



Interactions between continuous predictors

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The concept of interaction



$$y = b_0 + b_1x_1 + b_2x_2$$

$$y = b_0 + b_1x_1 + b_2x_2 + b_3(x_1 * x_2)$$



An example: Iconicity (again)

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REGULAR ARTICLE

Lonely sensational icons: semantic neighbourhood density, sensory experience and iconicity

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ABSTRACT

Perry, Perlman, and Lupyan (2015). Iconicity in English and Spanish and its relation to lexical category and age of acquisition. *PLoS One*, 10, e0137147. doi:10.1371/journal.pone.0137147 found that a sample of English words was rated as being slightly iconic, on average, with words varying in their iconicity. Thus, the relationship between word form and meaning does not seem to be categorically arbitrary. We investigated factors that might explain variation in iconicity: specifically, that concepts with sparser semantic neighbourhoods have more iconic word forms, and that concepts with more sensory information are more likely to have iconic word forms (as in Winter, Perlman, Perry, & Lupyan, *in press*. Which words are the most iconic? Iconicity in English sensory words. *Interaction Studies*. Retrieved from http://sapir.psych.wisc.edu/papers/winter_perlman_perry_lupyan_interaction-studies.pdf), even after accounting for age of acquisition (AoA; Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012). Age-of-acquisition ratings for 30,000 English words. *Behavior Research Methods*, 44, 978–990. doi:10.3758/s13428-012-0210-4). We found support for both predictions: words with sparser semantic neighbourhoods (ARC; Shaoul & Westbury, 2010. Exploring lexical co-occurrence space using HiDEx. *Behavior Research Methods*, 42, 393–413. doi:10.3758/Brm.42.2.393), and greater associated sensory experience (SER; Juhasz & Yap, 2013. Sensory experience ratings for over 5,000 mono- and disyllabic words. *Behavior Research Methods*, 45, 160–168. doi:10.3758/s13428-012-0242-9), were more iconic, even after accounting for AoA. ARC was also found to moderate SER. These results further our appreciation of iconicity as a general property of the lexicon.

ARTICLE HISTORY

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KEYWORDS

Sound symbolism; iconicity;
arbitrariness; semantic
neighbourhoods; sensory
features



An example: Sidhu & Pexman

```
lonely <- read_csv('sidhu&pexman_2017_iconicity.csv')  
  
lonely
```

```
# A tibble: 1,389 x 4  
  Word     SER    ARC Iconicity  
  <chr>   <dbl>  <dbl>      <dbl>  
1 one     1.55  0.702     1.85  
2 him     2.55  0.689     0.583  
3 she     1.60  0.687     0.714  
4 me      2.33  0.664     0.600  
5 he      1.40  0.694     1.06  
6 mine    2.08  0.641     1.50  
7 near    2.10  0.674     0.538  
8 spite   2.91  0.625     2.86  
9 few     1.55  0.697     2.50  
10 none   1.73  0.661     0.833  
# ... with 1,379 more rows
```



Model with interaction term

```
lonely_mdl <- lm(Iconicity ~ SER * ARC, data = lonely)  
  
tidy(lonely_mdl) %>% select(term, estimate)
```

	term	estimate
1	(Intercept)	1.3601014
2	SER	0.3612026
3	ARC	-0.7929281
4	SER:ARC	-0.5255308

Standardising the predictors

```
# Standardize continuous predictors:

lonely <- mutate(lonely,
                  SER_z = (SER - mean(SER)) / sd(SER),
                  ARC_z = (ARC - mean(ARC)) / sd(ARC))

lonely

# A tibble: 1,389 x 6
  Word    SER    ARC Iconicity    SER_z    ARC_z
  <chr> <dbl> <dbl>     <dbl>    <dbl>    <dbl>
1 one     1.55  0.702     1.85   -1.74    1.16
2 him     2.55  0.689     0.583   -0.745   1.06
3 she     1.6    0.687     0.714   -1.69    1.05
4 me      2.33  0.664     0.6     -0.956   0.871
5 he      1.4    0.694     1.06   -1.89    1.10
6 mine    2.08  0.641     1.5     -1.21    0.691
7 near    2.1    0.674     0.538   -1.19    0.949
8 spite   2.91  0.625     2.86   -0.382   0.567
9 few     1.55  0.697     2.5     -1.74    1.13
10 none   1.73  0.661     0.833   -1.56    0.842
# ... with 1,379 more rows
```



