E-Diary Data Collection in Neurology and Psychiatry: Computational Achievements and Challenges

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Achievement and Challenge

• Computational Achievement:
  – Using e-diary data to link symptom expression to routine life events

• Computational Challenge:
  – How to automate the identification of linkages between events and symptoms
Localized Symptoms

Impairments of:
• Speaking – Broca’s Aphasia
• Comprehending – Wernicke’s Aphasia
• Repeating – Conduction Aphasia
• Reading – Alexia
• Writing - Agraphia

Localization of Function

• Broca’s Aphasia: Speech
• Wernicke’s Aphasia: Auditory Comprehension
Ambiguous Symptoms

- Spells
- Lapses of Attention and Memory
- Emotional Outbursts
- Fatigue & Hypersomnia
- Headaches
- Odd Behavior

Causes

- Brain Damage/Dysfunction
- Psychiatric Disorder (Prior or Reactive)
- Non-neuropsychiatric Illness (Infection, Diabetes, Sarcoidosis, BP)
- Iatrogenic Causes (Medication Toxicity)
Brain Dysfunction Hypotheses

• Random Spontaneous Dysfunction
• Events Precipitate Dysfunction
  – Many event influences
  – Symptom specific event influences
  – Patient specific event influences

Patient Specific Event Patterns

• Single event
  – Cyclic
  – Graded
• Cumulative events
  – Simultaneous: one triggers other modulates
  – Sequential: one lowers threshold, other triggers
  – Simultaneous: both required
• Symptom Combinations
  – Two symptoms produce a third
Case 1: Spells and Weekday Cycle

Spell Totals and Day of the Week

Case 2: Headaches and Weekday Cycle

Headache Intensity and Day of Week
Case 3: Event Intensity & Symptom Frequency

Symptom Frequency and Hours of Activity

HOURS OF SPORTS, CLASS & STUDY
- 0 or 1 lapse
- Two or more lapses

Case 3 Continued

Frequency of Lapses of Attention (times)

SAD/HAPPY - 7 pil

ANGRY/PEACEFUL 7 pil

Period/NYN/Yes
Case 3 Continued

Lapses & Anger ↑ with Activity ↑

Bubble size with ↑ Anger

Case 4: Activity Related to Energy & Confidence

2/25/2012
Case 5: Two Sequential Events & the Occurrence of Symptom Outbursts

<table>
<thead>
<tr>
<th>Incidents</th>
<th>Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TBI Cognitive Failure</td>
</tr>
<tr>
<td>Outbursts</td>
<td>15</td>
</tr>
<tr>
<td>No Outbursts</td>
<td>5</td>
</tr>
</tbody>
</table>

Case 6: Dual Event Triggers Symptom Clusters

- Menstruation
- Night Sweats
- Symptom Clusters

- 5 Number
- 4 per day
- 3
- 2
- 1
- 0
Case 6 Continued

• Moderate to severe headaches require two events: a) family discord and b) being tense and overwhelmed.

Computational Challenge

• Identifying symptom-event patterns
### Patient Specific Event Patterns

- **Single event**
  - Cyclic
  - Graded
- **Cumulative events**
  - Simultaneous: one triggers other modulates
  - Sequential: one lowers threshold, other triggers
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- **Symptom Combinations**
  - Two symptoms produce a third

### Computational Issues

- Presence/Absence of Patterns
- Outlier Producing/Hiding Patterns
- Measuring Degree of Association
- Use of Exact Test Statistics

\[ \text{e.g., Sensitivity} = P(S/E) \quad \text{Specificity} = P(\sim S/\sim E) \]