Transcranial Current Stimulation of the Temporoparietal Junction Improves Lie Detection

Highlights

- Inconsistency between one’s own and another’s stated opinion impairs lie detection
- Stimulation of the right TPJ improves lie detection in opinion-inconsistent situations

Authors

Sophie Sowden, Gordon R.T. Wright, Michael J. Banissy, Caroline Catmur, Geoffrey Bird

Correspondence

sophie.sowden@kcl.ac.uk

In Brief

Sowden et al. demonstrate how a mechanism involved in inhibiting imitation and in perspective taking extends to lie detection. They show that inconsistency between the opinions of the self and another impedes lie detection and that electrical stimulation of the temporoparietal junction improves performance in these opinion-inconsistent situations.
Transcranial Current Stimulation of the Temporoparietal Junction Improves Lie Detection

Sophie Sowden,1,* Gordon R.T. Wright,2 Michael J. Banissy,3,4 Caroline Catmur,1,6 and Geoffrey Bird1,4
1MRC Social, Genetic, and Developmental Psychiatry Centre, Institute of Psychiatry, Psychology, and Neuroscience, King’s College London, London SE5 8AF, UK
2Department of Psychological Sciences, Birkbeck, University of London, London WC1E 7HX, UK
3Department of Psychology, Goldsmiths, University of London, London SE14 6NW, UK
4Institute of Cognitive Neuroscience, University College London, London WC1N 3AR, UK
5School of Psychology, University of Surrey, Guildford GU2 7XH, UK
6Correspondence: sophie.sowden@kcl.ac.uk
http://dx.doi.org/10.1016/j.cub.2015.08.014

SUMMARY

The ability to detect deception is of vital importance in human society, playing a crucial role in communication, cooperation, and trade between societies, businesses, and individuals. However, numerous studies have shown, remarkably consistently, that we are only slightly above chance when it comes to detecting deception [1]. Here we investigate whether inconsistency between one’s own opinion and the stated opinion of another impairs judgment of the veracity of that statement, in the same way that one’s own mental, affective, and action states, when inconsistent, can interfere with representation of those states in another [2]. Within the context of lie detection, individuals may be less accurate when judging the veracity of another’s opinion when it is inconsistent with their own opinion. Here we present a video-mediated lie-detection task to confirm this prediction: individuals correctly identified truths or lies less often when the other’s expressed opinion was inconsistent with their own (experiment 1). Transcranial direct current stimulation (tDCS) of the temporoparietal junction (TPJ) has previously been shown to improve the ability to selectively represent the self or another [3–5]. We therefore predicted that TPJ stimulation would enable lie detectors to inhibit their own views, enhance those of the other, and improve their ability to determine whether another was presenting their true opinion. Experiment 2 confirmed this second prediction: anodal tDCC of the TPJ improved lie detection specifically when one’s own and others’ views were conflicting.

RESULTS AND DISCUSSION

Despite the frequency of deception in everyday life [6] and the importance of detecting deception within human society, humans are remarkably consistent in their inability to detect deception. Meta-analyses demonstrate a mean success rate of 54% across all published studies of lie detection ability, where chance performance is 50%, with a measurement-corrected SD of just 0.8% [1]. Although one or two cues have been demonstrated to signal deception at above-chance levels in some studies (e.g., response latency [7]), these cues are mostly overlooked in favor of non-diagnostic behavioral cues (such as the avoidance of eye contact [8]) or person-level cues relating to the perceived deceptiveness of the individual rather than what they are saying (“demeanor bias” [9]), resulting in poor performance. Here we investigate the existence of a further factor that may decrease the accuracy of lie detection when one is attempting to determine the veracity of another’s stated opinion: inconsistency between one’s own opinion and that of another.

It is well-established that self-representations can interfere with representation of another even when task irrelevant. The act of planning or executing an action interferes with the perception of an incongruent action performed by another [10], one’s own affective state biases perception of another’s incongruent affective state [11], one’s own visual perspective interferes with the representation of another’s spatially inconsistent visual perspective [12], and the contents of one’s own mental states interfere with representation of those of another when they differ from our own [13]. A body of previous research has highlighted how each of these social abilities recruits a mechanism to enable the individual to control, or switch between, representation of the self and of others to avoid interference between inconsistent representations, such that representation of the self is enhanced and the other inhibited, or representation of the other is enhanced and the self inhibited according to task demands [14–18]. These results raise the possibility that holding an opinion inconsistent with that expressed by another may interfere with the ability to judge the veracity of the expressed opinion and that increasing the ability to inhibit representation of one’s own opinion and enhance that of the other may result in improved lie-detection performance when opinions are inconsistent. Accordingly, over two experiments, participants were asked to complete a video-mediated lie-detection task based on the false-opinion paradigm [19–21] (Figure 1A), in which they were
asked to rate whether an individual (the “sender”) had expressed their true or a false opinion.

