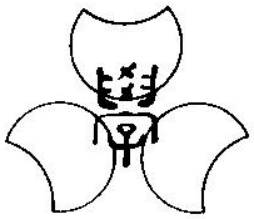

# Joint Information Value of Syntactic and Semantic Prominence for Subsequent Pronominal Reference

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Gunma, Japan

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Multidisciplinary Approaches to Discourse
Chorin, Germany

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The list of discourse referents is partially-ordered with respect to *salience*, determined by a number of potential factors including syntactic role and recency (cf., Hirst, 1981; Mitkov, 2002).

Subsequent reference to the most salient entity in the context should be done pronominally (cf., Rule 2 of Centering Theory Grosz et al., 1995).

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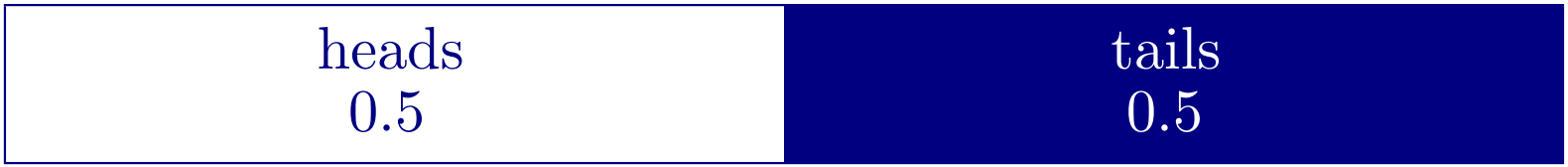

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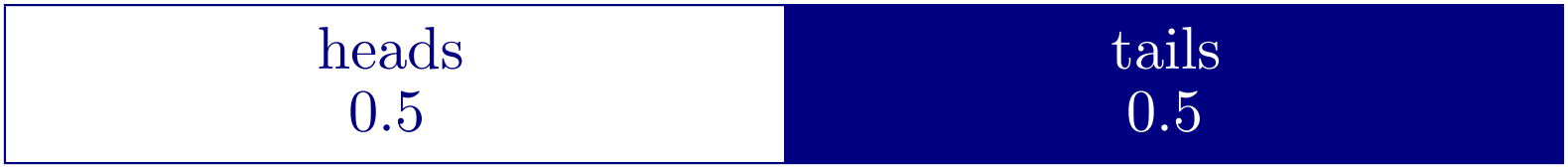


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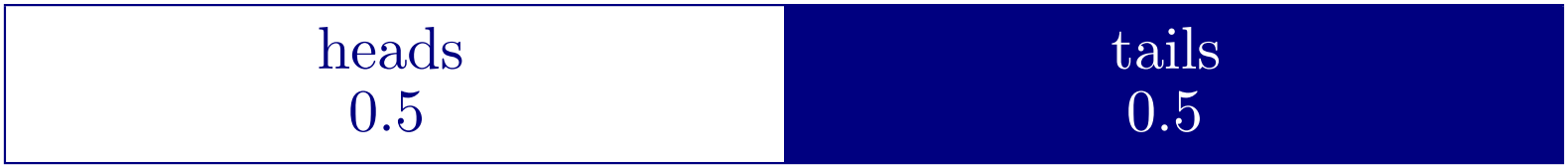


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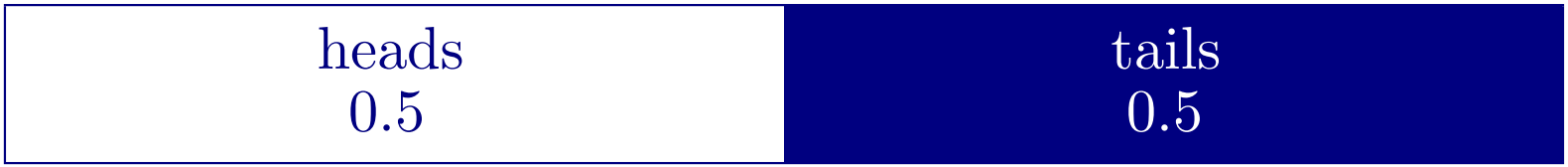


