Quantifiers in Object Position
Evidence from Sentence Processing

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Thanks!

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- Andrea Gottstein
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- Natasha Lewis
- Jason Varvoutis
- The students in LGCS121: Psycholinguistics (Spring 2005)
A fundamental fact about quantifiers is that they do not refer. How do we combine quantifiers with expressions whose conceptual core is that of an n-place relation between individuals?

1. Mary laughed. \( L(m) \)
2. Everybody laughed. \( \forall x[L(x)]; \ *L(\forall x) \)
3. Mary hates John. \( H(j)(m) \)
4. Mary hates every boy. \( \forall x[B(x) \rightarrow H(x)(m)] \)
Quantifiers and Compositionality

What accounts for the (surface-) distributional uniformity of quantificational and referential DPs (in languages like English)?

- Is the Computational System (CS) sensitive to the *semantic* fact that quantifiers don’t refer?
- If so, what are the mechanisms employed by CS to integrate quantifiers into a larger structure?
Quantifiers versus Referring Expressions

Do quantifiers have different combinatorial properties than referring expressions?

- Quantifiers are 2\textsuperscript{nd} order predicates, proper names and definite descriptions are not (e.g. Heim & Kratzer 1998)

1. $\llbracket \text{every student} \rrbracket = \lambda X \in D_{et}. \ X \subseteq \{x: \text{x is a student}\}$ \hspace{1cm} \text{type } \langle et, t \rangle
2. $\llbracket \text{Mary} \rrbracket = m$ \hspace{1cm} \text{type } e
3. $\llbracket \text{the student} \rrbracket = \iota x: x \text{ is a student}$ \hspace{1cm} \text{type } e

- All DPs are arity-reducing functions, type $\langle e_{n+1}t, e_nt \rangle$ (n = 0, 1, ...)
  - ex.: $\langle et, t \rangle$, $\langle eet, et \rangle$, $\langle eeet, eet \rangle$, ... (Keenan’05)
- All DPs are syntactically type e (Kempson et al ’01)
Motivation
Local Ambiguity Resolution with Quantifiers
Processing Antecedent Contained Ellipsis
Processing Quantifiers in Intensional Environments
Appendix

Quantifiers in Object Position (QOb)

- Quantifiers in subject position take the VP as argument.

(1) $IP_t \quad | \quad DP_{et,t} \quad | \quad VP_{e,t} \quad | \quad NP_{e,t} \quad | \quad D_{et,ett} \quad | \quad NP_{e,t} \quad | \quad V_{e,et} \quad | \quad DP_e \quad | \quad Every \quad student \quad | \quad likes \quad | \quad Mary$ 

- Quantifiers in object position cannot combine with the verb.

(2) $IP_{???,} \quad | \quad DP_e \quad | \quad VP_{???,} \quad | \quad Mary \quad | \quad likes_{e,et} \quad | \quad every \quad student \quad | \quad DP_{et,t}$

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Quantifiers in Object Position
Semantic Solution: Type-shifting

- The type of the verb (or determiner) is shifted so that it can combine directly with a quantifier (or verb).

\[
\text{[[likes}_1\text{]]} = \lambda x : x \in D_e. \lambda y : y \in D_e. y \text{ likes } x.
\]

\[
\text{[[likes}_2\text{]]} = \lambda f : f \in D_{\langle ett \rangle}. \lambda y : y \in D_e. f(\lambda x. [\text{[[likes}_1\text{]]}(x)(y)=1)) = 1
\]
Syntactic Solution: Quantifier Raising

- The quantifier is moved by a syntactic operation to the top of the clause (like PL: $\forall x[L(x)(m)]$ not $^*L(\forall x)(m)$).

$$
(1) \quad \text{TP}_t
\quad \begin{array}{l}
\quad \text{TP}_t
\quad \begin{array}{l}
\quad \text{DP}_e
\quad \text{Mary}
\quad \text{VP}_{<e,t>}
\quad \text{talked to}
\quad \text{VP}_{<e,t>}
\quad \text{TP}_t
\quad \begin{array}{l}
\quad \text{DP}_e
\quad \text{t}_6
\quad \text{every student}
\end{array}
\end{array}
\end{array}
$$
The Rich DP Hypothesis - Keenan 2005

