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ORIGINAL RESEARCH

"A Fear of the Unknown": Understanding the Perceptions of Transcranial Electrical Stimulation (tES)

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Abstract
Transcranial electrical stimulation (tES) are popular techniques for modulating behaviour within research and clinical settings. However, individuals are apprehensive around undergoing tES, with clear misconceptions around safety and efficacy. This work aimed to capture perceptions of tES and identify drivers and barriers to undergoing stimulation through a mixed-methods approach. Participants completed an online survey ($n = 145$) and follow-up semi-structured interviews ($n = 7$) to explore knowledge of tES, perceptions of safety, expectations of effects, and willingness to undergo stimulation. Change in safety and comfort scores were measured following increasing levels of information (basic overview, safety standards, ethical practice, photos of tES testing). Qualitative data were analysed using thematic analysis and quantitative data through descriptive and logistic regression analyses. Participants were uncomfortable with the idea of "messing" with the brain and therefore reluctant to undergo procedures. Apprehension and fear around tES were evident, particularly were deemed to have low efficacy. tES was viewed as safer (χ^2 (3) = 40.842, $p < 0.001$, $W = 0.094$) and individuals were more comfortable with the prospect of receiving stimulation (χ^2 (3) = 49.587, $p < 0.001$, $W = 0.114$) as they were provided with more information. Participant misconceptions around tES must be addressed to support larger-scale and appropriate recruitment. Provision of clear, explicit, and independent information is important for building trust and demonstrating need of the techniques.

Keywords Non-invasive brain stimulation · NIBS · Safety · Comfort · Ethical practice

Introduction

Non-invasive brain stimulation (NIBS) techniques, and particularly transcranial electrical stimulation (tES), have become increasingly popular over recent years in both research and clinical settings (Filmer et al., 2014; Lefaucheur, 2016; Sun et al., 2022). This is due to the relative low-cost, scalability, and possibility of at-home treatments (Hall et al., 2018). Additionally, when applied in controlled research or clinical settings, these techniques are considered safe for a wide range of individuals, including children, adults, healthy populations, and patient groups (Brunoni et al., 2011; Matsumoto & Ugawa, 2017; Zewdie et al., 2018). During NIBS, electrical or magnetic currents are applied to specific regions of the scalp, causing reversible modulation of cortical activity resulting in temporary modulation of behaviour, learning and task performance (Coffman et al., 2014; Nitsche & Paulus, 2000, 2001). However, the true efficacy of these techniques remains unclear; particularly for regions outside of the motor cortex (Jamil & Nitsche, 2017; Woods et al., 2016). Despite this, there are many promising applications of these techniques (e.g., chronic pain; Dissanayaka et al. (2023); Moshfeghinia et al. (2023)).

A major limiting factor of current NIBS research is sample size (de Graaf & Sack, 2018). For example, our recent meta-analysis revealed a mean sample size of 36 across published work exploring the impact of tDCS on eating-related measures (Beaumont et al., 2022b). While some studies have recruited large participant cohorts, many studies suffer from relatively small sample sizes which affects the

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statistical power of these studies (Li et al., 2015; Thair et al., 2017). To elucidate the true efficacy of NIBS, it is important that studies achieve sufficient power (Li et al., 2015), along with applying appropriate stimulation parameters in suitable cohorts (e.g., Beaumont et al. (2022a)). However, in our work with transcranial direct current stimulation (tDCS), 74% of interested individuals were excluded due to ineligibility, largely arising from contraindications to stimulation. Additionally, while there is generally high interest from potential participants in our work, we have noted high attrition following screening, with around 50% of eligible individuals dropping out of studies. Informal feedback indicated apprehension around undergoing stimulation procedures. Compound with the rigorous screening procedures often leading to only a relatively small number of individuals deemed low-risk for stimulation-related complications (Antal et al., 2017; Potter-Baker et al., 2016), participant recruitment to NIBS-based studies is particularly challenging. Indeed, only 15% of individuals originally interested in participating in our work go on to complete study protocols. This is not uncommon, with similar recruitment issues highlighted by other groups (Fineberg et al., 2023; Hagenacker et al., 2014; Potter-Baker et al., 2016).

