

Transkription Interview 17

1 **I:** now it's working.. so first of all, thank you very much
2 **TN:** mhm
3 **I:** for your time now
4 **TN:** thank you
5 **I:** and um.. yeah, my first question would be uh, how did you came in uh, contact with BCIs? was it like a
6 long time ago? was it during your studies?
7 **TN:** well, it's unfortunately a-a study of uh.. of failure so far of not actually achieving my goal
8 //I: mhm//
9 **TN:** I.. started working on BCIs in the mid-1990s, when I was a graduate student, uh, with [mister a]-
10 //I: mhm//
11 **TN:** at [a university in the US] and part of what got me interested in it is I had a cousin who has cerebral
12 palsy, and so she has always had difficulty moving and speaking, uh she's otherwise very capable, she's
13 very smart, but uh, I realize the extent to which a physical disability can affect the other parts of
14 someone's life. and so, when I first started with BCIs, I did not yet realize that they, at least at the time,
15 were not really so helpful to people who had only moderate movement disabilities, and so I initially got
16 interested in the field with.. with the goal of helping my cousin, or more broadly, people who had some
17 movement disabilities, but, my cousin can speak and she's relatively healthy compared to a late-stage
18 ALS patient. so this is still something that I hope will happen, and ironically, only last year I edited a
19 book chapter from a group in [European country] that was talking about the use of brain-computer
20 interface technology for persons with cerebral palsy. also you may have seen other work, such as the
21 stroke rehabilitation work and uh, there was an excellent talk yesterday about this, but also other groups
22 are working on it, where brain-computer interfaces seem to be extending beyond communication and
23 control to other applications, and one of them is movement restoration.
24 //I: mhm//
25 **TN:** helping people.. in a way that provides a benefit even when you turn off the BCI. and this was a big
26 change in the field, so, having been in the field for a long time, you see a lot of papers that say this, and
27 it's true, that for most of the field, the main goal was to provide communication, no other goal, just
28 communication
29 //I: mhm//
30 **TN:** and to provide communication for persons with very severe movement disabilities, with very little or no
31 remaining movement, and this has been a huge change that you see, uh, first in expansion of goals
32 beyond communication, so the excellent talk by [mister b], which I'm not affiliated with him, I just
33 really liked his talk-
34 **I:** mhm. me too, yeah
35 **TN:** and [Name unclear??] and others, where so many people are thinking about more practical, mainstream,
36 broader applications for BCIs, I think is very, very good. so again there, getting back to the question of
37 what started me in the field and how it connects to where things are going now.. um, one of the big
38 changes is going beyond communication to other things, and the second one is going for much broader
39 groups of patients. and so I-I do think my goal will ultimately be successful, that is, I will help my
40 cousin someday-
41 //I: yeah//
42 **TN:** and other people like her, um, but of course, for the last (laugh) more than 20 years, my work has ended
43 up helping other types of patients.
44 **I:** so you fo-focus is um, on patients

45 **TN:** yes

46 **I:** okay

47 **TN:** so I have- most of my work has involved BCIs either with patient groups or that were meant to help

48 patients, you know, so for example, P300 BCIs, where.. like anyone else, I was thinking about helping

49 patients. however, I've always had some papers exploring BCIs for the general po-population.

50 **//I:** mhm//

51 **TN:** another point with this is that there has always been a controversy in the field, what is the best way to

52 help patients? is it to directly help patients, or is it to develop BCIs for the general public, so that people

53 will spend more money, big companies get involved, and then that will go back to help patients in an-

54 **//I:** mhm//

55 **TN:** indirect way

56 **I:** mhm. okay so, what do you think? what would be the best way to help patients?

57 **TN:** I think I was wrong for most of the time. I was really concerned with directly immediately helping them,

58 so was everybody, and look what happened: for more than 10 years, the field did help a lot of individual

59 patients.. many people have helped several patients, dozens of patients, and yet, the critical barriers to

60 getting BCIs to patients, such as the cost of the system and the cosmetic, uh, appeal of it, and

61 functionality, have not really improved as much as they could.

62 **//I:** mhm//

63 **TN:** so I-I'm starting to shift my view, and it's a frustrating one emotionally and personally because you want

64 to help the patients directly, but, the truth is that if you can get, for example, companies like Facebook

65 or Elon Musk

66 **//I:** mhm//

67 **TN:** or other things. if those efforts are successful.. and even if they're only partly successful, the-the attention

68 that they will draw from other companies could drive the price down dramatically-

69 **//I:** mhm//

70 **TN:** and could lead to other changes that are just not gonna happen with a few universities working on grants

71 for a few million euros from the European commission, a few million euros here. if BCIs are really

72 going to advance, you need bigger-big money.

