The Exception of Humour: Iconicity, Phonemic Surprisal, Memory Recall, and Emotional Associations

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- Time slows down (perceptually)

Matthews, W. J. (2015). Time perception: The surprising effects of surprising stimuli. Journal of Experimental Psychology: General, 144(1), 172–181. https://doi.org/10.1037/xge0000041

Ulrich, R., Nitschke, J., & Rammsayer, T. (2006). Perceived duration of expected and unexpected stimuli. Psychological Research, 70(2), 77–87. https://doi.org/10.1007/s00426-004-0195-4

- Time slows down (perceptually)
- Response time increases

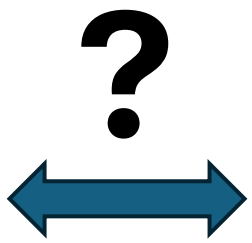
Simon, J. R., & Rudell, A. P. (1967). Auditory S-R compatibility: The effect of an irrelevant cue on information processing. Journal of Applied Psychology, 51(3), 300–304. https://doi.org/10.1037/h0020586

- Time slows down (perceptually)
- Response time increases
- Initial reporting accuracy decreases

Winman, A., & Smith, J. (2010). Surprise-induced blindness: Attentional effects of unexpected stimuli. Consciousness and Cognition, 19(4), 734–742. https://doi.org/10.1016/j.concog.2010.02.005

- Time slows down (perceptually)
- Response time increases
- Initial reporting accuracy decreases
- Long term memory accuracy increases

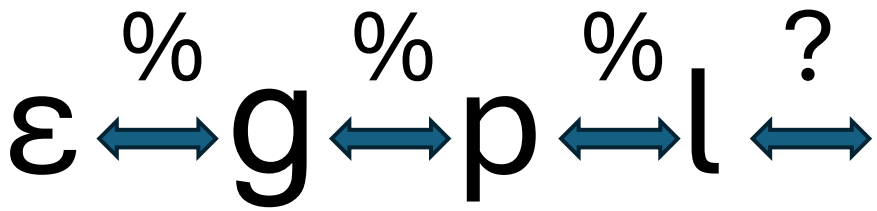
Futrell, R., Gibson, E., & Levy, R. P. (2020). Lossy-context surprisal: An information-theoretic model of memory effects in sentence processing. Cognitive Science, 44(3), e12814. https://doi.org/10.1111/cogs.12814

The child ate an 

The child ate an eggplant.

The child ate an ice-cream.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4



Does the cognitive load hypothesis apply to within-word probability?

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Information Theory

- Focuses on quantifying how information is expressed in communication systems.

$$Surprisal = -log_2 P$$

- Surprisal quantifies the expression of information based on probabilities.

Shannon, C. E. (1948). A mathematical theory of communication. Bell System Technical Journal, 27(3), 379-423.

$$Surprisal = -log_2 P$$

Phonemic Bigram Surprisal

$$Surprisal = -log_2 P$$

% chance of one phoneme following another

/ɪ/	/ŋ/	19.90%
/ɪ/	/s/	8.44%
/ɪ/	/k/	4.89%

$$Surprisal = -log_2 P$$

Logarithmic transformation

Chance	Surprisal
50%	1
25%	2
12.5%	3
6.25%	4

$$Surprisal = -log_2 P$$

Surprisal returns values in bits of information where high information represents low chance.

/ɪ/	/ŋ/	19.90%	2.33
/ɪ/	/s/	8.44%	3.57
/ɪ/	/k/	4.89%	4.35

lingusitics /lɪŋgwɪstɪks/

/lɪ/	/ɪŋ/	/ŋg/	/gw/	/wɪ/	/ɪs/	/st/	/tɪ/	/ɪk/	/ks/
8.67%	19.90%	9.01%	0.19%	13.63%	8.44%	31.46%	7.99%	4.89%	10.50%
3.53	2.33	3.47	9.04	2.88	3.57	1.67	3.65	4.35	3.25