Experiment 1 sought to establish evidence for the hypothesized opinion inconsistency effect by comparing lie-detection performance for opinion-consistent (where the participant’s opinion matched the sender’s stated opinion) and opinion-inconsistent (where the participant’s opinion was opposite to the sender’s stated opinion) statements. A group of healthy adult volunteers (n = 63; mean age = 33.5, SD = 6.4; 44 female) were asked to complete the lie-detection task after completing a questionnaire ascertaining their views on a number of controversial topics. As hypothesized, when rating the veracity of opinion statements expressed by senders (i.e., whether the sender had presented their true opinion), participants were significantly more accurate when the view expressed by the sender was consistent with their own view (mean percent accuracy ± SEM: 54.9% ± 0.8%) than when inconsistent (51.2% ± 1.1%; consistent with their own view (mean percent accuracy ± SEM: 59.5% ± 0.20), whereby participants who underwent rTPJ stimulation (52.7% ± 1.2%; rTPJ) significantly from the population derived average of 54% [1] in either the TPJ (t(15) = 1.18, p = 0.257) or MO (t(16) = 0.25, p = 0.804) group.

Lie-detection performance was then analyzed using a mixed-effect two-way ANOVA with a within-subjects factor of opinion consistency (two levels: performance on opinion-consistent versus opinion-inconsistent trials) and a between-subjects factor of stimulation group (two levels: stimulation of TPJ versus MO). As predicted, there was a significant opinion consistency × stimulation group interaction (F(1,31) = 3.32, p = 0.009, ηp² = 0.20), whereby participants who underwent rTPJ stimulation were significantly more accurate when the sender’s expressed opinion was inconsistent with their own opinion (59.5% ± 1.6%) when compared to those administered MO control stimulation (52.7% ± 1.2%; t(31) = 3.32, p = 0.002, d = 1.15). Conversely, there was no significant difference in lie-detection performance between stimulation groups during trials in which the sender and participant’s opinions were consistent (t(31) = 1.03, p = 0.313; Figure 1C).

The significant improvement in lie detection after tDCS of the TPJ, specific to situations in which one must suppress one’s own opinion to judge the veracity of another’s statement, supports both the involvement of a self-other control mechanism in lie detection and the involvement of the TPJ in this process. Results suggest that in situations of conflict between one’s own opinion and that of another, one must inhibit the representation of one’s own opinion and enhance that of the other in order to successfully discriminate between a truth and a lie.

The relatively modest improvement in absolute accuracy observed after TPJ stimulation is in accordance with both the size of the consistency effect observed in experiment 1 and the degree of individual differences in the population as a whole. A mean success rate of 54% across all published studies (albeit with an unknown proportion of opinion-consistent and -inconsistent trials), with a measurement-corrected SD of just 0.8% [1], means that the increase in lie detection ability after TPJ stimulation is therefore not trivial with respect to population-level
to the opinions of the self and the other. Participants were less accurate at distinguishing truthful from false opinions when the sender’s opinion was inconsistent with their own. Experiment 2 demonstrated that this performance interference effect could be reduced through anodal stimulation of TPJ, improving lie detection specifically on those trials in which this effect was most prominent. These results suggest that boosting the ability to control representations of the self and other—in this case inhibiting one’s own opinion in order to more accurately represent that of the other—can improve lie detection in opinion-inconsistent situations.

**EXPERIMENTAL PROCEDURES**

**Lie-Detection Task**

In both experiments 1 and 2, participants began by completing an “opinion questionnaire” in which they gave their opinion on 20 topics. For each item they rated the degree to which they agreed or disagreed with the topic on a six-point scale (with an answer of “1” demonstrating strong agreement, and “6” strong disagreement, with a topic). Example items on the questionnaire include “euthanasia,” “medical abortion,” “genetically modified foodstuffs,” and “animal testing.” During the lie-detection task, participants watched a series of 80 randomly ordered video clips of individuals (“senders”) expressing their views, as well as a brief justification of their view, on the same topics included in the opinion questionnaire. These took the form of “I am in favor of euthanasia because everyone deserves a chance to die with dignity.” After watching each video, participants were asked to rate whether the sender had presented their true opinion or whether they had lied, on a 6-point scale (1, definitely true; 6, definitely lie; see Figure 1A). The task took a total of 25 min.

