

1 **Influencing discussions and use of Neuroadvancements: Perspectives of Canadian**
2 **Occupational Therapists**

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15 **Abstract:**

16 **BACKGROUND:** The early involvement of many actors including health professionals is
17 identified in neuroethics and neurogovernance discussions as crucial in constructing conversations
18 around awareness, reaction, and knowledge development pertaining to the ethical, legal, and
19 societal consequences of neuroscientific or neurotechnological advancements (NA). Occupational
20 Therapists (OTs) have a stake in NA; however, OTs are rarely mentioned within this context.
21 Lifelong learning (LL) could be used to increase OTs knowledge on NA and its consequences.
22 However, LL is rarely mentioned within neuroethics and neurogovernance discussions.

23 **OBJECTIVE:** The study's purpose is to understand the role of OTs as professionals and citizens
24 in neuroethics and neurogovernance discussions and to examine the utility of LL processes put in
25 place for OTs to empower OTs to contribute in a meaningful way to NA discussions.

26 **METHODS:** 8 semi-structured interviews with OTs were conducted and analyzed using a directed
27 content analysis.

28 **RESULTS:** Although participants believed OTs can provide a holistic perspective to
29 neurogovernance discussions, their knowledge on NA and its consequences is limited, and LL is
30 not used as a tool to remain informed about such consequences.

31 **CONCLUSION:** More education on NA and its consequences throughout their OT degree and
32 through LL opportunities is warranted to facilitate their involvement.

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35 **Keywords:** neuroscience, neuroethics, neurogovernance, role expectation; occupational
36 therapists;

43 **1. Introduction:**

44 As neuroscientific and neurotechnological advancements (from now on called NA) such as
45 deep brain stimulation, cochlear implants, brain-computer interfaces, neurosurgery, and cognitive
46 enhancement, continue to develop, they give rise to multiple ethical, legal, and social implications
47 [1, 2]. NA can be used for a variety of reasons including for medical purposes, educational
48 purposes, human enhancement, and for recreational purposes [3-6]. People with disabilities are
49 direct recipients of NA including cochlear implants, deep brain stimulation, brain computer
50 interfaces and virtual reality and by using neuro-linked assistive technologies [7-12]. Neuroethics
51 and neurogovernance discourses have emerged to deal with the ethical, legal, social, and other
52 impacts of these advancements [5, 13, 14]. One focus of neuroethics and neurogovernance
53 discourses is to include the views of stakeholders such as researchers, health care professionals,
54 policymakers, consumers, civil society, and funders [5, 13, 15]. Occupational therapists (OTs) are
55 also stakeholders in how NA are governed due to their exposure to various NA [16-19], the impact
56 of NA on occupation [20-22], the expected role of OTs as advocates for emerging NA [23], and
57 the societal role to engage as active citizens [24]. Due to the impact of NA on occupation, their
58 field, and their clients, they have something to contribute to these discussions. Lifelong Learning
59 (LL) is essential for individuals to stay up to date with the changes in society, and specifically for
60 healthcare workers to stay up to date with the changing health care field [25, 26]. Therefore, OTs
61 can utilize LL mechanisms not only within their professional role but also within their role as
62 citizens to obtain knowledge needed to contribute in a meaningful way to neuroethics and
63 neurogovernance discussions. Given the role expectation of OTs and the impact of NA on OTs,
64 the purpose of our study is to give voice to Canadian OTs on the role of OTs as professionals and
65 citizens in NA including neuroethics and neurogovernance discussions. To fulfil the purpose, we
66 aimed to obtain answers on the following research questions by interviewing Canadian OTs: 1)
67 What is the familiarity of OTs with NA, their ethical, legal, and social implications, and their
68 governance? 2) What are the views of OTs on the impact of NA on their field, occupation, and
69 clients? 3) What are the views of OTs on using their knowledge and experiences to get involved
70 in neuroethics and neurogovernance discussions? 4) What are the views of OTs on lifelong
71 learning mechanisms put in place for OTs? 5) What are the views of OTs on the utility of LL to
72 learn about NA, especially the ethical, legal, and social implications, and how and to what extent
73 do the current LL mechanisms enable OTs to participate in neuroethics and neurogovernance
74 discussions in a meaningful way?

75 **1.1. OT and NA**

76 The term occupation is used to describe the daily tasks and purposeful activities in which
77 individuals involve themselves in due to the meanings and values they have to individuals [27].
78 Occupation is an essential part of human nature that is manifested by active participation in self-
79 maintenance, work, leisure, play, and rest [27, 28]. Occupation and humans as occupational beings
80 are impacted by the development of NA, either by outdated occupations, creating new

81 occupations, or by changing current occupations [2, 20-22, 29-31]. Given that occupation is
82 impacted by NA, and that OTs aim to enable occupation for the wellness and wellbeing of their
83 clients [32], OTs are impacted as well by NA. OTs and their clients can be impacted by therapeutic
84 and non-therapeutic NA, by enhancing the neuro-abilities of the person beyond the norm, and by
85 the use of NA to fix the person to the norm [1, 5, 33, 34]. For instance, OTs use specific NA in
86 their workplace including biofeedback [35, 36], virtual reality [23, 37], neurofeedback [16, 38],
87 brain stimulation [17], neuroimaging [39], deep brain stimulation [18], transcranial direct current
88 stimulation [40], and transcranial magnetic stimulation [19], and are stated to be advocates for
89 themselves, their field, and their clients who are end users of these NA [23]. Their clients, such as
90 people with disabilities, are impacted by NA and make use of NA including neuro-linked assistive
91 technologies [7-9, 41]. Some examples include cochlear implants [42], virtual reality used as a tool
92 for communication [41], brain machine interfaces, [43] and deep brain stimulation [44]. Given the
93 impact of NA on occupation and the OT field [2, 20-22, 29-31], and their clients [7-9, 41-44] ,
94 OTs are impacted by NA as consumers, users, educators, and advocates for their clients and field.

95 **1.2. Neuroethics and Neurogovernance**

96 Due to the increase in NA, the neurogovernance discourse has emerged that focuses on how to
97 best advance these processes [5]. The association of the term governance with science and
98 technology is used to refer to the expanded network of actors and organizations that drive the
99 development and uptake of science and technology, as part of the process of policy-making [14].
100 As further supported by Garden & Winickoff (2018), "*science and technology should inform
101 policy, and policy should guide science and technology and govern responsible innovation with
102 respect to diverse cultural domains*" Garden and Winickoff (5). Neuroethics was coined as a term
103 and developed as a field to investigate various ethical, social, and legal issues raised by the
104 advancement of the neuro-field. This includes the advancement of neuroscience,
105 neurotechnology's, and neuro-engineering as a whole [45-51], as well as individual neuro-
106 applications such as brain-computer interfaces [52, 53] and deep brain stimulation [54].

107 With the increasing impact of NA, there is an increased need for stakeholder engagement to
108 get a variety of perspectives [52, 55, 56]. Stakeholder engagement is one focus of discussions
109 within neuroethics and neurogovernance discourses and consists of societal members' opportunity
110 to inform researchers and scientists on the development of practices and policies, including the
111 distribution of education and awareness for society to develop an input [5, 13, 15, 57].

