

# On the locus of strong exhaustivity in *wh*-questions and how it is derived

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# Introduction

- ▶ Agreement that *wh*-questions have a strongly exhaustive reading
- ▶ Disagreement about where and how strong exhaustivity comes about when it is observed
- ▶ The loci/ways of exhaustive strengthening assumed in the literature:

Sue knows  $[\gamma$  ANS  $_{-}$   $[\beta$  who<sub>1</sub>  $[\text{Q}$   $_{-}$   $[\alpha$   $t_1$  left]]]]

                  ↑          ↑  ↑          ↑

                  ④          ③  ②          ①

- ▶ Today: novel empirical observations only ① can explain

## Superlative modified degree questions

*An automatic radar on a highway detects all the cars that move at 100 kph or more at a certain location. For any car, it records its owner, which is sent electronically to Sue, who sits in an office. So Sue knows that certain cars (identified by their owners) are speeding, but never knows their speed apart that it's at least 100 kph. She was notified that Tom's car was speeding. This car was in fact moving at exactly 100 kph.*

Sue weiß, wie schnell sich Toms Auto bewegt hat.



'Sue knows how fast Tom's car was moving.'

Spector (2018): Degree questions are **always strongly exhaustive**.

Sue weiß, wie schnell sich Toms Auto mindestens bewegt hat.



'Sue knows for which  $d$  Tom's car was moving at least  $d$ -fast.'

⇒ **Superlative modified** degree questions have a **weaker reading**.

## Superlative degree questions lack the strong reading

Sue weiß, wie schnell sich Toms Auto mindestens bewegt hat  
Tom's car was moving at exactly 100 kph

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Sue knows that Tom's car was moving at exactly 100 kph **X**

⇒ Superlative degree questions are **never strongly exhaustive**  
(except when modalized, as we'll see).

## Non-interrogative counterparts

*An automatic radar on a highway detects all the cars that move at 100 kph or more at a certain location. For any car, it records its owner, which is sent electronically to Sue, who sits in an office. So Sue knows that certain cars (identified by their owners) are speeding, but never knows their speed apart that it's at least 100 kph. She was notified that Tom's car was speeding. This car was in fact moving at exactly 100 kph.*

Same context

Same contrast with embedded declaratives:

Sue knows that Tom's car was moving at 100 kph. (X)

Sue knows that Tom's car was moving at at least 100 kph. ✓

## Structural hypothesis for superlative degree questions

Apart from *wh*-movement, (1) has the same structure as (2).

(1) wie schnell sich Toms Auto mindestens bewegt hat

(2) Tom's car was moving at at least 100 kph

That is, *mindestens* in degree questions is a degree modifier.

Thus, (1) has the following structure (1<sup>st</sup> draft):

(3) how<sub>1</sub> [Q [T's car was [at least t<sub>1</sub>-fast]]]

2<sup>nd</sup> and final draft:

(4) how<sub>1</sub> [Q [exh<sub>A</sub> [T's car was [at least t<sub>1</sub>-fast]]]]

↑  
①

## Exhaustification at site ① (Nicolae 2013)

The first part of my argument:

- ▶ If exhaustification applies (only) at site ①, strong exhaustivity of *wh*-questions is just a special case of exhaustive strengthening of sentence meanings in general.
- ⇒ If a declarative resists exhaustification, its interrogative counterpart is predicted to lack the strong reading.
- ▶ Thus, the fact in (5) allows to infer the corresponding fact observed about superlative degree questions.

(5) Tom's car was moving at at least 100 kph.

✗ Tom's car was moving at exactly 100 kph

The second part is that exhaustification in the way of ②, ④, or ③ derives unavailable strong readings.

## Symmetric alternative prevent scalar inferences

The fact that **at least 100** resists exhaustification follows if:

- ▶ it has symmetric alternatives (Büring 2008, Kennedy 2013, Mayr 2013, Schwarz 2016)
- ▶ exh respects innocent excludability (Fox 2007).