- DPs are arity-reducing functions, type \( \langle e_{n+1}t, e_nt \rangle \)
  
  \( (n=0,1,...) \) ex.: \( \langle et, t \rangle, \langle eet, et \rangle, \langle eeet, eet \rangle ... \) (c.f. Keenan’05)

\[
\text{Every student likes Mary}
\]

\[
\llbracket \text{every student}_1 \rrbracket = \lambda f : f \in D_{et}. \\
\quad \forall x [ (x \text{ is a student } \rightarrow f(x)=1].
\]

\[
\llbracket \text{every student}_2 \rrbracket = \lambda f : f \in D_{eet}. \lambda y : y \in D_e. \\
\quad (\lambda x. f(x)(y)=1)=1.
\]

\[
\llbracket \text{every student}_3 \rrbracket = \lambda f : f \in D_{eeet}. \lambda y : y \in D_e. \lambda z : z \in D_e. \\
\quad (\lambda x. f(x)(y)(z)=1)=1.
\]
The “Simple DP Hypothesis” - Kempson et al. 2001

All DPs (quantificational or not) are of type e. Hence, there is never a case of type mismatch when the CS combines n-place relations of individuals with a quantifier.

- The semantic difference between quantifiers and referring expressions does not affect their combinatorial properties.
- The semantic properties that distinguish quantifiers from referring DPs become only relevant post LF.

(1) \[ \text{laughed} = \lambda x \in D_e. \ x \text{ laughed} \quad \text{type } \langle e,t \rangle \]
(2) \[ \text{smiled} = \lambda x \in D_e. \ x \text{ smiled} \quad \text{type } \langle e,t \rangle \]
Three Empirical Questions

Are there compositional differences between ...

- Quantifiers in object position and quantifiers in subject positions?
- Quantifiers in object position and definite descriptions in object position?
- Quantifiers in subject position and definite description in subject position?
Plan for the remainder of the talk

Studying processing of quantifiers in real-time can contribute important data that can help sort out these questions.

- Experiment 1a shows that the semantic status of a DP is a factor in local ambiguity resolution during first pass parsing.
- Experiment 2 argues in favor of a syntactic mechanism to resolve QOb and against purely semantic accounts.
- Experiment 3 argues that “transparent” interpretations of object DPs in intensional environments (e.g. look for) are due to the object DP scoping over the intensional verb at LF.
- Appendix I: Experiment 4 shows that indefinite objects can be interpreted in situ even in extensional contexts.
- Appendix II: Experiments 1b,c support the interpretation of the data observed in Experiment 1a.
The basic idea

- If quantifiers in object position aren’t directly interpretable but quantifiers in subject position are and ...
- if this difference is visible to the parser we expect that
- Subject QPs are easier to process than object QPs.
QPs can be a factor in local ambiguity resolution.

Example: NP/S Ambiguity

(1) The judge believed every witness ...
   a. ...was at the scene of the crime.
   b. ...who was at the scene of the crime.

A direct comparison of (1)a and b won’t be informative!
NP/S-Ambiguity with Quantifiers.

- **2x2 Design: "Determiner by Attachment"**

  (1) The judge believed the witness ...  
    a. ...was at the scene of the crime.  
    b. ...who was at the scene of the crime.  

  (2) The judge believed every witness ...  
    a. ...was at the scene of the crime.  
    b. ...who was at the scene of the crime.  

- **We expect an interaction between Determiner type and Attachment type: Object QPs should be relatively harder.**
Self-Paced Reading

John

John...talked...Martin Hackl

Quantifiers in Object Position
Self-Paced Reading

---talked---
Self-Paced Reading

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The basic Idea
Methods and Materials
Results
Conclusion

John--------------------------------
-----talked-------------------------

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Quantifiers in Object Postion
Self-Paced Reading

---

every

---

John

didn't talk

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Quantifiers in Object Position
John--------------------------------------

---boy------------------------------------

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Quantifiers in Object Position
Self-Paced Reading

\[ \text{---did.} \]
Self-Paced Reading

- Measures RT as intervals between button presses
- We analyze residual RTs for each word
- Length of rRT is a measurement of processing difficulty for each position (longer rRTs = more processing difficulty)
To get a handle on possible interference from verb preferences (cf. Trueswell et al.’93, etc.) we ran two versions of the experiment:

- Experiment 1a: S-biased verbs
- Experiment 1b: NP-biased verbs

**Methods**

- 20 undergraduates from Claremont Colleges, native speakers of English.
- Single word, self-paced, moving window reading paradigm.
- 32 target items (8 in each cell), 92 filler items.
- Each sentence was followed by a comprehension question.
Experiment 1a: S-bias

Materials

- 4 versions of target sentences were constructed as exemplified below.
- S-biased verbs were chosen from Trueswell et al.'93 (verb bias was checked against Brown and Wall Street Journal Corpus of Penn Tree Bank).

