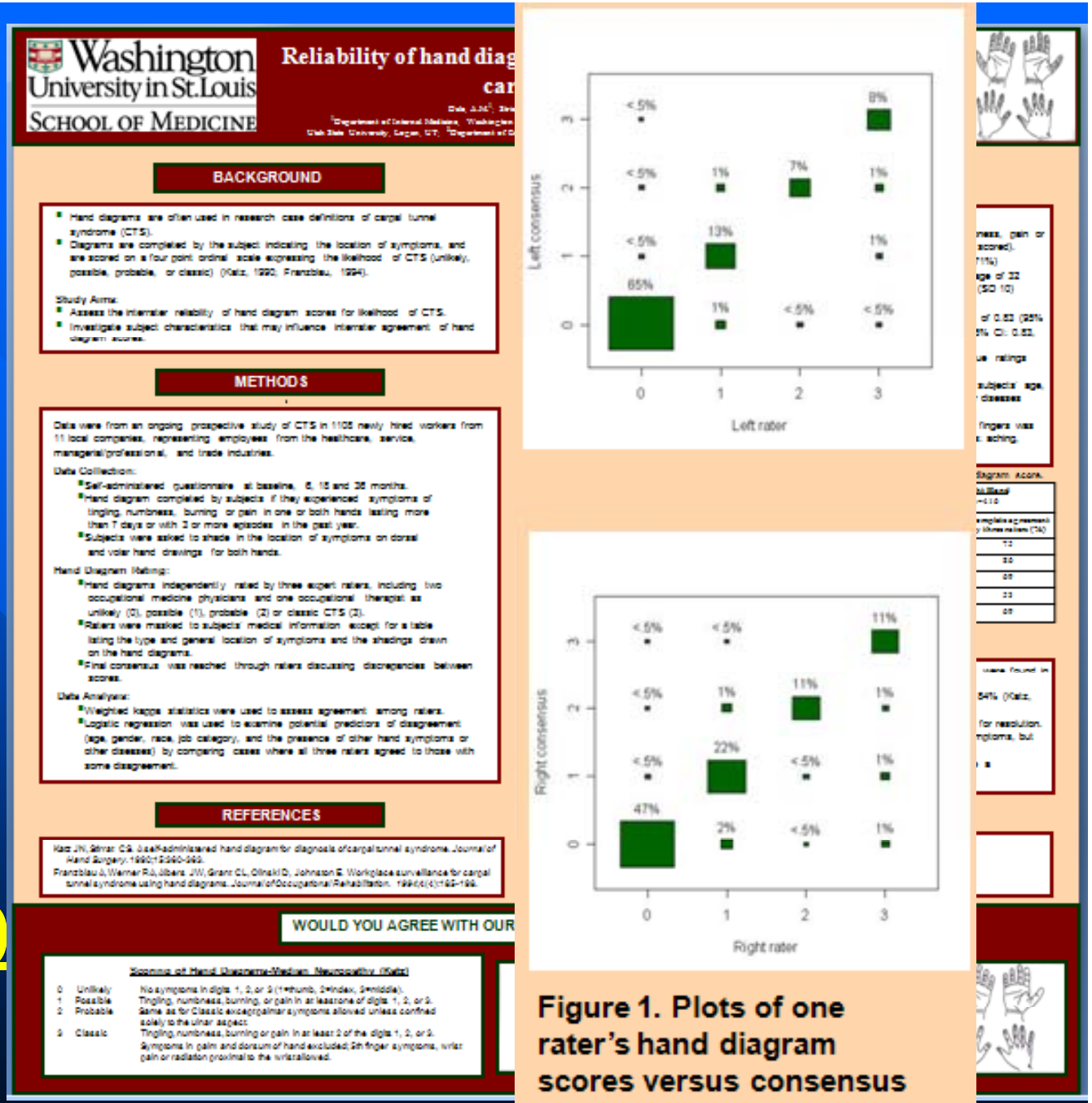