Apprehension around receiving stimulation (and therefore interest in participating in associated studies) may, in part, be due to the representation of these techniques within mass media. For example, tES are often described as "brain zapping" (Biegler, 2019; Fox, 2011; Hutchinson, 2019; Waltz, 2023) and "mind-altering" (Katwala, 2019) and are generally considered controversial (Simons, 2023). In addition, the set-up of tES procedures has been described as "wiring up your brain" (Hutchinson, 2019) and involving "electrodes clamped around [the] skull" (Ingle, 2015). These depictions conjure negative images, akin to more invasive and intensive treatments such as electroconvulsive therapy (ECT). Such comparisons are evident in the media; for example, a recent Harvard Health article listed tDCS alongside ECT (Shmerling, 2023). Unlike the subthreshold modulation of cortical activity seen following tES delivering up to 2.0 milliampere (mA) (Filmer et al., 2014; Jamil & Nitsche, 2017), ECT induces seizures by delivering high electrical currents (up to 900 mA) to the brain (Abbott et al., 2021; Duriez et al., 2020). Whilst methodologically different, these techniques are conceptually similar — they both involve delivering electrical currents to the brain with the aim of changing an aspect of behaviour — which may explain why individuals associate the techniques.

This portrayal of NIBS procedures within mass media, and indeed the way researchers and clinicians discuss brain stimulation, may impact the perceptions of these techniques by potential participants. The present study looked to capture perceptions of NIBS with the aim of identifying drivers and barriers to undergo stimulation (specifically tES) and whether misconceptions are present. A survey on the ethical principles of applying NIBS in children identified differences in perceptions of safe practice based on participant demographic characteristics (e.g., parental status) (Wagner et al., 2018). We were interested in exploring this further and whether any demographic characteristics (e.g., age, gender) are associated with perceptions and willingness to undergo these procedures. This question has not yet been assessed in sufficient depth to show if groups of individuals exist who are more reluctant to consider NIBS procedures. This study also considers the type and format of information provide to potential participants. We explore how different forms of communication around tES may allow more informed decisions during research recruitment and address attrition across related research.

Materials and Method

Study Design

The study used an explanatory sequential mixed-methods approach, with a cross-sectional survey capturing general knowledge and perceptions followed by in-depth semi-structured interviews to allow deeper exploration of such perceptions and provide clarity on the themes identified from the survey. The study was approved by an institutional ethics committee (ethics code: SSHS-2021–01). All participants provided written informed consent.

Participants

The survey was open to those over the age of 18 years, with participants recruited through self-selection in response to study advertisements. The study was advertised through social media, flyers and posters, internal announcements, and word-of-mouth. In line with previous survey studies (Cancer et al., 2018, 2021; Duncan et al., 2022; Héroux et al., 2015; Jwa, 2018; Wexler, 2018), the present study aimed to recruit a representative sample of the potential participant cohort with a minimum sample size of 142 individuals. Interview participants were selected from those who completed the online survey and agreed to be contacted about follow-up work. For the interviews, we recruited until data saturation (Moser & Korstjens, 2018).

Procedures

Interested individuals were directed to the survey via a web link, where they were then provided with an information sheet and required to complete informed consent procedures. During the survey, participants responded to a series of open- and closed-ended questions, with completion taking

15 to 20 min. Data were primarily quantitative, with participants selecting a response from a discrete set of options. Depending on these responses, participants were asked for further information through closed-ended questions or an open-ended qualitative statement. The survey comprised 57 questions, with participants responding to between 30 and 46 of these questions (see Supplemental Material). The survey was piloted by the research team prior to recruitment to ensure questions were appropriate and to minimise survey fatigue whilst still addressing the research aims. Data were collected using Online Surveys (Jisc, Bristol, UK).

Individuals who completed all required elements of the online survey and provided an email address for follow-up were contacted to participate in a 30-min individual semi-structured interview. The interviews were conducted in-person or using videoconferencing platforms to suit the individual participant. All interviews were recorded and transcribed; interview transcripts were checked for errors and anonymised by two authors (JB, EG).

Measurements

The survey consisted of questions on participant characteristics, knowledge of NIBS techniques, expectations of effects, and willingness to undergo NIBS. To explore the expectation of effects, we chose to focus on eating behaviour and weight management as examples where brain stimulation techniques have been applied (e.g., Beaumont et al., 2021, 2023); this was intended as an example that is more tangible for participants (i.e., many individuals experience issues with weight and/or eating). The survey also explored participants' perceptions of how safe NIBS techniques are (safety score) and how comfortable participants are with the prospect of receiving stimulation (comfort level). To determine whether level of knowledge around tES affected safety score and comfort level, during the survey participants were provided with information: (i) ethical practices, (ii) safety standards and procedures, and (iii) shown images of individuals receiving stimulation. Safety score and comfort level were captured at baseline and after each additional piece of information.