(1) The nun claimed the child ...
   a. ...who was abused and malnourished.
   b. ...was abused and malnourished.

(2) The nun claimed every child ...
   a. ...who was abused and malnourished.
   b. ...was abused and malnourished.
Residual reading times were calculated from sentences whose follow-up question was answered correctly.

RRTs were trimmed by 3 stdv across subjects.

Repeated Measures ANOVA on mean RRTs (word by word and across regions).
Residual Reading Times: S-Bias

Sentential Bias

Res.RTs

The/Was
The/Who
Every/Was
Every/Who

the nun claimed the/every child who/was word1 word2 word3

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Residual Reading Times: S-Bias

Sentential Bias

Res.RTs

The/Was
The/Who
Every/Was
Every/Who

the nun claimed the/every child who/was word1 word2 word3

*.036
Residual Reading Times: S-Bias

Sentential Bias

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Residual Reading Times: S-Bias

Sentential Bias

- Res.RTs
- The/Was
- The/Who
- Every/Was
- Every/Who

The diagram illustrates the sentential bias with various quantifiers in different object positions. The x-axis represents different words: 'the', 'nun', 'claimed', 'the/every', 'child', 'who/was', 'word1', 'word2', 'word3'. The y-axis shows the residual reading times, with values ranging from -50 to 30. The shading indicates a significant result at p < .043.
Residual Reading Times: S-Bias

Sentential Bias

<table>
<thead>
<tr>
<th>Res.RTs</th>
<th>the</th>
<th>nun</th>
<th>claimed</th>
<th>the/every</th>
<th>child</th>
<th>who/was</th>
<th>word1</th>
<th>word2</th>
<th>word3</th>
</tr>
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<tbody>
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<td>Every/Was</td>
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</tbody>
</table>

*.022
Residual Reading Times: S-Bias

Sentential Bias

Res.RTs

-50 -40 -30 -20 -10 0 10 20 30

the    nun    claimed    the/every    child    who/was    word1    word2    word3

The/Was
The/Who
Every/Was
Every/Who

*.01

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Quantifiers in Object Position
Findings of Experiment 1

- Main effect of Determiner Type one word after the determiner.
- Interaction as early as one word after POD.
- Interaction stable over region from POD through three following words.
Conclusions from QOb experiments

- The parser distinguishes definite descriptions from quantifiers in object position.
- Quantifier-hood is a factor in local (first pass) ambiguity resolution.
- These observations are inconsistent with uniform analyses of DPs.
- What is the mechanism by which quantifiers in object position are integrated into the larger structure?
Antecedent Contained Ellipsis (ACE):

(1) John read every book Mary did (___).

(2) John \(\text{read every book Mary did} (___).\)

- An elided constituent can never be identical to its antecedent if the antecedent properly contains the elided constituent!
QR undoes Antecedent Containment

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Antecedent Contained Ellipsis
Experimental Design
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QR undoes Antecedent Containment

Antecedent VP

Op Mary did

Elided VP

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Quantifiers in Object Position
ACE as V-Ellipsis

ACE is a case of V-ellipsis (e.g. Jacobson’94)

(1) John read every book Mary did (____).

(2) John (read) every book Mary did (____).

There is no paradox since the ellided constituent is never a subconstituent of the antecedent!
Advantages of On-Line Data

Real time sentence processing is sensitive to linear order. The parser encounters the *QOb* trigger for QR before it encounters the *ACE* trigger for QR.

(3) Mary talked to every student Sue did.

- Jacobson: QOb und ACE are independent.  
  \[\implies\text{Complexity is additive!}\]

- QR-based: QR to resolve QOb anticipates QR to resolve ACE.  
  \[\implies\text{Complexity is not additive!}\]
Experimental Design

2 Factors: Determiner by Gap Size

The secretary was trained to manage...