112 Concerning NA, there are a variety of stakeholder groups including researchers, health care
113 professionals, policymakers, patients, consumers, regulators, civil society, and funders [5]. OTs
114 are therefore stakeholders due to: the impact of NA on occupation and their field [2, 20-22, 29-
115 31], their exposure to NA [16-19, 23, 35-40], their expected roles as advocates and educators of
116 technologies [23, 58], and their expected roles as active citizens [24]. Therefore, OTs have the
117 potential to contribute to neuroethics and neurogovernance discussions, specifically pertaining to
118 the ethical, legal, and social implications of NA, as professionals and as active citizens. Their roles
119 can include, but are not limited to, influencer of neuroethics and neurogovernance discussions,
120 advocates for their field and clients, and researchers on topics related to OT linked to neuroethics
121 and neurogovernance.

122 **1.3. OTs as professionals and active citizens**

123 Occupational therapy is responsible for enabling an inclusive society for all people to participate
124 in their daily occupations [59], and is grounded in the belief that humans are complex beings
125 engaged in a process of dynamic interactions with the physical, social, temporal, cultural and
126 virtual environments [58]. Specifically, according to the Canadian Association of Occupational

127 Therapists (CAOT), the roles of OTs include being an expert in enabling occupation, a
128 communicator, collaborator, practice manager, change agent, scholarly practitioner and
129 professional [60]. Supported by CAOT, scholars have further explained the role of OT to include
130 various competencies such as the role to (a) apply relevant knowledge of the physical, social,
131 psychosocial, environmental, and fundamental biomedical and social sciences to practice; (b)
132 analyze physical, cultural, social, and institution environmental impact on occupational
133 engagement issues; (c) incorporate cultural, social, physical, and institutional options to increase
134 inclusion and (d) balance the ethical and professional issues inherent in client advocacy, including
135 altruism, autonomy, integrity, social justice, and idealism [61]. Furthermore, OTs are stated to be
136 crucial in addressing the development of society and its issues of the present and future [62]. One
137 way in which this can be achieved, is by exercising their role of being advocates for their clients
138 and promote inclusive communities [61, 63].

139 Active citizenship refers to the various forms of participation that ensures to reduce the gap
140 between citizens and governing institutions through the continuation of participatory and
141 representative democracy [64]. It involves a range of citizen participatory actions including
142 participatory democracy such as holding government actions accountable, and representative
143 democracy such as voting [64]. However, being an active citizen does not only encompass being
144 involved with political actions, yet also participating in one's everyday social and cultural life [24].
145 This is interconnected with the concept of occupational rights [24]. It is argued that occupational
146 therapy as a field must "*conceptualize the occupational nature of active citizenship, located as a*
147 *practice in the interconnectedness of the individual and the larger community*" Fransen, Pollard
148 (24). Furthermore, OTs have the capacity to enable and advocate for their clients, and act as active
149 citizens by researching and influencing at the policy level [65]. This can be further understood by
150 using the Person-Environment-Occupation (PEO) Model, a conceptualized term that is often
151 applied by OTs in their practice [66]. Specifically, the person is defined as a dynamic individual
152 constantly interacting with the environment, the environment is assumed to have an enabling or
153 constraining effect on occupational performance, and occupation is defined as self-directed
154 activities an individual partakes in [66]. Due to their unique understanding and experience of the
155 relationship between occupation, the person, and the environment, their involvement in developing
156 policies is warranted [65]. Additionally, health professionals are argued to be able to bring fruitful
157 knowledge from their everyday life and in their workplace to policy networks, and get involved as
158 active citizens [67, 68]. Therefore, falling in accordance with the democratization of science and
159 technology [69-71], OTs can fulfill the expectation of getting involved at the policy level through
160 their role as professionals and role as active citizens.

161 **1.4. LL for OTs as professionals and active citizens**

162 With the constantly evolving and changing society, it is necessary for individuals to learn new
163 skills and stay up to date with such changes [26]. Lifelong learning (LL) is therefore a process
164 where individuals engage in the continuous development of their knowledge, skills, and interests
165 throughout their lives [72]. Viewing LL as a lifelong, educational commitment is essential and
166 advocated for by various international organizations including The United Nations Educational
167 Scientific and Cultural Organisation (UNESCO), the Organisation for Economic Cooperation and
168 Development (OECD), and the World Bank, to name a few [73]. For health professionals,
169 including OTs, LL is essential to stay up to date with the changes in the health field and advocate
170 for the care of others [25]. Given that health professionals must constantly increase their
171 knowledge and skills throughout their careers to provide safe and competent care, and with the
172 accelerating advances in health information and technology, LL is necessary [74].

173 The process of LL falls in accordance with the College of Occupational Therapists' Research
174 and Development Strategic Vision and Action Plan, where the College emphasizes the importance
175 of continuing personal and professional development for all members including students,
176 associated, and professional members [75]. This reflects the continuum of competence required by
177 practitioners, educators, managers, and researchers to provide services based upon evidence of
178 effectiveness and best values, applying equally to all OT personnel across the range of practice
179 settings. Furthermore, according to the OT Code of ethics, all OTs are expected to contribute to
180 the continuing professional development of support workers in OT services [76]. In other words,
181 not only is LL essential for OTs, yet also an educational expectation that must be provided by OTs.

182 With the fast-pace development of neuroscience and the direct impact on society, LL has been
183 discussed as a tool to educate professionals on how to become competent consumers of such
184 research, including the ethical implications [77, 78]. Given that OT personnel have a responsibility
185 to use new technologies and new learning in order to maximize their impact for the benefit of
186 service users, LL can be one way for OTs to increase their knowledge on the ethical, legal, and
187 social issues of NA [75]. This knowledge can enhance the confidence of OTs to be involved in
188 and provide meaningful input within their professional identity towards neuroethics and
189 neurogovernance discussions.

190 As stated earlier, LL mechanisms are not only used by professionals to advance their practice,
191 but also by citizens to stay up to date with their constantly changing society [26, 79, 80]. The self-
192 motivated practice of LL not only increases individual development but also shapes individuals
193 into active citizens [81, 82]. Several characteristics required to be an active citizen include political
194 literacy and informed decision making [83]. Subsequently, these characteristics can be achieved
195 and mastered through knowledge acquired in the process of LL [64, 83]. In other words, LL
196 mechanisms can provide citizens with fruitful knowledge on how to actively get involved in
197 society and one's community, if it is not separated from other occupational activities [84].
198 Therefore, OTs can utilize LL mechanisms to increase their knowledge and identify with the role
199 of being an active citizen within their professional and personal roles.

200 To conclude, we posit that OTs have a stake not only in the utility of NA and how they impact
201 their clients medically, but also on the societal impact of NA and how they are governed. In other
202 words, given their exposure to NA and their impact, OTs have a stake and should be involved in
203 neuroethics and neurogovernance discussions. Therefore, our study focused on the following
204 research questions: 1) What is the familiarity of OTs with NA, their ethical, legal, and social
205 implications, and their governance? 2) What are the views of OTs on the impact of NA on their
206 field, occupation, and clients? 3) What are the views of OTs on using their knowledge and
207 experiences to get involved in neuroethics and neurogovernance discussions? 4) What are the
208 views of OTs on the lifelong learning mechanisms put in place for OTs? 5) What are the views of
209 OTs on the utility of LL to learn about NA especially the ethical, legal, and social implications and
210 how and to what extent do the current LL mechanisms enable OTs to participate in neuroethics
211 and neurogovernance discussions?