The interview built on the data collected from the survey and comprised questions assessing perceptions of safety and ethical procedures, expectations of effects following NIBS, willingness to receive stimulation, and perceptions of efficacy for modulating eating behaviour and use in weight management. These topics were identified following preliminary analysis of survey data and in response to our wider research questions. During the interview, participants were reminded of the ethics and safety standards adhered in NIBS research to further explore perceived safety of the techniques and how comfortable the participant was with the prospect of receiving stimulation. The interview schedule is available in the Supplemental Material.

Data Analysis

Responses to closed-ended questions were binary (i.e., yes, no) or ordinal (e.g., Likert scale). Responses to questions with "other" as an option, which required the participant to provide a qualitative statement where an appropriate response was not listed (e.g., source of knowledge on tES), were coded as additional quantitative responses and analysed as appropriate for the specific question. Data were explored descriptively and in accordance with participant demographic characteristics and analysed using binomial (e.g., whether comfort level differed between those with or without prior knowledge of tES) or multinomial logistic regression analysis (e.g., whether level of education predicted assumed efficacy of tES in weight management) as appropriate for the specific question. Normality of data was assessed for safety score and comfort level using Kolmogorov–Smirnov tests; data were not normally distributed ($p < 0.001$). Change in safety score and comfort level were analysed using Friedman's test, and effect sizes were determined using Kendall's *W*. Statistical analyses were performed using JASP version 0.17.1 (University of Amsterdam, Amsterdam, The Netherlands).

Responses to open-ended survey questions and interview transcripts were analysed thematically, with responses coded according to the section of the survey; themes were established in the absence of any pre-determined framework (Braun & Clarke, 2006). In line with the recommendations by Braun and Clarke (2006), a six-step approach was taken to analysing qualitative data. Authors familiarised themselves with data by listening to recordings and reading through transcripts; initial codes were developed and used to inform themes. These themes were defined and agreed, at which stage the full transcripts were analysed and brought together into this report. Thematic analysis was completed by two authors (JB and EG). To improve clarity of reporting, where appropriate quantitative and qualitative data will be discussed concurrently. The anonymised data and analysis files are available via the Open Science Framework (OSF):https://doi.org/10.17605/OSF.IO/4TMVW.

Results

A total of 145 individuals participated in the online survey, with data saturation in the interviews reached at seven participants. Demographic characteristics are displayed in Table 1; the views expressed in this section predominantly reflect those of people identifying as female, white, educated, of healthy weight and living in high income countries.

Table 1 Participant demographic characteristics

		n	%
Age (years) (mean ± SD)		34 ± 14	
Gender	Female	92	63.4
	Male	52	35.9
	Agender	1	0.7
Ethnicity	White	127	87.6
	Asian/Asian British	5	3.4
	Mixed/multiple ethnic group	5	3.4
	Black/African/Caribbean/Black British	4	2.8
	Prefer not to say	3	2.1
	Arab	1	0.7
Country of residence	UK	134	92.4
	Portugal	3	2.1
	New Zealand	2	1.4
	Australia	1	0.7
	Germany	1	0.7
	Italy	1	0.7
	The Netherlands	1	0.7
	Saudi Arabia	1	0.7
	USA	1	0.7
Highest level of education	College or university	48	33.1
	Higher, secondary or further education	47	32.5
	Post-graduate degree	41	28.2
	Secondary school (up to 16 years)	9	6.2
Perceived weight category	Healthy weight	100	69.0
	Overweight	34	23.4
	Obese	8	5.5
	Underweight	3	2.1
Struggle to maintain healthy weight	Yes	90	62.1
	No	55	37.9

Despite this, data collected still enabled testing of the primary hypotheses given this reflects the population often recruited to tES studies exploring weight management (Beaumont et al., 2022b). Six key themes were identified from the interviews and qualitative survey responses: experiences, decision making, research practice, efficacy, adverse events, and risk versus benefit. An overview of themes and subthemes is displayed in Fig. 1. Survey and interviews data are presented below in these themes.

Theme 1: Experiences

While few participants had previously received NIBS ($n = 2$; 1%), 41 (28%) of survey respondents noted previous knowledge of tES, primarily from reading academic/research articles ($n = 20$; 14%). A further 19 (13%) participants had previously heard of tES from anecdotal sources or mass media. Several interview participants acknowledged mass media as a source of their understanding around brain stimulation. For example, the film *One Flew Over a Cuckoo's Nest* was repeatedly mentioned. This film depicts an individual receiving ECT, and while participants acknowledge the differences between ECT and tES, connotations were often made.