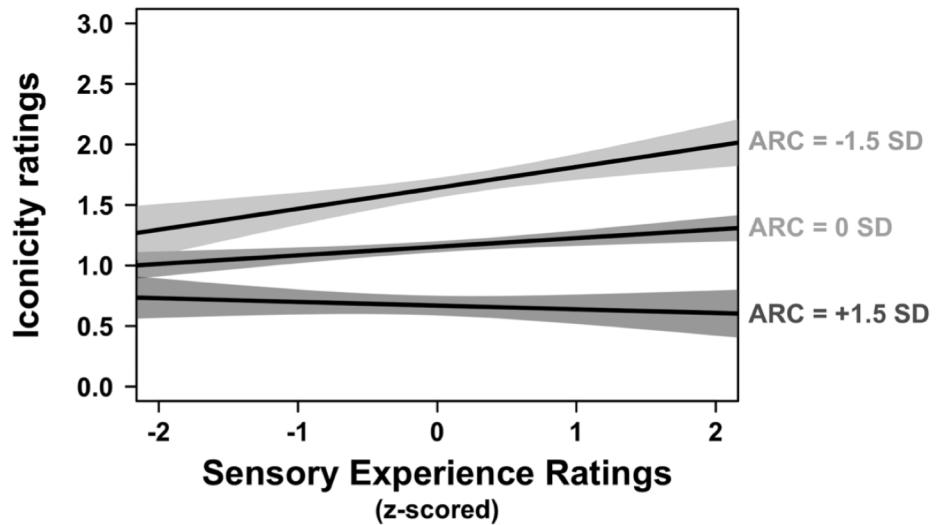
Model with interaction term, using standardized predictors

```
# Fit model with standardized predictors:  
  
lonely_mdl_z <- lm(Iconicity ~ SER_z * ARC_z,  
                     data = lonely)  
  
tidy(lonely_mdl_z) %>% select(term, estimate)
```

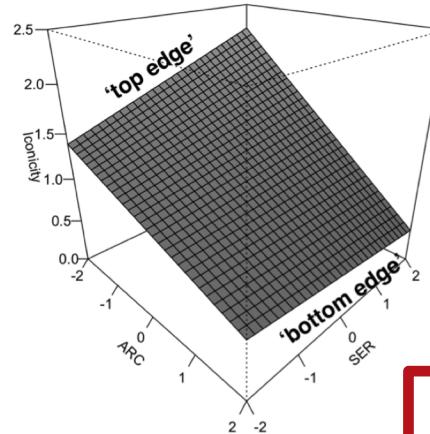
	term	estimate
1	(Intercept)	1.15564895
2	SER_z	0.07115308
3	ARC_z	-0.32426472
4	SER_z:ARC_z	-0.06775347

Interpretation

(a) Iconicity by SER and ARC



(b) Perspective plot



Summary

- Interaction: describes a situation where the influence of a predictor on the response depends on another predictor.

$$y = b_0 + b_1 x_1 + b_2 x_2 + b_3 (x_1 * x_2)$$

```
lm (y ~ x1*x2, data)
```

```
lm (y ~ x1 + x2 + x1:x2, data)
```

- Center and standardize continuous predictors to facilitate interpretation.
- Spend some time interpreting the coefficients!
- If interaction significant, can't interpret predictors in isolation anymore.
- Slope for interaction can be read as: If both predictors increase, then