73 **I:** yeah. yeah, you mentioned Facebook

74 **//TN:** mhm//

75 **I:** and Elon Musk as well

76 **//TN:** mhm//

77 **I:** um, what do you think? what do they have in mind? what-because now, they like announced they want to

78 do some reach-uh, research-

79 **//TN:** yes//

80 **I:** in this field, but

81 **//TN:** mhm//

82 **I:** nobody knows what they want to achieve exactly.

83 **TN:** I have been in contact with Facebook to try to answer that question

84 **//I:** ah//

85 **TN:** um, a colleague of mine from the BCI research community named [misses a],

86 **//I:** mhm//

87 **TN:** who many people know, her last name is [spelling last name],

88 **//I:** mhm//

89 **TN:** uh, is with Facebook, uh, they hired her as the BCI person. and I have contacted her because I said, in

90 [month] I have to give a talk for [a center in the US], there is a summer school and I was asked to give a

91 lecture about adaptive neurotechnologies for the general population.. and I was even asked this year to

92 comment specifically on what Facebook was doing because there was so much attention to that.

93 //I: mhm//

94 **TN:** so I contacted, uh, [misses a], I asked her for a reference with the most detail that I could use, I watched
95 the videos from Facebook and their-their publicity, and, what they have claimed is that, in the near
96 future, you know, within about two years or so now, they will have a BCI at 100 words per minute.
97 now, nobody takes this seriously. there is basically no one that I've talked to who really believes this
98 will be the type of breakthrough that they.. suggest will happen.

99 //I: mhm//

100 **TN:** the [??] article that [misses a] sent me, which I would be happy to send you, also failed to answer some
101 critical questions and criticisms that I have

102 //I: mhm//

103 **TN:** so in my lecture, then, when I was being recorded, and now when I-I'm being recorded, I have the
104 following predictions about how they're going to basically cheat, how they're going to say they have a
105 major breakthrough but they don't. first of all.. vocabulary size, so when you say that you can send 100
106 words per minute, is that from the adult vocabulary of 35,000-38,000 words, or is that from a
107 vocabulary of only 100 words? so, if you can only choose 100 words to say in total, that's a much less
108 impressive achievement. it's somewhat like, in any BCI, you have a vocabulary that is defined by the
109 things that you can choose. so in a P300 BCI with letters, you can choose one letter at a time. now.. you
110 could change a P300 BCI where you choose letters into a BCI where you choose two letters at the same
111 time, I was the first to do this in a [year] paper I think, and you could also have words, you could have
112 pictures, you could theoretically have complete sentences. so, here is a-a question, and I.. don't have an
113 answer, but, what if you reprogrammed a common P300 BCI, so instead of having individual letters,
114 you sent 100-word sentences, each selection. so, each cell-it'd be very hard to see, but instead of having
115 one letter there, you have a sentence with a hundred words. now, you can easily choose more than 100
116 words per minute with such a system.

117 //I: mhm//

118 **TN:** with a P300 BCI, you could get one selection every two seconds or so.. would anyone consider that a
119 breakthrough? absolutely not. so this is trick number one t-to look for-

120 //I: mhm//

121 **TN:** vocabulary size, and then, a second trick that is in there is the.. the si-the-the size of each signal. with-
122 with each message, are you sending only one letter, or are you sending a whole sentence?

123 //I: mhm//

124 **TN:** so.. the simplest type of BCI is just a simple switch, where you have "nothing" or "yes," or maybe you
125 have "yes" and "no,"

126 //I: mhm//

127 **TN:** we could've-people have done this decades ago.. let's say you take one of these BCIs and you change the
128 word "yes" to "I'm thirsty and I would like my nurse to come here and bring me a glass of water,"

129 //I: mhm//

130 **TN:** and "no" means "I'm not thirsty, tell the nurse that I want to go to sleep, turn off the light".. well, again,
131 this would, in some way, be a 100 word-per-minute BCI, but no one would consider it a breakthrough.

132 //I: mhm//

133 **TN:** the third thing to watch, and I think this is, uh, very interesting, is word and sentence completion. so, that
134 is, are you actually thinking 100 individual separate words, or do you th-is it-is it putting most of the
135 words in for you? so maybe you send a few words per minute, you say "thirsty," "nurse," "water," the
136 system has a very intelligent semantic completion network, where it assumes from that that you want to
137 say "I'm thirsty, please tell the nurse I would like a glass of water." that would be a modest
138 achievement, to have that level of semantic completion, but it would not be the same as a true 100
139 word-per-minute BCI.

