Pseudoreplication in primate communication research: 10 years on.

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Supplementary materials

SI1 Literature database searches. 2009-2020 Articles.

Our database of articles were originally generated by Liebal et al., 2022, for the purpose of examining the use of multimodal frameworks within primate communication research. We repurposed this literature search, and subsequently conducted additional coding to meet our own research goals.

Two databases (Web of Science and Science Direct) were used, and the articles which returned from the following search terms were coded:

> *"facial communication OR facial expression* OR facial display OR gestur* OR gestur* communication OR gestur* display OR vocalisation OR vocalization OR call* OR vocal communication OR vocal*" AND "primate* OR ape* OR monkey* OR macaque* OR gorilla* OR baboon* OR vervet OR chimpanzee OR gibbon*"*

Liebal, K., Slocombe, K. E., & Waller, B. M. (2022). The language void 10 years on: Multimodal primate communication research is still uncommon. *Ethology Ecology & Evolution*, *0*(0), 1–14. https://doi.org/10.1080/03949370.2021.2015453

SI2 Likelihood ratio test outputs and GLMM outputs.

Model 1.

```
Likelihood ratio test

Model 1: pseudo_bi ~ oldnew + (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df Chisq Pr(>Chisq)
1   3 -373.23
2   2 -383.04 -1 19.62  9.446e-06 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.159	0.179	-6.490	<0.001
Pre/post 2009	0.948	0.220	4.313	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.750	0.866

Model 2.

```
Likelihood ratio test

Model 1: pseudo_bi ~ yeardiff + (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   3 -371.16
2   2 -383.04 -1 23.761   1.09e-06 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	1.326	0.423	3.132	0.002
Year difference	-0.050	0.011	-4.687	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.724	0.851

Model 3.

```
Likelihood ratio test

Model 1: pseudo_bi ~ yearz * glmm_present + (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   5 -153.61
2   2 -163.29 -3 19.364  0.0002299 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-0.690	0.183	-3.766	<0.001
Year	-0.038	0.156	-0.239	0.811
GLMM present	-1.467	0.407	-3.602	<0.001
Year * GLMM present	-0.312	0.456	-0.686	0.493

Random effects	**Variance**	**Std. Dev**
first author	0.254	0.504

Model 4.

```
Likelihood ratio test

Model 1: pseudo_bi ~ methods + methods:oldnew + (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   5 -355.49
2   2 -381.59 -3 52.188  2.731e-11 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.269	0.276	-4.600	<0.001
Methods (Observational)	0.181	0.328	0.550	0.583
Methods (Experimental:Old/new)	0.113	0.349	0.331	0.740
Methods (Observational:Old/new)	1.572	0.300	5.244	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.842	0.918

Model 5.

```
Likelihood ratio test

Model 1: pseudo_bi ~ research_environment_bi + research_environment_bi:oldnew +
    (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   5 -356.03
2   2 -370.95 -3 29.849  1.485e-06 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.380	0.266	-5.184	<0.001
Research environment (Wild)	0.497	0.330	1.503	0.13279
Research environment (Non-wild:Old/new)	0.892	0.303	2.945	0.00323
Research environment (Wild:Old/new)	1.420	0.353	4.029	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.657	0.811

Model 6.

```
Likelihood ratio test

Model 1: pseudo_bi ~ species_group_bi + species_group_bi:oldnew + (1 |
    first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df Chisq Pr(>Chisq)
1   5 -369.65
2   2 -383.04 -3 26.78  6.548e-06 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.491	0.325	-4.591	<0.001
Species (Non-ape)	0.479	0.360	1.328	0.184
Species (GreatApe:Old/new)	0.707	0.422	1.674	0.094
Species (Non-Ape:Old/new)	0.997	0.249	3.997	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.667	0.817

Model 7.

```
Likelihood ratio test

Model 1: pseudo_bi ~ modality + modality:oldnew + (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   8 -368.23
2   2 -383.04 -6 29.622  4.638e-05 ***
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.922	0.591	-3.252	0.001
Modality (Gestural)	0.457	0.695	0.658	0.512
Modality (Vocal)	0.995	0.612	1.628	0.104
Modality (Facial:Old/new)	1.783	0.650	2.742	0.006
Modality (Gestural:Old/new)	0.381	0.546	0.697	0.486
Modality (Vocal:Old/new)	0.883	0.249	3.545	<0.001

Random effects	**Variance**	**Std. Dev**
first author	0.546	0.739

Model 8.

```
Likelihood ratio test

Model 1: pseudo_bi ~ samplesize + citations_per_year + journal_SNIP +
    (1 | first_author)
Model 2: pseudo_bi ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   5 -134.35
2   2 -137.66 -3 6.6354    0.08447 .
```

GLMM output

Predictor: Pseudoreplicated data (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-0.988	0.421	-2.345	0.019
Sample Size	-0.016	0.010	-1.707	0.088
Citations per year	0.055	0.031	1.815	0.070
SNIP	-0.292	0.304	-0.963	0.335

Random effects	**Variance**	**Std. Dev**
first author	0.535	0.731

Model 9.

```
Likelihood ratio test

Model 1: glmm_present ~ yearz + (1 | first_author)
Model 2: glmm_present ~ 1 + (1 | first_author)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   3 -161.78
2   2 -169.26 -1 14.972  0.0001091 ***
```

GLMM output

Predictor: GLMM present (1/0).

Fixed Effects	**Estimate**	**Std. Error**	**z**	**p**
(intercept)	-1.346	0.350	-3.844	<0.001
Year	0.749	0.218	3.426	<0.001

Random effects	**Variance**	**Std. Dev**
first author	2.313	1.521