Superlative-modified numerals and negation:

A multiply negotiable cost

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@ Experiments in Linguistic Meaning (ELM) 1 | U of Pennsylvania | Sep 16-18, 2020

Outline

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What does the literature say...?

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Four implicit or explicit views...

T0: No contrast

T1: Contrast not interesting: Processing cost

[1][Geurts et al., 2010, Alexandropoulou, 2018]
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DE modifiers are also costly.[3] (to appendix »)

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(16) **If** you click **at least twice**, # **the system will crash** / ✓**you will get a discount**.
(17) **If** you do**n't** click **at least twice**, ✓**the system will crash** / # **you will get a discount**.

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(22) Jo **doubts** that Jack is**n't** ✓**at least 40** years old.

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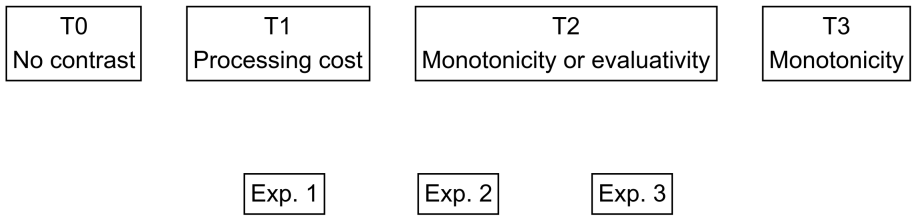
In this talk. . .

In this talk. . .


T0
No contrast
T1
Processing cost
T2
Monotonicity or evaluativity
T3
Monotonicity

In this talk. . .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Exp. 1
Exp. 2
Exp. 3

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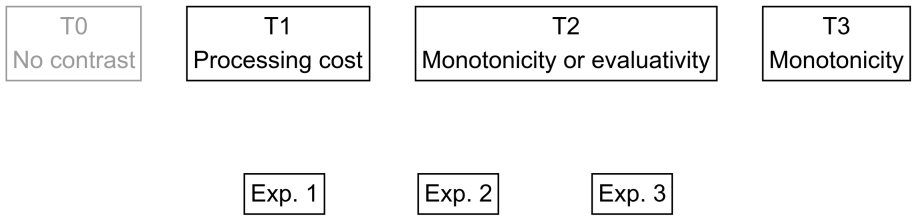
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Outline

Exp. 1: Goal

To test T0 vs. T1-3, and T1 vs. T2-3:

Is there a contrast, and is it theoretically interesting?

Exp. 1: Participants

Recruited on MTurk.
99, of which 3 excluded prior to analysis.

Exp. 1: Task

Challenges: The inherent awkwardness of the target items. Ignorance as a possible confound. Wide scope as a possible rescue mechanism. The specific nature of the badness.

In this survey you will answer questions about a group of friends playing a game. At the beginning of the game each player gets dealt a hand of seven cards. After taking a quick look at them, they must place the cards face down and try to remember their hands.[6] *Then they take turns giving clues about their hands to the other players in the form of statements describing their hands. You will see what a player remembers about his/her cards and the statement s/he makes, then you will be asked if you think the other players will understand what s/he said.*

Note: a  *or*  *a means that the player doesn't remember if a particular card in his hand was a club or a spade, or a diamond or a heart, respectively.*

[6] Adapted from [Cremers and Chemla, 2017].

Exp. 1: Sample trial

Charizard remembers:

Charizard says: I don't have at most 3 hearts.

Do you think the other players will understand what he said?

Yes.

No.