140 //I: mhm//

141 **TN:** in other words, something where you can just choose freely from anything, you can choose any 100
142 words that you want, without this experience of saying “oh, this system is putting words in my mouth,
143 this is not what I said.” uh, fourth item that I would get at is error correction. so, if the sys-an-or-error
144 rate. so, I haven’t seen anything about error rate. do they mean that you say 100 words per minute and,
145 after that minute, you say “yes, every one of those words is correct. that’s exactly what I meant to say
146 from the beginning,” or is it-you know, you make a mistake and you tell the nurse “I would like a glass
147 of table,” and the system realizes that “table” is not correct and they put in “water”?

148 //I: mhm//

149 **TN:** now again, this is not such a bad thing, it would be an achievement, but it would not be a true 100 word-
150 per-minute BCI.

151 //I: okay//

152 **TN:** another big one, (laugh) see, I have a list-

153 **I:** yeah, yeah, good-

154 **TN:** I’m going on Facebook

155 **I:** (laughs)

156 **TN:** another big one.. illiteracy-

157 //I: mhm//

158 **TN:** what percentage-and I-I think the word “illiteracy” that has been used is um, some people have
159 considered it offensive because it-it seems like you’re blaming the user. so, other words have come up,
160 like “BCI-inefficiency” or things, but it’s still the same basic idea, that.. a certain percentage of the
161 population simply cannot use a BCI. now..

162 **I:** of the normal population?

163 **TN:** yes

164 //I: mhm//

165 **TN:** so, for example, [mister a], who gave, like I said, a very good talk, he and his group have long been very
166 interested in this issue of.. illiteracy, a percentage of people that cannot use a BCI.

167 //I: mhm//

168 **TN:** with motor imagery, it is at least ten percent. so at least one out of every ten people seems to be unable to
169 use a motor imagery BCI,

170 //I: mhm//

171 **TN:** even with the best training methods and things. and the keynote speaker from yesterday, [mister b], he
172 actually cited me in one of his early slides, it had [a citation], where I had said that it is ten to thirty
173 percent of people, so it is going down.

174 //I: mhm//

175 **TN:** also with P300 BCIs, it appears to be much lower. so, uh, one of the most.. important papers was uh,
176 from [authors and year]

177 //I: mhm//

178 **TN:** a great achievement in German neuropsychology, and what they found is that if you present faces, the
179 P300 BCI, if it changes to a face instead of the same letter, then that’s good in many ways, and one of
180 those ways is that it reduces this, uh, the perc-people that can’t use it. so, nearly everybody can use a
181 P300 BCI. so, back to point 5 with Facebook, what is this rate? so, when you say, I noticed the phrasing
182 of what uh, [misses b] said, is what she said is, and I think she said “in three years, we will demonstrate
183 such a system.” well, when she says “we will demonstrate,” that really just means they only have to
184 choose one person out of potentially thousands of people, that is, are they making a BCI that *most*
185 people can use at 100 words per minute-

186 //I: mhm//

187 **TN:** or is it only one person out of a hundred or potentially a thousand people? so, Facebook very certainly
188 has the resources to do these things.

189 **I:** mhm. but, how could this look like? uh, what kind of BCI? what do you think?

190 **TN:** they have stated that they think it will be a result of optical imaging, so that is something that [misses b]

191 said clearly. there was no indication that they actually intended to use EEG.

192 **//I:** mhm//

193 **TN:** now-

194 **I:** it wouldn't be practical, yeah

195 **TN:** well, I don't.. this has happened many times.

196 **//I:** yeah//

197 **TN:** so, since the early days of BCI, uh.. or at least for 15 years, there have been people that have been

198 coming up with optical imaging, functional near-infrared-

199 **//I:** mhm//

200 **TN:** and they have tried to say this is the next-the next wave of BCI, that it will replace EEG, that you get big

201 improvements. well, it's 2017 and how many BCIs do you see based on FNIR?

202 **//I:** mm//

203 **TN:** and in particular, the systems that are being used with patients, the practical systems are-are based on

204 EEG.. unless the patient can have an invasive method, and then it's essentially invasive EEG, which

205 would be called ECoG or other things, that is, there have been a lot of bold claims about optical imaging

206 and how this will be the-the future and they've failed catastrophically

207 **//I:** mhm//

208 **TN:** so I'm pretty unimpressed with this. in other words, I, um, I find it very difficult to see how that could

209 happen. and so, with that fifth point I was talking about, the number of people that could use it, is it

210 something that most people could use, or only one person out of hundreds of people they test? now, if

211 they could do that even with one person, I mean she said "within three, years we will demonstrate."

