NeuroRegulation

ISNR INTERNATIONAL SOCIETY FOR NEUROREGULATION & RESEARCH

Towards the Clinical Implementation of Noninvasive Brain Stimulation for Alleviating Social Communication Challenges: Input From Two Critical Stakeholder Groups

Joan Esse Wilson[1,3], M. Blake Rafferty[1], Guadalupe Duran[1], Alexandra Ortiz[2], and Claudia D. Tesche[3]*

[1]New Mexico State University, Department of Communication Disorders, Las Cruces, New Mexico, USA
[2]Towson University, Department of Speech-Language Pathology & Audiology, Towson, Maryland, USA
[3]University of New Mexico, Department of Psychology, Albuquerque, New Mexico, USA

Abstract

Introduction. Using noninvasive brain stimulation (NIBS) during social communication therapy significantly improves performance when compared to providing therapy alone. Speech-language pathologists (SLPs) have expertise and training in providing social communication therapy for individuals with social communication challenges, such as autistic individuals. **Methods.** Two studies were completed to gain input from stakeholders who will influence NIBS's path forward for clinical use in treating social communication challenges. Study 1 examined surveys from SLPs on the clinical implementation of NIBS. Study 2 examined surveys from autistic adults about their own personal experiences after completing a research study using NIBS. **Results.** The top concerns of SLPs for the clinical implementation of NIBS were focused on the availability of safety and efficacy research, access to training, and the cost of using NIBS. Autistic adults who had previously participated in a research study using NIBS reported no safety concerns but did report a desire to use NIBS again, especially if they could access it remotely through video supervision with a trained professional. **Conclusions.** The findings of these studies inform the future clinical implementation of NIBS for improving social communication therapy with individuals with social challenges, such as autistic individuals.

Keywords: noninvasive brain stimulation; transcranial direct current stimulation; social communication; autism spectrum disorder; speech-language pathology

Citation: Esse Wilson, J., Rafferty, M. B., Duran, G., Ortiz, A., & Tesche, C. D. (2025). Towards the clinical implementation of noninvasive brain stimulation for alleviating social communication challenges: Input from two critical stakeholder groups. *NeuroRegulation, 12*(1), 29–39. https://doi.org/10.15540/nr.12.1.29

***Address correspondence to**: Joan Esse Wilson, Department of Communication Disorders, P.O. Box 30001, MSC 3SPE, New Mexico State University, Las Cruces, NM 88003, USA. Email: wilsonj@nmsu.edu

Edited by:
Rex L. Cannon, PhD, Currents, Knoxville, Tennessee, USA

Reviewed by:
Rex L. Cannon, PhD, Currents, Knoxville, Tennessee, USA
Tanya Morosoli, MSc: 1) Clínica de Neuropsicología Diagnóstica y Terapéutica, Mexico City, Mexico; 2) PPCR, ECPE, Harvard T. H. Chan School of Public Health, Boston, Massachusetts, USA

The past 2 decades have seen a sharp increase in research into the use of noninvasive brain stimulation (NIBS), such as transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS), to safely accelerate and/or enhance performance across many areas of cognitive performance including perception, mood, motor activities, and other cognitive functions (Antal et al., 2022; Mattioli et al., 2024). For example, in tDCS, weak, constant amplitude (direct) currents are delivered through electrodes placed on the scalp. Current flow between the electrodes that penetrates into the brain induces changes in local cortical excitability. In TMS, a brief pulse of current is induced to flow through a coil that is placed over the scalp. This stimulation can cause neuronal axons to fire, changing both local brain activity and activity at sites distant to the stimulation (for a review of tDCS/TMS, see Filmer et al., 2014). An attractive feature of NIBS is the ability to provide targeted treatment that focuses on specific brain processes to address each individual's challenges and needs, allowing for a personalized treatment approach. Importantly, tDCS units are also affordable,

lightweight, portable, and safe, making their use attractive for clinical implementation in the field (Mondino et al., 2014).

While many NIBS devices are currently only available in investigational research settings, TMS has long been FDA-approved for clinical use in depression (Connolly et al., 2012). The FDA has also granted an investigational device exception (IDE) for a clinical trial utilizing an at-home based tDCS stimulation device in major depressive disorder (Soterix Medical Inc.), opening a path forward for future FDA approval and clinical implementation of NIBS for a wide variety of clinical disorders.

Speech-language pathologists (SLPs) have expertise and training in providing interventions that improve social communication, which encompasses language used in social contexts, social interaction, social cognition, and language processing—domains that are needed when one desires to share their experiences, thoughts, and emotions (American Speech-Language-Hearing Association, 2024a) SLPs must consistently seek to improve therapeutic effectiveness (American Speech-Language-Hearing Association, 2024b). Even if a treatment appears to work with a client, "we cannot afford, and our clients cannot afford, for therapy to be less efficient or effective than it might be given the state of research available to us" (Ratner, 2006, p. 258). While current social therapies may facilitate improved social communication, we and others have repeatedly shown that NIBS delivered during social communication therapy significantly improves social performance when compared to providing therapy alone (for a recent review and meta-analysis, see Liu et al., 2023). Specific improvements achieved through NIBS have been found for autistic individuals in many areas important to successful social communication and social interactions such as sociocognitive information processing (Chan et al., 2023), empathy and facial emotion recognition (Esse Wilson et al., 2021), emotion face processing and gaze behavior towards emotional faces (Qiao et al., 2020), social functioning and reduced restrictive, repetitive behaviors (Han et al., 2023), verbal emotion expression (Esse Wilson, Trumbo, et al., 2018), perspective taking and self-other processing (Martin et al., 2019) and social skills and sociability (Esse Wilson, Quinn, et al., 2018; Hadoush et al., 2020). Improvement of social communication is closely tied to quality of life (QoL) for individuals with autism spectrum disorder (ASD), especially autistic adults without a co-occurring intellectual disability who report a desire for improving their quality of relationships and social interactions (Camm-Crosbie et al., 2019) and their mental health that has been negatively impacted by high levels of loneliness (Schiltz et al., 2021). It is important to investigate paths forward for the clinical implementation of NIBS for improving social communication, including for individuals with ASD, where core diagnostic criteria include "persistent deficits in social communication and social interaction across multiple contexts" (American Psychiatric Association, 2013).

