What can wh-questions tell us about real-time language production? Evidence from English and Mandarin

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1. Introduction

- **Language production, like comprehension, is incremental**[1]
  - When describing an image, speakers: (1) Apprehend Scene → **(2) Formulate Message** → (3) Grammatically Assemble Message/Select Lexical Items → (4) Phonologically Encode Message → (5) Begin Articulation
- **What factors determine where we start incrementally formulating messages?**
  - ***Linear Accounts:*** Start with most accessible lexical concept; mention that first (e.g. as the subject in English).[2]
  - ***Structural Accounts*:** Start with subject of the sentence; insert relevant lexical concept into the 'subject slot'[3]
  - ***Multi-factorial Accounts:*** Production varies due to accessibility and structure[4]
- **How do we tease apart these accounts if subjects are often the first arguments in a sentence?**
  - Active vs Passives: Grammatical (not thematic) roles drive message formulation, but still subject-initial[5]
  - Free word order: Russian, Finnish[6] || Verb-initial: Tzeltal, Tagalog[7]
  - But, results complicated by discourse and/or morphological factors

2. Current Study

- **Research Question:** How do linear word order and subjecthood interact to inform the starting point of message formulation?
- **English object wh-questions can tease apart linearity & subjecthood**

Which chefs did the nurses tickle?

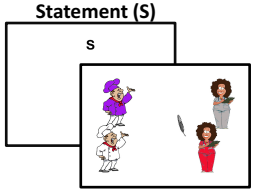
3. Hypotheses & Predictions

	Declaratives The nurses tickled the chefs.	Object Wh-Questions Which chefs did the nurses tickle?
Linear Account: Linearly first word	**Subject**	**Object**
Structural Account: Subject	**Subject**	**Subject**
Multi-Factorial: Both interact	**Subject**	**?????**

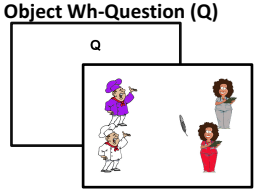
4. Experiment Design

- **Participants first saw sentence type cue, then saw image; produced the cued sentence type**

Statement (S)



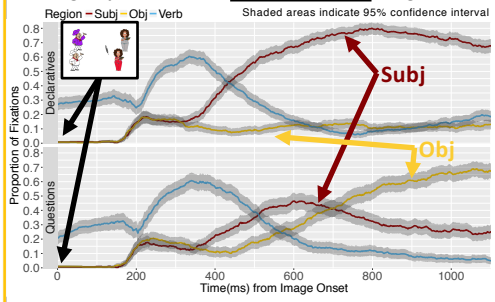
Object Wh-Question (Q)



- **Verbs indicated by instruments (e.g. feather), instrument location indicated subject character**
- 33 targets; 30 fillers. Familiarization session before experiment
- **Measured** Proportion of fixations to **subject**, **object** and **verb**, & Sub-Obj Difference Scores

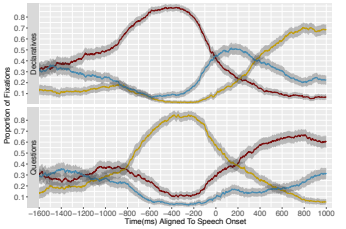
5. Exp 1: English. Linear Word Order vs Subjecthood

Fig1: Eye-Movements Immediately After Image Onset



- Speakers (n=30) look to **verb** first to determine Subj/Obj
- **Differences between decl & ques emerge ~400ms**
- **Differences become significant ~600ms**
  - **Subj-Obj difference scores** in declaratives **larger** than in object wh-questions (|z|= 2.67)
- **Key Pattern:** Speakers look to the **subject before object** in decl & ques (~400ms), but consider the **object more in ques** than in decl
- **Message formulation modulated by syntactic structure**
  - **Decl:** Rapid rise in looks to subject only ~400ms
  - **Ques:** Rise in looks to subject & object ~400ms
- **How do linear word order and subjecthood interact?**
  - **They are separable, competitive effects**
  - **Subjecthood is privileged** over linear word order during message formulation
  - **But, linear word order is not ruled out:** It competes with subjecthood
- **But, Linear Word Order or Information Focus?**
  - *wh*-words are **informationally focused** elements
  - **Possible Alternative Account:** *Information focus* drove competitive looks to object *wh*-phrase in English questions.