Exp. 1: Trial summary

3 x 2 x 2 x 2 = 24 trials

Env	Pol	ModType (COMP, SUP) x ModMon (UE, DE) = Mod
DECL	POS	I have Mod 3 [suit]
	NEG	I don't have Mod 3 [suit]
ANTCOND	POS	If you have Mod 3 [suit], then we have something in common
	NEG	If you don't have Mod 3 [suit], then we have something in common
RESTUNIV	POS	Everyone who has Mod 3 [suit] has something in common with me
	NEG	Everyone who doesn't have Mod 3 [suit] has something in common with me

Exp. 1: Results

(to appendix »)

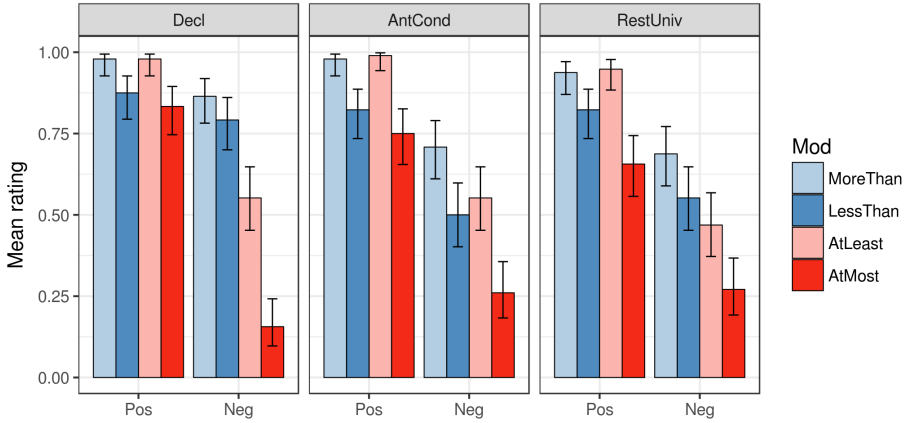


Figure: Exp 1 raw means, by Modifier. Bars = 95% binomial confidence intervals. n = 96.

(Decl) I have/don't have [Mod] 3 [suit].
(AntCond) If you have/don't have [Mod] 3 [suit], then we have something in common.
(RestUniv) Everyone who has/doesn't have [Mod] 3 [suit] has something in common with me.

Exp. 1: Discussion

MODMON-DE worse.

- Evidence for T1.

POL-NEG worse

- Evidence for T1.

SMNs in DECL-NEG significantly worse than CMNs.

- Consistent with T1-T3.

SMNs in ANTCOND/RESTUNIV-NEG still significantly worse than CMNs.

- Consistent with T1, puzzle for T2-3.

SMNs don't degrade between DECL-NEG and ANTCOND/RESTUNIV-NEG, unlike CMNs.

- Puzzle for T1, consistent with T2-3.

Outline

Exp. 2: Goal

To test an expectation from T2:

The felicity of a SMN in AntCond/RestUniv depends on predicate polarity.

Exp. 2: Participants

Recruited on MTurk.
45, of which 5 excluded prior to analysis.

Exp. 2: Task

Similar to Exp. 1, adapted to support positive/negative continuations.

In this survey you will answer questions about a group of friends playing a game. At the beginning of the game each player gets dealt a hand of seven cards. They are not allowed to see their own cards but they are allowed to take a quick look at their neighbor's hand. They try to remember their neighbor's hand as well as they can because in the next step they have to come up with a rule that would make that neighbor (and possibly other players too) lose or win. You will see what a player remembers about their neighbor's hand and the rule they make up, then you will be asked if you think the other players will understand what they said. Note, we're not asking you if it is a good rule or a bad rule, but whether it is a rule that is going to be understandable for the other players to follow.