(A) the/every program that the intelligent young professional designed

(B) the/every program that the intelligent young professional did

(C) the/every program that the intelligent young professional was

...during her four years at college.
Ellipsis size and Locality of QR

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Quantifiers in Object Position
Expected results (non-QR vs. QR)

Semantic (NonQR) Analysis: If the mechanisms to resolve QOb and ACE are different, we would expect two main effects:

Ellipsis size - different gap sizes cause linear(?) increase
Expected results (non-QR vs. QR)

Syntactic (QR) Analysis: If QOb and ACE are dealt with in the same manner we predict an interaction between the two variables such that QR will only need to occur once in sentences that have both QOb and (low) ACE.
Methods and Materials

- 48 undergraduates from Claremont Colleges, native speakers of English.
- Single word, self-paced, moving window reading paradigm.
- 60 target items (10 in each cell), 120 filler items.
- Each sentence was followed by a comprehension question.
Residual reading times were calculated from sentences whose follow-up question was answered correctly.

rRTs were trimmed by 2 standard deviations.

Repeated Measures ANOVA on mean rRTs (word by word and across regions).
Residual Reading Times: ACE

Mean Residual Reading Times (48 participants)
Residual Reading Times: ACE

Mean Residual Reading Times (48 participants)

RRTs (ms)

-80 -60 -40 -20 0 20 40 60 80 100 120

DET program that the intelligent young professional Ved during her four years at

The/Was The/Did The/Verb Every/Was Every/Did Every/Verb
Residual Reading Times: ACE

Mean Residual Reading Times (48 participants)

- The/Was
- The/Did
- The/Verb
- Every/Was
- Every/Did
- Every/Verb

RRTs (ms)

DET | program | that | the | intelligent | young | professional | Ved | during | her | four | years | at

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Effects in the areas of interest:

- Main effect of Determiner on two words after determiner.
- Interaction Det. by GapSize on 2nd word after the gap.
Residual reading times two words after gap

Mean Residual Reading Times
Two Words After the Embedded Verb

- The
- Every

Ellipsis Size

Verbs

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Quantifiers in Object Position
Conclusions

- Uniform analyses cannot explain our processing evidence.
- QOb and ACE are resolved using the same mechanism, quantifier raising (QR).
- QR is local.
Are there “In situ Quantifiers”?

The results of Experiment 2 suggest that we can use the ease with which a down-stream ACE site is processed as indicator for in situ interpretations of DPs.

- If a DP hosting a ACE site stays in situ, we expected increased difficulty for processing the ellipsis site.
- If a DP hosting a ACE site is QR-ed, we expect no additional processing cost for ellipsis site.

- Strong vs. weak QPs
- Intensional transitive verbs
- Wide-scope indefinites
Intensional transitive verbs like **look for** give rise to opaque readings for some types of quantifiers.

1. Mary found a cat.  \( \exists x [C(x) \land F(x)(m)] \)
2. Mary was looking for a cat.  \( \exists x [C(x) \land L(x)(m)] \)
3. Mary was looking for a dragon.  \( \exists x [D(x) \land L(x)(m)] \)
4. Mary was looking for a unicorn.  \( \exists x [U(x) \land L(x)(m)] \)
5. Mary was looking for every unic.  \( \forall x [U(x) \rightarrow L(x)(m)] \)
6. Mary was looking for the unicorn.  \( \exists ! x [U(x) \land L(x)(m)] \)
The classical Quine-Montague analysis of **look for** exploits the fact that it can be faithfully paraphrased as **try to find**.

(1) Mary was looking for a screw driver.
(2) Mary was trying to find a screw driver.

(3) $\llbracket \text{seek} \rrbracket^w.g = \lambda Q \in D_{set, st}. \lambda x. x \text{ tries for}_{w'} Q_{w'}(\lambda w''. \lambda y. x \text{ finds } y \text{ in } w'')(w')$
Opaque and Transparent Readings via Scope

The Quine-Montague analysis explains the transparent/opaque ambiguity in terms of scope.