212 **Ethical Considerations**

213

214 This study was approved by the Conjoint Health Re-search Ethics Board (CHREB) at the
215 University of Calgary on February 23, 2018 (REB17-0785). Participants were required to read and
216 sign the informed consent form mandated by CHREB before participating. Participants were
217 informed of their role in the study, what was expected of them, expected harms and benefits, and

218 that their willingness to participate is completely voluntary and may be withdrawn at any time for
219 any reason.

220

221 **2. Methods:**

222 **2.1 Theoretical framework and research questions**

223

224 According to role theory, the expectations of the roles one thinks one should occupy at work
225 or in one's social life [85-88] are influenced by the role expectations others have of oneself [89,
226 90]. OTs are expected to fulfill many roles such as being experts in enabling occupation, being
227 communicators, collaborators, practice managers, change agents, scholarly practitioners, and
228 professionals [60], being advocates for their clients, and promoters of inclusive communities [61,
229 63]. OTs are also seen as having an essential role in addressing the development of society and its
230 issues of the present and future [62]. Given role theory, this role expectation of OTs should shape
231 OTs' own expectations of what roles they are to fill [90]. Stakeholder engagement is one focus of
232 discussions within neuroethics and neurogovernance discourses [5, 13, 15, 57] and OTs have a
233 stake in NA due to the impact of NA on occupation and their field [2, 20-22, 29-31] and their
234 exposure to NA [16-19, 23, 35-40]. However, literature does not exist that looks at OTs as
235 stakeholders in neuroethics and neurogovernance discourses. Given the role expectation of OTs
236 and the impact of NA on OTs, the purpose of our study was to give voice to Canadian OTs on
237 the role of OTs as professionals and citizens in NA including neuroethics and neurogovernance
238 discussions. To fulfil the purpose, we aimed to obtain answers to the following research questions
239 by interviewing Canadian OTs: 1) What is the familiarity of OTs with NA, their ethical, legal, and
240 social implications, and their governance? 2) What are the views of OTs on the impact of NA on
241 their field, occupation, and clients? 3) What are the views of OTs on using their knowledge and
242 experiences to get involved in neuroethics and neurogovernance discussions? 4) What are the
243 views of OTs on lifelong learning mechanisms put in place for OTs? 5) What are the views of OTs
244 on the utility of LL to learn about NA, especially the ethical, legal, and social implications and
245 how and to what extent do the current LL mechanisms enable OTs to participate in neuroethics
246 and neurogovernance discussions in a meaningful way?

247

248 **2.2. Study Design and Questionnaire**

249 We chose for our study a qualitative design [91] using semi-structured interviews
250 developed by the researchers. A qualitative design is most appropriate because the topic covered
251 by the research questions has not been engaged with in relation to OTs so far, although one study
252 investigated the views of OT students on the topic of OTs and science and technology governance
253 [21], and because we want an in-depth understanding of OTs' views and experiences [91]. This is
254 something that cannot be done by quantitative methods. The protocol also allowed us to ask
255 additional, unscripted probing questions as the interview progressed to clarify or further explore
256 participant's responses and permit participants the opportunity to discuss issues that are important
257 to them [1, 91, 92]. A semi-structured procedure was advantageous because it allowed the
258 researcher to control the line of questioning and probe further as necessary, and because
259 participants were free to incorporate personal or hypothetical examples and narratives if they felt
260 it contributes to their answering of the question [91]. Additionally, this method allowed for
261 impromptu clarification questions, which serves to strengthen qualitative validity. To answer our

262 research questions, we designed a 23-question, 9 sub-question research protocol that covered
263 demographics and our research questions and was informed by our knowledge of the literature on
264 NA and OT, neuroethics, and governance of NA. Questions were a combination of yes and no and
265 open-ended to encourage in-depth exploration of the research questions.

266 **2.3 Participants and Sampling**

267 As to inclusion criteria, participants had to be occupational therapy practitioners in Alberta,
268 practicing for at least one year. As to exclusion criteria, any subjects not practicing within the
269 province of Alberta were not considered. The researchers conducted semi-structured interviews
270 with eight practicing OTs. The participants were recruited via expert purposive sampling which
271 allowed to explore a specific group in-depth, and gather participants with particular relevant
272 knowledge [93]. We initially contacted 11 OTs with profiles on the Autism Calgary Website
273 after obtaining approval from the organization, out of which 2 practitioners volunteered to
274 participate in the study. We also contacted 33 OTs listed on the Canadian Association of
275 Occupational Therapists' website, from which 2 OTs volunteered to participate in the study. The
276 inclusion criteria for these two sources were that participants had to be registered OTs within
277 Alberta, listed in Calgary, and have an email address for contact information. It was later noted
278 that 1 participant recruited through the CAOT website listed in Calgary had moved to Edmonton
279 for work. 2 additional OTs were introduced through personal contacts, and 2 more OTs were
280 referred by another participant. These four also fit our inclusion criteria being registered OTs
281 within Alberta, listed to be in Calgary, and having an email address for contact information.

282 **2.4 Data Collection and analysis**

283 Data were collected from July 13, 2018 (first interview) to Feb 8, 2019 (last interview) by
284 performing 6 semi structured interviews face to face, 1 over the phone and 1 over skype (a total
285 of 8). The interviews lasted 40 min up to 1 hr. After conducting the interviews, they were
286 orthographically transcribed using Express Scribe® playback software into Microsoft Word®.
287 This style of transcription emphasized what was said instead of how it was said [91]. To ensure
288 the privacy and confidentiality of the participants, each transcription was anonymized, including
289 any identifiable information and every participant was given a unique number, P1-P8. Once
290 transcribed, the transcriptions were uploaded into Atlas.TI8™ [94], a qualitative analysis
291 software, where a directed content analysis [94] of the interviews was performed. A directed
292 content analysis [94] was performed to enlarge the scope of research on the views of OTs related
293 to the research questions that "*would benefit from further description*" Hsieh and Shannon (94).
294 We chose a directed content analysis approach because we made use of prior research [94]
295 around OTs and NA, OTs and LL, and NA governance and neuroethics. Within a directed
296 content analysis, codes are defined before and during data analysis which we did using prior
297 research to develop the initial coding scheme prior to beginning to analyze the data and
298 additional codes were developed as the analysis proceeded [94, 95]. As such, the coding is
299 deductive in the sense that the top level themes are defined by the questions of the survey, which
300 were generated based on the authors' prior knowledge of the literature and to fill a gap of
301 knowledge [96, 97] identified by the authors. However, the sub-themes that emerged under the
302 top-level theme were not pre-set and as such could be seen as an inductive approach, as we
303 identified in a 'bottom-up' way the content by identifying themes, organizing the themes into

304 larger categories, and then the themes were interpreted as a whole [91, 95-97]. Both authors first
305 familiarized themselves with the qualitative data by reading the whole PDF of a given transcript,
306 then re-read the content identifying potentially meaningful data whereby the unit of analysis is
307 the word level through performing semantic coding on the data [95]. The authors then identified
308 themes under each of the pre-set top themes based on meaning, repetition, and the research
309 question. Both authors engaged in analysis, and codes were cross-checked between the two
310 researchers. The interviews were re-analyzed twice after the initial coding to ensure that themes
311 had not been overlooked. Throughout the analysis, the investigators engaged in peer-debriefing
312 and personal reflection to strengthen the validity of the findings. Dependability was ensured in
313 the audit trail made possible by using Memo and coding functions within ATLAS.ti-8®.