Note: a  *or*  *a means that the player doesn't remember if a particular card in his hand was a club or a spade, or a diamond or a heart, respectively.*

Exp. 2: Sample trial

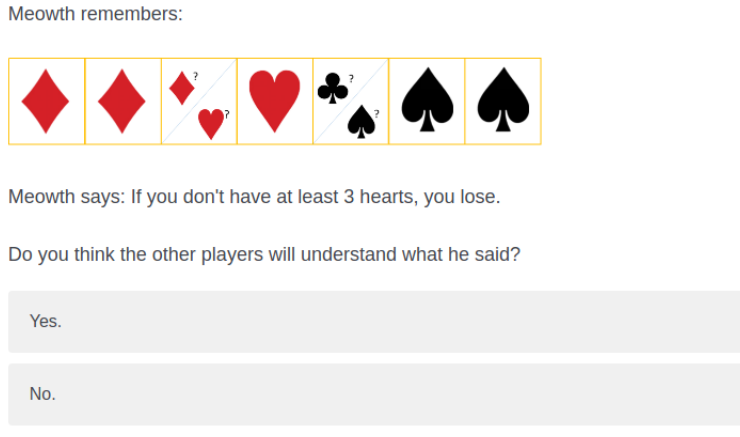


Figure: Exp. 2 example trial.

Exp. 2: Trial summary

2 x 2 x 2 x 2 x 2 = 32 trials

Env	Pol1	Pol2	ModType (COMP, SUP) x ModMon (UE, DE) = Mod
ANTCOND	POS	POS	If you have Mod 3 [suit], you win
		NEG	If you have Mod 3 [suit], you lose
	NEG	POS	If you don't have Mod 3 [suit], you win
		NEG	If you don't have Mod 3 [suit], you lose
RESTUNIV	POS	POS	Everyone who has Mod 3 [suit] wins
		NEG	Everyone who has Mod 3 [suit] loses
	NEG	POS	Everyone who doesn't have Mod 3 [suit] wins
		NEG	Everyone who doesn't have Mod 3 [suit] loses

Table: Exp. 2 trial summary.

Exp. 2: Results

(to appendix »)

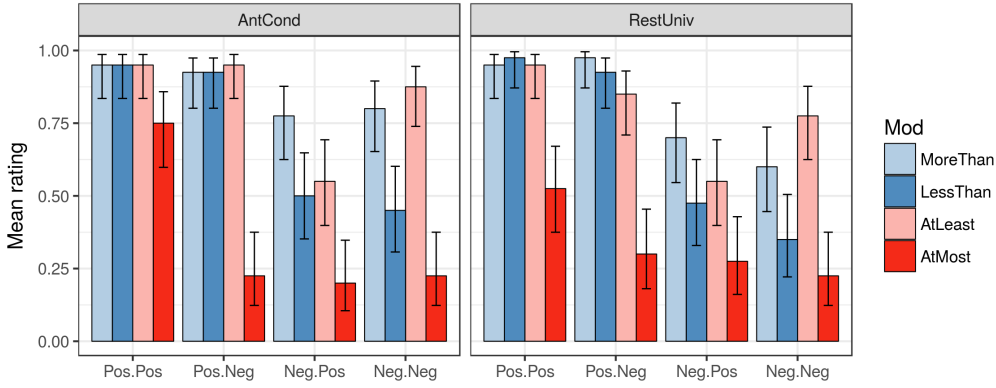


Figure: Exp 2 raw means, by Modifier. Bars = 95% binomial confidence intervals. n = 40.

(AntCond) If you have/don't have [Mod] 3 [suit], you win/lose.
(RestUniv) Everyone who has/doesn't have [Mod] 3 [suit] wins/loses.

Exp. 2: Discussion

The felicity of a SMN in AntCond/RestUniv does depend on predicate polarity.

- Puzzle for T3 (and a significant problem for T1).
- Evidence for T2.

The patterns differ dramatically between AtLeast and AtMost.

- Puzzle for T2.

Outline

Exp. 3: Goal

To test an expectation from T3:

The felicity of a SMN under POL=NEG depends on overall monotonicity, specifically, further embedding under a DE operator.

Exp. 3: Participants

Recruited on MTurk.
45.

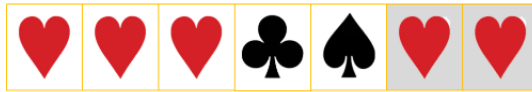
Exp. 3: Task

Similar to Exps. 1 and 2, adapted to support clausal embedding.