- If the object is in the scope of *try* we get the opaque reading.
- If the object scopes higher than *try* the transparent reading.

\[(4) \quad [\text{Mary is looking for a screw driver}]^{w,g} = 1 \iff m \text{ tries for } w' \text{ in } w \text{ that } \exists x [\text{screw driver}(x) \text{ in } w' \text{ and } m \text{ finds } x \text{ in } w']\]

\[(5) \quad [\text{Mary is looking for a screw driver}]^{w,g} = 1 \iff \exists x [\text{screw driver}(x) \text{ in } w \text{ and } m \text{ tries for } w' \text{ that } m \text{ finds } x \text{ in } w']\]
If we assume that world evaluation parameters are realized in the object language as silent world pronouns that can stay unbound (e.g. Percus 2001), we can represent the transparent reading of an object quantifier in situ.

(6) \[ \mathcal{M} \textit{Mary is looking for D screw driver}^w.g = 1 \text{ iff } \]
    \[ m \text{ tries for } w' \text{ in } w \text{ that } D(\text{screw driver in } w')(\lambda y. m \text{ finds } y \text{ in } w') \]

(7) \[ \mathcal{M} \textit{Mary is looking for D screw driver}^w.g = 1 \text{ iff } \]
    \[ m \text{ tries for } w' \text{ in } w \text{ that } D(\text{screw driver in } w)(\lambda y. m \text{ finds } y \text{ in } w') \]
Looking for an Interaction

We can distinguish QR-based approaches to transparent readings under intensional transitive verbs from in situ approaches in terms of their predictions for down-stream ACE resolution.

(1) Mary was looking for a screw driver John was.

- A QR based account of opacity predicts an interaction between the opacity of the object DP and ACE.
- An in situ approach predicts a main effect of ellipsis.
Experimental Design

2 Factors: Determiner by Ellipsis

Mary: Who was looking for what? John: The producer was looking for...

a. an/the/every actress that the director was
b. an/the/every actress that the director wanted

...before finalizing the casting list.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>every</th>
<th>a</th>
<th>the</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb</td>
<td>3</td>
<td>1</td>
<td>3 / 1</td>
</tr>
<tr>
<td>ACD</td>
<td>3</td>
<td>5</td>
<td>3 / 5</td>
</tr>
</tbody>
</table>
30 undergraduates from Claremont Colleges, native speakers of English.

Single word, self-paced, moving window reading paradigm.

60 target items (10 in each cell), 120 filler items.

Each sentence was followed by a comprehension question.
Residual reading times were calculated from sentences whose follow-up question was answered correctly.

rRTs were trimmed by 2 standard deviations.

Repeated Measures ANOVA on mean rRTs (word by word and across regions).
Residual Reading Times: Intensional Verbs

Intensional ACD: n = 30

RRT (ms)

-60 -40 -20 0 20

photographer was seeking DET instructor that the aspiring art student Ell/Ved in order to learn how to

p = .021

every/was
an/was
the/was
every/Ved
an/Ved
the/Ved

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Quantifiers in Object Position
Effects in the areas of interest:

- Interaction Determiner by Ellipsis on 2nd word after the gap, $F(2,28) = 4.526; p = .021$
- Interaction driven by det*ell for every/the and an/the // ($F(1,29) = 4.805; p = .037$, $F(1,29) = 9.224; p = .005$)
Conclusions

- ’Every’ and ’the’ seem to undergo QR in intensional contexts; ’a’ does not
- Definite determiners can behave like quantifiers in certain environments
- Transparent readings for DPs and ACE are resolved using the same mechanism, quantifier raising (QR).
Conclusions from Experiments 1 - 3

- The parser’s sensitivity to the semantic status of DPs is conditioned by the syntactic environment.
- Quantificational host DPs anticipate ACE resolution downstream.
- “Transparent DPs” (whether they are inherently quantificational or not) anticipate ACE resolution downstream.
- The grammar needs to provide a mechanism (such as QR), which tightly links ...
  - Qob and ACE
  - transparent interpretations of object DPs and ACE
Thank You!
Indefinites and Existential Closure

- Indefinites are existential quantifiers (type et,t) and create the same problem as other quantifiers do when they appear in internal argument positions.
  - $\Rightarrow$ Indefinites behave like *every NP*
  - $\Rightarrow$ Facilitation of ACE processing downstream.