314 **3. Results:**

315 The findings in this study are presented in six sections. The first part will cover demographics.
316 The second the familiarity of OTs with n=37 NA. The third section will explore the participants'
317 understanding of the ethical, legal, and social implications of NA, and their views on the impact
318 of NA on their field, occupation, and clients. The fourth section will cover their views on using
319 their knowledge and experiences to get involved in neuroethics and neurogovernance discussions.
320 The fifth section will outline their views on the utility of LL in general, and their use of LL to learn
321 about NA, their implications, and how and to what extent they enable them to participate in
322 neuroethics and neurogovernance discussions. Finally, the sixth section discusses the limitations
323 to the study.

324 **3.1 Demographics**

325 Once our sample was established, a total of n=8 OTs participated in 1-1 interviews,
326 specifically seven females and 1 male, whose ages ranged from twenty-nine to sixty-four years of
327 age (Table 1). Specific demographic variables including their gender, age, and their focus of
328 practice are outlined in Table 1.

329 **(Insert Table 1 here)**

330 **3.2 Familiarity with Neurotechnology's (NT)**

331 The participants interviewed expressed minimal familiarity with the term neurotechnology
332 and specific processes. Specifically, n= 2 were familiar with the term, n= 2 were not familiar with
333 the term but could guess the meaning of it, and n= 4 were not familiar with the term. In terms of
334 specific products and processes that we offered as examples of neurotechnology's the results
335 varied (Table 2).

336 **(Insert Table 2 here)**

337 We then asked where the participants' knowledge on the above NA came from: n=5 learned
338 about them in their Master's degree, n=4 learned about them from the media, n=3 have heard about
339 them in their practice, n=3 have heard about them from their colleagues, n=2 keep up with
340 neuroscience research, n=2 learned about it in their undergrad, n=1 has used it for their child's
341 therapy, and n=1 has watched neuroscience documentaries.

342 **3.3 Perceived Implication of NA**

343 We further asked the participants' views on the impact that NA will have on their
344 occupation in the future. Six of the participants expressed that NA would impact their occupation.
345 For instance, *"I think they have a huge potential to impact occupational therapy especially within
346 the rehabilitation setting, so I think the profession as a whole absolutely it has a big opportunity
347 to impact the way we practice and how far we are able to assist people within their recovery"*
348 (P4). Another participant expressed how OTs have to deal with the consequences of some
349 technologies, if considering medicine and other forms of treatment. For instance: *"you know a lot
350 of pain medications cause drowsiness and sleepiness and so then it actually reduces function of
351 the clients and that's how it can affect impact my practice right because for example, like I get a
352 referral that the client is is like you know leaning forward in their wheelchair, there is a risk of
353 falling out and and then you find out they're on lots of like medications that make them drowsy"*
354 (P8). However, n=2 participants expressed that NA will not have an impact due to barriers such as
355 access, cost, and due to their occupational setting. For example, P3 works with children and their
356 families in their homes and does not perceive NA as being implemented as part of home care.

357 All of the participants stated that NTs in particular and technologies in general will have
358 implications on society. The ethical, legal and social implications participants indicated in relation
359 to neurotechnology's are listed in Table 3.

360 **(Insert Table 3 here)**

361 Below are some quotes that highlight the participants' perceptions of the ethical, legal, and
362 social implications of NA:

363 *"One of my clients is interested in in doing the neurofeedback they can afford to go do the QEEG
364 done so if those are the only clients that I offer it to they're the ones that can afford than there is
365 a social implication of accessibility"* (P1)

366 *"how much do you wanna fine tune a person or if something is being controlled like remotely or
367 controlled by someone else like how much free will then does that person have"* (P4)

368 *"the previous approach is using these technologies to get people who are defined as lower abilities
369 back to normal now if you have this technology, some people say why should we be normal, we
370 want to go even higher. If you're going to give me artificial limbs, give me limbs that are going to
371 make me stronger than the other guy"* (P7)

372 *"there can be situations where people are deemed not to be competent to make their own decisions
373 and I think that it in of itself brings a huge ethical concern because then despite if they did not
374 want to participate in something or have this treatment if they're deemed incapable of making
375 their own decisions then they're essentially forced to have treatment when they may not have
376 wanted it"* (P6)

377 *"when you think about artificial intelligence for instance right and the concern about um replacing
378 humans right and creating these other machines to do what humans do and there is a certain
379 amount of humanness that is really important in many things we do and jobs and careers and
380 changes a lot of things for a lot of people right those types of thoughts come to mind"* (P2)

381 *“with like the whole brain emulation um I think there’s a lot of discussion around um if you can*
382 *copy a brain if you can understand you know what the function is of each different piece of that*
383 *person’s brain and even if it’s specific to them” (P4)*

384 We then asked their opinion on the importance of knowing about the ethical, legal, and
385 social implications regarding NA in their workplace, and n=7 OTs stated that it is important to
386 think in terms of these implications. Furthermore, n=6 OTs believe that it is important to talk about
387 these implications in the workplace. *“I think it’s really important to talk about it because I think*
388 *when we have that conversation then it raised awareness in people and it starts to open that*
389 *different perspective and hear other people’s opinions” (P6); “I think it’s a good idea for the*
390 *public to have awareness because you know or for professionals to have awareness because you*
391 *know if it’s one of your clients who’s asking you about it you need to be able to advise them from*
392 *all kinds of standpoints” (P5).*

393 One OT stated that OTs could be addressing the implications of NAs but they should not
394 necessarily be doing so, *“I don’t know if they should but they can, if you consider that they should*
395 *then that would bring a lot of responsibility on the OT which they don’t have that much power, it’s*
396 *just one member of the whole treatment team but they definitively can and they contribute hugely*
397 *to this because sometimes they’re the first line of defence or the first line of care provision in these*
398 *situations. They can especially as the role of an advocate for the users and also the society, but I*
399 *don’t believe they’re the sole groups responsible it’s much much bigger than just OT” (P7).*

400 Five participants indicated that OTs are uniquely positioned to understand the implications
401 of neurotechnology’s on occupation. The PEO model (person - environment – occupations)
402 provides a more holistic view and allows for a better exploration of the effects of certain NAs on
403 the multiple aspects of occupations, as explained by participant 2.

