German relative clauses: The missing-VP effect in double and triple embeddings

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Overview

1. The missing-VP effect
   - Definition
   - Previous studies
2. The missing-VP effect in German relative clauses
   - Current Experiments
   - Self-paced reading
   - Eye-tracking

The missing-VP effect

a) The patient who the nurse who the clinic had hired met Jack.

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b) [The patient [who the nurse [who the clinic had hired] **admitted**] met Jack.]

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- Complex ungrammatical sentences perceived as grammatical

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→ **Grammaticality illusion in SVO languages**

- in double embeddings in English and French
  - when middle verb missing

(Gibson & Thomas, 1999; Gimenes, 2009)

Previous research: SVO languages

Working memory based explanation:

- memory load too high $\rightarrow$ V2 prediction forgotten
  (as associated with greatest memory cost)

(Gibson & Thomas, 1999)

Multiple embeddings in German

Double centre-embeddings in German:

[M Der Junge, [C-1 den das Haus,[C-2 welches abgerissen wurde], verängstigt hatte], lächelte.]

'The boy that the house that was demolished frightened smiled.'

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'The boy that the house that was demolished frightened smiled.'

Multiple centre-embeddings in German:

[M Der Ritter von Malzahn, [C-1 dem der Junker sich als einen Fremden, [C-2 der bei seiner Durchreise den seltsamen Mann, [C-3 den er mit sich führe,] in Augenschein zu nehmen wünschte,] vorstellte,] nötigte ihn ...]

'The rider from Malzahn to whom the Junker had introduced himself as a stranger who during his journey wanted to have a look at the strange man whom he would bring with him urged him . . . '

(H. von Kleist, Michael Kohlhaas; Schneider 1959: 469)

Previous research: SOV languages

Several SPR and ET experiments:

- **English**: grammaticality illusion
  $\Rightarrow$ in line with working memory based "forgetting" account

  (Gibson & Thomas, 1999)

- **German**: no grammaticality illusion
  $\Rightarrow$ slowdown in ungrammatical sentences in SPR and ET experiments

  (Vasishth et al., 2010;
  Frank et al., 2015 for Dutch;
  cf. Häussler & Bader for German, 2015)

Previous research: SOV languages

- **German**: Slowdown in ungrammatical (middle verb missing) sentences ($\neq$ English)

  Why?

- German parser adapted to complex structures
  $\Rightarrow$ prediction of verb "preserved" more easily than in English

(Vasishth et al., 2010)

Hypothesis

SOV languages:

- Higher frequency of memory-straining structures
  $\rightarrow$ parser "trained" to more efficiently use WM resources for these structures
  $\Rightarrow$ *no grammaticality illusion detected in German*

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- Idea: Increase of WM load $\Rightarrow$ grammaticality illusion also in German (SOV)

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- Idea: Increase of WM load $\Rightarrow$ grammaticality illusion also in German (SOV)
- add third embedding to German ORCs
  - Grammaticality illusion in triple embeddings
    $\Rightarrow$ in support of working memory "forgetting" account

Current experiment: Method & Design

Method Self-paced reading and eye-tracking

SPR Exp. 1 (N=40): comprehension questions
Exp. 2 (N=40): grammaticality judgements

ET Exp. 3 (N=40): comprehension questions
Exp. 4 (N=40): grammaticality judgements

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Design 2 x 2 fully-crossed factorial design

Factor 1: Number of embeddings (two vs. three)
Factor 2: Grammaticality (V2 present vs. V2 missing)