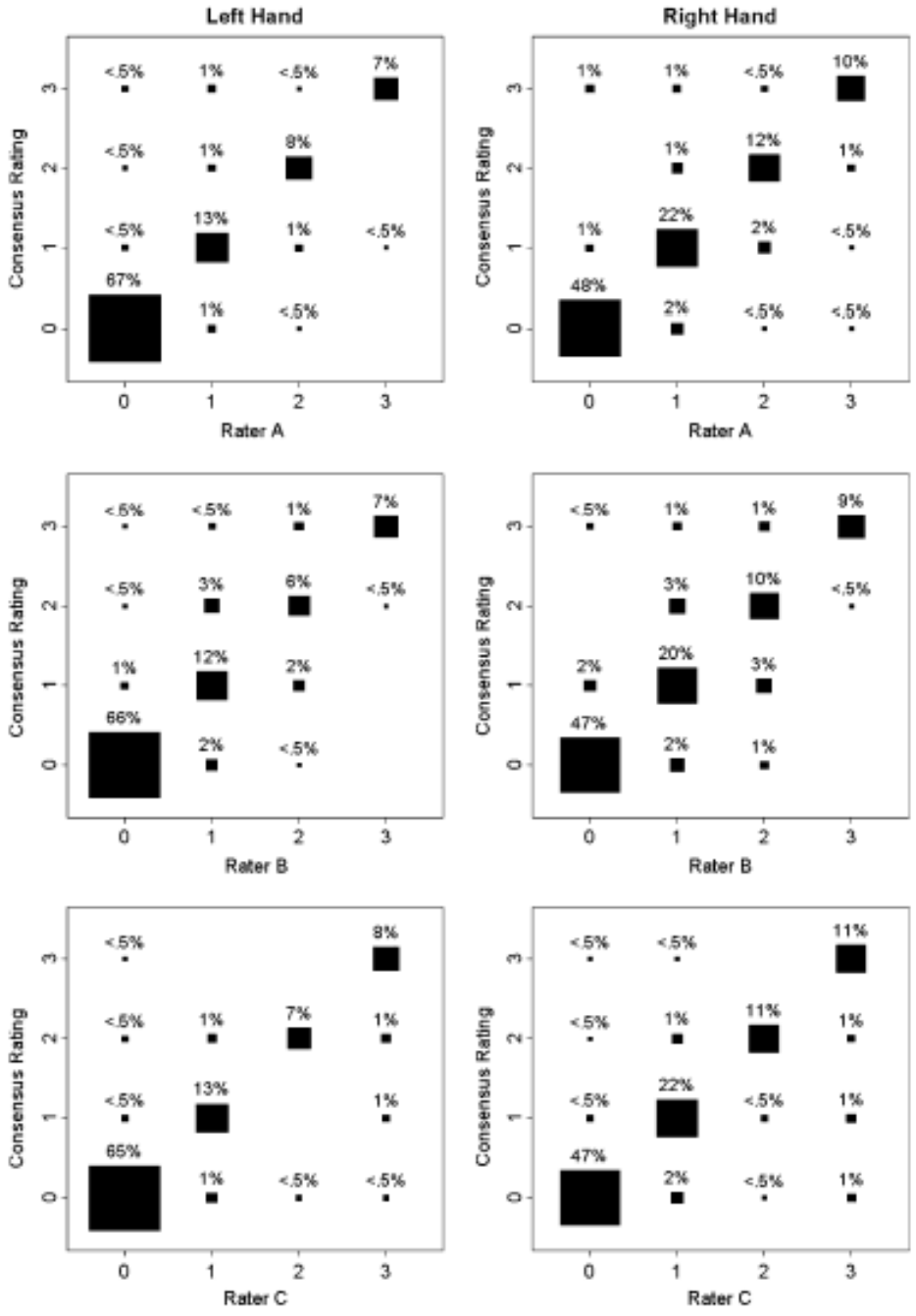


