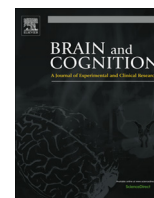


Contents lists available at [ScienceDirect](http://ScienceDirect.com)

Brain and Cognition

journal homepage: www.elsevier.com/locate/b&c

Corrigendum

Corrigendum to “The neural correlates of moral decision-making: A systematic review and meta-analysis of moral evaluations and response decision judgements” [Brain Cogn. 108 (2016) 88–97]

Beverley Garrigan^a, Anna L.R. Adlam^b, Peter E. Langdon^{c,d,*}^a Department of Clinical Psychology, Norwich Medical School, University of East Anglia, United Kingdom^b School of Psychology, College of Life and Environmental Sciences, University of Exeter, United Kingdom^c Tizard Centre, University of Kent, United Kingdom^d Hertfordshire Partnership University NHS Foundation Trust – Norfolk, United Kingdom

A cluster-level thresholding error in the version of GingerALE software used by the authors (version 2.3.4) was reported by [Eickhoff et al. \(2016\)](#) recently. The authors subsequently re-ran the ALE analysis using version 2.3.6 of GingerALE. This resulted in a change to the meta-analysis clusters, with the two smallest clusters for moral evaluations (ME) and moral response decisions (MRD) being no longer being significant. There was no change to the conjunction analysis, or to the ME-MRD contrast (still no significant clusters). The results for the MRD-ME contrast are slightly different after re-running the analysis, although the area labels remain the same. [Table 1](#) below shows the corrected results obtained from re-running the analysis in GingerALE version 2.3.6

and [Fig. 1](#) displays the brain activation maps for MEs, MRDs and the MRD-ME contrast based on the revised analysis.

We stated in our original paper that “six significant clusters of activation were found across the ME experiments (18 experiments, 174 foci, 383 participants): two in the left medial frontal gyrus (MFG), the left superior temporal gyrus (STG), left cingulate gyrus (CG), right STG and right MFG. Six significant clusters were found across the MRD experiments (10 experiments, 97 foci, 259 participants): left middle temporal gyrus (MTG), left precuneus, right MFG, right MTG, right inferior frontal gyrus (IFG) and left caudate.” (p. 91). After re-running the analysis in GingerALE 2.3.6, only four significant clusters of activation were found for ME and MRD

Table 1
Significant clusters of activation for moral evaluations, moral response decisions, and conjunction and convergence analysis.

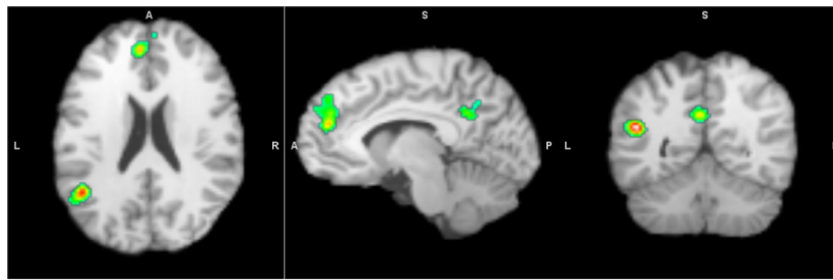
	#	Volume (mm ³)	X	y	z	Cerebrum	Label	Brodman area
Moral evaluations	1	3296	-6	44	20	Left	MFG	9
	2	2176	-44	-56	18	Left	STG	39
	3	2024	-2	-56	26	Left	CG	31
	4	744	50	6	-20	Right	STG	38
Moral response decisions	1	1968	-44	-64	20	Left	MTG	39
	2	1928	-2	-60	30	Left	Precuneus	7
	3	1512	2	44	36	Right	MFG	6
	4	1248	44	-60	24	Right	MTG	39
Conjunction of moral evaluations and moral response decisions	1	712	-44	-60	18	Left	MTG	19
	2	680	-2	-56	28	Left	CG	31
	3	312	-6	44	40	Left	MFG	8
Moral response decisions-moral evaluations	1	896	42.9	-56.9	23.4	Right	MTG	39
	2	328	2	-61	31	Right	Precuneus	7
	3	280	-39	-64.5	16.5	Left	MTG	39

X, y, z coordinates are reported in Talairach space and refer to the maximum value of each cluster. Moral evaluation and moral response decision ALE analyses performed using cluster-level = 0.05, 1000 permutations, p = 0.001. Conjunction and contrast analysis performed using p = 0.01, 1000 permutations, minimum volume = 200mm³. Labels and Brodmann areas generated by GingerAle 2.3.6. MFG = medial frontal gyrus, STG = superior temporal gyrus, CG = Cingulate gyrus, MTG = middle temporal gyrus.

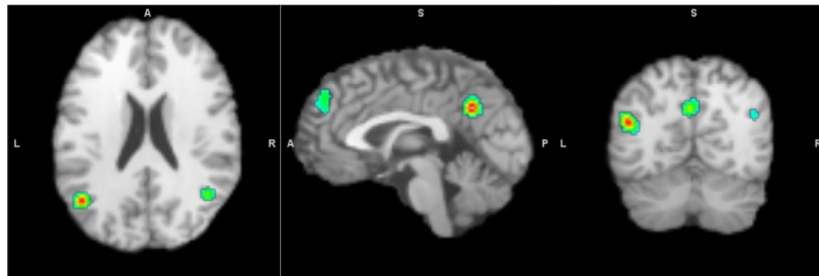
DOI of original article: <http://dx.doi.org/10.1016/j.bandc.2016.07.007>

* Corresponding author at: Tizard Centre, University of Kent, Canterbury CT2 7LR, United Kingdom.