In this survey you will consider a commentator for a televised card-playing game, and answer questions about how understandable the commentator is.
At the beginning of the game each player gets dealt seven cards, two of which are hidden. Then in each round some rule is issued, and players can choose whether or not to bet on their own hand. A commentator, who knows what the hidden cards are for each player, discusses the player's move.
You will see a player's hand and the commentator's comment, then you will be asked if you think the viewers will understand what the commentator said.
Note: In the hands that you will see, cards with a white background such as  *represent cards that are visible to the player, while cards with a grey background such as*  *represent hidden cards, that is, cards that are not visible to the player but visible to the commentator.*

Exp. 3: Sample trial

Scyther's hand:



The commentator says: Scyther doesn't know that he doesn't have at most three hearts.

Do you think the viewers will understand what the commentator said?

Yes.

No.

Figure: Exp. 3 example trial.

Exp. 3: Trial summary

2 x 2 x 2 x 2 = 16 trials

Env	Pol	ModType (COMP, SUP) x ModMon (UE, DE) = Mod
MATRIXNEG	POS	[name] doesn't know that s/he has Mod 3 [suit]
	NEG	[name] doesn't know that s/he doesn't have Mod 3 [suit]
ANTCOND	POS	If [name] knew that s/he has Mod 3 [suit], s/he would bet differently
	NEG	If [name] knew that s/he doesn't have Mod 3 [suit], s/he would bet differently

Table: Exp. 3 trial summary.

Exp. 3: Results

(to appendix »)

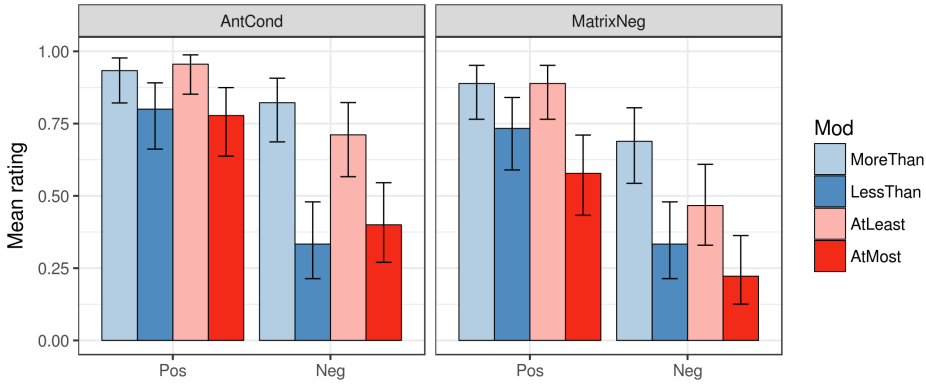


Figure: Exp 3. raw means, by Modifier. Bars = 95% binomial confidence intervals. n = 45.

(AntCond) If [name] knew that s/he has/doesn't have [Mod] 3 [suit], s/he would bet differently.
(MatrixNeg) [name] doesn't know that s/he has/doesn't have [Mod] 3 [suit].

Exp. 3: Discussion

A SMN was rated pretty highly in MATRIXNEG-POS.

- Significant problem for T2 (and T1).
- Evidence for T3.

A SMN was rated as CMNs in ANTCOND-NEG but worse slightly worse than CMNs in MATRIXNEG-NEG.

- Puzzle for T3.
  - Possibly due to T1 for SMNs?

    We didn't actually detect a net effect of MODTYPE=SMN, but maybe it is there and manifests itself as attenuation / exaggeration of effects obtained otherwise.

Outline

Conclusion: Which one of T0-T3?

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Modifier monotonicity and immediate negation both led to lower ratings.

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Still, open questions remain:

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For example, [Spector, 2015]/[Mihoc, 2020a] + [Mihoc, 2020b].