(6)  $\text{how}_1 [\text{Q} [\text{exh}_A [\text{T's car was } [\text{at least } t_1\text{-fast}]]]]$

How do symmetric alternatives arise? – By access to ‘two scales’:

1.  $t_1$  can be replaced with any other syntactic variable.
2. **at least** can be replaced with **exactly**.

Yields:

$$A = \{ [\text{T's car was at least } t_n\text{-fast}]^g : n \in \mathbb{N} \} \\ \cup \{ [\text{T's car was exactly } t_n\text{-fast}]^g : n \in \mathbb{N} \}$$

where the range of  $g$  is  $\mathbb{Q}^+$ :

$$A = \{ [\lambda w. \text{T's car was at least } d\text{-fast in } w] : d \in \mathbb{Q}^+ \} \\ \cup \{ [\lambda w. \text{T's car was exactly } d\text{-fast in } w] : d \in \mathbb{Q}^+ \}$$



## Exhaustification at site ①, cont'ed

- ▶ Every possible answer has symmetric alternatives in  $A$ .
- ▶ Consider w.l.o.g.  $[\lambda w. T\text{'s car was at least 100-fast in } w]$ :
  - ▶  $[\lambda w. T\text{'s car was exactly 100-fast in } w]$
  - ▶  $\bigvee\{[\lambda w. T\text{'s car was at least } d\text{-fast in } w] : d > 100\}$   
 $\equiv [\lambda w. T\text{'s car was more than 100-fast in } w]$
- ▶ This means that exhaustification of  $\alpha$  is vacuous:

$$\begin{aligned} & \llbracket \text{exh}_A [\alpha \text{ T's car was [at least } t_1\text{-fast]}] \rrbracket^g \\ &= \llbracket \alpha \rrbracket^g \\ &= [\lambda w. T\text{'s car was at least } g(1)\text{-fast in } w] \end{aligned}$$

- ▶ Thus, we correctly derive that superlative degree questions don't have a strong reading. ✓

## Prediction: modalized SDQs have distributive readings

The declarative in (7) has a strong (distributive) reading:

(7) Sue must take at least 2 classes.

↷ ◇ Sue takes exactly 2 classes

↷ ◇ Sue takes more than 2 classes

(The stronger alternatives are innocently excludable.)

Prediction: the question counterpart in (8) has this reading, too.

(8)  $\text{how}_1 [\text{Q} [\text{exh}_A [\text{Sue } \underline{\text{must}} \text{ take } [\underline{\text{at least}} \ t_1\text{-many classes}]]]]]$

It seems to me that this prediction is borne out:

Sue weiß, wieviele Kurse sie mindestens belegen muss

Sue is forbidden to take just one class

Sue is free to take any other number of classes

---

Sue knows that she's allowed to take exactly 2 classes

Sue knows that she's allowed to take more than 2 classes



## Exh in the way of ②, ④ (G&S 1982, Heim 1994)

- ▶ Exhaustification by way of partitioning the set of worlds
- ▶ Defined on the basis of the semantic objects in (9)/(10):

(9)  $[\lambda w \lambda d. T\text{'s car moved at least } d\text{-fast in } w]$

(10)  $\{[\lambda w. T\text{'s car moved at least } d\text{-fast in } w] : d \in \mathbb{Q}^+\}$

- ▶ Specifically, defined by the equivalence relation in (11):

(11)  $w \sim w'$  iff  $\forall d : T\text{'s car moved } \underline{\text{at least}} \text{ } d\text{-fast in } w$   
 $\leftrightarrow T\text{'s car moved } \underline{\text{at least}} \text{ } d\text{-fast in } w'$ .

- ▶ However, (11) defines the same relation as (12):

(12)  $w \sim w'$  iff  $\forall d : T\text{'s car moved } \underline{\text{exactly}} \text{ } d\text{-fast in } w$   
 $\leftrightarrow T\text{'s car moved } \underline{\text{exactly}} \text{ } d\text{-fast in } w'$ .