404 **3.4 Participating in Neurogovernance Discussions**

405 When participants were asked about whether OTs should be involved in neurogovernance
406 discussions, particularly around the discussions involving the ethical, legal, and social implications
407 of NA, n=6 reported that OTs should be involved. Below are some quotes that highlight this belief:

408 *“I think we’re actually one of the best suited people to start these discussions because even to just*
409 *go back to that PEO model, person environment occupation, um in environment we’re looking at*
410 *the physical environment, the cultural environment, the societal, you know uh all of these*
411 *institutional environments you know person and what’s going on task and how they’re doing the*
412 *task and what are they using to do the task, all these factors right we’re looking at the big picture*
413 *we’re not looking at one we’re not looking at that muse or the neuron or that brain we’re looking*
414 *at how this affects big scale right” (P2).*

415 *“I think we should definitely be giving input you know if you’re an OT working with the deaf*
416 *culture I think you should definitely be aware of the issues and aware of the you know umm I*
417 *think in terms of making decisions that’s our specialty area” (P5).*

418 *“I think the other thing reason we’re well suited is that we do consider the whole person including*
419 *the environment and their occupation and the person factor so like it really speaks well to thinking*
420 *about the social implications as well and thinking about the ethical implications” (P6).*

421 **3.4.1 Barriers to Getting Involved**

422 Although participants felt they should be involved in neurogovernance discussions, they
423 also expressed why they believe OTs are not involved yet. More specifically, n=3 participants
424 suggest that OTs are undervalued and not seen as credible. For instance: *“despite that OT has been*
425 *around like since the first world war we’re still advocating for our need in the medical profession*
426 *that it’s hard then to even become a leader in something when you’re still advocating for the*
427 *reason why you’re there” (P6); “I think we’ve been largely undervalued and so we don’t have a*
428 *lot of confidence in other people’s perceptions of our value” (P2).*

429 Another barrier mentioned by n=3 participants was the lack of access to platforms that
430 engage in neurogovernance discussions. *“umm I think it’s probably just the access to it right so I*
431 *think that most people if you’re not invited to be on the panel or to discuss this” (P4).* Furthermore,
432 the lack of access was also connected to a lack of access to NA, and therefore OTs do not have the
433 initial exposure to those implications and possibly contribute to discussions, as expressed by n=2
434 participants: *“we’re looking at a clinical OT right it might be working with an individual and some*
435 *of these um technologies might apply to them but if they don’t have access to using that technology*
436 *um they may not be able to comment on it or have an opinion about it” (P4).*

437 Lastly, n=4 participants suggest that OTs prefer direct client care and are not interested in
438 the politics of NA. For instance: *“the other reason is that there is not that many occupational*
439 *therapists in high leading um roles or policy positions um that’s not a very common space for OTs*
440 *to be not that we can’t um it’s just I find that I think more OTs kind of stay in direct client care not*
441 *as many OTs will move on into policy change um so I think that can be a barrier for like us as a*
442 *profession to engage in and kinda become a forefront leader” (P6); “they’re focused much on*
443 *their individual client and getting a positive outcome so that’s maybe an issue to that I mean yes*
444 *I’ve heard of to create system somatic changes within the environment or culture maybe OTs will*
445 *evolve not to work with individual clients only and work with more of the larger systems I don’t*
446 *know but the funding and the service delivery model doesn’t support a lot of public relation or*
447 *public education for your average OT I would say” (P3).*

448 In regards to how to overcome the above barriers, participant 6 suggested that the
449 provincial and national associations of OT must start to raise awareness on the impact of NA on
450 their profession: *“I think that our um like the Canadian association of OTs and all the colleges in*
451 *the provinces can also have an opportunity to start to raise awareness for some of these*
452 *technologies and how this impacts our profession and how it impacts our practice umm because*
453 *they do like often post signs on social media or there may be um interviewed perhaps for like a*
454 *news article or something so I guess there is that aspect as well” (P6).* Another suggestion was to
455 increase the knowledge through professional development practices: *“umm public awareness*
456 *campaigns from companies that wanna promote their products I guess and um Professional*
457 *development for these people to make occupational therapists and other professionals aware of*
458 *what’s out there” (P3).*

459 **3.5 Lifelong Learning and Professional Development**

460 All (n=8) of our participants stated that LL is essential. They argued that it is necessary to
461 provide best practice, avoid stagnation, and to learn new approaches .. *“It’s essential to keep up to*
462 *date as much as you can even though knowledge is expanding in so many field so you have to as*
463 *an OT you can’t know everything about everything so you sort of specialize in certain areas of*
464 *practice um but um you have to keep seeking opportunities”* (P3); *“there is there is no way that*
465 *you can learn enough to actually be like a competent professional you have to really also*
466 *continually learn and grow as a professional throughout your career so and it’s hard because no*
467 *every instance is the same like not every client is the same what works in one case may not always*
468 *work in the next case you have to really like be a critical thinker to re-evaluate your approaches*
469 *sometimes”* (P6). Our participants engaged in formal professional development opportunities such
470 as conferences (n=6), courses (n=5), seminars (n=2) and informal opportunities such as learning
471 through coworkers (n=7), by reading online journals (n=3) and through the media (n=1).

472 **3.5.1 Catalysts and Barriers for doing LL**

473 Table 4 outlines catalyst that encouraged participants to be engaged in LL and barriers that
474 inhibited their willingness to seek it.

475 **(Insert Table 4 here)**

476 We further asked practitioners how they could overcome the barriers listed. One suggestion
477 by participants 2 and 6 was to be more connected and collaborative with other professionals to
478 share and disseminate information. Another suggestion by participant 6 was offering a variety of
479 ways to attend conferences such as virtually. To overcome one of the most common barriers of
480 money, participants 2 and 3 suggested that there must be more funding that is allocated for private
481 practices to provide LL and for practitioners themselves to access LL.

482 **3.5.2 Using LL to Learn About NA**

483 Specifically pertaining to NA, only n=1 participant has used LL mechanisms to become
484 more knowledgeable on NA. Participant 3 explains the lack of exposure to NA as the reason for
485 not learning about them, *“maybe if I was still working for Alberta health services I might have*
486 *heard about some of them, but they don’t seem terribly relevant to what I’m doing”* (P3).
487 Furthermore, n=2 participants described different methods that OTs could increase their
488 knowledge on NA: *“they could take courses they could read articles research they could talk to*
489 *people who are involved in companies that provide those products”*(P2); *“employers are*
490 *responsible for ensuring OTs learn about NTs”* (P4). Participant 1 expressed their interest in
491 connecting with other OTs who are interested in working with NA, *“this neurofeedback I would*
492 *like to know if there’s OTs in Calgary in who are doing it other OTs who are thinking about doing*
493 *it uh if there’s some kind of process that’s already in place that I wouldn’t have to reinvent the*
494 *wheel and become the first person doing it in Calgary for instance umm .. yeah so when you are*
495 *in a general way when you’re looking at doing something more efficient by using technology how*
496 *to get together with other OTs to do that as a group other than in isolation would be nice”* (P1).

497 **3.6 Limitations**

498 Given the nature of this study, social desirability bias is a possibility. Interviews were
499 conducted face-to-face and over the phone, and though participants were guaranteed anonymity,
500 they may not have been honest about some of their views. However, this method of data collection
501 was chosen because it allowed for exploration and identification of a relevant issue that was
502 identified as being a gap in the OT literature. The face-to-face and over the phone interactive
503 format allowed participants to ask clarification questions, which was useful given that it was a
504 novel topic to several of them. Additionally, it allowed the researcher to ask probing questions
505 based on the responses of OTs. Moreover, we only interviewed 8 OTs whose views may not be
506 analogous across this field. However, despite its limitations, this study provided greater insight
507 into the topic of NA and OTs and allowed us to generate information-rich knowledge [91]. Using
508 this insight, further research can be conducted to gauge how prevalent these practices and beliefs
509 are.