212 **//I:** mhm//

213 **TN:** well, does that mean.. does that mean just a demonstration with just one person, and if so, that would still

214 be something. I would like to see that. but it's not the same as saying "anybody can come up here from

215 the audience and use it."

216 **//I:** mhm//

217 **TN:** that leads me to my sixth point, which I think is also big. there was no mention of training time, training

218 requirements.

219 **//I:** mhm//

220 **TN:** so.. Facebook has the resources to start training people now, so combining my fifth point and my sixth

221 point, they could just simply do this-the fifth point is the number of people that can use it, the sixth

222 point is training time: they might have already started training people. I don't think that they did, but I

223 mean, just hypothetically, they might have already chosen a hundred people and they start training them

224 and then, after a while, they're going to choose the best few people and keep doing that. and so,

225 combining points five and point six, what you would get is a system that works only for elite users who

226 have very extensive training.

227 **//I:** mhm//

228 **TN:** and, again, to try to be positive about it, this could still be an improvement. I mean, this still could be

229 very nice, it could have a lot of implications that could help people and these-these technologies could

230 go on to be, uh transferred to the BCI community here at such events. but, I think, um.. it's-it's difficult

231 to really get excited about a claim that most people think is uh, is not true or at least will require a lot

232 of.. you know, lawyering and talking and things, you know mo-I think when they come out with their

233 system in two or three years, of the six problems I listed, or things-six challenges, at least some of them

234 will be there and I think most of us in the BCI community will say "hey, come on. if we got up and we

235 said we had a 100 word-per-minute BCI, we would get torn apart." people would say, "that's not really

236 a hundred words per minute. that's not really up to the standards of the field."

237 //I: yeah//

238 TN: the other side of it is, you know, is it good because it pushes the field forward? like I was saying, it

239 encourages new research, and this is a question I'm not really sure about to-to to be honest. so, let's say

240 their approach does completely fail, but it sparks the imagination of thousands of students, and so,

241 thousands of people see that, uh, kids taking engineering, kids in high school, and they really start to

242 think about that and that results in new solutions. that could be a very good thing, and then uh,

243 Facebook's actions would be very good.

244 I: yeah, maybe it-to, just to make it more popular.

245 TN: mhm

246 I: so,

247 TN: right

248 I: more in-to bring it more in the brains of people, of normal people.

249 TN: right, I mean people are thinking about it now. there are a lot of people who didn't think about it before.

250 I: yeah me too (laughs).

251 TN: but as, as-

252 I: I just started one year ago.

253 TN: right

254 I: I was like "what is this?" (laughs)

255 TN: right, and that's very exciting.

256 I: it's a brain-computer interface (laughs)

257 TN: it is, and you are an example of it

258 //I: mhm//

259 TN: and here you are doing other work because of it. now, you're interviewing people-

260 //I: mhm//

261 TN: and you're trying to learn more about the field, and so, this is an example of what I was saying-

262 //I: mhm//

263 TN: that, maybe there are thousands of people like you, and so they will see the thing in two years, and they'll

264 say "well, this wasn't exactly the greatest thing, but I still have hope, I still think about it. I want to

265 work for Facebook, I want to work for a big company," and also to be positive and her talk, she did

266 express an interest in helping patients.

267 //I: mhm//

268 TN: and if Facebook gets into helping patients, great. we need the help.

269 I: yeah. what do you think about, uh, Tesla, Elon Musk, you know, this guy?

270 //TN: mhm//

271 I: what has he in mind? do you have like, any ideas?

272 TN: my understanding, no. he's been much more murky. I have made quite an effort to contact them

273 //I: uh-huh//

274 TN: and nobody is answering me,

275 //I: mhm//

276 TN: and I've heard rumors that they-they're intentionally avoiding the main BCI community because they

277 wanna think outside the box.

278 //I: mhm//

279 TN: they don't want to be constrained by what we tell them. and so, I just don't know. I know that he is

280 interested in invasive technology,

281 //I: mhm//

282 TN: of course, in the long-term especially, invasive BCIs can give you much more information and provide

283 more options..

284 //I: mm//

285 **TN:** um, but of course, they-it requires neurosurgery.

286 **I:** and in the United States, it's like, uh, possible with invasive BCIs, because in Europe, we have a lot of

287 restrictions, you know.

288 //TN: mhm//

289 **I:** it's not ethical, it's, yeah

290 **TN:** right

291 **I:** and, but in the United States, there are no-no-not a lot of-

292 **TN:** fewer

293 **I:** restrictions.