- ▶ Thus, ② and ④ make the wrong prediction that superlative degree questions have a strongly exhaustive reading. ✗

## Exh in the way of ③ (Klinedinst & Rothschild 2011)

- ▶ Alternatives of exhaustification are defined in semantic terms:
  - ▶ Questions map every  $w$  to the weakly exhaustive answer in  $w$ .
  - ▶ Stronger questions map every  $w$  to a stronger (or equally strong) non-exhaustive answer.
- ▶ Exhaustification relative to these stronger questions is performed pointwise for each  $w$ .
- ▶ Exhaustification of a superlative degree question SDQ relative to the set of stronger questions  $\llbracket \text{SDQ} \rrbracket_{F^+}$  yields the strongly exhaustive reading: ✗

$$\begin{aligned} [\lambda w. \text{T's car was at least 100-fast in } w] &= \llbracket \text{SDQ} \rrbracket(w'), \text{ for some } w' \\ \forall d > 100 : [\lambda w. \text{T's car was at least } d\text{-fast in } w] \\ &= Q(w'), \text{ for some } Q \in \llbracket \text{SDQ} \rrbracket_{F^+} \end{aligned}$$

## Exh in the way of ③, cont'ed

- ▶ Can symmetric alternatives be introduced to  $\llbracket Q \rrbracket_F$ ?
- ▶ Semantically, only by recursive exhaustification, i.e., by also considering mappings to exhaustive answers:

$$(13) \quad \begin{aligned} \llbracket Q \rrbracket_F &= \llbracket Q \rrbracket_{F_w} \cup \llbracket Q \rrbracket_{F_s} \\ \llbracket Q \rrbracket_{F_w} &= \{Q' : \forall w \exists w'. Q'(w) = \llbracket Q \rrbracket(w')\} \\ \llbracket Q \rrbracket_{F_s} &= \{Q' : \forall w \exists w'. Q'(w) = \text{exh}(\llbracket Q \rrbracket_{F_w})(\llbracket Q \rrbracket(w'))\} \end{aligned}$$

- ▶ Then, we correctly derive no strong meaning for superlative degree questions. ✓
- ▶ However, we lose the ability to exhaustify any question: ✗

### Who (among Sue and Ann) left?

$$[\lambda w. \text{Sue left in } w] = \llbracket \text{Who left?} \rrbracket(w'), \text{ for some } w'$$

$$[\lambda w. \text{Sue left in } w \wedge \text{Ann left in } w] = Q(w'), Q \in \llbracket \text{Who left?} \rrbracket_{F_w}$$

$$[\lambda w. \text{Sue left in } w \wedge \neg \text{Ann left in } w] = Q'(w'), Q' \in \llbracket \text{Who left?} \rrbracket_{F_s}$$

## Intermediate conclusion

- ▶ ① ✓
  - ▶ ② ④ ③ ✗
  - ▶ ③ can be rescued by exhaustification relative to formal alternatives (③ ✓). Proof omitted.
- ⇒ Strong exhaustivity of *wh*-questions must be derived by reference to formal alternatives.
- ▶ Exhaustification at site ① (of the question nucleus) leads to the most uniform theory of strong sentence meanings.

## SDQs have weakly exhaustive readings

Sue weiß, wie schnell sich Toms Auto mindestens bewegt hat  
Tom's car was moving at exactly 100 kpm

---

Sue knows that Tom's car was moving at at least 100 kpm ✓

⇒ Superlative degree questions have a **weakly exhaustive reading**.

## SDQs have non-exhaustive readings

*An automatic radar on a highway detects all the cars that move at 100 kph or more at a certain location. For any car, it records its owner, which is sent electronically to Sue, who sits in an office. So Sue knows that certain cars (identified by their owners) are speeding, but never knows their speed apart that it's at least 100 kph. She was notified that Tom's car was speeding. This car was in fact moving at exactly 150 kph.*

Sue weiß, wie schnell sich Toms Auto mindestens bewegt hat. ✓

'Sue knows for which  $d$  Tom's car was moving at least  $d$ -fast.'