> …the classic film, I'm of that generation. One Flew Over the Cuckoo's Nest, OK, but that's about ECT I know it's completely different, but I think that hasn't helped the image of research you know after that film. I'm sure it's traumatized a lot of people… [Interview 2]
>
> …just from the movies and those pictures you'd think you get an electric shock, a bit like touching an electric fence. Your elbow or your body jerks and you have an incontrollable movement. [Interview 7]

However, there was some acknowledgement of the low-intensity and non-invasive nature of tES.

> To be honest it's not that terrifying […] I'd assume that they'd be set to a certain level that is not going to

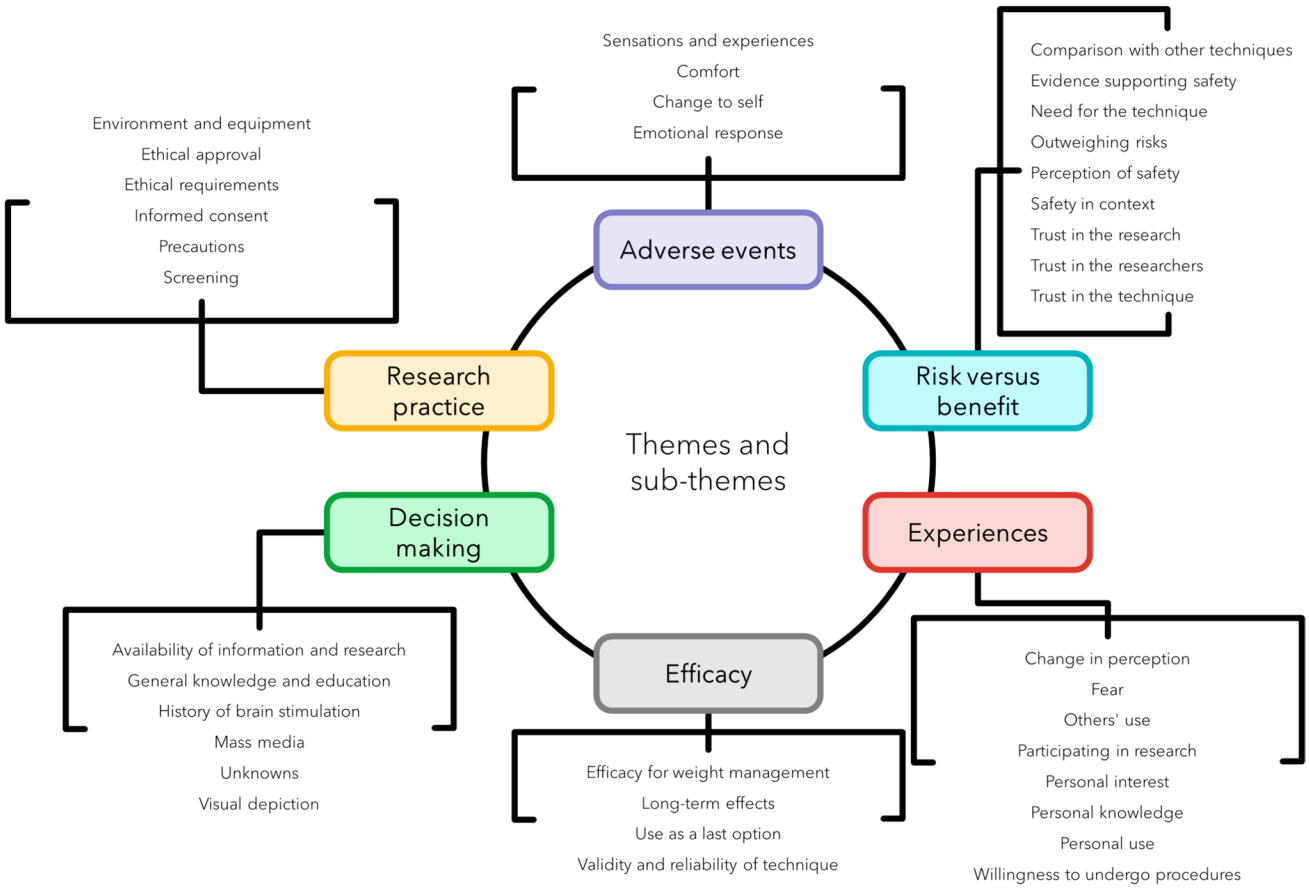

Fig. 1 Themes and sub-themes emerging from semi-structured interviews

like make you feel like you're sat in an electric chair or something [Interview 1]