Currently available pharmacological and behavioral social supports often show only modest effects for alleviating social challenges. Additionally, current treatments may be associated with adverse and sometimes serious side effects (Aishworiya et al., 2022) and employ approaches that are not individualized (Klinger et al., 2021). Hence, the development of therapeutic supports demonstrating improved efficiency, effectiveness, and individualization is critically important for improving QoL for individuals facing social challenges, such as autistic adults.

Input is needed from important stakeholders, such as from autistic adults who have previously used NIBS, as well as from SLPs whose perceptions and beliefs about NIBS will greatly influence its path forward for clinical use. Thus, our investigation completed two studies: (a) examining the perceptions of SLPs on topics relevant to the clinical implementation of NIBS, and (b) investigating the perceptions of autistic adults who recently participated in research that utilized NIBS paired with social therapy. The rationale for completing this investigation is that results will inform the future clinical implementation of NIBS in SLP practice for use in improving social communication to improve QoL for individuals with social communication challenges, including autistic individuals.

Study 1

Methods

Survey and Participants. Study procedures were reviewed and approved by the New Mexico State University (NMSU) Institutional Review Board (IRB #2211026046). Study data were collected and managed using Research Electronic Data Capture (REDCap; Harris et al., 2009) software hosted at NMSU. Upon gaining access to the survey, participants read a brief consent statement and answered *yes* if they agreed to participate in the study (*no* if not). Of the 17 total survey questions, 11 were modeled after a previous survey of SLPs on the use of tDCS with aphasia (Keator et al., 2020). A

total of 207 participants provided consent and completed surveys. The target participant population was licensed and certified SLPs (Clinical Fellow [CF] or Certificate of Clinical Competence [CCC]-SLPs). To evaluate the likelihood that the respondent was a CF or CCC-SLP, two questions were included in the survey for the purpose of evaluation by author Esse Wilson (an American Speech-Language Hearing Association [ASHA] certified and state licensed SLP) and author Duran (a 2nd-year masters-level graduate student). One evaluation question asked the respondent to provide a written answer describing the tool they would use to evaluate progress with clients with ASD. The second evaluation question asked the respondent to provide written text explaining why they thought more research studies have been completed on NIBS with individuals with aphasia than with autism. For both questions, a CF or CCC-SLP is expected to provide answers that demonstrate their training and qualifications. Responses to these two questions, along with the response to the question *What are your credentials?* were evaluated together. For example, surveys were disqualified from use in the study if a respondent answered "other" for their credentials and also wrote "I don't know" for either of the two evaluation questions. Both reviewers had 100% agreement that 21 surveys substantially departed from the answers a trained and qualified SLP would provide, and these surveys were removed from the final sample. Additionally, three surveys were removed as being incomplete. Twelve respondents reported being from countries outside the United States, six of whom did not report having CF or CCC-SLP and reported "other" as their credential. Given that certification requirements vary across countries, the survey responses of these six respondents were evaluated and determined to be reflective of responses that trained and qualified SLPs would provide. These six respondents were included in the final sample. Thus, surveys from a total of 184 respondents were included in the final sample. Participant professional characteristics gathered from the surveys are summarized in Table 1.

Table 1
Participant Professional Characteristics

Participant Characteristic	*N*	%
Years practicing as an SLP (mean = 18.0 years, range = 1–60 years)		
1–10 years	60	33
11–20 years	51	28
21–30 years	49	27
> 31 years	24	13
Credentials		
Masters CF-SLP	7	4
Masters CCC-SLP	140	76
Doctoral CCC-SLP	31	17
Other	6	3
Country where practicing		
United States (U.S.)	172	93
Canada	4	3
Other	8	4

Table 1
Participant Professional Characteristics

Participant Characteristic	*N*	%
SLP work setting (select all that apply)		
School-based	86	46
Private practice	53	28
Pre-K	49	26
University/higher ed.	42	23
Early intervention	36	19
Other	31	17
Hospital	18	10
Home visits	18	10
Adult outpatient	8	4

Note. Percentages yield greater than 100% accounted for by SLPs employed in more than one work setting. CF = clinical fellow, CCC = Certificate of Clinical Competence, SLP = speech-language pathologist.

Data Analysis

Quantitative Analysis. We first sought to characterize SLPs' existing familiarity with NIBS by constructing binary logistic regression models predicting participant responses to the question: *Before taking this survey, were you familiar with noninvasive brain stimulation, such as transcranial direct current stimulation (tDCS) or transcranial magnetic stimulation (TMS).* Models were built using the *glm* function in R's *stats* package (R Development Core Team, 2008). Our decision to use binary logistic regression was motivated by the dichotomous structure of the response data (Gardner et al., 1995). Separate models were created to predict the likelihood that participants had prior knowledge of NIBS on the basis of (a) work setting, (b) experience, and (c) current clinical involvement with ASD clients.

