PNAS LETTER

Spontaneous dishonesty does not specifically engage the perigenual anterior cingulate cortex

Shanshan Zhen[a] and Rongjun Yu[a,1]

Cognitive theories of lying posit that spontaneous dishonesty is more effortful and requires volition and cognitive control to inhibit the prepotent truth response (1, 2). Using activation likelihood estimation (ALE) metaanalysis (3), Sai et al. report that, in comparison with spontaneous truth telling, spontaneous dishonesty shows consistent activations uniquely in the perigenual anterior cingulate cortex (pgACC) (4). The authors argue that the motivational/volitional dimension is central to deliberate dishonesty.

However, this analysis was incorrectly conducted. First, the authors mistakenly used the number of subjects recruited rather than the number of subjects included in the specific analysis. ALE calculations create a modeled activation map using a Gaussian kernel of which the size depends on the sample size of the study (5). Wrongly exaggerated subject size may produce false-positive results. Second, incorrect contrasts were chosen for a few included studies. Third, several qualified papers were not included in this original analysis.

We have made the following changes to the analysis (Table 1). First, we correct the number of subjects. Second, the original metaanalysis included ineligible studies and contrasts that did not reflect dishonesty vs. honesty. We have excluded three studies and corrected contrasts used in four studies. Third, four eligible studies are now included. In addition, three papers, originally coded as instructed lying, are now reclassified as spontaneous lying. In these studies, participants were allowed to freely decide whether and when to lie, and hence their decisions should be classified as spontaneous. We do not report findings on a progression of analysis, as our main focus is to update

Author affiliations: [a]Department of Management, Hong Kong Baptist University, Hong Kong, 999077, China

Author contributions: S.Z. and R.Y. designed research, performed research, analyzed data, and wrote the paper.

The authors declare no competing interest. This work was supported by the Hong Kong Baptist University Research Committee Tier 2 Start-Up Fund (RC-OFSGT2/20-21/BUS/003).

[1]To whom correspondence may be addressed. Email: rongjunyu@hkbu.edu.hk.

Published June 21, 2022.

Table 1. The list of changes and justifications

Studies	Changes	Justification
Greene et al. (2009)	*N* from 35 to 14	Fourteen subjects were identified as dishonest. "Increased activity … in dishonest subjects."
Sip et al. (2010)	*N* from 18 to 14	Eighteen subjects were recruited; "4 subjects were discarded due to technical problems."
Abe and Greene (2014)	*N* from 28 to 26	Twenty-eight subjects were recruited. For the coin-flip task, "the data from two subjects were excluded."
Volz et al. (2015)	*N* from 34 to 29	Thirty-four subjects were recruited. "We had to exclude four participants from the analysis ... and one participant … "
Sun et al. (2017)	*N* from 21 to 17	Twenty-one subjects were recruited. "Four participants were excluded from further statistical analyses."
Yin et al. (2019)	*N* from 37 to 23	The "fMRI model was performed based on the remaining 23 participants."
Greene et al. (2009)	Used opportunity wins vs. no-opportunity wins	The original foci are from op loss vs. no-op loss. Op loss trials involve "limited honesty."
Kireev et al. (2013)	Used deception claim vs. honest claim	The original foci are from the deception claim vs. catch contrast. Catch trails are a low-level baseline.
Abe & Greene (2014)	Used first-level contrast	The original foci are from second-level regression results.
Sun et al. (2015)	Contrast changed to dishonest vs. honest	The original foci included two coordinates from the negative effect (i.e., honest vs. dishonest).
Spence et al. (2008)	Added (originally misclassified)	"Subjects were free to choose when to tell the truth or to lie."
Browndyke et al. (2008)	Added (originally misclassified)	"To feign a memory impairment for financial gain"
McPherson et al. (2012)	Added (originally misclassified)	"To feign a serious hearing loss in both ears by deliberately responding to the sounds"
Lee et al. (2002)	Newly added	"To fake memory impairments"
Lee et al. (2009)	Newly added	"To feign a memory problem and deliberately do badly on the test"
Sip et al. (2013)	Newly added	"Participants were not explicitly instructed to produce false statements."
Sun et al. (2016)	Newly added	"Subjects were free to choose between dishonesty and honesty decisions."
Yin et al. (2016)	Removed	No whole-brain results for contrasts
Kireev et al. (2017)	Removed	No whole-brain results reported
Baumgartner et al. (2009)	Removed	No relevant contrasts other than between-group differences

N, number of subjects.