Again, with no knowledge of it or seen any, whatever, how this technique is done, I can imagine now that it's a case that somebody isn't [sic] got to be strapped to a gurney so that they can't move and the head locked in one position and I'm sure it'll be sitting in a nice comfortable chair and there'll be some very discrete wires that'll be attached to you somewhere […] you probably hardly even notice that the treatment is being carried out. [Interview 7]

Theme 2: Decision Making

Informed consent, and particularly a participants' capacity to make informed decisions about receiving treatment, was of concern to some participants. This appears particularly important given the comparison to more intensive and invasive techniques such as ECT, which has a particularly challenging ethical background (González-Pando et al., 2021; Sweetmore, 2022).

I think obviously there's ethical issues around the capacity of the person that's having the treatment that they understand exactly what they're agreeing to. [Interview 1]

…because there may be some instances where you may have a vulnerable person that cannot make the decision themselves or on what treatment is best for them, that might affect an individual person's judgment […] I think there are a lot of really serious ethical considerations. [Interview 5]

The ability to review evidence independently appears important, including being able to access research and information freely beyond the potentially biased information shared by researchers or clinicians. This information should be accessible to everyone and include a complete picture, for example, around efficacy and safety. Participants stress the importance of avoiding jargon and adjusting the formatting of information to suit the individual.

…but it's [the information provided to different groups] still the same and make sure like you're not

missing anything out or you're not like removing something that's like really important. [Interview 4]

The information shared should be carefully considered, however, as this may lead participants to expect that they will experience adverse events.

I think on the one hand, you need to warn people that you might get those sensations, but on the other hand, knowing about it is also scary as well because you start expecting to feel something. […] That would just reinforce my fears. [Interview 2]

Theme 3: Research Practice

Adhering to ethical principles (e.g., ensuring participants understand they can terminate procedures at any moment) and ensuring the participant is comfortable with procedures appeared to be particularly important.

…they know about withdrawal, and they know that the researcher is going to protect the participants and make sure that no harm comes to them. […] there is nothing forcing you to, like, fully complete if you don't want to. […] maybe explaining to them like 'oh, this is what's going to happen, this is how it works, this is what each part does', if it looks a bit like different to what they're usually used to seeing. [Interview 4]

As part of ethical and safety procedures for our laboratory-based studies, we employ a stringent screening procedure that excludes anyone with contraindications to stimulation, even where these pose minimal risk. Stimulation can only be delivered by trained researchers, with a second researcher available during the entire testing visit; one of these researchers must be first aid trained to respond to adverse events should they occur. We are also required to carefully monitor adverse events and report any serious events to the relevant ethics committee for review. These procedures were explained to interview participants to gauge their interpretation of the requirements. While some valued these precautions, they were also viewed as a "double-edged sword".

I think it makes me more comfortable in a way that, you can see that obviously the research team around you are trying to care for you. […] having a first aider there almost makes it seem like something might happen. […] it's a bit of a double-edged sword […] if it's safe then why does there need to be a first aider there? [Interview 1]

Trust was a fundamental concept for participants. This included trust in the technique (e.g., that it is safe and ethical), trust in the research (e.g., no bias in publication), and in the researcher or clinical team (e.g., no hidden agenda).

…the researcher has an agenda […]. Not to say that that means that what you say is going to be wrong, but I'd like to then have the evidence as well to back that up and to look into it myself. [Interview 1]

If someone will [sic] do any research on this part of my body then I want someone that I can trust […] the simple fact that we had this discussion I think increased the trust on [sic] what you're doing, the willingness increased to take part in the research. [Interview 3]

