



## Assessment of double blinding in tES research: A call for the establishment of standard procedures



Dear Editor,

As researchers, we understand the importance of efficacious blinding in clinical trials, both for participants and researchers. As detailed in the CONSORT guidelines, blinding achievement is imperative to reduce the risk of bias [1], and account for the extent of any placebo effects. The lack of consistent and rigorous assessment of blinding, however, remains a critical yet under-acknowledged problem in transcranial electrical stimulation (tES) research.

Active tES elicits sensations when the electrical current passes through the skin, such as tingling, itching, burning, and pain [2]. The use of a tES sham condition typically involves the ramping up of current and the application of the target current for a short time at the start of stimulation, after which the current is ramped down [3]. The aim of using this sham protocol is to mimic the sensations elicited by active tES, whereby participants typically habituate to the tES-induced sensations after a short period, and therefore cannot distinguish between active and sham conditions. Additionally, tES-induced skin vasodilation causes observable redness under the electrode [4], which is a unique property when considering other interventions (e.g., rTMS, pharmacology). This is visible to researchers when removing the electrodes, and in many cases these same individuals are involved in administration of pre/post assessments. Consequently, due to the tES-elicited sensations and observable cues induced by the active condition compared to sham, tES techniques can be difficult to blind effectively for participants and researchers [5].

Thus, inclusion of a sham condition, or the use of masking to blind participants and researchers, does not necessarily mean that a study is effectively sham-controlled or double-blinded. This can only be determined via proper assessment. Indeed, blinding assessment demonstrates that inconsistent blinding efficacy in the tES field is not new. Some studies demonstrate successful single- and double-blinding [6], while others demonstrate that blinding is not achieved [2,3,5,7]. Further studies demonstrate successful participant blinding, but not experimenter blinding [4]. We recently conducted a search within the journal *Brain Stimulation* from Jan 2008–April 2019 (limited to original studies using offline, single-channel tDCS in adult human participants) to assess the number of sham-controlled studies, and ascertain the blinding protocols and blinding assessment methods utilised. Of the 39 papers that met inclusion criteria, 15 studies (37%) were not sham-controlled. Of the 24 remaining papers, 15 (63%) did not include any form of blinding assessment (including comparison of tDCS-elicited sensations between groups). Nine papers were included

in the final qualitative synthesis (published 2012–2017). Eight papers assessed participant blinding via condition judgement, and of these, three (38%) demonstrated that blinding was not successful. Only one study assessed operator blinding, and found that it was not achieved.

tES researchers have called for the assessment of both participant and operator blinding for a while now [5,8]. Consistency in rigorous blinding assessment was not found to be the case, however, in the small number of identified studies above. So, to assess the current state of the field in terms of blinding assessment and reporting, a search of original tES papers published so far this year (2019) was also conducted. Papers were identified via Scopus using 'tDCS' or 'transcranial direct current stimulation' on June 1st, 2019. 149 sham-controlled studies (83% of all eligible studies) were returned. Approximately one quarter of these sham-controlled studies assessed blinding efficacy directly (41 studies; 28%), by asking participants their condition judgement. Though not a blinding assessment *per se*, given that participants may base their condition judgements on factors other than sensation [2], a further 24 studies relied on sensation comparison as their only form of assessment (16%). Indeed, 84 of the 149 studies (56%) assumed participant blinding to be maintained without any form of assessment (sensation comparison or condition judgement). Among the 149 sham-controlled papers, only 65 (44%) attempted to blind the tES operator. A further 10 studies attempted to blind the assessor, but not the operator (7%). Only one study actually assessed double blinding.

Justification for efficacious sham control too often relies on a small handful of key papers (e.g. Refs. [6,9,10]). As evidenced by the results described above, however, processes for effective participant and operator blinding in tES research have not yet been reliably established. It is therefore not sufficient to cite a paper or two that have demonstrated efficacious blinding to justify the approach to blinding in all subsequent studies. Additionally, it is not enough to include a sentence stating that the study was 'blinded' without providing data which shows that this is the case, as was frequently observed in both reviews.

We need to be rigorous and consistent in how we assess and report blinding. Blinding checks are straightforward to administer; indeed, there are tES questionnaires already established for this purpose. Working towards the establishment and consistent uptake of standard, best-practice assessment and reporting procedures, at a minimum we recommend: 1) Blinding checks be administered as soon as is practical after the experimental session has ceased, by asking the participant whether they believe they received sham or active stimulation and assessing their judgement

confidence; 2) Outcome assessments should ideally not be undertaken by the tES operator, who may be exposed to additional cues that could compromise blinding; 3) Blinded operators and assessors indicate, as soon as practicable following each participant's session of data collection, their condition judgement and judgement confidence; 4) When reporting, the blinding status attempt (participant, operator, and/or assessor) and method of blinding assessment should be fully described, with specific blinding assessment results provided; 5) Descriptive statistics should be reported alongside the inferential tests for results of blinding assessment. Rigorous assessment and reporting using the steps outlined above is critical as we move toward the development of more efficacious and reliable sham procedures see Ref. [11].

The reliance of the majority of tES research on the relatively few studies that have rigorously assessed participant blinding should be of major concern to the field. There is enough conflicting research to demonstrate that blinding needs to be systematically evaluated in every sham-controlled study; a relatively simple process when considered against other techniques used in brain stimulation research. We propose that researchers work together to establish consensus on how best to assess and report blinding efficacy, and to develop more reliable sham protocols. Fundamental research will encourage the optimisation of sham and blinding assessment protocols, and ensure standardised and best-practice research procedures.

### Conflicts of interest

There are no conflicts of interest.

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23 July 2019

Available online 21 August 2019