The experience model included factors for *Years of Clinical Experience* and *Clinician Credentials*. *Years of Experience* was treated as an ordinal factor, with each participant being assigned to one of four groups based on percentile rank. The groups consisted of those with less than 9 years of experience, those with 9–16 years of experience, those with 17–25 years of experience, and those with more than 25 years of experience. The group with less than 9 years of experience was treated as the reference level. The category of *Credentials* was also treated as an ordinal factor, with MS-CFY was treated as the reference level.

In addition to evaluating clinicians' familiarity with NIBS, we also sought to characterize clinicians' perceptions regarding the safety of NIBS. For this, we constructed binary logistic regression models to predict the likelihood that study participants agreed/disagreed with the statement: *I believe noninvasive brain stimulation (NIBS) is safe to use*. However, because this question permitted three types of responses (*yes, no, unsure*), we evaluated two separate classes of regression models. In the first, we evaluated which factors predicted increased likelihood that participants would select *yes* (i.e., the target response) as opposed to *no* or *unsure*, which were grouped together as nonaffirmative responses. In the second, we evaluated which factors predicted increased likelihood that participants would select the target response of *no* as opposed to *yes* or *unsure*, which were grouped together as non-oppositional responses. Within each model class, we constructed separate models to predict SLPs' perceptions of NIBS safety on the basis of (a) work setting, (b) experience, and (c) current clinical involvement with ASD clients.

Qualitative Analysis. Respondents were asked their concerns about incorporating NIBS, such as tDCS, into their practice and were offered choices for *safety, cost, administrative approval, reimbursement concerns, NIBS/tDCS training and education/continuing education, N/A I have no concerns,* and *other*. For respondents who chose *other*, they were asked to expand on their concerns by providing written comments. Authors Esse Wilson

(an established researcher and SLP) and Ortiz (a 1st-year graduate student in speech-language pathology) independently evaluated the written answers by completing analysis based on Vaismoradi et al. (2016) including the phases of initialization and construction which involved reading transcriptions and noting meanings, coding, writing notes; classifying, comparing, and labeling repeating ideas that contribute to the study's questions; and defining and describing these ideas. After completion of the independent analyses, a discussion between the two evaluators was completed to determine final themes and their variations, as well as their connections to one another.

Results

Prior Familiarity With NIBS. (Answer options – *select one: yes, no*) Prior to taking the survey, 85 respondents (46.2%) reported being familiar with NIBS while 99 (53.8%) reported unfamiliarity. Prior familiarity with NIBS was significantly predicted by respondent work setting, years of experience as an SLP, and credentials. Working in a university setting (p = .002) or adult outpatient setting (p = .049) significantly predicted prior familiarity with NIBS. Additionally, prior familiarity significantly decreased with years of experience practicing as an SLP (p = .016). Specifically, prior familiarity was more likely to be reported in the group of respondents who had practiced fewer than 9 years and less likely in those with more than 9 years of experience. A marginally significant effect was observed for credentials, where those with the MS-CF and PhD-CCC (p = .077) were more likely to indicate prior familiarity than respondents with their MS-CCC.

Believe Safe to Use. (Answer options – *select one: yes, no, unknown*) The majority of respondents reported they did not know if NIBS was safe to use (n = 128, 69.6%), whereas 51 (27.7%) reported they believed it was safe to use, and 5 (2.7%) believed it was not safe to use. Believing NIBS is safe to use was significantly predicted by respondent work setting and experience. Specifically, adult outpatient SLPs (p = .048) were significantly more likely to select that NIBS is safe to use than the other possible responses. Additionally, SLPs with less years of experience were significantly more likely to believe NIBS is safe to use (p = .019).

Concerns About Incorporating NIBS Into Your Practice. (Answer options – *select all that apply: 1) safety, 2) cost, 3) administrative approval, 4) reimbursement concerns, 5) NIBS/tDCS training/continuing education, 6) N/A I have no concerns, 7) Other (please expand in the question that follows*)). The three highest concerns were: (a) safety 76% (n = 142), (b) NIBS/tDCS training and education/continuing education 66% (n = 122), and (c) cost 58% (n = 108). SLPs working in private practice (p = .007) or adult outpatient work settings (p = .057) or "other" setting (p = .004) were significantly more likely to indicate a concern about incorporating NIBS into practice due to reimbursement concerns. SLPs working in school-based (p = .087) or hospital (p = .078) work settings were marginally more likely to indicate a concern about incorporating NIBS into practice due to training and continuing education concerns.

Would Consider Using NIBS With My Clients With Autism Spectrum Disorder If. (Answer options – *select all that apply: 1) reasonably priced, 2) I were able to receive extensive training for it, 3) I could refer my client to another professional who was trained in using noninvasive brain stimulation, 4) research showed it was effective for helping my clients meet their goals, 5) research showed it was safe for use with my clients, or 6) I would not consider using noninvasive brain stimulation with my SLP clients.*) Observed as the three most important factors in considering the use of NIBS with autistic clients were: (a) research showed it was safe to use with clients (n = 145, 78%), (b) research showed it was effective for helping clients meet their goals (n = 142, 76%), and (c) SLPs were able to receive extensive training (n = 87, 47%) or could refer to another professional who was trained (n = 86, 46%). Price was also an important factor (n = 60, 32%).

Qualitative Analysis

Additional Concerns About Using NIBS. More than 30% (n = 56) of respondents reported they had additional concerns about incorporating NIBS into practice with their clients and provided written responses, from which four main themes emerged: (a) efficacy, (b) concerns about NIBS as a neuroaffirming treatment, (c) need for training/continuing education, and (d) need for treatment protocols. All comments were reviewed, with statements that reflected multiple respondents noted and provided as examples categorized by the four main themes, as shown in Table 2.