Theme 4: Efficacy

Participants' perception of efficacy was predicted by their willingness to use stimulation; those more willing to use tES for weight management viewed the techniques are more effective for both modulating eating behaviour (χ^2 (141) = 3.880, $p = 0.049$, OR = 2.510) and in weight management (χ^2 (141) = 4.343, $p = 0.037$, OR = 2.420). Efficacy for one domain of behaviour (general behaviour, eating behaviour, weight management) predicted increased efficacy for the other domains (see Supplemental Material). In addition, efficacy for modulating eating behaviour (χ^2 (143) = 8.876, $p = 0.003$, OR = 4.594) and in weight management (χ^2 (143) = 5.433, $p = 0.020$, OR = 2.808) were significant predictors of willingness to undergo tES procedures. Age was a significant predictor of efficacy (χ^2 (143) = 5.870, $p = 0.015$, OR = 0.967), where younger adults viewed tES as more effective than older adults. Willingness to undergo stimulation specifically for weight management was predicted by perceived weight status, with those of higher weight showing greater interest in using the use of tES (χ^2 (141) = 22.240, $p < 0.001$), and where participants struggle to maintain a healthy weight (χ^2 (143) = 15.329, $p < 0.001$, OR = 3.985).

Regardless of views around efficacy, participants were uncomfortable with the idea of receiving stimulation themselves. However, they do not rule the techniques out completely and appear happy to suggest stimulation to others especially where they view this as a useful paradigm for weight or wider health issues.

I feel that you've made me feel more comfortable about it, but I think I still would not have it on myself. But if it was somebody I knew I wouldn't dissuade them from having it. Like if it was one of my children, in view of what you've just told me, whereas at the beginning of the interview I would have said don't go anywhere near that… [Interview 5]

…if I knew somebody that was struggling to lose weight I'd say 'oh well I've heard of this you know

why don't you find out a bit more about it?', it's not to say I wouldn't promote it, but, just at the moment myself, I don't think I'd have it done. [Interview 1]

This may be due to the target of these techniques — the brain — which is viewed as the most vital organ and central to what defines us as individuals.

…I don't mind the image of it on any other part of the body but once you get to something so central and core to you to your system like the brain, that really quite frightens me and it's something that makes me recoil really. [Interview 5]

When you don't know much about brains, you think that's the centre of everything of your whole being […] so people could be worried that if it goes, hits a wrong part of the brain that that could have an impact. [Interview 1]

The brain is the most fragile, complex and vital organ in the body and it's still a long way from being fully understood by science so the idea of messing with it in this way is frightening for me. [Survey response]

Theme 5: Adverse Events

Participants appear to be more comfortable with the idea of receiving stimulation as they were provided with greater information on the techniques (χ^2 (3) = 49.587, $p < 0.001$, $W = 0.114$), and view the techniques as safer (χ^2 (3) = 40.842, $p < 0.001$, $W = 0.094$) (Fig. 2). Indeed, both safety score (χ^2 (141) = 23.815, $p < 0.001$, OR = 7.059) and comfort level (χ^2 (111) = 37.697, $p < 0.001$, OR = 28.138) significantly predicted willingness to receive tES.

Despite this, there was still evident apprehension around undergoing stimulation.

…I probably wouldn't, but that's not because I think it's unsafe or anything like that that's just a personal feeling that I'd like to try other things first… [Interview 1]

…even though I've warmed towards it, it's only in a way that I would think that if I had a condition where I was absolutely desperate and there was no other way out, like a very severe eating disorder that I could not manage and every other possibility had been tried, then if the research had already been done, it would be something that I'd consider, but at the moment, I feel that it's too, it's not researched enough for me to want to take a chance. [Interview 5]

This may be the result of "a fear of the unknown" [survey response], due to the relative novelty of the techniques and lack of clinical use or awareness, and the sense of lack of evidence around psychology and neuroscience disciplines.

Oh, it's just it's just scary, isn't it? […] I think it's the unknowns probably. I mean, my common sense is telling me it's probably not too much different from taking a drug and you've still got side effects from drugs, haven't you? […] I think it's something about the physical electrical stimulation of the brain that makes you think 'what's going on there? What's being triggered? What are the chemicals you know being activated. Are there any long-term effects?' [Interview 2]

Well, when I first heard the phrase, I thought I didn't know anything about it at all. I thought it just seemed very, very obscure and quite frightening really. [Interview 5]

Level of education also predicted baseline comfort level (χ^2 (108) = 13.358, $p = 0.038$), as well as change in comfort