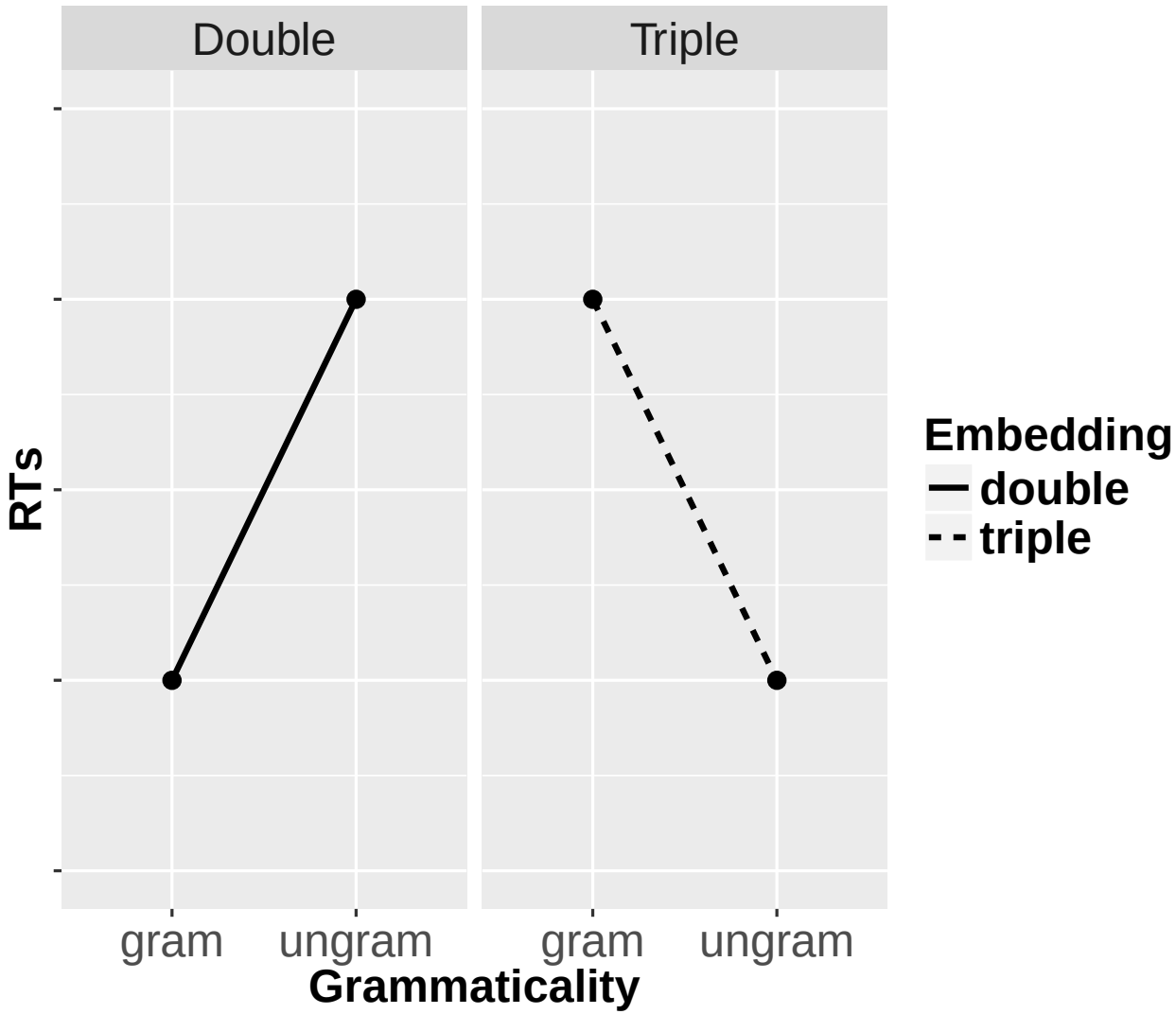
Experimental items, N=48

NP1	NP2	NP3	NP4	V4	V3	V2	V1	NP5 ...
a) two embeddings, grammatical								
Der Hase,	den der Fuchs,	den der Hund			jagte,	biss,	**erreichte**	**das Versteck**
The rabbit	*that the fox*	*that the dog*			*chased, bit,*		*reached*	*the den*
b) two embeddings, ungrammatical								
Der Hase,	den der Fuchs,	den der Hund			jagte,	~~biss~~,	**erreichte**	**das Versteck**
The rabbit	*that the fox*	*that the dog*			*chased,*	~~*bit*~~,	*reached*	*the den*
c) three embeddings, grammatical								
Der Hase,	den der Fuchs,	den der Hund,	den der Jäger	sah,	jagte,	biss,	**erreichte**	**das Versteck**
The rabbit	*that the fox*	*that the dog*	*that the hunter*	*saw,*	*chased, bit,*		*reached*	*the den*
d) three embeddings, ungrammatical								
Der Hase,	den der Fuchs,	den der Hund,	den der Jäger	sah,	jagte,	~~biss~~,	**erreichte**	**das Versteck**
The rabbit	*that the fox*	*that the dog*	*that the hunter*	*saw,*	*chased,*	~~*bit*~~,	*reached*	*the den*

V1=critical, **NP5**= postcritical

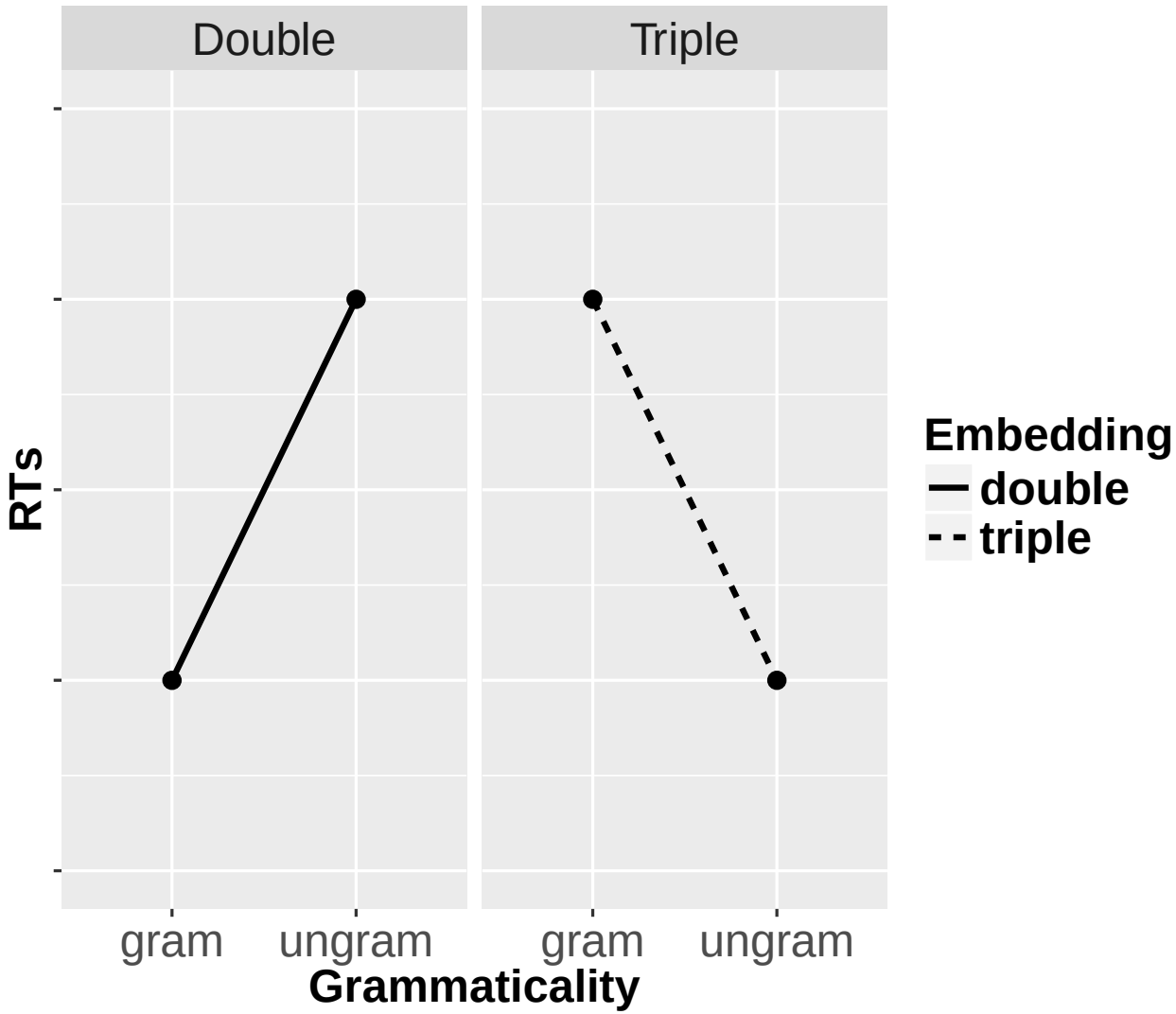
Predictions: Double embeddings

No grammaticality illusion (replication of Vasishth et al.,2010) $\rightarrow$ *Ungrammatical sentences (V2 missing)* read slower than *grammatical sentences (V2 present)* at **V1 (critical)**