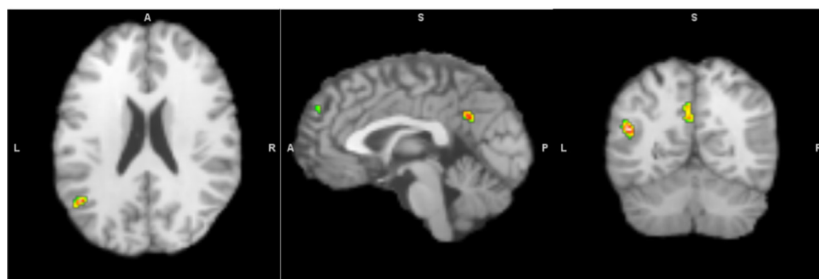
E-mail address: P.E.Langdon@kent.ac.uk (P.E. Langdon).



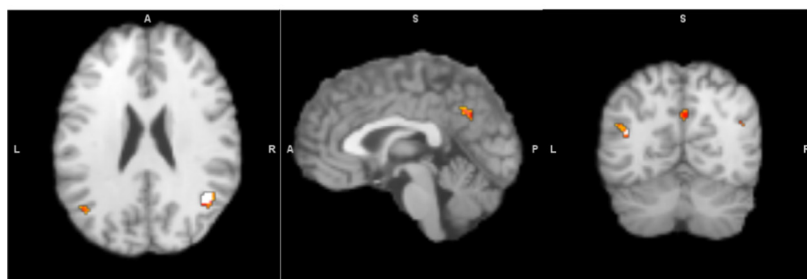
Moral evaluation clusters



Moral response decision clusters



Conjunction analysis: Shared activation for moral evaluation and moral response decisions



Contrast analysis: Moral response decisions-moral evaluations

Fig. 1. Brain activation maps showing significant clusters of activation. Images created in GingerALE 2.3.6, overlaid onto Colin 2.2.2 template in Mango (Lancaster & Martinez, 2006–2015). Brain images are axial, sagittal and coronal view of main clusters of activation for each ALE analysis. Image labels: L = left, R = right, P = posterior, A = anterior, S = superior.

experiments, with the two smallest clusters for each type being no longer significant. There were no longer significant clusters for MEs in the left and right MFG, Brodmann area (BA) 10, although the largest cluster for MFG, BA 9 remained. For MRDs, there was no longer a significant cluster in the right IFG, BA 47 or the left caudate. The number of experiments, foci and participants remained the same.

In terms of how the new results affected the discussion within our original paper, we had stated that we found significant clusters of activation in the ventromedial prefrontal cortex (vmPFC) for MEs: cluster 5 and 6, MFG BA 10. However, clusters 5 and 6 for MEs were no longer significant after we re-ran the analysis, due to the cluster-level threshold bug in GingerALE 2.3.4. Our

meta-analysis therefore only found one cluster (cluster 1 for MEs; MFG, BA 9) adjacent to the regions commonly referred to as the vmPFC. This further strengthens the argument that although the vmPFC has traditionally been the brain region most commonly implicated in moral decision-making, further research is needed to establish whether this brain region is involved for different types of moral evaluation tasks, and when making your own moral decisions.

In our comparison of our ME results with Bzdok et al.'s (2012), we previously said that we both found activation in the left and right MFG, BA10, while our revised findings indicated significant activation of the left MFG, BA9 only. Comparing our ME results

with that of [Sevinc and Spreng \(2014\)](#), we had previously stated that we both found activation in the right MFG, BA 10 but this cluster was no longer significant in our revised analysis. In the comparison of our MRD results with that of [Sevinc and Spreng \(2014\)](#) we also previously stated that while they found activation in the left IRF, we found activation in the right IFG, but this region is no longer significant in our revised analysis.

References

- Bzdok, D., Schilbach, L., Vogeley, K., Schneider, K., Laird, A., Langner, R., & Eickhoff, S. (2012). Parsing the neural correlates of moral cognition: ALE meta-analysis on morality, theory of mind, and empathy. *Brain Structure and Function*, 217(4), 783–796. <http://dx.doi.org/10.1007/s00429-012-0380-y>.
- Eickhoff, S. B., Laird, A. R., Fox, P. M., Lancaster, J. L., & Fox, P. T. (2016). Implementation errors in the GingerALE Software: Description and recommendations. *Human Brain Mapping*. <http://dx.doi.org/10.1002/hbm.23342>.
- Lancaster, J., & Martinez, M. (2006–2015). *Mango*. Research Imaging Institute: University of Texas Health Science Center.
- Sevinc, G., & Spreng, R. N. (2014). Contextual and perceptual brain processes underlying moral cognition: A quantitative meta-analysis of moral reasoning and moral emotions. *PLoS one*, 9(2), e87427.