Table 2
Participant Example Statements (n = 56) by Theme From Question on Concerns About Incorporating NIBS Into Practice

Theme	Statements
Efficacy (*n* = 34)	• I want to see that it is evidence-based practice. • The amount and duration of research completed on what number of children and ages of children. • I don't think it is appropriate for school-based therapy.
Concerns about NIBS as a neuroaffirming treatment (*n* = 20)	• We should be working to affirm autistic people and not trying to make them neurotypical. • I do not believe that autism needs to be cured. • Despite reframing from neurodiversity, some children have extreme challenges resulting in self-injury and aggression. I would consider NIBS for these types of challenges.
Need for training/continuing education (*n* = 11)	• I would want to read the literature about NIBS and ASD. I need much more information.
Need for treatment protocols (*n* = 9)	• No existing protocols to match intervention to target specific areas of concern for clients with autism, given the spectrum of the disorder.

Study 2

Autistic adults without a co-occurring intellectual disability frequently possess unique gifts (Baron-Cohen, 2009; Happe & Vital, 2009) and a near 50% college completion rate (Rødgaard et al., 2022). Yet, many autistic adults continue to face social challenges that negatively impact their mental health (Schiltz et al., 2021), contribute to the lowest employment rate among disability groups (Roux et al., 2015), high rates of self-reported depression and anxiety (Ayres et al., 2018), and a desire for improved relationships and social interactions (Camm-Crosbie et al., 2019). Research into the use of NIBS has demonstrated success in alleviating social challenges (Esse Wilson et al., 2021), treating depression (Palm et al., 2012), and reducing anxiety (Zheng et al., 2024). However, any future clinical implementation of NIBS will require input from autistic adults who have themselves used NIBS. Thus, Study 2 is a survey of autistic adults who have previously participated in a research study that utilized NIBS (specifically tDCS) paired with simultaneous social learning activities.

Methods

Study and survey procedures were approved by the Office of the Institutional Review Board of the University of New Mexico (IRB #21814). Thirty-two autistic adults (adults diagnosed with ASD or having high traits of autism) without a co-occurring intellectual disability (as confirmed by the Shipley-2 test of intelligence) were contacted who had previously completed a research study that utilized tDCS. Of these 32 autistic adults, all had requested to be contacted in the future for studies. Fourteen respondents provided consent to participate and completed a 15-item email survey on their experiences with NIBS. Participants scored a 17 or higher on the autism quotient (AQ), a measure of one's level of autistic traits (Baron-Cohen et al., 2001). Additionally, the Autism Diagnostic Observation Schedule – Second Edition (ADOS-2; Lord et al., 2012) was administered. Participant characteristics are summarized in Table 3.

Participants provided their level of agreement or disagreement or each survey statement (1 = *definitely disagree*, 2 = *disagree*, 3 = *agree*, 4 = *definitely agree*).

Table 3
Participant Characteristics

Participant Characteristic	Range	Mean
Years of age	18–29	23
Shipley-2 standard scores	89–125	114
AQ scores	18–44	33
ADOS-2 categorization	autism (11), non-autism (but with high traits of autism) (2)	
Sex at birth	male (3), female (11)	

Note. Shipley-2 = Shipley second-edition, AQ = autism quotient, ADOS-2 = Autism Diagnostic Observation Schedule, Second Edition.

Results

Results were organized into four categories (a) *general NIBS topics*, (b) *autistic prioritized NIBS treatment*, (c) *development of NIBS treatment goals*, and (d) *NIBS for alleviating negative symptoms*.

General NIBS Topics. In response to *Had you heard of noninvasive brain stimulation before participating in a research study?* 93% replied *no* with 7% replying *yes.* For the question *During my research study, I felt NIBS was safe to use,* all respondents reported *agree* or *definitely agree.* For *NIBS is appealing to me as a possible alternative to other therapies, such as pharmaceuticals,* the majority of respondents replied with *agree* or *definitely agree,* with two replying with *disagree,* and the statement *It is important that people with autism play a role in the design phase of brain stimulation research that will treat negative symptoms of autism* was overwhelmingly answered with *definitely agree* with one respondent answering *agree.*

Delivery of NIBS. The majority of respondents chose *agree* or *definitely agree* in response to the question *If NIBS were available as a free or low-cost treatment to address negative symptoms of autism, I would seek this treatment,* with four respondents choosing *disagree*. In response to *I would be comfortable setting up and administering NIBS myself in my own home if a trained professional was assisting me through a video meeting,* the majority of respondents chose *agree* or *definitely agree* with one respondent replying with *disagree*, and for *I would only want to use noninvasive brain stimulation if it is administered by a trained professional when I visit them in their office* the overwhelming majority chose *disagree* with one respondent choosing *agree*.

Autistic Prioritized NIBS Treatment. For the statement, *I would like trained professionals to work with me to develop treatment goals for using NIBS*, respondents were closely split three ways between *disagree, agree,* and *definitely agree*. For *I'd like to develop my own treatment goals for using NIBS* the majority responded with *agree* or *definitely agree,* with three respondents who replied with *disagree*. In response to the statement *Parents should be solely responsible for determining the NIBS treatment goals for their minor children* all respondents replied with *disagree* or *definitely disagree*. Last, in response to *Parents should work with highly trained professionals to determine NIBS treatment goals for their children* the majority of respondents replied *agree* or *definitely agree,* with two respondents providing *disagree*.

NIBS for Alleviating Negative Symptoms. For the statement *NIBS should be used to address negative symptoms of autism, not used to become what is considered closer to neurotypical,* the majority of respondents overwhelmingly replied with *definitely agree*, with four respondents replying with *agree*. In response to *Parents should pursue the use of NIBS to attempt making their child more neurotypical, if that is an option,* respondents overwhelmingly chose *disagree* or *definitely disagree,* with one respondent choosing *agree*. Last, in response to *Parents should pursue using NIBS to treat their child's negative symptoms of autism, but they should not pursue using it in an attempt to make their child more neurotypical,* the majority responded with *agree* or *definitely agree*, with three responding with *disagree*.