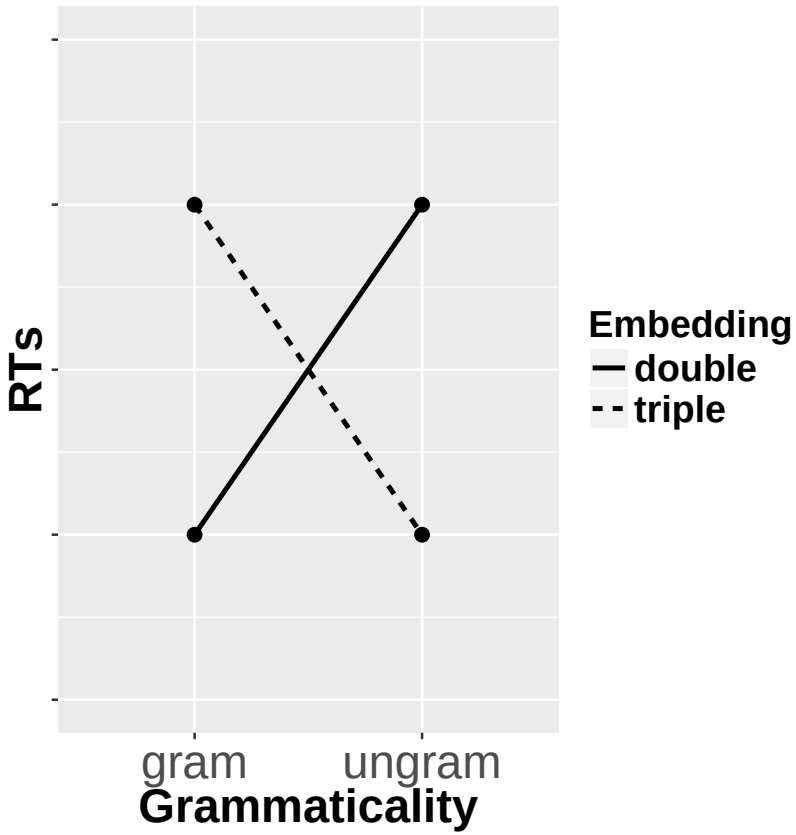
Predictions: Triple embeddings

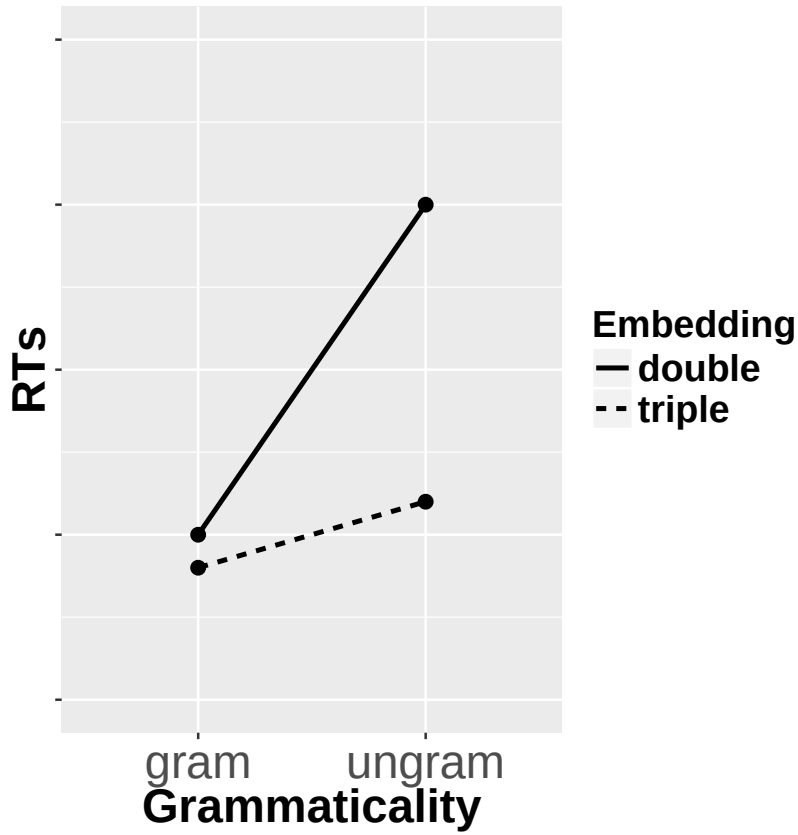
Grammaticality illusion due to memory overload → *Ungrammatical sentences* read faster than *grammatical sentences* at **V1 (critical)**



Predictions: Interaction between *number of embeddings* and *grammaticality*

Grammaticality illusion →
Speed-up for ungrammatical sent. in triple embeddings (= English double emb.) or at least *smaller slowdown than in double embeddings at V1*