⇒ Superlative modified degree questions have a reading that is weaker than the weakly exhaustive reading.

- ▶ What reading is this? – A **non-exhaustive reading**.
  - ▶ By contextual entailment, Sue knows that Tom's car was moving at at least 100 kph.
  - ▶ The contextual entailment validates the non-exhaustive reading.



## The distribution of modifiers in degree questions

SDQs can be used as direct questions:

- (14) *Wie schnell hat sich Toms Auto mindestens bewegt?*  
'For which  $d$ : Tom's car moved at least  $d$ -fast?'

They can be formed with *höchstens* 'at most':

- (15) *Wie schnell hat sich Toms Auto höchstens bewegt?*  
'For which  $d$ : Tom's car moved at most  $d$ -fast?'

Degree questions allow the modifier *genau* 'exactly':

- (16) *Wie schnell hat sich Toms Auto exactly bewegt?*  
'For which  $d$ : Tom's car moved genau  $d$ -fast?'

... but disallow comparative modifiers:

- (17) \**Wie schnell hat sich Toms Auto mehr als bewegt?*  
*intended*: 'For which  $d$ : Tom's car moved more than  $d$ -fast?'

## The distribution of modifiers in degree questions, cont'ed

Thus, the distribution of modifiers in degree questions mirrors their distribution in declarative split constructions.

- (18) 100 km/h schnell hat sich Toms Auto mindestens bewegt.  
'Tom's car moved at at least 100 kph.'
- (19) 100 km/h schnell hat sich Toms Auto höchstens bewegt.  
'Tom's car moved at at most 100 kph.'
- (20) ?100 km/h schnell hat sich Toms Auto genau bewegt.  
'Tom's car moved at exactly 100 kph.'
- (21) \*100 km/h schnell hat sich Toms Auto mehr als bewegt.  
*intended*: 'Tom's car moved at more than 100 kph.'

## Cross linguistic distribution

- ▶ There's no direct counterpart of German SDQs in English:

(22) \*Sue knows how fast Tom's car was moving at least.

... but there are close counterparts:

(23) Sue knows how fast Tom's car was moving at a minimum.

(24) Sue knows the minimum speed of Tom's car.

- ▶ I speculate that the difference between English and German is syntactic in nature: splits are ungrammatical in English.
- ▶ Taiwanese Mandarin also has SDQs (I-An Tan):

(25) Su zhidao Yuehan you zhi-shao ji-ge haizi.  
Sue know John have at least how many-CL child  
'Sue knows for which *d* John has *d*-many children.'

(26) Su zhidao Yuehan you zhi-shao liang-ge haizi  
Sue know John have at least two-CL child  
'Sue knows that John has at least 2 children.'

# Conclusion

- ▶ There are questions without strongly exhaustive reading.
- ▶ The existence of these questions follows if *wh*-questions are strengthened in the same way as declaratives, and in no other way.
- ▶ Conclusions towards the locus of exhaustification are not fully determined by these questions.
- ▶ Exhaustification of the question nucleus seems to be a natural option.

## Further observations, cont'ed

- ▶ NPIs can only occur in questions that support a strongly exhaustive reading (Guerzoni&Sharvit 2007):

(27) Ich weiß, wie oft du jemals in China warst.

(28) ??Ich bin überrascht, wie oft du jemals in China warst.  
(Complements of *surprise* don't have a strongly exhaustive reading; Heim 1994)

- ▶ The prediction that NPIs aren't licensed in superlative degree questions is borne out:

(29) Wie oft warst du mindestens in China?

'For which  $d$ : you have been in China at least  $d$ -many times?  
(no strongly exhaustive reading as before)

- (30) a. \*Wie oft warst du jemals mindestens in China?  
b. \*Wie oft warst du mindestens jemals in China?