Still, open questions remain:

Why are SMNs sensitive to environment monotonicity and evaluativity?

Thank you!

Outline

Exp. 1.1

(to main »)

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	4.19	0.72	5.796	0.0000 ***
ModMonDE	-1.98	0.78	-2.536	0.0112 *
ModTypeSup	0.00	1.01	0.000	1.0000
PolNeg	-2.08	0.78	-2.677	0.0074 **
EnvAntCond	0.00	1.01	0.000	0.9999
EnvRestUniv	-1.18	0.83	-1.410	0.1585
ModMonDE:ModTypeSup	-0.37	1.10	-0.335	0.7378
ModMonDE:PolNeg	1.41	0.88	1.604	0.1088
ModTypeSup:PolNeg	-1.86	1.08	-1.723	0.0848 .
ModMonDE:EnvAntCond	-0.45	1.10	-0.409	0.6829
ModMonDE:EnvRestUniv	0.73	0.93	0.778	0.4364
ModTypeSup:EnvAntCond	0.71	1.59	0.449	0.6538
ModTypeSup:EnvRestUniv	0.20	1.19	0.169	0.8657
PolNeg:EnvAntCond	-1.08	1.08	-0.994	0.3204
PolNeg:EnvRestUniv	-0.01	0.92	-0.015	0.9877
ModMonDE:ModTypeSup:PolNeg	-1.22	1.23	-0.999	0.3176
ModMonDE:ModTypeSup:EnvAntCond	-0.83	1.69	-0.495	0.6207
ModMonDE:ModTypeSup:EnvRestUniv	-0.84	1.32	-0.637	0.5240
ModMonDE:PolNeg:EnvAntCond	-0.01	1.21	-0.005	0.9960
ModMonDE:PolNeg:EnvRestUniv	-0.83	1.07	-0.772	0.4399
ModTypeSup:PolNeg:EnvAntCond	0.36	1.66	0.219	0.8267
ModTypeSup:PolNeg:EnvRestUniv	0.60	1.29	0.464	0.6424
ModMonDE:ModTypeSup:PolNeg:EnvAntCond	2.00	1.83	1.095	0.2736
ModMonDE:ModTypeSup:PolNeg:EnvRestUniv	2.10	1.50	1.403	0.1605

Table: Model: Response ~ ModMon * ModType * Pol * Env + (1|Participant)

1.2

Env	Pol	ModType by ModMon	OR	CI	z	p
Decl	Pos	MoreThan-AtLeast	1.00	[0.09, 11.20]	-0.000	1.0000
Decl	Pos	LessThan-AtMost	1.44	[0.52, 4.03]	0.856	0.3918
Decl	Neg	MoreThan-AtLeast	6.41	[2.57, 15.98]	4.872	<.0001
Decl	Neg	LessThan-AtMost	31.49	[12.01, 82.56]	8.569	<.0001
AntCond	Pos	MoreThan-AtLeast	0.49	[0.03, 9.33]	-0.579	1.0000
AntCond	Pos	LessThan-AtMost	1.63	[0.66, 4.00]	1.304	0.3843
AntCond	Neg	MoreThan-AtLeast	2.19	[1.00, 4.76]	2.402	0.0163
AntCond	Neg	LessThan-AtMost	3.33	[1.50, 7.38]	3.618	0.0003
RestUniv	Pos	MoreThan-AtLeast	0.82	[0.18, 3.72]	-0.318	1.0000
RestUniv	Pos	LessThan-AtMost	2.73	[1.15, 6.50]	2.771	0.0168
RestUniv	Neg	MoreThan-AtLeast	2.88	[1.33, 6.23]	3.278	0.0021
RestUniv	Neg	LessThan-AtMost	4.00	[1.81, 8.84]	4.181	0.0001

Table: Exp. 1 predicted contrasts for levels of ModType, given same level of ModMon.