General Discussion

This is the first study to report on the perceptions of either SLPs or autistic adults on topics related to the clinical implementation of NIBS. To determine these perceptions, two studies were completed: (a) Study 1 which was an online survey of SLPs and (b) Study 2 which was an email survey of autistic adults who had recently participated in a research study that used NIBS paired with social therapy.

Study 1: SLPs

SLPs from diverse work settings with a broad range of years of experience were represented in the survey. Most SLPS reported practicing in the United States, nearly half reported at least one of their work settings was school-based, and most had the credentials of MS CCC-SLP. Of these respondents, more than half reported they had no familiarity with NIBS prior to taking the survey. Overall, SLP respondents reported similar perceptions and bconcerns for implementing NIBS into their practice with their clients with ASD, expressing top concerns for needing research demonstrating the safety and effectiveness of NIBS, training and continuing education for using NIBS, and the cost of using NIBS. These findings were at odds with recent literature that has widely reported on the safety, efficacy, and affordability of tDCS, in particular (Bikson et al., 2016; Sauvaget et al., 2019; Zheng et al., 2024). However, the high number of SLP respondents who reported having no prior knowledge of NIBS may explain their unfamiliarity with recent findings reporting safety, efficacy, and affordability. Regardless of their perceptions and concerns, 76% of SLP respondents reported they would use NIBS with their clients with ASD if it was safe, and even more (78%) reported they would use NIBS with the clients with ASD if it was effective in meeting client goals. These findings suggest the willingness of SLPs to seek novel evidence-based interventions to help their clients, as well as the critical importance of raising awareness among SLPs about the safety, efficacy, and affordability of NIBS, which will be necessary for future efforts to move research findings to clinical implementation.

Additionally, future studies would benefit from the addition of survey questions that address perceptions of SLPs on NIBS use with autistic children separately from adults, as several of our findings results suggest SLPs have different perceptions for using NIBS with children versus adults.

Concerns were also expressed in the qualitative analysis about whether NIBS is a neuroaffirming treatment (n = 20, 11% of total respondents). Autistic adults without a co-occurring intellectual disability (approximately 44% of individuals in the United States [Maenner et al., 2023]) are positioned to engage in self-advocacy and make decisions about their own care (Leadbitter et al., 2021), which may include choosing to help researchers during the design phase of a study or participating in studies utilizing NIBS. An interest in self-advocacy may explain why all of the autistic adults who completed the NIBS research study requested to be contacted for future studies.

It was revealed through qualitative analysis of SLP comments that many respondents were viewing NIBS primarily through the lens of its use with children (e.g., “I don't think it is appropriate for school-based therapy”, “… some children have extreme challenges”, “… the amount and duration of research completed on what number of children and ages of children”). This view may be explained by the high number of respondents who reported that at least one of their work settings involved working with children (early intervention, pre-K, or school-based). However, these responses highlight a need for a continued effort to raise awareness about the safety and efficacy of using NIBS with children, including children with ASD (Romei et al., 2019).

Study 2: Autistic Adults

Although most autistic adult respondents (93%) reported having no familiarity with NIBS prior to participating in the study, all respondents reported they either *agree* or *definitely agree* that NIBS felt safe to use during their study. Autistic adults overwhelmingly reported they *agree* or *definitely agree* they would consider purchasing a NIBS device to use at home if a trained professional was assisting through a video meeting. These responses speak to the potential for future research and clinical implementation for the use of tDCS, a portable, lightweight, and inexpensive methodology (Sauvaget et al., 2019), particularly home-based, remotely supervised tDCS (RS-tDCS) which delivers the same treatment one would receive in person except through supervision provided remotely with a device provided to the client that is programmed to administer a predetermined “dose” of tDCS when an assigned code is entered. RS-tDCS has shown evidence for use with a variety of conditions, including major depressive disorder (Cappon et al., 2022), aphasia (Richardson et al., 2023), and cognitive decline (Gough et al., 2020). There are potential challenges and limitations involved with

home-based RS-tDCS administration, such as possible risks related to the loss of confidentiality, ensuring safety and client tolerability, client training and technical difficulties, and concerns that home administration may increase the burden on caregivers (Cucca et al., 2019; Pilloni et al., 2022). Despite these potential challenges, RS-tDCS remains an attractive future option that may allow autistic adults to receive treatment services in any location they choose, which suggests alignment with autistic prioritized treatment that supports lower anxiety and distress through fewer changes to routines and lowered environmental sensory demands, areas that often provide challenges for autistic individuals (Boulter et al., 2014).

Adult autistic respondents also reported they *agree* that NIBS is appealing as a possible alternative to other therapies, such as pharmaceuticals. This perspective may be accounted for by reports that 30–50% of autistic individuals are prescribed at least one psychotropic medication and 30% are prescribed three or more, despite the frequency of experiencing adverse side effects (Feroe et al., 2021).

Autistic adult respondents reported they *definitely agree* that NIBS should be used to address negative symptoms that reduce QoL, not trying to use NIBS to become more neurotypical. To this point, a notable feature of NIBS is its ability to provide highly individualized interventions by pairing evidence-based social interventions with NIBS based on the functional and structural anatomy and/or connectivity of each person to reach specifically targeted networks (Jog et al., 2019). This approach suggests partnerships for autistic prioritized outcomes that respect individual neurotypes, which is in alignment with the responses received from the majority of autistic adults who *agree* or *definitely agree* that they would like to play a role in developing their own treatment goals.