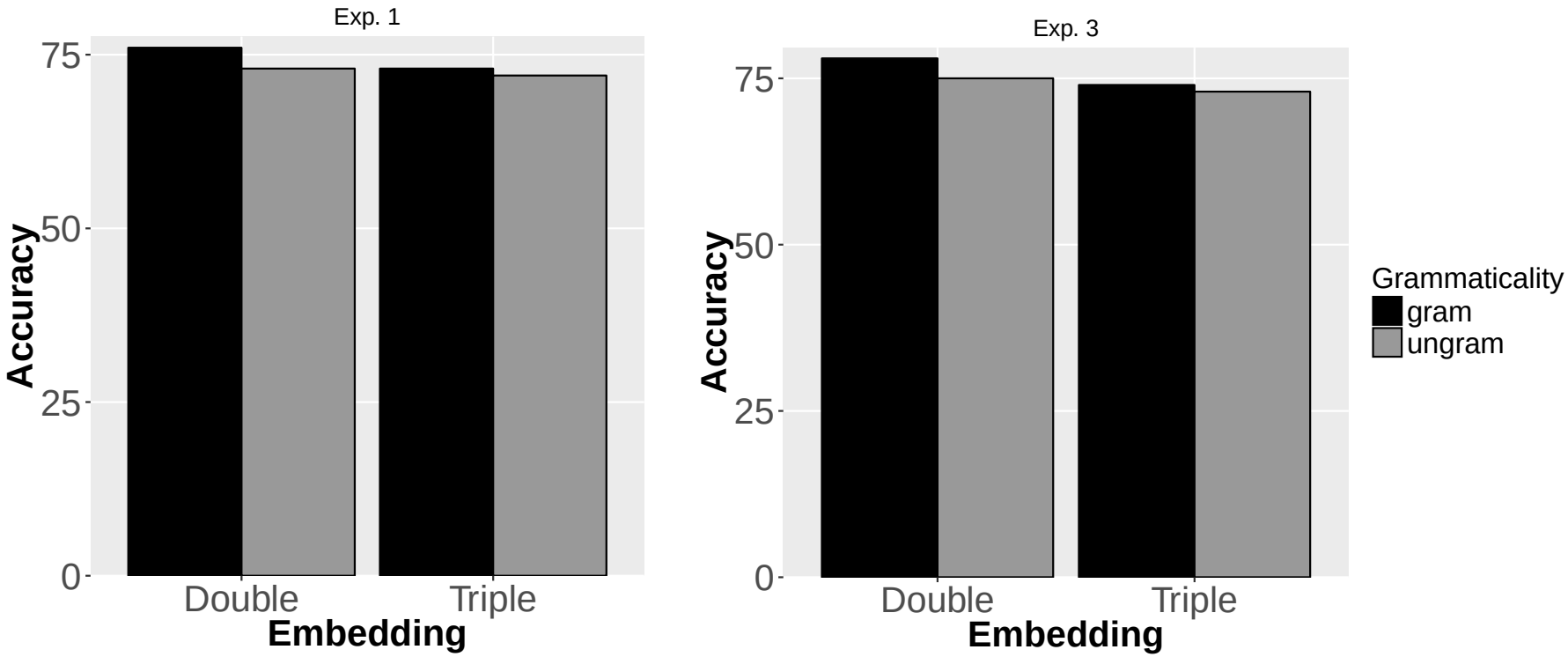
Predictions: Grammaticality judgements

Double embeddings:
Grammatical sentences judged correctly
Ungrammaticality detected

Triple embeddings:
Grammatical sentences misjudged as ungrammatical more frequently
Ungrammaticality remains undetected more frequently

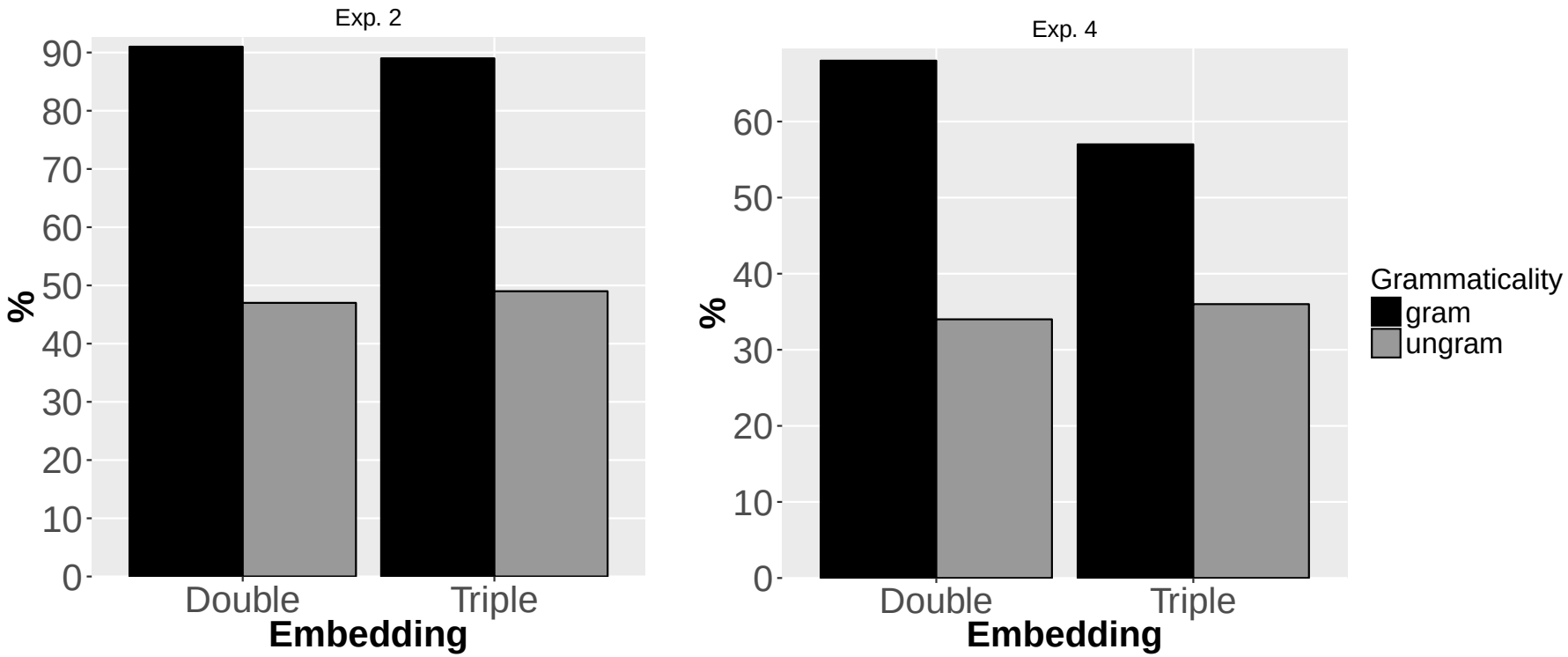
Results: Comprehension questions

Response accuracy, Exp. 1 (SPR) and Exp. 3 (ET)