For the same level of monotonicity, SMNs (a) in a positive declarative are the same as CMNs; (b) in a negative declarative are much worse than CMNs; (c) in a positive antecedent/restriction are largely (except for *at most* in a restriction) the same as CMNs; and (d) in a negative antecedent/restriction are worse than CMNs, but less so than in a negative declarative.

1.3

Env	Pol	Mod	OR	CI	z	p
Decl-AntCond	Neg	MoreThan	2.93	[1.15, 7.48]	2.752	0.0118
Decl-RestUniv	Neg	MoreThan	3.28	[1.30, 8.33]	3.060	0.0066
Decl-AntCond	Neg	LessThan	4.62	[2.02, 10.55]	4.434	<.0001
Decl-RestUniv	Neg	LessThan	3.62	[1.58, 8.28]	3.728	0.0004
Decl-AntCond	Neg	AtLeast	1.00	[0.47, 2.11]	0.000	1.0000
Decl-RestUniv	Neg	AtLeast	1.48	[0.70, 3.11]	1.246	0.6382
Decl-AntCond	Neg	AtMost	0.49	[0.19, 1.23]	-1.853	0.1305
Decl-RestUniv	Neg	AtMost	0.46	[0.18, 1.16]	-2.019	0.1305

Table: Exp. 1 predicted contrasts for levels of Env, given Pol = NEG.

CMNs under negation degrade from a declarative to an antecedent/restriction, but SMNs don't.

As in Exp. 1, downward modifier monotonicity and negative polarity in the antecedent/restriction seem to negatively affect comprehensibility, although the trend for monotonicity is not always clear (in positive antecedents/restrictions *less than* was on a par with *more than*; this is possibly due to differences in the overall flow of Exp. 2 vs. Exp. 1). Matching this, regression analysis doesn't detect a significant effect of ModMon = DE, although it does detect a significant effect of Pol1 = NEG ($\beta = -1.80,\ z = -2.167,\ p = 0.0303$ *).

2.2

(to main »)

Env	Pol1	Pol2	ModType by ModMon	OR	CI	z	p
AntCond	Pos	Pos	MoreThan-AtLeast	1.00	[0.10, 10.20]	-0.000	1.0000
AntCond	Pos	Pos	LessThan-AtMost	7.08	[1.11, 45.22]	2.365	0.0180
AntCond	Pos	Neg	MoreThan-AtLeast	0.64	[0.08, 5.43]	-0.468	0.6400
AntCond	Pos	Neg	LessThan-AtMost	62.48	[12.05, 323.99]	5.631	<.0001
AntCond	Neg	Pos	MoreThan-AtLeast	3.18	[0.99, 10.23]	2.222	0.0526
AntCond	Neg	Pos	LessThan-AtMost	4.74	[1.43, 15.73]	2.904	0.0074
AntCond	Neg	Neg	MoreThan-AtLeast	0.55	[0.13, 2.31]	-0.938	0.3484
AntCond	Neg	Neg	LessThan-AtMost	3.20	[0.99, 10.34]	2.222	0.0526
RestUniv	Pos	Pos	MoreThan-AtLeast	1.00	[0.10, 10.22]	0.000	1.0000
RestUniv	Pos	Pos	LessThan-AtMost	45.15	[4.08, 500.05]	3.551	0.0008
RestUniv	Pos	Neg	MoreThan-AtLeast	7.38	[0.61, 89.96]	1.793	0.1461
RestUniv	Pos	Neg	LessThan-AtMost	40.53	[8.14, 201.71]	5.171	<.0001
RestUniv	Neg	Pos	MoreThan-AtLeast	2.07	[0.68, 6.30]	1.464	0.1431
RestUniv	Neg	Pos	LessThan-AtMost	2.67	[0.86, 8.26]	1.944	0.0518
RestUniv	Neg	Neg	MoreThan-AtLeast	0.40	[0.12, 1.28]	-1.768	0.1542
RestUniv	Neg	Neg	LessThan-AtMost	1.99	[0.60, 6.56]	1.296	0.1949

Table: Exp. 2 predicted contrasts for levels of ModType, given same level of ModMon.

