Some thoughts on how to measure association strength
The concept of **Association** is central to the study of language and mind.
Some types of associative links between linguistic elements

- form – meaning (i.e. signs, Constructions in CxGs)
- form – form (collocations)
- form – function (colligations)
- meaning – meaning (semantic fields/networks)
- sign – sign (collostructions)

Association strength is the glue between units
**Association** in language processing: Local syntactic ambiguity

Information about **associative relationships speeds-up comprehension** (e.g. Hare et al. 2003, 2004; Wiechmann 2008; Zeschel 2008)

► **association** between a given

verb & complementation type [nominal/sentential]

*The athlete revealed his problem...*  
Nominal complement  
... with drugs  

Sentential complement  
... worried his parents
How to measure association strength?

Situation:
Many candidate measures suggested in the corpus linguistic and computational linguistic literature (Evert 2004 lists as many as 47 measures).

Question:
Which one should we use?
- Is (brute force) co-activation frequency too crude?
- Is predictiveness of a stimulus more important?
- And if so, how exactly should we measure?

Answer:
Let's put them to the test
Steps involved in the analysis

1. COMPUTATION of association strength:
   VERB & NOMINAL OBJECTS
   [47 candidate measures]

2. GROUPING of measures output wrt similarity
   [cluster analysis]

3. EVALUATION of corpus-based results experimental data
   (eye-tracking data)
   [regression modelling]
For all candidate measures (n=47),
Compute **association strengths**
verb – nominal complements

21 polysemous verbs
**Corpus:** BNC$_{\text{spoken}}$
**N = 6417**

<table>
<thead>
<tr>
<th>INPUT: Frequency signature</th>
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<tbody>
<tr>
<td>nominal complements</td>
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<tr>
<td>verb v</td>
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<td>other verbs</td>
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NP complements
S complements
Step 1: Assessing association strength

Fisher exact test

- Fisher Exact pv
- minimum sensitivity (MS)
- discounted odds ratio

verbs: believe, realize, say, feel, claim, assume, suggest, understand, expect, notice, remember, discover, promise, deny, announce, accept, established, report, hear, write, mention
Step 1: Assessing association strength 

**VERB** – **NP** **COMP**

Fisher exact test - (disc) odds ratios - minimum sensitivity
Step 2: (Dis-)similarity of association measures

- Fisher's exact test
- Corrected chi-squared test
- Binomial likelihood
- Raw frequency
- Minimum Sensitivity
- Pointwise MI
- (discounted) odds ratios
- MI (confidence interval at alpha .05)
Step 3: Corpus-based result vs. Experimental data
(eye-tracking - Kennison 2001)

(a) The student **revealed** **his problem** **worried his parents**
(b) The student **revealed** that **his problem** **worried his parents**

**SUBJ** **V** **NP** disambiguation

Quantity of interest: 
**fixation times deltas (in ms)**
Regression analysis (example)
Degree of fit (co-)determines adequacy of measure

Coefficient of interest:
Adjusted $R^2$ from quadratic models
Best measure:
**Minimum Sensitivity**
adjusted $r^2 = .34$
Minimum Sensitivity (MS)
(Pedersen & Bruce 1996; Pedersen 1998)

MS uses two conditional probabilities:
$P(\text{verb} \mid \text{construction})$ and $P(\text{construction} \mid \text{verb})$
Minimum Sensitivity should be the measure of choice, because it is...

1. *free from underlying distributional assumptions* that are not met by natural language data.

2. *computationally less demanding* than exact statistical hypothesis tests (e.g. Fisher-Yates test)

3. *less dependent on sample sizes* than (exact or asymptotic) statistical hypothesis tests

4. *empirically most adequate* not only in the present study but it in Krenn (2000).
Thank you for your attention.

And special thanks to...

**Sheila Kennison** (U Oklahoma) for sharing her fixation time data,

**Steffi Wulff** (U Michigan) for her ICE-isomorphic BNC-sample

**Stefan Gries** (UCSB) for his Cluster Eval 0.9

**Stefan Evert** (U Osnabrück) for his UCS 0.5

...and their helpful comments.
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