510 **4. Discussion**

511 The purpose of this study was to grasp a better understanding of the views of OTs on getting
512 involved in neuroethics and neurogovernance discussions as part of their roles as professionals and
513 private citizens. Our findings suggest that the current knowledge on NA is limited and participants
514 are currently not involved in neuroethics and neurogovernance discussions, particularly on the
515 emerging ethical, legal, and social implications of NA and that LL are not used in their workplace
516 to empower OTs to contribute in a meaningful way to NA discussions including neuroethics and
517 neurogovernance discussions. Such findings suggest that changes might be beneficial in the
518 education of current OT students and in the LL opportunities for OTs in order to empower these
519 professionals to get involved in such discussions. Our findings also suggest that the neuroethics
520 and neurogovernance field has to change how they engage with OTs if they want to fulfill their
521 aim of involving health professionals in neuroethics and neurogovernance discussions. The
522 remainder of this section will focus on interpreting our findings through the perception of OTs as
523 a field and the role expectations of OTs as professionals and citizens, and literature around LL and
524 professional development.

525 **4.1 The Role of OTs**

526 OTs are trained health professionals responsible for enabling an inclusive society for
527 individuals to participate in their daily occupations [59]. Furthermore, OTs are also members of
528 society and therefore have the role of being active citizens, advocate for their clients, and influence
529 at the policy level [65, 98]. Below we will discuss how participants perceived their role as
530 professionals and as active citizens involved in neuroethics and neurogovernance discussions, in
531 comparison to the current OT literature.

532 **4.1.1 The role of OTs as professionals**

533 Various organizations such as CAOT and the World Federation of Occupational Therapists
534 (WFOT) have outlined various roles warranted by OTs. Such roles include being experts in
535 enabling occupation, communicators, practice managers, change agents, scholarly practitioners

536 and professionals [61]. Furthermore, WFOT emphasizes the role of OTs as advocates and
537 promoters of health, well-being, and occupation as a human right [99], through a lens of
538 occupational justice [100]. In other words, OTs have the responsibility to develop the knowledge
539 needed to support the participation of all individuals, advocate for occupation as a human right,
540 foster cultural sensitivity, identify and solve occupational justice issues, and work with groups and
541 individuals to address such barriers [99]. However, in order to promote occupational justice for
542 their clients, OTs must engage themselves in their community and stay aware of the societal and
543 environmental issues that impact their clients [101].

544 As addressed earlier, occupation and humans as occupational beings are continually
545 impacted by the development of NA, either by outdated occupations, creating new occupations,
546 or by changing current occupations [2, 20-22, 29-31]. Given the therapeutic and non-therapeutic
547 ways that their clients are impacted by NA and the societal and environmental issues that arise [1,
548 2, 33], OTs have a role and responsibility to develop the knowledge on how to address such issues
549 and support their clients [99, 101]. Furthermore, with the increasing impact of NA on society,
550 stakeholder engagement is needed to get a variety of perspectives [52, 55, 56], and is a focus of
551 discussion within neuroethics and neurogovernance discourses [5, 13, 15, 57]. Stakeholder groups
552 can include researchers, policy makers, consumers, civil society, and health care professionals [5].
553 With the impact of NA on their field [2, 20-22, 29-31], their exposure to NA [16-19, 23, 35-40],
554 and their expected roles as advocates and educators of technologies [23, 58], OTs have the
555 potential to contribute to neuroethics and neurogovernance discussions. Such contributions and
556 actively participating in neuroethics and neurogovernance discussions fits with the role of OTs
557 [61].

558 From our findings, 75% of participants stated that OTs are uniquely situated to be involved
559 in neuroethics and neurogovernance discussions. Specifically, OTs have the potential to address
560 some of the occupation-related implications of NA using the PEO model and help protect and
561 advance occupational rights. For instance:

562 *“the PEO model so you’re looking at the person the environment the occupation so you*
563 *don’t just look at the occupation and there is a few different ways that you could look at that so I*
564 *think that what we bring to the table right is that more holistic view of how um some of these*
565 *technologies are able um or what impacts they could have within those different areas” (P4).*

566 The PEO model is conceptualized by OT as the person, their environment, and occupations
567 that dynamically interact [102]. Specifically, the environment includes the cultural, institutional,
568 physical and social factors that can impact occupations and affect occupational performance [102].
569 Given that NA impact their clients directly as the person, impact their social, cultural, and
570 institutional environments, and their occupations [103], OTs can provide a holistic view and
571 exploration of the implications of NA to neuroethics and neurogovernance discussions.
572 Furthermore, due to their unique understanding and experience of the relationship between
573 occupation, the person, and the environment, their involvement in developing policies is warranted
574 [65], thus fulfilling their socio-political role [104, 105].

575 Despite the literature on an increased need in stakeholder engagement and the potential for
576 OTs to fulfill their role as advocates, and 75% of participants expressing that OTs can be involved

577 in neuroethics and neurogovernance discussions, our findings suggest OTs are not involved yet.
578 In other words, we can assume that OTs are currently not fulfilling their professional roles as
579 advocates for and educators of the ethical, legal, and social implications of NA on their clients.
580 Participants did not see themselves as able to fulfill the role of being an educator, advocate, or
581 policy influencer and partaking in neuroethics and neurogovernance discussions, a role they think
582 OTs should fulfill. This was due to a lack of exposure and opportunities to update their knowledge
583 and competencies on NA, and not an unwillingness on their part. Other barriers included how OTs
584 and their voice are undervalued in the medical field, how there is a lack of access to platforms that
585 engage in neuroethics and neurogovernance discussions, and that OTs prefer direct client care
586 rather than policy change.

587 *“the other reason is that there is not that many occupational therapists in high leading um*
588 *roles or policy positions um that’s not a very common space for OTs to be not that we can’t um*
589 *it’s just I find that I think more OTs kind of stay in direct client care not as many OTs will move*
590 *on into policy change um so I think that can be a barrier for like us as a profession to engage in*
591 *and kinda become a forefront leader” (P6).*

592 These findings are problematic given the responsibility and need for OTs to actively
593 advocate for all areas impacting their clients and their occupation [63].

594 As such, an increase in support and opportunities for OTs are needed in order to increase
595 their breath of knowledge on the ethical, legal, and social implications of NA and their impact on
596 their field. With the increased demand for continuous and collaborative discussions on the
597 advancement of science and technology, OTs must have access to such education beginning at the
598 student level and expanding throughout their career [106]. Furthermore, as supported by
599 Participant 6, the provincial and national associations must raise awareness on the impact of NA
600 on all facets of OT. By doing so, OTs will feel empowered to actively link their role expectations
601 of advocacy and policy development with getting involved in neuroethics and neurogovernance
602 discussions.