For both environment types, (a) the upward-monotonic SMN (*at least*) was generally rated similarly to its CMN counterpart, while (b) the downward-monotonic SMN (*at most*) was generally rated worse, although to varying degrees, as follows: POS-NEG >> POS-POS >> NEG-POS >> NEG-NEG.

2.3

(to main »)

Env	Pol1	Pol2	Mod	OR	CI	z	p
AntCond	Pos	Pos-Neg	MoreThan	1.56	[0.18, 13.24]	0.468	1.0000
AntCond	Pos	Pos-Neg	LessThan	1.56	[0.18, 13.26]	0.468	0.6398
AntCond	Pos	Pos-Neg	AtLeast	1.00	[0.10, 10.22]	0.000	0.9999
AntCond	Pos	Pos-Neg	AtMost	13.80	[3.97, 47.99]	4.719	<.0001
AntCond	Neg	Pos-Neg	MoreThan	0.85	[0.24, 3.05]	-0.286	0.7750
AntCond	Neg	Pos-Neg	LessThan	1.26	[0.43, 3.66]	0.477	0.6332
AntCond	Neg	Pos-Neg	AtLeast	0.15	[0.04, 0.56]	-3.214	0.0026
AntCond	Neg	Pos-Neg	AtMost	0.85	[0.23, 3.08]	-0.286	1.0000
RestUniv	Pos	Pos-Neg	MoreThan	0.48	[0.03, 7.98]	-0.585	1.0000
RestUniv	Pos	Pos-Neg	LessThan	3.25	[0.23, 46.43]	0.995	0.6397
RestUniv	Pos	Pos-Neg	AtLeast	3.55	[0.51, 24.63]	1.464	0.2863
RestUniv	Pos	Pos-Neg	AtMost	2.92	[0.96, 8.92]	2.153	0.0314
RestUniv	Neg	Pos-Neg	MoreThan	1.64	[0.54, 5.03]	0.992	0.6423
RestUniv	Neg	Pos-Neg	LessThan	1.80	[0.60, 5.37]	1.205	0.4562
RestUniv	Neg	Pos-Neg	AtLeast	0.31	[0.10, 1.01]	-2.222	0.0263
RestUniv	Neg	Pos-Neg	AtMost	1.35	[0.40, 4.58]	0.542	1.0000

Table: Exp. 2 predicted contrasts for levels of Pol2.

Ratings are quite high for all the modifiers when both polarities are positive (except for *at most* in a universal), but for *at most* they drop dramatically when the second polarity becomes negative (including in the case of a universal). And ratings are generally lower for all modifiers when the first polarity is negative (cf. R1), but for *at least* they improve dramatically when the second polarity becomes negative also.

As for Exp. 1 and (largely also) Exp. 2, we notice a negative effect of downward modifier monotonicity and polarity of the immediate embedding clause being negative. Regression analysis confirms this: there was a significant effect of ModMon = DE ($\beta = -2.34$, $z = -2.481$, $p = 0.0131$ *) and of Pol = NEG ($\beta = -2.15$, $z = -2.186$, $p = 0.0288$ *).

Env	Pol	ModType by ModMon	OR	CI	z	p
AntCond	Pos	MoreThan-AtLeast	1.30	[0.10, 16.05]	0.233	0.8161
AntCond	Pos	LessThan-AtMost	1.33	[0.30, 5.96]	0.428	0.6687
AntCond	Neg	MoreThan-AtLeast	2.96	[0.69, 12.71]	1.672	0.0946
AntCond	Neg	LessThan-AtMost	0.62	[0.16, 2.37]	-0.793	0.5065
MatrixNeg	Pos	MoreThan-AtLeast	2.47	[0.34, 17.98]	1.023	0.6131
MatrixNeg	Pos	LessThan-AtMost	3.13	[0.84, 11.63]	1.946	0.1033
MatrixNeg	Neg	MoreThan-AtLeast	4.38	[1.17, 16.40]	2.505	0.0245
MatrixNeg	Neg	LessThan-AtMost	2.09	[0.49, 8.85]	1.143	0.5065

Table: Exp. 3 predicted contrasts for levels of ModType, given same level of ModMon.