A limitation of this study is the small sample size of autistic adults in Study 2. There is a need for future research that gathers the input of a larger number of autistic adults on the topic of NIBS use. To this end, our research team has implemented a poststudy survey on NIBS use with all current and future autistic adults who are participating in our studies that utilize NIBS. Another limitation of this study is the possibility of selection bias related to the autistic adults who participated in Study 2. Given that these participants were a convenience sample available to the authors from previously completed studies, biases may be present based on prior experience with the study team and NIBS, although the prior experience with NIBS was key to why these participants were recruited. Again, this suggests the need for future studies with larger sample sizes to reduce the chance of selection bias and sampling error.

The findings of these two studies inform the future clinical implementation of NIBS in SLP practice for use in improving social communication and QoL for people with social communication challenges, including autistic adults.

Author Declarations

We have no known conflicts of interest to disclose. This work was completed without funding. The original research study that provided contact with the autistic adult respondents for this work was completed with support from the Mind Research Network, 1101 Yale Blvd. NE, Albuquerque, New Mexico 87106, USA.

References

Aishworiya, R., Valica, T., Hagerman, R., & Restrepo, B. (2022). An update on psychopharmacological treatment of autism spectrum disorder. *Neurotherapeutics, 19*(1), 248–262. https://doi.org/10.1007/s13311-022-01183-1

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

American Speech-Language-Hearing Association. (2024a). *Social communication disorder*. https://www.asha.org/Practice-Portal/Clinical-Topics/Social-Communication-Disorder/

American Speech-Language-Hearing Association. (2024b). *The EBP process*. ASHA. https://www.asha.org/Research/EBP/Evidence-Based-Practice-Process/

Antal, A., Luber, B., Brem, A. K., Bikson, M., Brunoni, A. R., Cohen Kadosh, R., Dubljević, V., Fecteau, S., Ferreri, F., Flöel, A., Hallett, M., Hamilton, R. H., Herrmann, C. S., Lavidor, M., Loo, C., Lustenberger, C., Machado, S., Miniussi, C., Moliadze, V., … Paulus, W. (2022). Non-invasive brain stimulation and neuroenhancement. *Clinical Neurophysiology Practice, 7*, 146–165. https://doi.org/10.1016/j.cnp.2022.05.002

Ayres, M., Parr, J. R., Rodgers, J., Mason, D., Avery, L., & Flynn, D. (2018). A systematic review of quality of life of adults on the autism spectrum. *Autism, 22*(7), 774–783. https://doi.org/10.1177/1362361317714988

Baron-Cohen, S. (2009). Autism: The empathizing-systemizing (E-S) theory. *Annals of the New York Academy of Sciences, 1156*(1), 68–80. https://doi.org/10.1111/j.1749-6632.2009.04467.x

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism spectrum quotient: Evidence from Asperger syndrome/high functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*, 5–17. https://doi.org/10.1023/A:1005653411471

Bikson, M., Grossman, P., Thomas, C., Zannou, A. L., Jiang, J., Adnan, T., Mourdoukoutas, A. P., Kronberg, G., Truong, D., Boggio, P., Brunoni, A. R., Charvet, L., Fregni, F., Fritsch, B., Gillick, B., Hamilton, R. H., Hampstead, B. M., Jankord, R., Kirton, A., … Woods, A. J. (2016). Safety of transcranial

direct current stimulation: Evidence based update 2016. *Brain Stimulation, 9*(5), 641–661. https://doi.org/10.1016/j.brs.2016.06.004

Boulter, C., Freeston, M., South, M., & Rodgers, J. (2014). Intolerance of uncertainty as a framework for understanding anxiety in children and adolescents with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 44*, 1391–1402. https://doi.org/10.1007/s10803-013-2001-x

Camm-Crosbie, L., Bradley, L., Shaw, R., Baron-Cohen, S., & Cassidy, S. (2019). 'People like me don't get support': Autistic adults' experiences of support and treatment for mental health difficulties, self-injury and suicidality. *Autism, 23*(6), 1431–1441. https://doi.org/10.1177/1362361318816053

Cappon, D., den Boer, T., Jordan, C., Yu, W., Lo, A., LaGanke, N., Biagi, M. C., Skorupinski, P., Ruffini, G., Morales, O., Metzger, E., Manor, B., & Pascual-Leone, A. (2022). Safety and feasibility of tele-supervised home-based transcranial direct current stimulation for major depressive disorder. *Frontiers in Aging Neuroscience, 13*, Article 765370. https://doi.org /10.3389/fnagi.2021.765370

Chan, M. M. Y., Choi, C. X. T., Tsoi, T. C. W., Shea, C. K. S., Yiu, K. W. K., & Han, Y. M. Y. (2023). Effects of multisession cathodal transcranial direct current stimulation with cognitive training on sociocognitive functioning and brain dynamics in autism: A double-blind, sham-controlled, randomized EEG study. *Brain Stimulation, 16*(6), 1604–1616. https://doi.org /10.1016/j.brs.2023.10.012

Connolly, K. R., Helmer, A., Cristancho, M. A., Cristancho, P., & O'Reardon, J. P. (2012). Effectiveness of transcranial magnetic stimulation in clinical practice post-FDA approval in the United States: Results observed with the first 100 consecutive cases of depression at an academic medical center. *Journal of Clinical Psychiatry, 73*(4), e567–e573. https://doi.org/10.4088/JCP.11m07413

Cucca, A., Sharma, K., Agarwal, S., Feigin, A. S., & Biagioni, M. C. (2019). Tele-monitored tDCS rehabilitation: Feasibility, challenges and future perspectives in Parkinson's disease. *Journal of NeuroEngineering and Rehabilitation, 16*(1), Article 20. https://doi.org/10.1186/s12984-019-0481-4