lingusitics /lɪŋgwɪstɪks/ = 3.77

/lɪ/	/ɪŋ/	/ŋg/	/gw/	/wɪ/	/ɪs/	/st/	/tɪ/	/ɪk/	/ks/
8.67%	19.90%	9.01%	0.19%	13.63%	8.44%	31.46%	7.99%	4.89%	10.50%
3.53	2.33	3.47	9.04	2.88	3.57	1.67	3.65	4.35	3.25

$$Average\ Surprisal = \frac{Total\ Surprisal}{Number\ of\ bigrams}$$

Increased Average Surprisal is associated with…

- Decreased accuracy and increased response time in lexical decision tasks.
- Decreased accuracy and increased response time in read aloud tasks.
- Increased age of acquisition.
- Increased accuracy in **long-term memory** tasks.

Kilpatrick, A. J., & Bundgaard-Nielsen, R. L. (Under Review). Decoding Surprisal and Iconicity in American English.

Negativity Bias in Memory

- Emotional events and stimuli are better remembered than neutral ones.

- This effect is stronger when those emotions are negative rather than positive.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. Review of General Psychology, 5(4), 323-370. https://doi.org/10.1037/1089-2680.5.4.323
Rozin, P., & Royzman, E. B. (2001). Negativity bias, negativity dominance, and contagion. Personality and Social Psychology Review, 5(4), 296-320. https://doi.org/10.1207/S15327957PSPR0504_2

The questions:

- If negative and high surprisal words are more memorable, then what is the relationship between these variables?

  i.e., is it negativity or surprisal driving increased memorability?

- How does humour—where humorous words are presumably both positive and surprising—work in this relationship?

Method

We combined the **SUBLEX-US** (N = 54 million lexemes) with the **CMU pronouncing dictionary** to obtain phoneme frequency counts to calculate average bigram surprisal.

This was cross referenced with **iconicity ratings** (Winter et al., 2023), **morpheme counts** (Sánchez-Gutiérrez et al., 2018), and **parts of speech** (Brysbaert et al., 2012).

*Full data and instructions on how it was obtained available in the OSF repository linked in the study!!!

Method

- Memory recall experiment (Cortese et al., 2010).

120 American English speakers trained on a list of words in one experimental session and the testing of their recall accuracy in a second session within the same week.

*Full data and instructions on how it was obtained available in the OSF repository linked in the study!!!

Method

- Memory recall experiment (Cortese et al., 2010).
- NRC Emotion Lexicon (Mohammad & Turney, 2013).

American English speakers assigned binary scores to words according to 9 emotion: Anger, Anticipation, Disgust, Fear, Joy, Negative, Positive, Sadness, Surprise, and Trust.
Also, Likert scores assigned to each word according to valence where a high score indicates a positive association.

*Full data and instructions on how it was obtained available in the OSF repository linked in the study!!!

Method

- Memory recall experiment (Cortese et al., 2010).
- NRC Emotion Lexicon (Mohammad & Turney, 2013).
- Glasgow Norms (Scott et al., 2019)

English speaking participants (of various dialects) assigned Likert scores to each word according to valence where a high score indicates a positive association.

*Full data and instructions on how it was obtained available in the OSF repository linked in the study!!!

Method

- Memory recall experiment (Cortese et al., 2010).
- NRC Emotion Lexicon (Mohammad & Turney, 2013).
- Glasgow Norms (Scott et al., 2019)
- Humour Study (Engelthaler & Hills, 2018)

821 English-speaking participants assigned Likert scores (1-5) to words according to how a word is “amusing or likely to be associated with humorous thought or language”.

*Full data and instructions on how it was obtained available in the OSF repository linked in the study!!!

Examples

Note that this is a binary funny/unfunny metric that takes no consideration for different types of humour.

	Humour
booty	4.32
egghead	3.95
oomph	3.93
fruitcake	3.83
gaggle	3.82
gun	1.44
measles	1.44
kill	1.43
casket	1.38
distrust	1.37

Results

Multiple linear regression model with **valence** as the dependent variable.