Given the same level of monotonicity, SMNs seem to be on a par with CMNs in every condition. Statistical analysis confirms this, except for *at least* in MATRIXNEG-NEG, which was found significantly worse than *more than*

Env	Pol	Mod	OR	CI	z	p
AntCond-MatrixNeg	Pos	MoreThan	1.68	[0.20, 14.37]	0.539	0.5898
AntCond-MatrixNeg	Pos	LessThan	1.56	[0.38, 6.38]	0.706	0.9598
AntCond-MatrixNeg	Pos	AtLeast	3.19	[0.35, 29.04]	1.179	0.2386
AntCond-MatrixNeg	Pos	AtMost	3.66	[1.02, 13.11]	2.282	0.0450
AntCond-MatrixNeg	Neg	MoreThan	2.32	[0.56, 9.64]	1.320	0.3738
AntCond-MatrixNeg	Neg	LessThan	1.07	[0.29, 3.89]	0.111	0.9598
AntCond-MatrixNeg	Neg	AtLeast	3.42	[1.10, 10.66]	2.426	0.0305
AntCond-MatrixNeg	Neg	AtMost	3.57	[0.90, 14.23]	2.065	0.0450

Table: Exp. 3 predicted contrasts for levels of Env.

In general ratings for each modifier appear similar between the two environment types, but more so for CMNs tha SMNs, which, given the same level of polarity, seem to degrade somewhat from AntCond to MatrixNeg. A qualitatively small but statistically significant trend.

(to main »)

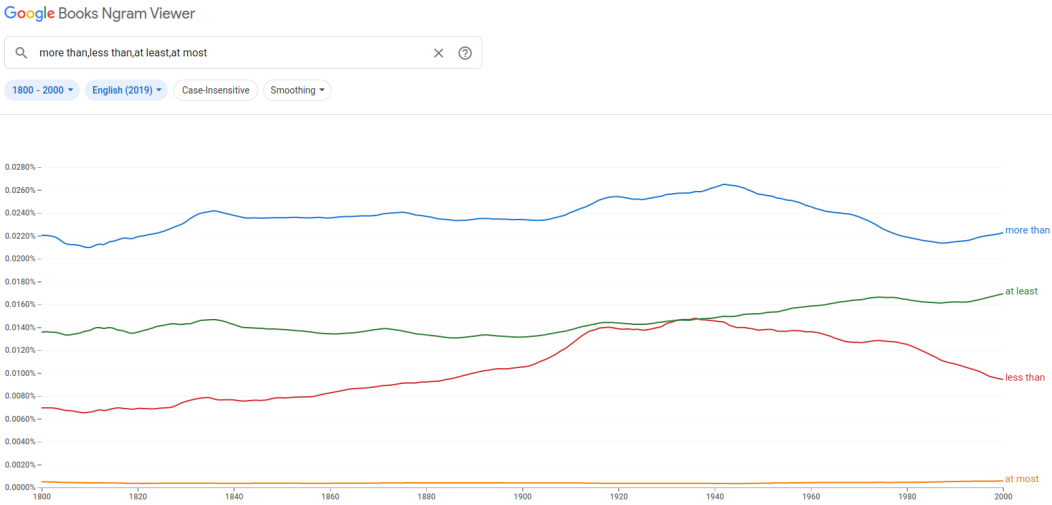

Figure: Frequency of modified numerals cf. Google Books Ngram Viewer English 2019 .

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