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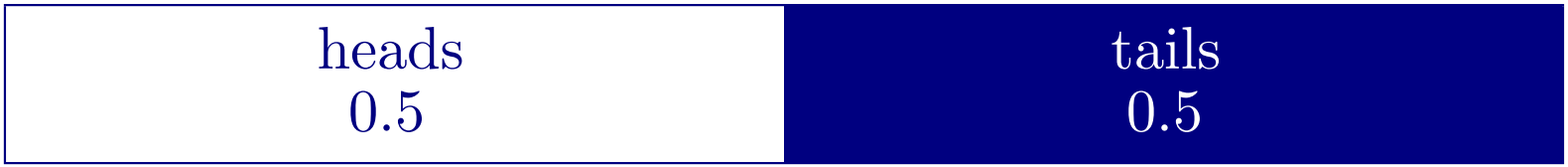


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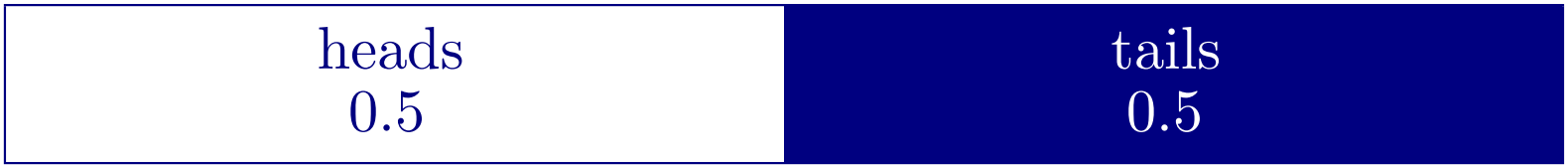


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The conditional entropy for a two-headed coin is

$$H(two - headed\ coin) = 0$$

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Note that entropy reduction may be negative.

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(1) Are you a male?

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What would be a good first question?

Compare:

(1) Are you a male?

(2) Are you Albert Einstein?

Clearly (1) is a better question (assuming no gender bias in either the list or Player 1's choice). (1) is a much more informative question because whatever the outcome, half of the possibilities are eliminated.

# Information Theory

Value of Information, $EIV$, is a quantitative estimate of how informative a particular question, $x$, is.

$$EIV(x) = P(x)H_r(x) + P(\neg x)H_r(\neg x)$$

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The value of *Are you Albert Einstein?* is

$$EIV(Einstein?) = 999/1000 * 0.001 + 1/1000 * 10 = 0.01$$

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Then the net value of information, $EIV_{tot}$, for syntactic prominence is the total of the individual $EIV$s:

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Similarly for Semantic Prominence.

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Thus, this study aims to answer two empirical questions:

- How do the $EIV_{tot}$ values for syntactic and semantic prominence compare?
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Manual mark-up in eXtensible Mark-up Language (XML):

- shallow syntactic parse into sentences and clauses
- information on noun-phrases
  - referent ID
  - syntactic role
  - semantic role

# Description of Corpus

The syntactic role of noun phrases was marked with one of the following:

- subject
- object
- oblique
- none (i.e., none of the above)

Ken threw a frisbee to Jaime.

```
<s>
  <c>
    <np synrole="subject">
      Ken</np>
    <verb>threw</verb>
    <np synrole="object">
      a frisbee</np>
    to
    <np synrole="oblique">
      Jaime</np>
  </c>
  <punc>.</punc>
</s>
```

# Description of Corpus

The FrameNet database (Baker et al., 1998), based on the frame semantics of Fillmore (1968, 1976), defines a large set of conceptual frames and frame elements (thematic roles) which participate in each frame.

For example, the CAUSE_MOTION frame includes the participants AGENT, THEME, and GOAL. The verb *throw* invokes this frame.

Semantic role information was marked on noun phrases following the FrameNet system.

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# Results and Analysis

291 instances of inter-utterance coreference (adjacent utterances only) were extracted from the corpus for the present analysis. In 224 of these instances (77%), the coreferential noun phrase in the latter utterances was a pronoun. Thus, the entropy of pronominalization (whether the second reference in each instance was a pronoun or not) was calculated as follows.