- Indefinites are predicates and stay insitu. There is an independent Existential Closure operator contributes the quantificational meaning. (e.g Heim 1982)
  - $\Rightarrow$ Indefinites behave like definites;
  - $\Rightarrow$ No facilitation of ACE processing downstream.
(1) The producer was talking to...

a. an/the/every actress that the photographer was looking for
b. an/the/every actress that the p. was looking for

...after the scene was completed.

Table 1

<table>
<thead>
<tr>
<th>Extensional</th>
<th>every</th>
<th>a</th>
<th>the</th>
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</thead>
<tbody>
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<td>3</td>
<td>3 / 1</td>
<td>1</td>
</tr>
<tr>
<td>ACD</td>
<td>3</td>
<td>3 / 5</td>
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</table>
Pilot data: Extensional Verbs (n=24)
Follow-up Experiments to Experiment 1a

Additional experiments showing that the parser is sensitive to the semantic status of a DP

- Quantifiers in Object Postion: NP-biased verbs
- Quantifiers in Subject Position
Experiment 1b: NP-bias

Materials

- Sentence frames as in Experiment 1a.
- NP-biased verbs were chosen from Trueswell et al.'93 (verb bias was checked against Brown and Wall Street Journal Corpus of Penn Tree Bank).

(1) The nun remembered the child ...
   a. ...who was abused and malnourished.
   b. ...was abused and malnourished.

(2) The nun remembered every child ...
   a. ...who was abused and malnourished.
   b. ...was abused and malnourished.
Residual Reading Times: NP-Bias

![Graph showing the residual reading times for various quantifiers in object position. The x-axis represents different words or phrases, and the y-axis represents the residual reading times. The graph compares the reading times for 'The/Was', 'The/Who', 'Every/Was', and 'Every/Who'.]
Residual Reading Times: NP-Bias

DO Bias

<table>
<thead>
<tr>
<th>Res. RTS</th>
<th>the</th>
<th>nun</th>
<th>remembered</th>
<th>the/every</th>
<th>child</th>
<th>who/was</th>
<th>worc1</th>
<th>word2</th>
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<tbody>
<tr>
<td>The/Was</td>
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<td>Every/Was</td>
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*0.005
Summary of Results: Experiment 1b

Findings of Experiment 1b

- Difference on word after the determiner approaches significance.
- Significant Interaction in region including POD and the following word.
Experiment 1c: Quantifiers in Subject Position

- Sentence frames as in Experiment 1a.
- S-biased verbs were followed by *that* to ensure that he following DP is construed as subject of the embedded clause.

(1) The nun claimed that the child ...  
   a. ...who was abused and malnourished ...  
   b. ...was abused and malnourished ...

(2) The nun claimed that every child ...  
   a. ...who was abused and malnourished ...  
   b. ...was abused and malnourished...
Residual RTs: Quantifiers in Subject Position (n=20)

<table>
<thead>
<tr>
<th></th>
<th>QSubject Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>the/was</td>
<td>7.188513424</td>
</tr>
<tr>
<td>the/who</td>
<td>3.074882471</td>
</tr>
<tr>
<td>every/was</td>
<td>-0.642915148</td>
</tr>
<tr>
<td>every/who</td>
<td>-10.51118896</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>was</th>
<th>-13.98520408</th>
<th>10.81661518</th>
<th>-12.45696037</th>
<th>-0.626319386</th>
<th>-11.47592475</th>
</tr>
</thead>
<tbody>
<tr>
<td>abused</td>
<td>9.950358662</td>
<td>8.343004989</td>
<td>5.378435139</td>
<td>-10.11338048</td>
<td>-15.38788695</td>
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<tr>
<td>and</td>
<td>1.650660359</td>
<td>0.827914121</td>
<td>-4.877519825</td>
<td>-12.17037997</td>
<td>-16.08488261</td>
</tr>
<tr>
<td>malnourished</td>
<td>-22.36989831</td>
<td>-23.38204092</td>
<td>-11.47651039</td>
<td>-20.4514209</td>
<td></td>
</tr>
</tbody>
</table>
Summary of Results: Experiment 1c

Findings of Experiment 3

- No significant difference across all conditions
- Every/who is not, on its own, more complex, and so could not explain results of Experiment 1 and 2
Percus, O. 2001."Constraints on some other variables in syntax". NALS 8:173 - 229.