Variable	G_Valence	NRC_Valence
(Intercept)	28.03***	37.22***
Average_Surprisal	**-2.11***	**-4.51*****
Iconicity_Rating	**-5.32*****	**-10.31*****
Phoneme_Length	0.37	-0.18
Morpheme_Length	1.31	-1.24
PoS_Adverb	1.61	2.89**
PoS_Determiner	0.41	0.029
PoS_Interjection	-0.05	0.87
PoS_Name	-0.18	2.40*
PoS_Noun	1.70	5.37***
PoS_Number	1.337	0.904
PoS_Preposition	-0.22	0.45
PoS_Pronoun	0.45	1.54
PoS_Unclassified	0.28	0.14
PoS_Verb	-1.48	0.74

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Words with negative associations are more surprising.

Results

Multiple linear regression model with **humour** as the dependent variable.

Variable	**Humor**
(Intercept)	38.202***
Average_Surprisal	3.125**
Iconicity_Rating	18.006***
Phoneme_Length	-1.368
Morpheme_Length	-6.374***
PoS_Adverb	-0.813
PoS_Interjection	1.497
PoS_Name	-0.768
PoS_Noun	2.449*
PoS_Number	-1.823
PoS_Preposition	0.593
PoS_Verb	-1.386

Results

Multiple linear regression model with **humour** as the dependent variable.

Variable	**Humor**
(Intercept)	38.202***
Average_Surprisal	3.125**
Iconicity_Rating	18.006***
Phoneme_Length	-1.368
Morpheme_Length	-6.374***
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PoS_Interjection	1.497
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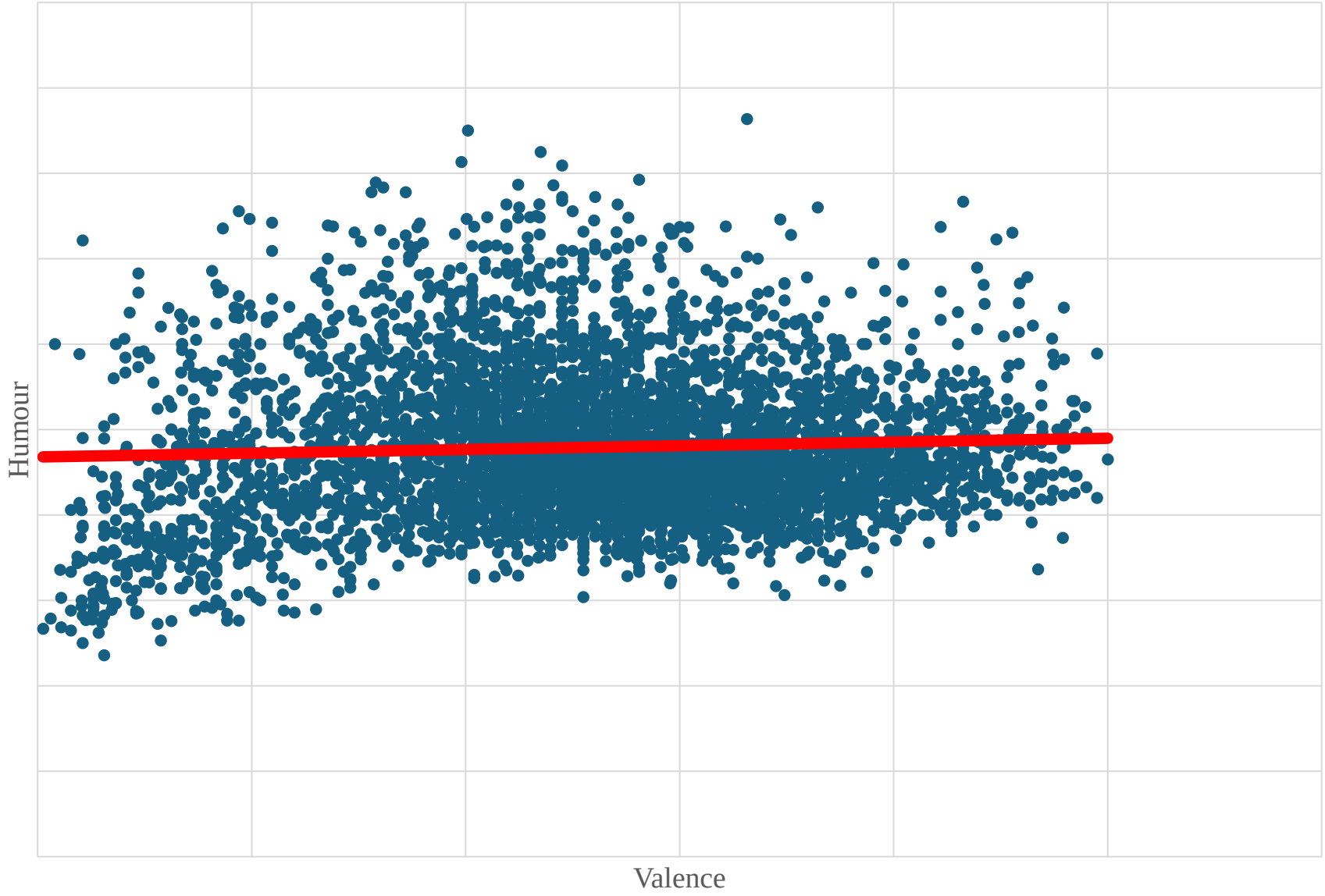
Humorous words are more surprising.