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This is the baseline for entropy reduction: How much does syntactic or semantic information reduce it?

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        semrole="experiencer"
      John</np>
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    <c>
      <np>his father</np>
      to
      <verb>give</verb>
      <np id="JOHN"
          synrole="object"
          semrole="recipient"
        him</np>
      <np>a bicycle</np>
    </c>
  </c>
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JOHN: syntactic prominence = "subject,object"

semantic prominence = "experiencer,recipient"

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| x | $EIV(x)$ |
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| subject | 0.059 |
| object | 0.021 |
| oblique | 0.010 |
| none | 0.011 |
| $EIV_{tot}$ | 0.101 |

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**Semantic Prominence** The highest group number which contains a frame element realized by a discourse referent is its semantic prominence.

| group | name | sample elements |
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| 1 | agentivity | agent, deformer, driver |
| 2 | perception | cognizer, experiencer |
| 3 | movement | theme, impactor, message |
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| 5 | movement parameters | direction, ground |
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This ordering parallels other thematic hierarchies in literature (cf., Jackendoff, 1972, 1990; Speas, 1990).

# Results and Analysis

## Semantic Prominence

| group | name | $EIV(group)$ |
|---|---|---|
| 1 | agentivity | 0.013 |
| 2 | perception | 0.045 |
| 3 | movement | 0.012 |
| 4 | affected | 0.002 |
| 5 | movement parameters | 0.005 |
| 6 | events | 0.004 |
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| $EIV_{tot}$ | | 0.101 |

Higher EIV for perception elements contrasts many thematic hierarchies which place agentive roles highest.

# Summary I

There is no difference among the $EIV_{tot}$ values.

| | |
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| syntactic prominence | $EIV_{tot} = 0.101$ |
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Cross syntactic prominence (4 cells) against semantic prominence (7 cells) and calculate $EIV$ values (28 cells). For example,

$$\begin{array}{ccccc} EIV(subject,1) & + & EIV(object,1) & + \\ EIV(oblique,1) & + & EIV(none,1) & + \\ EIV(subject,2) & + & EIV(object,2) & + \\ & \vdots & & \\ \hline & & EIV_{tot} & \end{array}$$

# Results and Analysis

| **Information Values** | |
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**Joint Information Value**

| | |
|---|---|
| Syntactic prominence $\times$ Semantic prominence | $EIV_{tot} = 0.165$ |

# Results and Analysis

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| semantic prominence | $EIV_{tot} = 0.101$ |

**Joint Information Value**

| | |
|---|---|
| Syntactic prominence $\times$ Semantic prominence | $EIV_{tot} = 0.165$ |

Joint Information value of syntactic and semantic prominence is higher than either is alone.

# Results and Analysis

**Information Values**

| | |
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| Syntactic prominence $\times$ Semantic prominence | $EIV_{tot} = 0.165$ |

Joint Information value of syntactic and semantic prominence is higher than either is alone.

These conclusions are tentative: Differences remain statistically unconfirmed.

# Discussion

Results suggest a model of discourse processing in which information about both syntactic and semantic prominence of discourse referents is used to determine the salience of referents in the representation of the current context.

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Information theory is thus a useful measure by which to evaluate the relative value of different sorts of information to salience and may therefore be a means to narrow down on the crucial factors which determine salience.

# Discussion

Results suggest a model of discourse processing in which information about both syntactic and semantic prominence of discourse referents is used to determine the salience of referents in the representation of the current context.

Information theory is thus a useful measure by which to evaluate the relative value of different sorts of information to salience and may therefore be a means to narrow down on the crucial factors which determine salience.

The prospect that syntactic and semantic prominence contribute unique information to the determining salience suggests that implementations of discourse processing mechanisms (e.g., text production agents, pronoun resolution algorithms) may benefit from inclusion of semantic prominence as a factor.

# Further Work

- Implementation of pronoun resolution algorithm with semantic prominence as a factor
- Explore reasons for the apparent high value of perceptual role information.
- Compare the information value of syntactic and semantic prominence in languages with freer word order (e.g., Spanish, Japanese).

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Thank You!

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