603 **4.1.2 The role of OTs as active citizens**

604 As private citizens, individuals have the role and responsibility of being active citizens and
605 exercising their knowledge in the public interest [98]. Being an active citizen refers to the act of
606 engaging in participatory and representative democracy, by actively participating in society,
607 community, and political life in accordance with human rights [64]. Engaging in this process
608 serves as a transformative tool for social change by promoting the development of knowledgeable
609 citizens and empowering them to take on activist roles [107]. It does not only pertain to the political
610 actions of voting in elections, yet it extends to the everyday participation in society, while being
611 interconnected with the concepts of human and occupational rights [24]. For instance, as an active
612 citizen, individuals express such roles through meaningful occupation with others in a social
613 context [24]. Furthermore, it is recognized that the fields of OT and occupational science must
614 conceptualize the *“occupational nature of active citizenship, located as a practice in the*
615 *interconnectedness of the individual and the larger community”* [24].

616 Not only is engaging in one's right and responsibility as an active citizen directly connected
617 with meaningful occupations and therefore impacting the field of OT [107], OTs are also members
618 of society and therefore have the responsibility of being an active citizen and actively engaging in
619 society [24]. It is argued that OTs have a socio-political role to fulfill including meeting with
620 politicians to influence policy decisions that promote inclusion [107]. Furthermore, it is crucial
621 that OTs stay aware of the societal issues that impact their clients and engage themselves in their
622 community for the promotion of social and occupational justice for their clients [101].

623 As professionals, OTs have a role to meet in advocacy and policy making, which can be
624 fulfilled by engaging in neuroethics and neurogovernance discussions. However, OTs also have a
625 role to play in these discussions under the identity of being an active citizen. In other words, OTs
626 can uniquely contribute to neuroethics and neurogovernance discussions as active citizens due to
627 their professional roles that allows them to view the possible implications of NA from a different
628 and holistic standpoint. In accordance with the democratization of science and technology, the
629 early involvement of stakeholders including engineers, policy makers, and public citizens is
630 warranted to construct conversations around awareness, reaction, and knowledge development and
631 sharing [70, 108-110]. Therefore, as active citizens, OTs can share their expertise and exercise
632 their personal and professional knowledge to contribute to neuroethics and neurogovernance
633 discussions [69].

634 According to Fransen et al., (2015), one of the ways to be empowered as an active citizen
635 is by being recognized and respected as a citizen with a contribution to make [24]. Therefore, it is
636 noteworthy that all participants in our study did not identify with the role of being active citizens
637 within neuroethics and neurogovernance discussions. Additionally, n=3 participants expressed that
638 their voice as OTs felt undervalued and was a barrier to getting involved past the clinical level.
639 Participants therefore did not feel empowered to act as active citizens in relation to the governance
640 of NA or scientific and technological governance in general. These findings are similar to the ones
641 by Fransen et al., (2015), where it is stated that some OTs may be challenged to fulfill their socio-
642 political role due to role constraints [24]. Therefore, OTs must be empowered and supported in
643 acknowledging how they can contribute with their identity as professionals and identity as active
644 citizens to neuroethics and neurogovernance discussions. By doing so, they can increase the
645 awareness of their thoughts and expertise on the ethical, legal, and social implications of NA they
646 and their clients experience and foster fruitful discussions between OTs and neuroethics and
647 neurogovernance stakeholders.

648 **4.2 Lifelong Learning**

649 As advocated for by international organizations including UNESCO, OECD, and the
650 World Bank, LL should be viewed as an essential and lifelong educational commitment [73]. LL
651 is also argued to be a cultural practice, where individuals are expected to be lifelong and self-
652 directed learners provisioned by goals, means, and evaluation in curriculum development [111].
653 With the constant changes in the health field, OTs are expected to use LL mechanisms to stay up
654 to date with such changes in order to efficiently advocate for the care of their clients [25]. Such
655 mechanisms are one of the strategies that are most recommended by professional associations to
656 enable OTs to stay up to date with new knowledge and evidence, and apply it to their work [112].
657 According to the College of Occupational Therapists' Research and Development Strategic Vision

658 and Action Plan, the continuation of personal and professional development is necessary for all
659 students and professionals, reflecting the continuum of competence required by practitioners [75].

660 The need for OTs to continuously engage as lifelong learners is further reflected in our
661 results, where all (n=8) participants stated that LL is essential to stay up to date, grow as a
662 professional, and provide best practice. To give one quote:

663 *“While especially in my profession I do think it's important for professional growth and*
664 *development just because in this area there's even though you went to school there's so much you*
665 *don't know”* (P8).

666 Despite the need for LL as a practitioner, participants outlined various barriers from getting
667 involved in more LL opportunities. Such barriers include lack of time (n=8), accessibility (n=7),
668 and lack of money (n=7). For instance:

669 *“time I think is a huge one because there could be so many different opportunities that we*
670 *could take advantage of like I know there is tons of different workshops that are offered within the*
671 *city and yet like we aren't able to take that time off work even if it could benefit our clients and it*
672 *could benefit ourselves us therapists”* (P6).

673
674 Furthermore, only n=1 participant has used LL mechanisms to increase their knowledge on
675 NA. However, the advancement and implementation of NA in the health field will only continue,
676 and it's the practitioner's role to continually become lifelong learners and increase their knowledge
677 on NA and their implications [113]. In order to get involved in neuroethics and neurogovernance
678 discussions, individuals must first have fruitful knowledge on the implications and topics at hand
679 [83]. Furthermore, given the impact of NA on all facets of OT, it is argued that OTs would be more
680 inclined to further engage in learning these implications and participate as advocates, as is expected
681 [114]. However, we suggest that the current formal LL mechanisms are not providing OTs with
682 meaningful information to guide them with getting involved in neuroethics and neurogovernance
683 discussions. Given that OTs are stakeholders of NA as health professionals and are expected to
684 take part in neuroethics and neurogovernance discussions, these findings are problematic.

685
686 Without a formal exposure to the ethical, legal, and social implications of NA, OTs will not
687 have the background tool and purpose for further learning about such implications on their own
688 time. As stated by Garden & Winickoff (2018):

689
690 *“ It is crucial to build a recognition of the importance of social and ethical issues into the*
691 *training of all those involved in developing and utilising novel neurotechnologies, thus principles*
692 *of responsible innovation and public engagement should be incorporated into education curricula*
693 *to foster a better understanding of benefits and risks. Strengthening of 'neuro-literacy' in the wider*
694 *public, including, for example, patient groups, practitioners, and lawyers would help responsible*
695 *use”* [5].

696
697
698 Therefore, we posit that provincial and national organizations must expose OTs to the
699 various societal and non-clinical consequences of NA. This will increase their knowledge and
700 encourage their involvement in neuroethics and neurogovernance discussions. A change in the

701 current LL mechanisms is also warranted in order to provide OTs sufficient information to be
702 comfortable with educating others on the implications of NA. Lastly, OT students have to be
703 exposed to the topic to be sensitized so that they actively seek out LL as professionals.

704 **4.2.1 Engaging in LL as an active citizen**

705 In the same way that OTs can formally use LL mechanisms to update their professional
706 competencies, LL mechanisms can also be used to empower OTs to identify with their role as
707 active citizens. It is essential for all individuals to become active lifelong learners, in order to be
708 able to actively deal with the changes in society and their consequences [79], including the
709 consequences of NA.