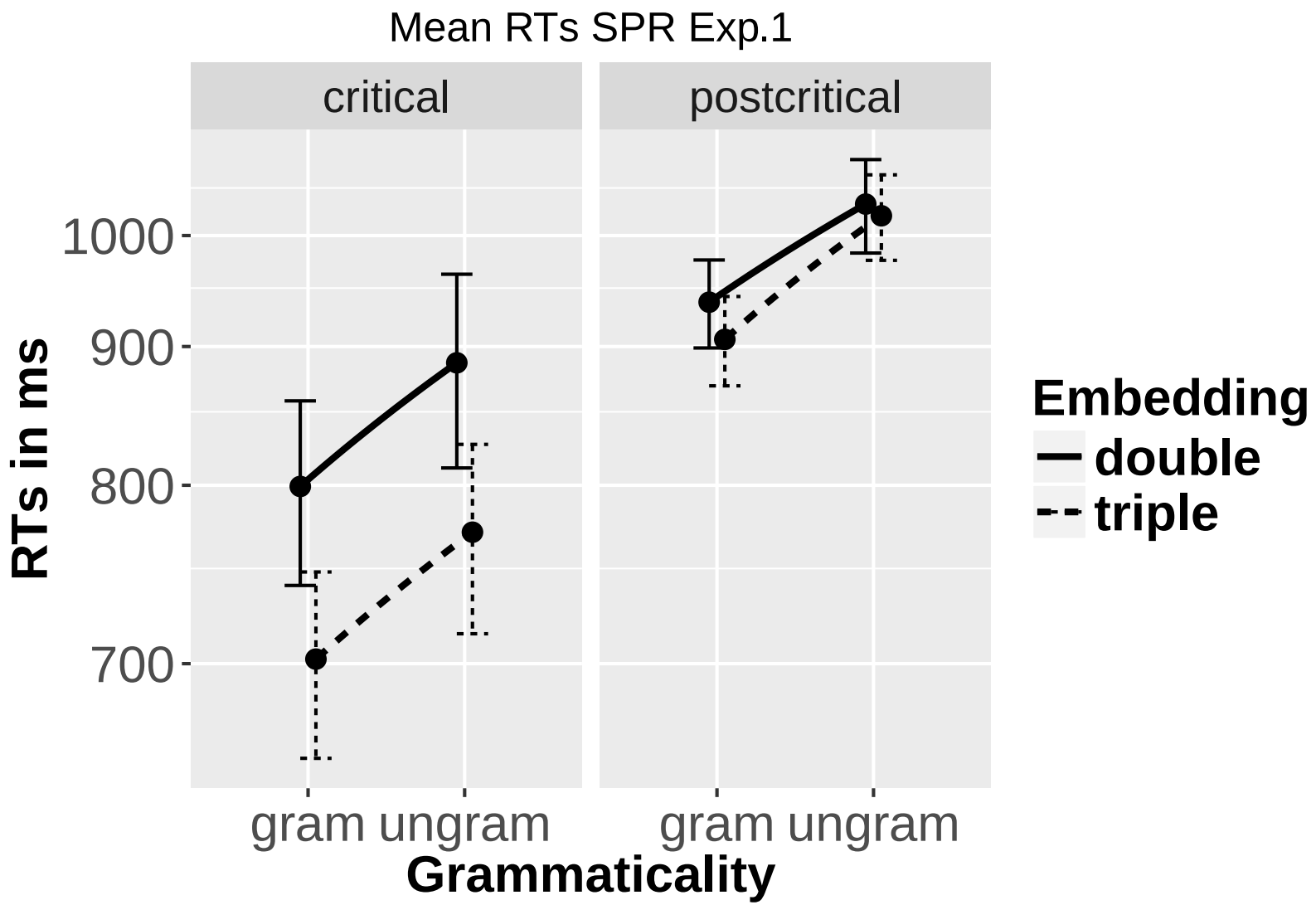


Results: Grammaticality judgements

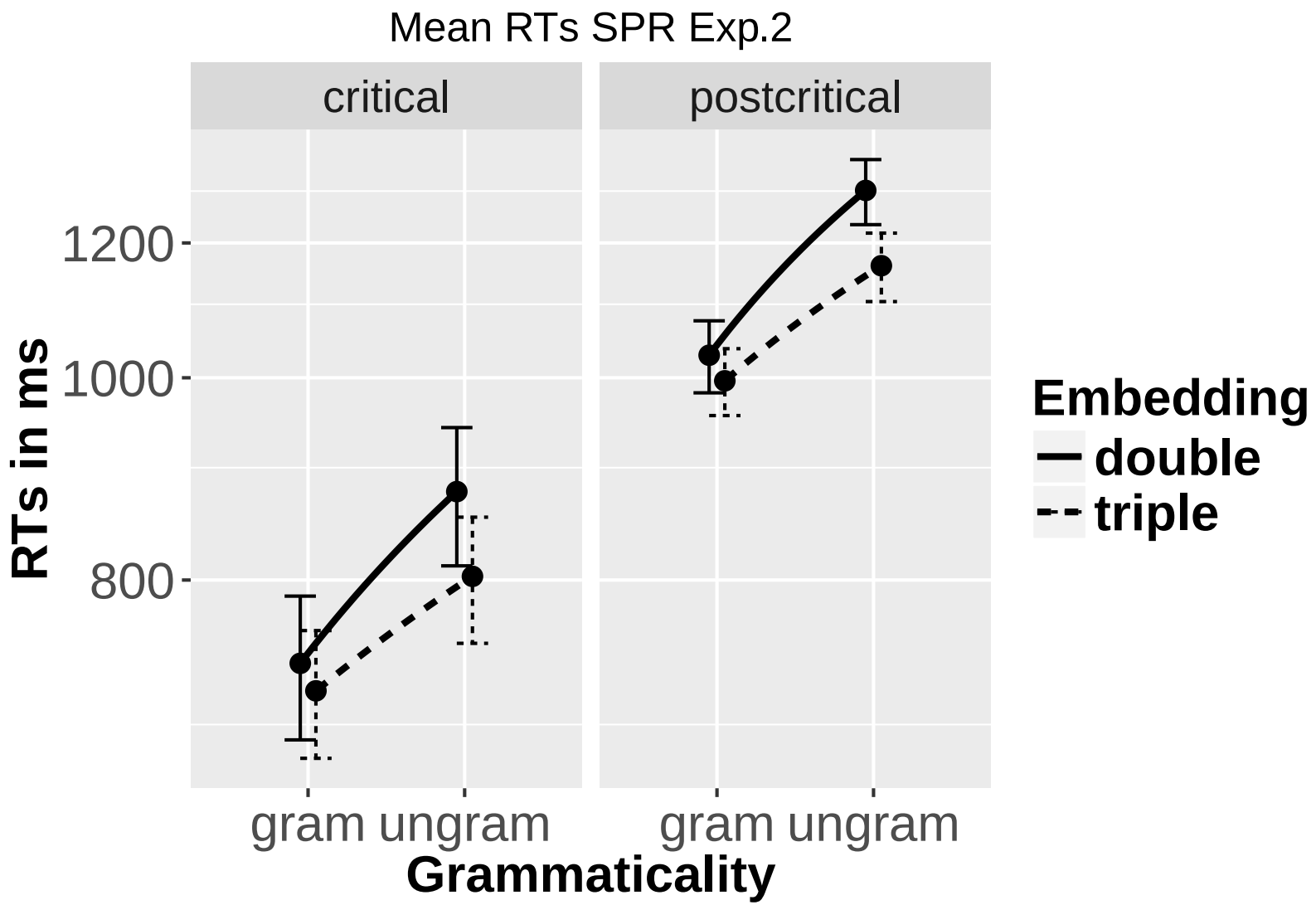
Proportions of trials judged as 'grammatical', Exp. 2 (SPR) and Exp. 4 (ET)



