Compound contributions and entropy

Matthew Purver, but mainly Christine Howes really

Cognitive Science Research Group
School of Electronic Engineering and Computer Science
Queen Mary, University of London

c.howes@qmul.ac.uk
Expansions

- Compound contributions are common in dialogue
- Some add material to something already “complete”:

  It was also noted today at these presentations that I was the one with the least Brummie accent.

  Oh

  Which made me feel good
Compound contributions are common in dialogue.

Some continue something apparently “incomplete”:

Oh here dad, a good way to get those corners out

is to stick yer finger inside

Well, that's one way
Why are they interesting?

- They’re quite common
  - 3-5% of turns (Purver et al 2009)
- They perform various important functions:
  - asking for clarification
  - demonstrating inter-person coordination
  - (Howes et al, 2011)
- They don’t mean the same as two independent turns!

- So dialogue systems need to understand them
  - (or at least be aware of them!)
When do they happen?

- To detect them we need to know when they’re likely:

  - The other person has, er, kind of stopped?
  - "Transition relevance points" (e.g. Schegloff, Lerner . . .)
  - We can tell what’s coming next?
  - Predictability of meaning, structure, words?
  - We can’t tell what’s coming next?
  - Unpredictability of meaning, structure, words?
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How can we measure “predictability” of various kinds?

Information-theoretic measure

Entropy of a linguistic item given its prior context:

- words $w_1 \ldots w_n$: emma wants to go to the shops
- PoS $s_1 \ldots s_n$: NP0 VBZ COMP VBP PRP DET NNP

$$p^i_w = p(w | w_i, w_{i-1}, \ldots) \quad H_{lex}^i = - \sum_w p^i_w \log(p^i_w)$$

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\]

Lexical vs syntactic; what about semantics? pragmatics?
Predictability

- How can we measure “predictability” of various kinds?

**Surprisal = self-information** $I(w)$

$$I(w) = -\log(p(w|w_i, w_{i-1}, \ldots))$$

Correlation with online reading times in incremental parsing (e.g. Hale, Roark . . .)

**Perplexity = average entropy (per word) of a linguistic dataset**

$$p^i_w = p(w|w_i, w_{i-1}, \ldots) \quad H^i_{lex} = -\sum_w p^i_w \log(p^i_w)$$

Quality of language models
The interface

- Text-based interface
  - Interventions can be introduced into a dialogue in real time
- Character-by-character interface
The intervention

Single contributions artificially split into two parts

- Truncation point manipulated according to:
  - POS entropy
  - Lexical entropy

- First part transmitted as typed
  - Followed by “...” or “...?”

- Pause during which other person could respond
  - Any response trapped by server and not transmitted

- Second part of turn transmitted as typed

- Observe response:
  - any response? continuation (CC)? clarification (CR)?
We can make some naive predictions:

**Hypothesis 1: End of turn predictability**
Cross-person continuations are more likely at transition relevance places

**Hypothesis 2: Structural predictability**
Cross-person continuations are more likely when they are syntactically and/or lexically predictable.

**Hypothesis 3: Contextual predictability**
Cross-person continuations are more likely when they address topics that are part of the common ground.
Response or not

- Of the 241 interventions, 171 elicited a response (71%)
- Main effect of completeness: responses more likely where the truncated turn could be considered complete
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Main effect of completeness: responses more likely where the truncated turn could be considered complete.

Predictability: no main effect.

Interaction effect of POS entropy by lexical entropy.

![Graph showing the interaction effect of POS entropy by lexical entropy.](graph.png)
Of the 241 interventions, 171 elicited a response (71\%).

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Interaction effect of POS entropy by lexical entropy.

Responses more likely where both next word and next syntactic element are unpredictable.
Compound contributions

- No simple main effects
- Interaction between antecedent end-completeness $\times$ lexical entropy

![Probability of a CC response graph]
Compound contributions

- No simple main effects
- Interaction between antecedent end-completeness × lexical entropy

When the truncated turn is complete, responses are less likely to be continuations where the next word is unpredictable.
Compound contributions

- No simple main effects
- Interaction between antecedent end-completeness × lexical entropy

Potentially complete, highly predictable next word

W: I feel like we should be talking . . . ?
J: about the prompt?
W: about something important.
Compound contributions

- No simple main effects
- Interaction between antecedent end-completeness $\times$ lexical entropy

When the truncated turn is not complete there is no difference in proportion of CCs by predictability
Compound contributions

- No simple main effects
- Interaction between antecedent end-completeness $\times$ lexical entropy

Not potentially complete, highly predictable

T: it's not that fair on the girl doing th . . .

H: exactly, you need to think of others and not be so selfish :P

T: study we should do lots of chatting although i doubt she'll read past the exercise what with it not being standardised etc
Compound contributions by topic

- Coded for topic: is the interrupted turn on-topic or introducing something new?
- Three-way interaction: lexical entropy $\times$ POS entropy $\times$ topic.

![Graph showing the probability of a CC response across different conditions of POS and lexical entropy.](http://cogsci.eecs.qmul.ac.uk)
Compound contributions by topic

- Coded for topic: is the interrupted turn on-topic or introducing something new?
- Three-way interaction: lexical entropy $\times$ POS entropy $\times$ topic.

Topic really matters if the next lexical item is unpredictable and the syntactic category is predictable.
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Cross-person continuations are more likely at transition relevance places

Hypothesis 2: Structural predictability
Cross-person continuations are more likely when they are syntactically/lexically predictable

Hypothesis 3: Contextual predictability
Cross-person continuations are more likely when they address topics that are part of the common ground.
Hypothesis 1: End of turn predictability
Cross-person continuations are more likely at transition relevance places **FALSE**

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Hypothesis 1: End of turn predictability
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Hypothesis 1: End of turn predictability
Cross-person continuations are more likely at transition-relevance places **FALSE**

Hypothesis 2: Structural predictability
Cross-person continuations are more likely when they are syntactically/lexically predictable **PARTLY (only with complete antecedents)**

Hypothesis 3: Contextual predictability
Cross-person continuations are more likely when they address topics that are part of the common ground. **TRUE**