Fig2: Eye-Movements After Message Formulation



Do speakers generally behave like we expect them to?

- **After** window of interest, fixation patterns reflect linear word order, as expected
- Tight gaze-to-speech coordination: Speakers look to the to-be-mentioned image before naming it
  - **Decl:** Subj planned before speech onset
  - **Ques:** Obj planned before speech onset

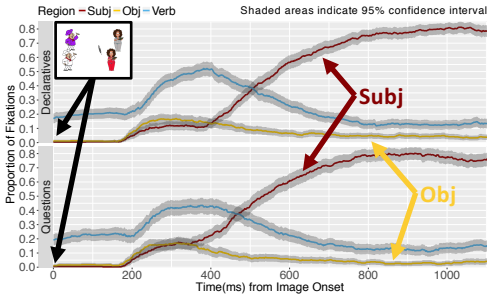
6. Exp 2: Mandarin. Linear Word Order vs Information Focus

- **Research Questions:**
  (1) To what extent did information focus drive competitive looks to the object in Exp 1 (English)?
  (2) Is planning different for overt vs covert dependencies?
- **Mandarin Chinese (Subject-Verb-Object)**
  - Wh-questions and declaratives have the **same linear word order**

    Declarative:
    护士们 枪毙了 厨师。
    The nurses shot the chefs.

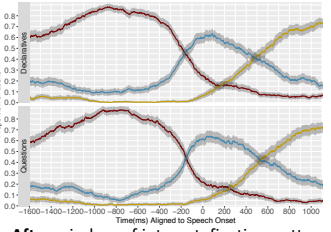
    Object Wh-Question:
    护士们 枪毙了 哪个厨师?
    The nurses shot which chefs?
  - Eye-movements differences **cannot** be due to surface word order
- **Native Mandarin speakers (n=35)**
- Exp 2 conducted in Mandarin; items differed to account for lexical differences

Fig3: Eye-Movements Immediately After Image Onset



- Speakers look to **verb** first to determine Subj/Obj characters
- Decl and ques do not differ 200-1000ms after image onset
  - **Subj-Obj difference scores** do not differ (|z|s < 1.4)
- **Key Pattern:** Speakers **fixate subject in both** decl & ques; **do not consider object** in either

Fig4: Eye-Movements After Message Formulation



Do speakers generally behave like we expect them to?

- **After** window of interest, fixation patterns reflect linear word order, as expected
- Tight gaze-to-speech coordination: Speakers look to the to-be-mentioned image before naming it
  - **Decl & Ques show same pattern:** Subj planned before speech onset

7. Discussion & Conclusion

- **First look at real-time production of questions**
- **Planning is structurally incremental**
- **Speakers start with syntactic roles** even when it conflicts with linear word order
- **No evidence covert dependencies formulated in the same way** as overt dependencies
- **No evidence information focus affects eye-movements** during message formulation; Exp 1 results not confounded by focus
  - **In line with prior work** showing late emergence of discourse-pragmatic effects in production[8]

Message Formulation is Multi-Factorial

Subjecthood is privileged → **Subject**

Some other factors can still play a role → **Agent**, **Linear word order**

But not all in the same way → **Information focus?**

REFERENCES: **[1]** Levelt, 1989; Bock and Levelt, 1994 **[2]** Gleitman et al., 2007; Brown-Schmidt & Konopka, 2008 **[3]** Griffin & Bock, 2000 **[4]** Kuchinsky, 2011; Konopka ,2012 **[5]** Griffin & Bock, 2000 **[6]** Myachykov et al., 2011 **[7]** Norcliffe et al., 2015; Sauppe et al., 2013 **[8]** Ganuschak et al., 2014, 2017
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