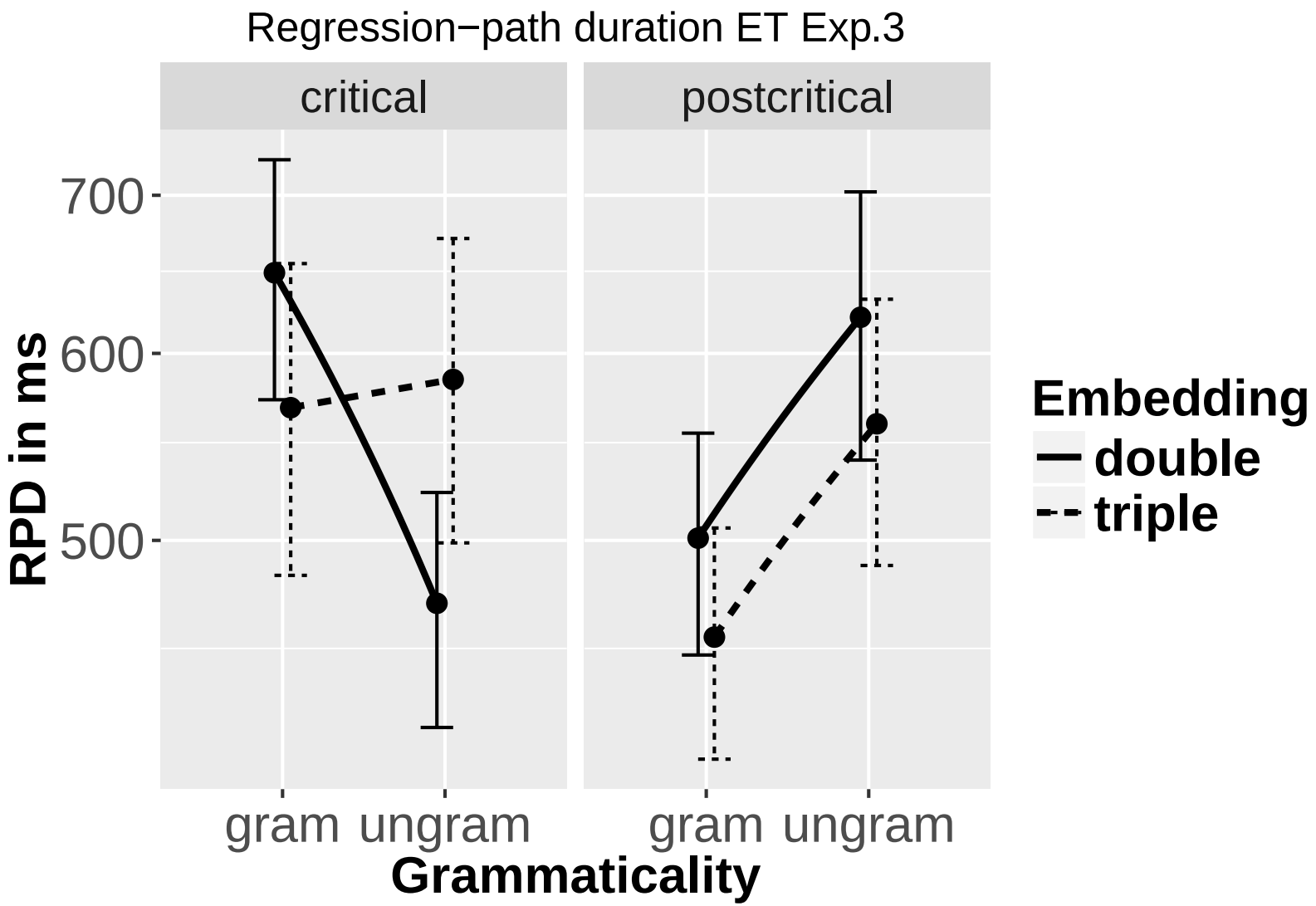
SPR Results


Mean RTs SPR Exp.1
critical
postcritical
1000
900
800
700
RTs in ms
gram ungram
gram ungram
Grammaticality
Embedding
double
triple