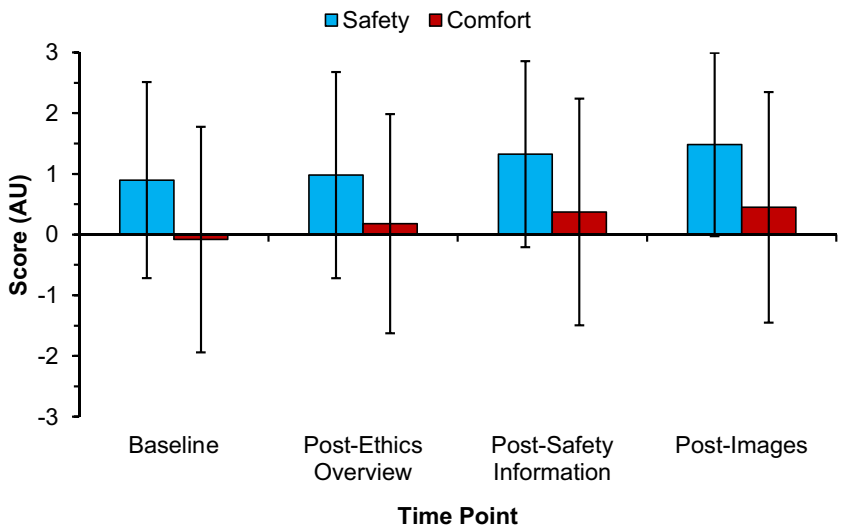

Fig. 2 Mean and SD for safety score and comfort level (y-axis) as participants are provided with greater information regarding stimulation (x-axis)

score (χ^2 (83) = 12.906, p = 0.045). Those with higher education status appeared to be more comfortable with tES.

Theme 6: Risk Versus Benefit

A clear description of any risks beyond a brief overview of cutaneous sensations was viewed as important to allow individuals to weigh up risks versus benefits. Overviewing more long-term impacts of the techniques was considered an important inclusion. There was some acknowledgement of the risks of many medical approaches. For example, participants acknowledged the use of drugs or bariatric surgery for weight management is not without adverse events. The context of safety issues appears important, particularly when participants are deciding whether to undergo stimulation procedures. This may have particular implications for clinical use, as patients may need to be provided with information around the risks versus benefits of stimulation in comparison with other treatment options (e.g., pharmacological or surgical procedures) so they can weigh up such risks across treatment options. Providing this information would allow patients to make more informed choices about their treatment.

> I think it's important that they know that everything has side effects and there's always something that could happen here or something that could happen there… [Interview 4]
>
> …if it can be ascertained and there's enough evidence to show that it's very low risk, you know, compared to drug therapy then, yeah, people could be given a choice. [Interview 2]

Discussion

This study explored the perceptions around tES; while the present study had a particular focus on perceptions within a research context, it is not possible to dissociate the perceptions of tES within a research and clinical setting. For example, where questions focussed on research use, participants often reflected on therapeutic tES. Overall, there was clear apprehension around the use of tES, particularly where they were deemed to have low efficacy or alternative treatment options were available. While the techniques were generally viewed as safe, participants were uncomfortable with the fundamental use of these stimulation protocols — applying an electric current to the brain, an organ viewed as central to human identity and functioning.

When considering the use of tES and wider NIBS, it is important to reflect on the four core ethical principles in research and clinical care: beneficence (act for the benefit of the participant), non-maleficence (doing no harm to the participant), autonomy (right of participants to accept or refuse treatment), and justice (fair, equitable and appropriate treatment of participants) (Beauchamp & Childress, 2019; Varkey, 2021). When delivering stimulation, we must ensure these ethical standards are strictly adhered — a concept captured in the participants' reflection of standard practice. While much of the current research often recruited "healthy" individuals who are able to express their autonomy in receiving stimulation (Filmer et al., 2014; Lefaucheur, 2016), there is interest in exploring use in, for example, dementia where the participants may not have capacity to make appropriate decisions regarding engagement in NIBS research (Harding, 2012; Wolfe et al., 2021).

Non-maleficence is of particular focus for NIBS research. Standard tDCS protocols (e.g., 2.0 mA for 20 min) are considered safe for adults, children, healthy individuals, and patient groups (Matsumoto & Ugawa, 2017). Indeed, a review of more than 33,200 tDCS sessions found no record of serious adverse events (e.g., seizure), irreversible brain damage or detrimental behaviour changes as a result of tDCS protocols that involve up to 4.0 mA for up to 40 min could be found (Bikson et al., 2016). Similarly, Pilloni et al. (2021) found no serious adverse events or sustained cutaneous sensations in 14,695 tDCS sessions, including following repeated sessions and in participants with advanced neurological conditions. While severe adverse events are scarce, participants often experience mild cutaneous sensations. For example, the most commonly reported sensations are tingling, itching, and a burning sensation (Poreisz et al., 2007). Such sensations are transient, and often subside once the current stabilises or shortly after (Nitsche et al., 2008).