Simple Linear Regression: weak but significant ($F(1, 4849) = 12.36$, $R^2 = 0.003$, $p < 0.001$) positive correlation between humour and valence.

Results

Multiple linear regression model with **memory** as the dependent variable.

Variable	**G_Valence**	**NRC_Valence**
(Intercept)	29.581***	15.168***
Valence	**-1.009**	**-5.154*** **
Average_Surprisal	**4.899*** **	**7.098*** **
Iconicity_Rating	1.707	2.582**
Phoneme_Length	-2.833**	-2.645**
Morpheme_Length	-2.345*	-3.637***
PoS_Adverb	-0.347	-0.973
PoS_Interjection		0.371
PoS_Name	2.581**	2.64**
PoS_Noun	6.666***	5.657***
PoS_Number	-1.774	0.481
PoS_Preposition	-0.936	-1.034
PoS_Verb	-7.083***	-10.398***

Results

Multiple linear regression model with **memory** as the dependent variable.

Variable	**G_Valence**	**NRC_Valence**
(Intercept)	29.581***	15.168***
Valence	**-1.009**	**-5.154*** **
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PoS_Interjection		0.371
PoS_Name	2.581**	2.64**

Negative words and surprising words are memorable.

Results

Multiple linear regression model with **memory** as the dependent variable.

Variable	**Humor**
(Intercept)	15.168***
Humor	**17.628***
Average_Surprisal	**5.371***
Iconicity_Rating	**-4.625***
Phoneme_Length	-2.203*
Morpheme_Length	-1.402
PoS_Adverb	-1.949.
PoS_Interjection	-0.053
PoS_Name	1.872.
PoS_Noun	3.563***
PoS_Number	1.474
PoS_Preposition	-1.437
PoS_Verb	-5.353***

Results

Multiple linear regression model with **memory** as the dependent variable.

Variable	Humor
(Intercept)	15.168***
Humor	**17.628*** **
Average_Surprisal	**5.371*** **
Iconicity_Rating	**-4.625*** **
Phoneme_Length	-2.203*
Morpheme_Length	-1.402
PoS_Adverb	-1.949.

Humorous words and surprising words are memorable.

Overall Findings

- Words with negative associations are memorable and surprising.
- Humorous words are stochastically positive, memorable, and surprising.
- In other words, despite being associated with positive emotions, humour behaves like negatively associated words in terms of memorability and phonemic bigram surprisal.

Thank you.