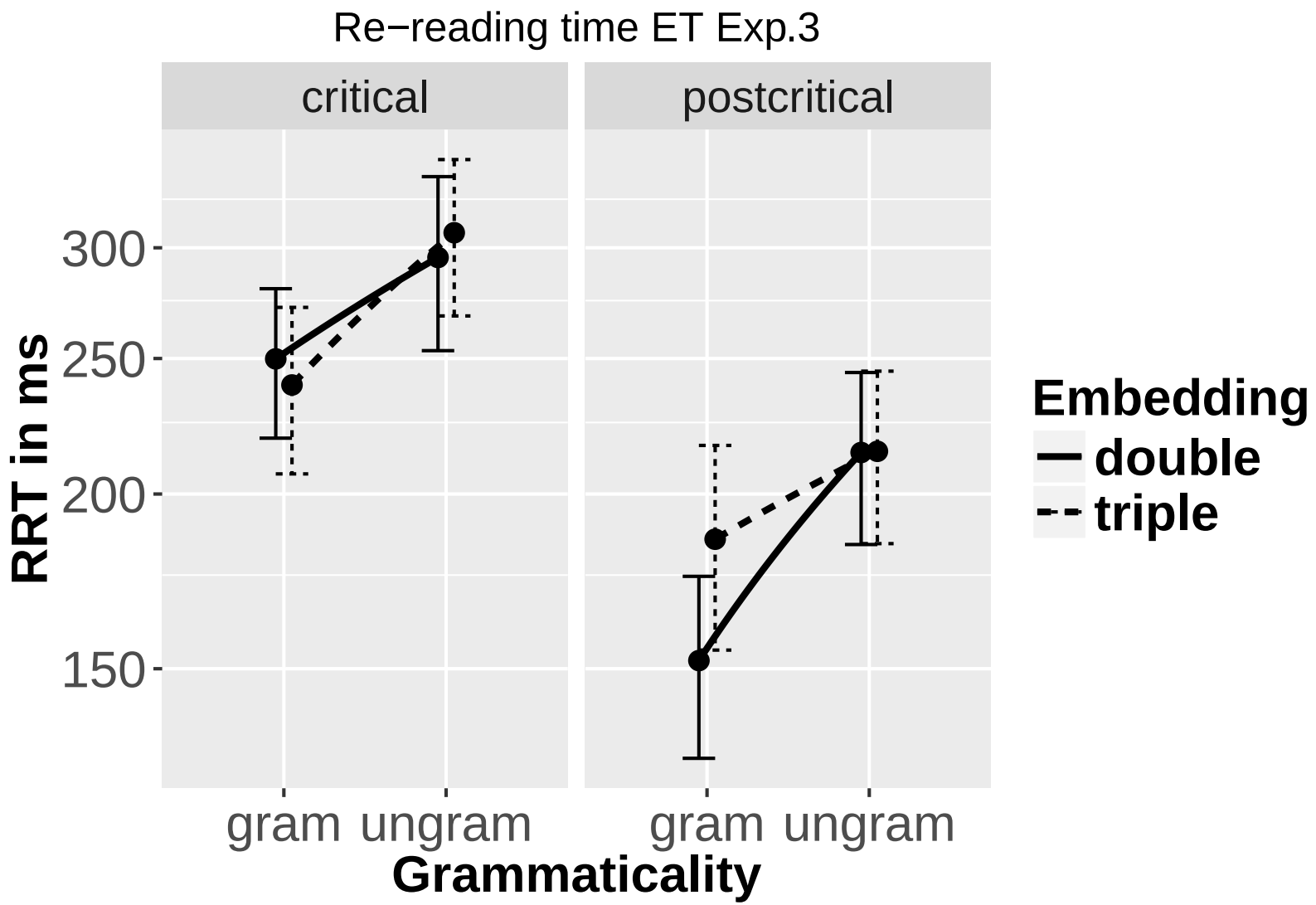
SPR Results


Mean RTs SPR Exp.2
critical
postcritical
1200
1000
800
RTs in ms
gram ungram
gram ungram
Grammaticality
Embedding
double
triple

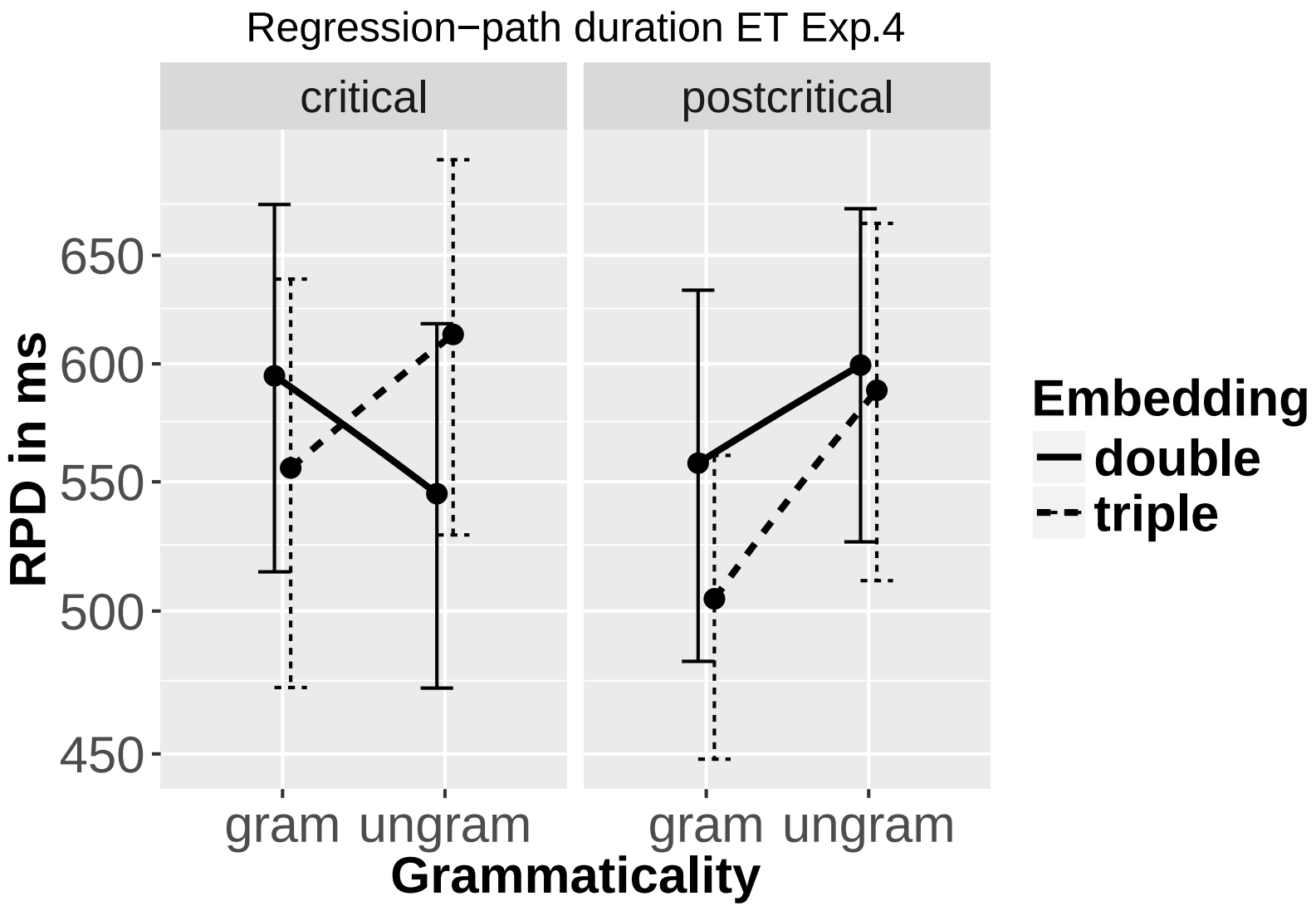
ET Results


Regression−path duration ET Exp.3
critical
postcritical
700
600
500
RPD in ms
gram
ungram
gram
ungram
Grammaticality
Embedding
double
triple