Explicit safety thresholds have been previously defined to ensure non-maleficence (Nitsche et al., 2003), with rigorous reporting mechanisms for potential severe adverse events often built into ethical practice. Where severe adverse events have been reported (e.g., Lu and Lam (2019)), these are often the result of poor adherence with safety thresholds. What may be particularly alarming for potential participants is the discussion around safety of stimulation. Woods et al. (2016) discuss the difference between safety and tolerability, where safety refers to the damaging effects of stimulation whereas tolerability is the presence of uncomfortable or unintended effects (i.e., cutaneous sensations). It is important that we inform potential participants of cutaneous sensations and potential for severe adverse events, but shifting terminology from discussing safety of stimulation to participant tolerability may alleviate some of the apprehension around undergoing tES procedures while still allowing equivalent consideration by researchers for the maintenance of safe and ethical practice.

Sufficient evidence to warrant the use of stimulation appears of particular importance to potential participants. When exploring an eating behaviour domain, the evidence in

support of tES to modulate eating behaviour is mixed (Beaumont et al., 2022b; Lowe et al., 2017). While there were promising early findings (Fregni et al., 2008; Goldman et al., 2011), more recent work shows a lack of consistency in effects (Beaumont et al., 2021, 2023; Carvalho et al., 2019; Grundeis et al., 2017). This lack of consistency in effects does not necessarily equate lack of efficacy; however, it will likely be challenging to provide an explicit justification for use to participants, especially where they may be unfamiliar with reading scientific literature (Hutchins, 2020). In addition, there is often the need for more research to support or oppose the use of NIBS techniques within specific domains — including eating behaviour and weight management. What is particularly important when providing participants an overview of the current evidence is to avoid expectation of effects. Where participants were informed of the expected effects of tDCS on eating behaviour, Ray et al. (2019) found a significant change in eating-related variables regardless of whether participants received active or sham protocols. Our analyses identified differences in perception of efficacy, safety, and comfort between different demographic groups (e.g., age, level of education). This may suggest different types or levels of information are needed for different groups of the population. Efficacious and safe tDCS protocol for the modulation of eating behaviour comprise current intensity between 1.5 and 2.0 milliampere (mA), with electrode size not exceeding 35 cm^2 over the target region (current density between 0.057 and 0.080 $mA{\cdot}cm^{-2}$), delivered for 20 min to the right dorsolateral prefrontal cortex (Beaumont et al., 2022a).

Beyond application and overview of this method, work using NIBS techniques should provide explicit information to potential participants on what the technique is, how it is used, evidence in support of efficacy (whilst carefully considering expectation of effects), the expected short- and long-term adverse events, safety and ethical procedures, and details on researcher training. Albeit only demonstrated to a small effect size with statistical analyses, qualitative data shows the use of multiple formats of communication is effective for improving views of these techniques. As such, this information should be provided in multiple formats beyond the participant information sheet (e.g., introductory video), with enhanced opportunities for participants to ask questions (e.g., frequently asked questions forum). Noting that up to 85% attrition may be observed, the present study suggests providing such explicit information may increase recruitment rates by up to 55%. Researchers may benefit from developing a bank of images and/or videos depicting the relevant NIBS procedures that can be shared with participants. This also links with participants' trust in researchers, a topic of focus across research domains, with particular reference to research integrity and governance, importance of shared understanding, and engagement with key participant groups (Guillemin et al., 2016, 2018; Kerasidou, 2017). Providing explicit, unbiased and accessible information is vital to building trust and ensuring participants can make fully informed decisions.

Conclusion

Links are often made between NIBS procedures and more invasive and intensive techniques, which can impact individual willingness to undergo brain stimulation. This poses a particular problem when research is needed to demonstrate their efficacy for clinical use. Considering the tightly regulated and ethically scrutinised protocols, these non-invasive techniques are viewed as safe, with participants comfortable with the idea of brain stimulation. However, participants are uncomfortable with the idea of "messing" with the brain and are therefore reluctant to undergo procedures. The provision of clear, explicit and independent information on the technique used in a study or clinical setting is important for building trust and reducing fear of the research and demonstrating the need to use such paradigms. Trust in the individual delivering NIBS appears particularly important, suggesting researchers must develop connections and build a relationship with participants early on into their participation in research.

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Declarations

Conflict of Interest The authors declare no competing interests.

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