710 In order to fulfill the identity of an active citizen where civic participation and social
711 cohesion is promoted, an educational process and responsibility must be taken [24]. LL
712 mechanisms can therefore be utilized as tools for individuals to identify as active citizens by
713 constantly learning and remaining engaged [79, 80, 82, 84, 115]. Such mechanisms must also
714 provide OTs with citizen education including moral and social responsibility, community
715 involvement, and political literacy, in order to achieve social, moral, and political outcomes [83].
716 With the efficient use of LL mechanisms, OTs can feel empowered to fulfill their role as active
717 citizens by contributing to neuroethics and neurogovernance discussions.

718 While LL mechanisms are necessary for individuals to gain new knowledge, OTs must
719 also be provided with appropriate learning environments, provided with opportunities to integrate
720 new knowledge to work, and provided with the right conditions to understand new situations
721 encountered, in order to build their skills and capabilities to be active and global citizens [116-
722 118]. As argued by researchers, adjustments will therefore need to be made to the early education
723 and training of OTs so that such professionals are better equipped to act as active citizens and
724 health promoters [65]. In other words, the current OT curricula should be reviewed and adapted as
725 it evolves with global needs, in order to train prospective OTs as responsible active and global
726 citizens [119]. Therefore, these findings posit an impact on the current education, occupational
727 learning environment, and LL mechanisms for OTs. We suggest such areas must be adapted in
728 order to provide OTs with knowledge and empower them to engage as active citizens. OTs would
729 be encouraged to utilize new knowledge learned about the implications of NA and how to create
730 profound change in the community from the University curricula and LL mechanisms, as well as
731 their expertise from working in the field. Such changes would empower OTs to merge their roles
732 as health professionals and roles as active citizens, and actively contribute to neuroethics and
733 neurogovernance discussions.

734 **5. Conclusion:**

735 Our findings suggest that the knowledge of NA is limited among our participants, and
736 participants are currently not involved in the discussions surrounding the ethical, legal, and social
737 implications of NA. Participants saw OTs as individuals who can uniquely contribute to
738 discussions due to their holistic way of thinking as a field and their use of the PEO model, allowing
739 them to view the impacts of NA in a different way. However, due to limiting factors such as access
740 to discussions and a lack of knowledge, participants did not see themselves and other OTs as

741 currently being involved in neuroethics and neurogovernance discussions. Furthermore, all (n=8)
742 participants view LL mechanisms are essential in order to stay up to date, provide best practice
743 and grow as a professional. However, these mechanisms are currently not providing OTs with
744 knowledge on NA past the clinical level and on the ethical, legal, and social implications of NA.
745 These findings are problematic given the role understanding of OTs [23, 61, 63], the impact of NA
746 on OTs [18, 19], their clients [7-9, 41], the OT field [16, 17], and occupation [20-22], and the
747 focus of neuroethics and neurogovernance on stakeholder engagement [52, 55, 56].

748 Our findings fit with a similar study that outline the limited role of OT students in the
749 involvement of science, technology, and innovation (STI) governance [21]. The students in this
750 study emphasized the importance of learning about STI developments early in their educational
751 career, starting at the undergraduate level [21]. It was also emphasized how they view OTs as
752 being uniquely and well positioned to support the governance and development of STI yet are not
753 involved due to a lack of access and lack of knowledge provided throughout their undergraduate
754 and Master's degrees [21]. Therefore, the barriers to getting involved in governance that were
755 reported in our study were already seen as problems by OT students. Such similarities imply that
756 a change of curricula at the undergraduate level and in OT schools is warranted so that students
757 can gain insight into the developments of NA and their implications and encourage future OTs to
758 further learn about them through LL mechanisms. Our findings also fit with other studies that
759 outline the limited role of OTs as portrayed in Canadian newspapers, the lack of engagement from
760 OT with ethics and ethical theories, and the limited role narrative of OTs in the artificial
761 intelligence and machine learning discourse.

762 Given the gap outlined by our study on how the OT field and neuroethics and neurogovernance
763 discourses interact, we suggest more must be done to facilitate the involvement of OTs in such
764 discussions. For example, the current undergraduate and OT graduate curricula must change, to
765 introduce prospective OTs to the constantly emerging consequences of NA and the impact NA
766 will have on their personal and professional lives. LL mechanisms must also be modified to
767 empower current OTs to bring forth new knowledge acquired through such mechanisms as well as
768 knowledge gained while working directly in the field to engage in neuroethics and
769 neurogovernance discussions.

770 As to future directions, a study can be done that focuses on evaluating the current OT curricula
771 to grasp a better understanding of how it can be adapted to better provide knowledge on NA and
772 its implications at the student level, while still falling in accordance with current OT learning
773 outcomes. Future studies can also focus on how to properly implement LL mechanisms involving
774 the implications of NA and analyzing the outcomes of such implementation. Such studies will
775 provide researchers the extent that OTs would get involved with such changes and more fruitful
776 information on how to better get OTs involved in neuroethics and neurogovernance discussions.
777 Lastly, it would be fruitful to grasp a better understanding of why there is a disconnect between
778 OT curricula and scholars and neuroethics and neurogovernance curricula and scholars. This
779 would include an investigation of what current stakeholders in neuroethics and neurogovernance
780 discussions think of the involvement of OTs in such discussions in order to brainstorm how OTs
781 can better contribute.

782 **Conflict of Interest**

783 **No conflict to declare.**

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Table 1: Participant demographics

Variables	N (n=8)	%
Gender		
Female	7	87.5
Male	1	12.5
Age		
29-31	3	37.5
38-53	3	37.5
58-64	2	25.0
Focus of Practice		
Practice in the community	3	37.5
Practice in clinical OT	2	25.0
Practice in mental health	2	25.0
Researcher	1	12.5
Province of practice		
Alberta	8	100.0

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Table 2: Familiarity of n=8 OTs with the following NAs.

NT	Participant knowledge
Artificial Brain	N=3
Artificial intelligence	N=8
Biofeedback	N=4
Bionic eye	N=6
Brain computer interface	N=5
Brain imaging	N=7
Brain stimulation	N=7
Brain to speech	N=2
Brain to text	N=1
Cochlear implants	N=7
Cognitive enhancement beyond the normal	N=4
DBS	N=5
EcoG	N=2
Electroencephalography	N=1
Facial EMG	N=2
Machine intelligence	N=3
Neuro stem cells	N=3
Neurochip	N=1
Spinal cord stimulator	N=4

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Virtual reality	N=8
Whole brain emulation	N=1

Table 3: Ethical, Legal, and Social Implications of NAs

Themes	Sub-Themes	
Ethical Implications	Competency	n=3
	Health	n=2
	No implications	n=2
	Loss of jobs	n=1
	Race of abilities	n=1
	Informed Consent	n=1
Legal Implications	Privacy	n=3
	none	n=2
	Access	n=1
	Liability	n=1
	risk	n=1
	Scope of practice	n=1
Social Implications	Restoring normality	n=3
	Accessibility	n=3
	Addiction	n=2
	Unemployment	n=2
	Marginalization	n=1

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Table 4: Catalysts and Barriers for doing LL

Themes	Sub-Themes	
Catalysts for doing LL	Provide best practice	n=6
	Avoid Stagnation	n=2
	Interest	N=2
	Learning new approaches	n=1
	Curiosity	n=1
	Relatability to practice	n=1
Barriers for doing LL	Time	n=8

	Accessibility	n=7
	Money	n=7
	Large case load	n=6
	Family Commitment	n=2
	Motivation	n=1