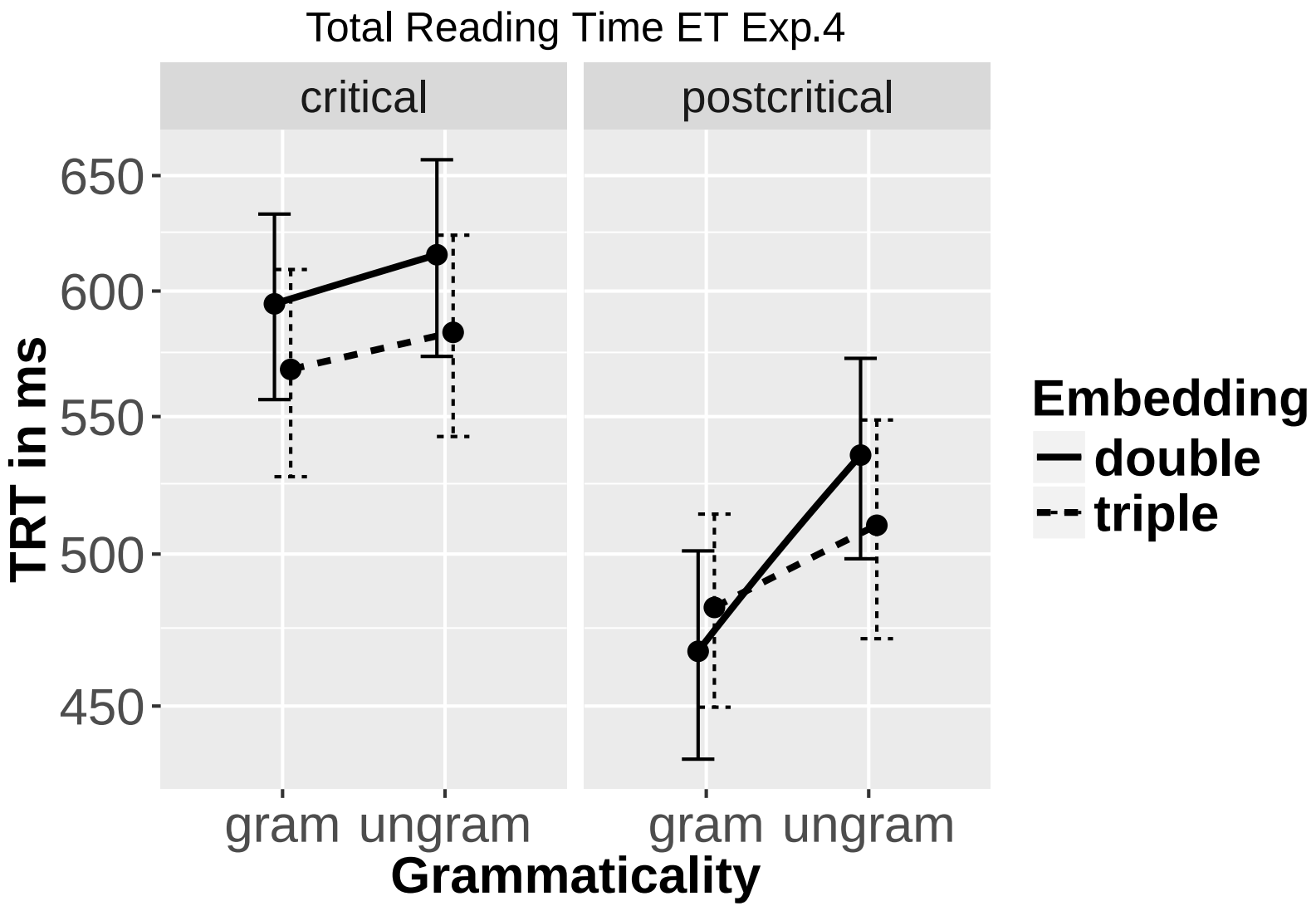
ET Results


Re−reading time ET Exp.3
critical
postcritical
RRT in ms
300
250
200
150
gram
ungram
gram
ungram
Grammaticality
Embedding
double
triple

ET Results


Regression−path duration ET Exp.4
critical
postcritical
650
600
550
500
450
RPD in ms
gram
ungram
gram
ungram
Grammaticality
Embedding
double
triple

ET Results


Total Reading Time ET Exp.4
critical
postcritical
650
600
550
500
450
TRT in ms
gram
ungram
gram
ungram
Grammaticality
Embedding
double
triple

Discussion

Summary of results

- **SPR Exp.1 and 2**:
  Slowdown in ungrammatical sentences at critical and postcritical region
  $\Rightarrow$ **no grammaticality illusion** ($\neq$ English)

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  Speed-up in ungrammatical sentences at critical region in early reading measures
  - independent of number of embeddings (driven by double embeddings)
  - Interaction (Exp. 3):
    higher FPRP for grammatical sentences *in double embeddings only*
    $\rightarrow$ facilitation in ungrammatical sentences

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  - Effect reversed in late reading measures and at postcritical region
    $\rightarrow$ **ungrammaticality detected**

Conclusion

Novel finding in eye-tracking:

- **momentary grammaticality illusion** (early reading, critical)

  $\rightarrow$ German data compatible with working memory "forgetting" account

  $\rightarrow$ unclear why illusion more prominent in double than triple embeddings ($\neq$ predictions)

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- **delayed detection of ungrammaticality in German** (late reading, postcritical)

  $\rightarrow$ **main difference between English and German**

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- **delayed detection of ungrammaticality in German** (late reading, postcritical)

  → **main difference between English and German**

- German parser "trained" to more efficiently use WM resources to deal with complex structures
  ⇒ **recovery from illusion**

Thank you.

References

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