Esse Wilson, J., Trumbo, M. C., & Tesche, C. D. (2021). Transcranial direct current stimulation (tDCS) improves empathy and recognition of facial emotions conveying threat in adults with autism spectrum disorder (ASD): A randomized controlled pilot study. *NeuroRegulation, 8*(2), 87–95. https://doi.org/10.15540/NR.8.2.87

Esse Wilson, J., Trumbo, M. C., Wilson, J. K., & Tesche, C. D. (2018). Transcranial direct current stimulation (tDCS) over right temporoparietal junction (rTPJ) for social cognition and social skills in adults with autism spectrum disorder (ASD). *Journal of Neural Transmission, 125*(12), 1857–1866. https://doi.org/10.1007/s00702-018-1938-5

Esse Wilson, J., Quinn, D. K., Wilson, J. K., Garcia, C. M., & Tesche, C. D. (2018). Transcranial direct current stimulation to the right temporoparietal junction for social functioning in autism spectrum disorder. *The Journal of ECT, 34*(1), e10–e13. https://doi.org/10.1097/YCT.0000000000000445

Feroe, A. G., Uppal, N., Gutiérrez-Sacristán, A., Mousavi, S., Greenspun, P., Surati, R., Kohane, I. S., & Avillach, P. (2021). Medication use in the management of comorbidities among individuals with autism spectrum disorder from a large nationwide insurance database. *JAMA Pediatrics, 175*(9), 957–965. https://doi.org/10.1001/jamapediatrics.2021.1329

Filmer, H. L., Dux, P. E., & Mattingley, J. B. (2014). Applications of transcranial direct current stimulation for understanding brain function. *Trends in Neurosciences, 37*(12), 742–753. https://doi.org/10.1016/j.tins.2014.08.003

Gardner, W., Mulvey, E. P., & Shaw, E. C. (1995). Regression analyses of counts and rates: Poisson, overdispersed Poisson, and negative binomial models. *Psychological Bulletin, 118*(3), 392–404. https://doi.org/10.1037/0033-2909.118.3.392

Gough, N., Brkan, L., Subramaniam, P., Chiuccariello, L., De Petrilloid, A., Mulsant, B. H., Bowie, C. R., & Rajjiid, T. K. (2020). Feasibility of remotely supervised transcranial direct current stimulation and cognitive remediation: A systematic review. *PLoS ONE, 15*(2), Article e0223029. https://doi.org /10.1371/journal.pone.0223029

Hadoush, H., Nazzal, M., Almasri, N. A., Khalil, H., & Alafeef, M. (2020). Therapeutic effects of bilateral anodal transcranial direct current stimulation on prefrontal and motor cortical areas in children with autism spectrum disorders: A pilot study. *Autism Research, 13*(5), 828–836. https://doi.org /10.1002/aur.2290

Han, Y. M. Y., Chan, M. M. Y., Shea, C. K. S., Mo, F. Y. M., Yiu, K. W. K., Chung, R. C. K., Cheung, M. C., & Chan, A. S. (2023). Effects of prefrontal transcranial direct current stimulation on social functioning in autism spectrum disorder: A randomized clinical trial. *Autism, 27*(8), 2465–2482. https://doi.org/10.1177/13623613231169547

Happe, F., & Vital, P. (2009). What aspects of autism predispose to talent? *Philosophical Transactions of the Royal Society, 364*, 1369–1375. https://doi.org/10.1098/rstb.2008.0332

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics, 42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Jog, M. V., Wang, D. J. J., & Narr, K. L. (2019). A review of transcranial direct current stimulation (tDCS) for the individualized treatment of depressive symptoms. *Personalized Medicine in Psychiatry, 17*, 17–22. https://doi.org/10.1016/j.pmip.2019.03.001

Keator, L. M., Basilakos, A., Rorden, C., Elm, J., Bonilha, L., & Fridriksson, J. (2020). Clinical implementation of transcranial direct current stimulation in aphasia: A survey of speech-language pathologists. *American Journal of Speech-Language Pathology, 29*(3), 1376–1388. https://doi.org /10.1044/2020_AJSLP-19-00037

Klinger, L. G., Cook, M. L., & Dudley, K. M. (2021). Predictors and moderators of treatment efficacy in children and adolescents with autism spectrum disorder. *Journal of Clinical Child & Adolescent Psychology, 50*(4), 517–524. https://doi.org /10.1080/15374416.2020.1833735

Leadbitter, K., Buckle, K. L., Ellis, C., & Dekker, M. (2021). Autistic self-advocacy and the neurodiversity movement: Implications for autism early intervention research and practice. *Frontiers in Psychology, 12*, Article 635690. https://doi.org/10.3389/fpsyg.2021.635690

Liu, A., Gong, C., Wang, B., Sun, J., & Jiang, Z. (2023). Non-invasive brain stimulation for patient with autism: A systematic review and meta-analysis. *Frontiers in Psychiatry, 14*, Article 1147327. https://doi.org/10.3389/fpsyt.2023.1147327

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism diagnostic observation schedule* (2nd ed.). Western Psychological Services.