The stimulus set comprised the same set of 40 truthful and 40 deceptive statements for all participants, conveyed by 20 different individuals (ten males and ten females). The stimulus set contained four video statements about each of the 20 topics contained in the opinion questionnaire—two truths and two lies—and in a fully factorial design, two statements were spoken in agreement and two in disagreement with each topic. The videos were recorded during a previous experiment and were all provided by individuals who had strong opinions for or against each topic (ratings of “1” or “6” on the opinion questionnaire). Note that the factorial combination of truthful and deceptive statements, for and against each topic, means that the observed improvement in lie detection performance on opinion-inconsistent trials after stimulation is an effect on accuracy rather than bias in both experiment 1 and experiment 2.

**Data Analysis**

Trials were divided into opinion-consistent and opinion-inconsistent trials on a trial-by-trial basis according to the sender’s expressed opinion and the participant’s opinion as reported on the opinion questionnaire. For example, if a participant listed their opinion as “against” a topic, a trial in which the sender had expressed their opinion as “against” the topic was classed as an opinion-consistent trial, whereas a trial in which the sender expressed their opinion as “for” the topic was classed as an opinion-inconsistent trial. Participants’ responses on each trial were dichotomized as either a “truth” (responses 1–3) or a “lie” (responses 4–6) judgment to account for individual differences in the use of the extremities of the rating scale. The percentage accuracy of judgments constituted the measure of lie detection performance, which was compared in experiment 1 for opinion-consistent and -inconsistent trials using a paired-sample t-test. In experiment 2, lie-detection performance was analyzed using a mixed-effect two-way ANOVA (with opinion consistency as the within-subjects factor and stimulation group as the between-subjects factor). Two participants were excluded prior to data analysis in experiment 2: one from the TPJ stimulation group, who responded “true” to over 90% of trials, and one from the MO stimulation group, who completed less than 20% of trials, leaving too few trials for analysis.

It should be noted that the design of both experiment 1 and experiment 2 followed current best practice guidelines by comparing lie detection performance on the critical condition of interest (opinion-inconsistent trials) with a...
within-participant baseline (opinion-consistent trials), which also served as an extremely closely matched control condition. Indeed, participants were performing the same task, to videotaped statements from the same people, concerning the same topics, on both opinion-consistent and opinion-inconsistent trials.

### Experiment 2 tDCS Protocol

Participants were randomly assigned to one of two tDCS groups: rTPJ (n = 17) or MO control (n = 18). All participants were healthy volunteers, with no known developmental or neurological disorders, normal or corrected-to-normal vision, and no contraindications to tDCS. Prior to study completion, all participants were naïve to the aims of the experiment.

All participants underwent anodal stimulation, induced with two saline-soaked surface sponge electrodes (35 cm²) and delivered by a battery-driven, constant current stimulator. According to group assignment, the anodal electrode was placed over central parietal 6 (CP6) for rTPJ stimulation and occipital zero (O2) for MO control stimulation (electroencephalography 10/20 system). MO was used as an active control site as there was no prior reason to assume that stimulation to this region would differ from baseline. The cathodal electrode was placed over the vertex as a reference point, individually measured on each participant (Figure 1B). A weak electrical current (1 mA) was delivered offline (preceding the task) for a total of 20 min, following the procedure used by Santiesteban and colleagues [4, 5], as these effects are reported to be more robust than online stimulation. The effects of stimulation with these parameters have been demonstrated to last for 90 min after stimulation [27]. Participants completed the opinion questionnaire prior to stimulation, whereas the lie detection task was completed within the critical 90 min window after stimulation. Both experiments 1 and 2 received full ethical approval by the local Research Ethics Committees (Birkbeck, University of London and Institute of Psychiatry, Psychology, and Neuroscience, King’s College London, respectively).

### ACKNOWLEDGMENTS

S.S is supported by a doctoral studentship from the Medical Research Council. M.J.B is supported by the Economic and Social Research Council (ES/K00882X/1). We would like to thank Henry Woodward and Katerina Capouskova for their assistance with the testing of the participants in experiment 2.

Received: June 19, 2015
Revised: July 23, 2015
Accepted: August 7, 2015
Published: September 3, 2015

### REFERENCES


22. Decety, J., and Lamm, C. (2007). The role of the right temporoparietal junc-