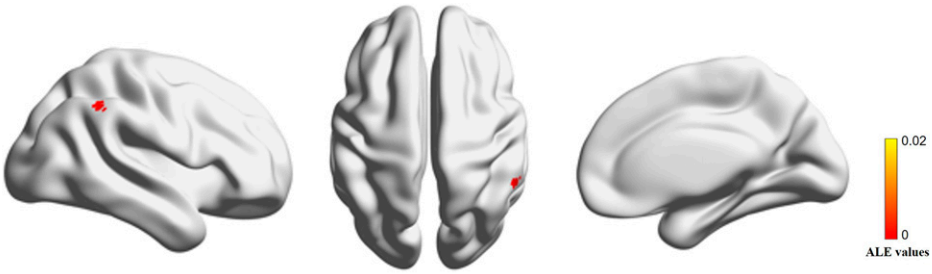

Fig. 1. The inferior parietal lobe showing convergent activations in spontaneous lying vs. truth-telling contrast. Images are displayed in neurological convention. The color bar indicates the range of ALE values.

the scientific record rather than to understand which adjustment makes a difference.

We then run ALE analyses with the well-powered sample size (19 contrasts, 153 foci, number of subjects = 354). We find consistent activities in the inferior parietal lobe only (x = 42, y = −44, z = 34, ALE value = 0.016, Z score = 4.48) (Fig. 1). There was no consistent involvement of the pgACC in spontaneous dishonesty. The maximum ALE value observed in the pgACC cluster was 0.014, lower than the ALE value of 0.018 in the original paper. Our finding does not support the view that spontaneous dishonesty is more volitional than spontaneous truth telling. This raises the question of whether spontaneous lying and spontaneous truth telling can be reliably distinguished in fMRI. Lie detection using fMRI, especially in forensic contexts, may face great challenges (6).

One possibility is that spontaneous lying and truth telling may share a similar level of volition. When faced with temptation, truth telling can be a highly volitional decision (7, 8). Another possibility is that previous studies failed to capture the intentional aspect of deception. For example, in the feigned memory paradigms, although participants can choose freely, the explicit instruction to lie removes the emotional burden and moral significance of lying, which are crucial elements of deception (9). Future studies may consider emphasizing the social dimension in experimental design in order to study realistic spontaneous dishonesty (10).

1. I. Blandón-Gitlin, E. Fenn, J. Masip, A. H. Yoo, Cognitive-load approaches to detect deception: Searching for cognitive mechanisms. *Trends Cogn. Sci.* **18**, 441–444 (2014).
2. K. Suchotzki, B. Verschuere, B. Van Bockstaele, G. Ben-Shakhar, G. Crombez, Lying takes time: A meta-analysis on reaction time measures of deception. *Psychol. Bull.* **143**, 428–453 (2017).
3. S. B. Eickhoff *et al.*, Coordinate-based activation likelihood estimation meta-analysis of neuroimaging data: A random-effects approach based on empirical estimates of spatial uncertainty. *Hum. Brain Mapp.* **30**, 2907–2926 (2009).
4. L. Sai, G. Bellucci, C. Wang, F. Krueger, Neural mechanisms of deliberate dishonesty: Dissociating deliberation from other control processes during dishonest behaviors. *Proc. Natl. Acad. Sci. U.S.A.* **118**, e2109208118 (2021).
5. V. I. Müller *et al.*, Ten simple rules for neuroimaging meta-analysis. *Neurosci. Biobehav. Rev.* **84**, 151–161 (2018).
6. M. J. Farah, J. B. Hutchinson, E. A. Phelps, A. D. Wagner, Functional MRI-based lie detection: Scientific and societal challenges. *Nat. Rev. Neurosci.* **15**, 123–131 (2014).
7. J. D. Greene, J. M. Paxton, Patterns of neural activity associated with honest and dishonest moral decisions. *Proc. Natl. Acad. Sci. U.S.A.* **106**, 12506–12511 (2009).
8. N. Pornpattananangkul, S. Zhen, R. Yu, Common and distinct neural correlates of self-serving and prosocial dishonesty. *Hum. Brain Mapp.* **39**, 3086–3103 (2018).
9. K. E. Sip, A. Roepstorff, W. McGregor, C. D. Frith, Detecting deception: The scope and limits. *Trends Cogn. Sci.* **12**, 48–53 (2008).
10. S. Zhen, R. Yu, Neural correlates of recursive thinking during interpersonal strategic interactions. *Hum. Brain Mapp.* **42**, 2128–2146 (2021).