Maenner, M. J., Warren, Z., Williams, A. R., Amoakohene, E., Bakian, A. V., Bilder, D. A., Durkin, M. S., Fitzgerald, R. T., Furnier, S. M., Hughes, M. M., Ladd-Acosta, C. M., McArthur, D., Pas, E. T., Salinas, A., Vehorn, A., Williams, S., Esler, A., Grzybowski, A., Hall-Lande, J., … Shaw, K. A. (2023). Prevalence and characteristics of autism spectrum disorder among children aged 8 years - Autism and developmental disabilities monitoring network, 11 sites, United States, 2020. *MMWR Surveillance Summaries, 72*(2), 1–14. https://doi.org /10.15585/mmwr.ss7202a1

Martin, A. K., Huang, J., Hunold, A., & Meinzer, M. (2019). Dissociable roles within the social brain for self-other

processing: A HD-tDCS study. *Cerebral Cortex, 29*(8), 3642–3654. https://doi.org/10.1093/cercor/bhy238

Mattioli, F., Maglianella, V., D'Antonio, S., Trimarco, E., & Caligiore, D. (2024). Non-invasive brain stimulation for patients and healthy subjects: Current challenges and future perspectives. *Journal of the Neurological Sciences, 456*, Article 122825. https://doi.org/10.1016/j.jns.2023.122825

Mondino, M., Bennabi, D., Poulet, E., Galvao, F., Brunelin, J., & Haffen, E. (2014). Can transcranial direct current stimulation (tDCS) alleviate symptoms and improve cognition in psychiatric disorders? The *World Journal of Biological Psychiatry, 15*(4), 261–275. https://doi.org/10.3109/15622975.2013.876514

Palm, U., Schiller, C., Fintescu, Z., Obermeier, M., Keeser, D., Reisinger, E., Pogarell, O., Nitsche, M. A., Möller, H.-J., & Padberg, F. (2012). Transcranial direct current stimulation in treatment resistant depression: A randomized double-blind, placebo-controlled study. *Brain Stimulation, 5*(3), 242–251. https://doi.org/10.1016/j.brs.2011.08.005

Pilloni, G., Vogel-Eyny, A., Lustberg, M., Best, P., Malik, M., Walton-Masters, L., George, A., Mirza, I., Zhovtis, L., Datta, A., Bikson, M., Krupp, L., & Charvet, L. (2022). Tolerability and feasibility of at-home remotely supervised transcranial direct current stimulation (RS-tDCS): Single-center evidence from 6,779 sessions. *Brain Stimulation, 15*(3), 707–716. https://doi.org/10.1016/j.brs.2022.04.014

Qiao, Y., Hu, Q., Xuan, R., Guo, Q., Ge, Y., Chen, H., Zhu, C., Ji, G., Yu, F., Wang, K., & Zhang, L. (2020). High-definition transcranial direct current stimulation facilitates emotional face processing in individuals with high autistic traits: A sham-controlled study. *Neuroscience Letters, 738*, Article 125396. https://doi.org/10.1016/j.neulet.2020.135396

Ratner, N. B. (2006). Evidence-based practice: An examination of its ramifications for the practice of speech-language pathology. *Language, Speech, and Hearing Services in Schools, 37*(4), 257–267. https://doi.org/10.1044/0161-1461(2006/029)

Richardson, J. D., Galletta, E. E., Charvet, L., & Shaw, M. (2023). Feasibility of remotely supervised transcranial direct current stimulation (RS-tDCS) for people with stroke-induced and progressive aphasia. *Aphasiology, 37*(7), 1039–1063. https://doi.org/10.1080/02687038.2022.2076279

Rødgaard, E.-M., Jensen, K., Miskowiak, K. W., & Mottron, L. (2022). Representativeness of autistic samples in studies recruiting through social media. *Autism Research, 15*(8), 1447–1456. https://doi.org/10.1002/aur.2777

Romei, V., Borgatti, R., & Urgesi, C. (2019). Non-invasive brain stimulation for the rehabilitation of children and adolescents with neurodevelopmental disorders: A systematic review. *Frontiers in Psychology, 10*, Article 135. https://doi.org/10.3389/fpsyg.2019.00135

Roux, A. M., Rast, J. E., Rava, J. A., Anderson, K. A., & Shattuck, P. T. (2015). *National autism indicators report: Transition into young adulthood*. Life Course Outcomes Research Program, A. J. Drexel Autism Institute, Drexel University. https://drexel.edu/autismoutcomes/publications-and-reports/publications/National-Autism-Indicators-Report-Transition-to-Adulthood/

Sauvaget, A., Tostivint, A., Etcheverrigaray, F., Pichot, A., Dert, C., Schirr-Bonnais, S., Clouet, J., Sellal, O., Mauduit, N., Leux, C., Cabelguen, C., Bulteau, S., & Riche, V.-P. (2019). Hospital production cost of transcranial direct current stimulation (tDCS) in the treatment of depression. *Neurophysiologie Clinique, 49*(1), 11–18. https://doi.org/10.1016/j.neucli.2018.11.001

Schiltz, H., McVey, A. J., Dolan Wozniak, B., Haendel, A. D., Stanley, R., Arias, A., Gordon, N., & Van Hecke, A. V. (2021). The role of loneliness as a mediator between autism features and mental health among autistic young adults. *Autism, 25*(2), 545–555. https://doi.org/10.1177/1362361320967789

Vaismoradi, M., Jones, J., Turunen, H., & Snelgrove, S. (2016). Theme development in qualitative content analysis and thematic analysis. *Journal of Nursing Education and Practice, 6*(5), 100–110. https://doi.org/10.5430/jnep.v6n5p100

Zheng, E. Z., Wong, N. M. L., Yang, A. S. Y., & Lee, T. M. C. (2024). Evaluating the effects of tDCS on depressive and anxiety symptoms from a transdiagnostic perspective: A systematic review and meta-analysis of randomized controlled trials. *Translational Psychiatry, 14*(1), Article 295. https://doi.org/10.1038/s41398-024-03003-w

Received: September 18, 2024
Accepted: October 30, 2024
Published: March 24, 2025