Figure 1. Plots of one rater's hand diagram scores versus consensus scores for right and left hand.

Graphical Result (Final) – Change of Layout and new Labels

Fig. 2 Comparison of hand diagram consensus scores among three raters to the individual raters' scores of unlikely (0), possible (1), probable (2) and classic (3)

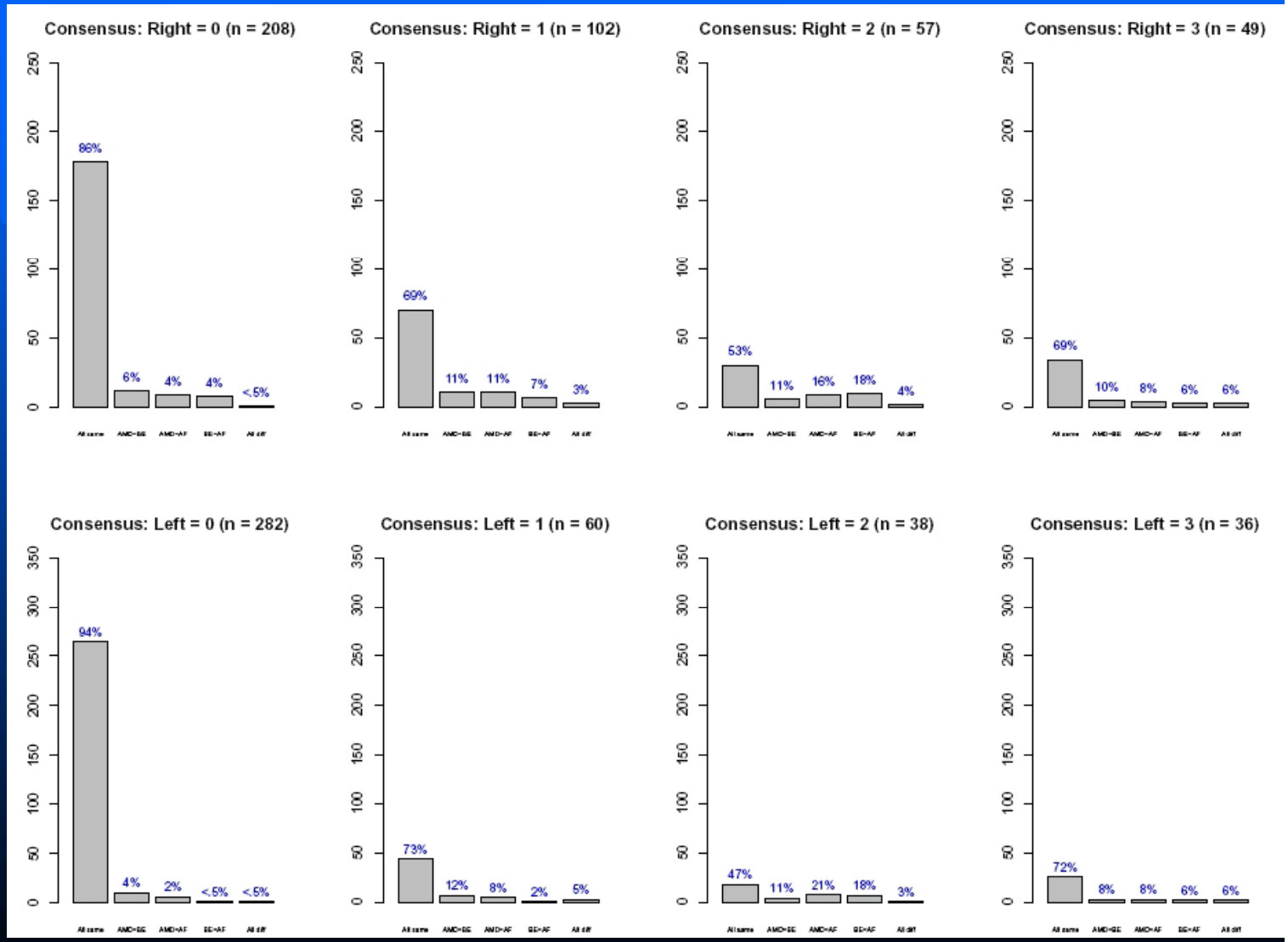


Numerical Results

- Weighted “kappa” represents agreement between three experts, based on difference between how much agreement is present compared to how much agreement would be expected by chance alone (possible range is -1.0 to 1.0)
- Interpretation:
  - < 0 : Less than chance agreement
  - 0.01 – 0.20: Slight agreement
  - 0.21 – 0.40: Fair agreement
  - 0.41 – 0.60: Moderate agreement
  - 0.61 – 0.80: Substantial agreement
  - 0.81 – 0.99: Almost perfect agreement
- Observed Results:
  - Left Hand Diagrams: 0.88 (95% CI: 0.83, 0.91)
  - Right Hand Diagrams: 0.83 (95% CI: 0.78, 0.87)

Additional Graphical Results

- Detailed Comparison of Raters' Individual Scores



Results in Paper

- Overall results (table & text):

Table 3 Proportion of ratings by coding scale and percent agreement by all raters for the left and right hand diagram completed by self-administered questionnaires

Consensus ratings	Left hand $n = 416$		Right hand $n = 416$	
	% of completed questionnaires	Complete agreement by three raters (%)	% of completed questionnaires	Complete agreement by three raters (%)
Unlikely (0)	67.8	94	50.0	86
Possible (1)	14.4	73	24.5	69
Probable (2)	9.1	47	13.7	53
Classic (3)	8.7	72	11.8	69
All diagrams	100	85	100	75

compared to the consensus results. As shown in Table 3, agreement was generally higher for the left hand compared to the right hand although there were a low proportion of abnormal hand diagrams for the left hand. The highest agreement was found for the 'unlikely' category (0), with very high agreement found for both the 'possible' (1) and 'classic' (3) categories. The lowest agreement was shown for the 'probable' (2) category. A small percentage of hand diagrams received unique ratings from all three raters (2% right hand, 2% left hand). Ratings of self-administered hand diagrams produced weighted kappa scores of 0.83 (95% CI: 0.78, 0.87) for right hand diagrams and 0.88 (95% CI: 0.83, 0.91) for left hand diagrams with similar results found for intraclass correlation coefficient (ICC) agreement and consistency analyses.

Overall Conclusions

- Constructing good, journal-quality graphics is a long path that often requires many iterations
- Not every graphic will make it into a paper, but many of those that do not make it will provide useful insights for the researchers:
  - Graphics often help to create new hypotheses
  - Graphics useful to verify results
  - (Interactive) graphics may serve as basis for a textual summary or a table
- Combination of different graphical techniques (static, interactive, various plots) most effective

- **References:**

Dale, A.M., Strickland, J., Symanzik, J., Franzblau, A., Evanoff, B. (2008): Reliability of Hand Diagrams for the Epidemiologic Case Definition of Carpal Tunnel Syndrome, Journal of Occupational Rehabilitation, 18(3):233-248.

Symanzik, J. (2010): Interactive and Dynamic Statistical Graphics, In: Lovric, M. (Ed.), International Encyclopedia of Statistical Science, Springer, Forthcoming.

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Questions ???