294 **TN:** fewer restrictions

295 //I: okay//

296 **TN:** well, the more extreme case is Japan. so, in Japan,

297 //I: mhm//

298 **TN:** neurosurgeons and medical professionals in general have much more freedom to choose the best way to

299 treat their patients.

300 //I: mhm//

301 **TN:** so the attitude of the.. Japanese medical group, and I guess the Japanese society that supports it, is that, if

302 you are a neurosurgeon, and, you know, Japan is a-a.. a society that is friendly to advanced technology.

303 //I: mhm//

304 **TN:** if you're a neurosurgeon, we trust you to make the right decision. you can choose what device to use, you

305 can choose what method to use, and.. in the United States, you have an intermediate case, where there's

306 always the issue with lawsuits. you know, can you-if a doctor makes a mistake, you can sue him or her.

307 and so.. doctors have to be much more cautious. the safe thing to do is to use everything that is standard,

308 everything that is common, everything that everyone else does,

309 //I: mhm//

310 **TN:** and then if there's a mistake, you say "hey, I just followed the rules." but you were right, that in-in

311 Europe, I think, uh, invasive BCI research has always been much more difficult, and part of that is the

312 different ethical views with animal research. um, but I think that's also changing because it is no longer

313 ethical to deny patients this opportunity.

314 //I: mhm//

315 **TN:** you know.

316 **I:** yeah.. and, you personally, do you have like, any fears-fears concerning this new technology?

317 //TN: mhm//

318 **I:** like, it changes, um, mankind in a certain way?

319 **TN:** oh yes, absolutely. so the-

320 //I: yeah//

321 **TN:** the broad long-term ethical implications of what we are all doing are.. are as big as anything I can think

322 of. I mean, you have other cases where science has come up with something that has.. multiple uses and

323 some of them are very nasty. nuclear power is a classic example. and.. many people would say of the

324 scientists who were working on this early on, many of them did not.. consider.. that their tools might be

325 used for war, and to create horrible devices that uh, can and unfortunately have killed millions of

326 people. a counterpoint is that in 1945.. if you, uh, and people did-if you ask most political scientists or

327 historians, or wor-world leaders, "now that a nuclear weapon has been used in anger, do you think it

328 will happen again within 70 years?" almost everyone would say "yes."

329 //I: mhm//

330 **TN:** and yet, it has not. we have fear about it, we have fear with North Korea,

331 //I: mhm//

332 **TN:** and all these things, but in fact, to the credit of our society, there have been many wars since then, many
333 people have been killed, this is not to the credit of our society, but nobody has used nuclear weapons.
334 the use of chemical and biological weapons that has happened, but certainly not on the scale that it
335 *could* happen without some ethical constraint. and so, I.. would like to be optimistic with BCIs. that,
336 yes, there are issues in terms of uh, learning more about people then they want-then they want you to
337 know about. there are issues with uh, going beyond privacy with personal identity and free will, and
338 decision making,
339 //I: mhm//

340 **TN:** and the one that scares me more, and this is uh, was in my [year] book chapter that [mister b] mentioned,
341 is, uh.. is laziness. that, if you have peop-let's say you have BCIs and there's no-all the other ethical
342 problems don't occur, so.. you just have people who find it increasingly easy to accomplish their goals
343 without moving... right, you can just sit there and control a smartphone.
344 //I: yeah, exactly, yeah//

345 **TN:** I think this is completely underappreciated. so, most people in the field, like, for example [Name
346 unclear?],
347 //I: mhm//

348 **TN:** who is an ethicist who I respect very much, and other ethicists, such as [miss b], who I met, uh, she spoke
349 for-in [city], uh, [mister c], these are some of the ethicists in the field. they are focused on ethical issues
350 like agency, free will, identity, control, these are good issues. but I would say that uh, a couple more,
351 one-one is laziness, societal laziness, and a second big one is-is the ethical implications of
352 misrepresenting what a BCI can do, and similarly, what a BCI practitioner can do, and this is something
353 I have been pushing with the [society] and with other groups, uh, to try to encourage this. so, right now,
354 if I were to go to a patient and say "I am a medical doctor and I'm going to treat you," but I am not a
355 medical doctor, in any country, that's very highly illegal.
356 //I: mhm//

357 **TN:** right, Europe, the U.S., all over. it's completely forbidden. similarly with devices, so let's say that um, a
358 patient needs to have a pacemaker implanted, and I say "I'm a doctor and I can put a device in your
359 heart." let's say I'm incredibly lucky and I do the surgery successfully, which is very unlikely.
360 //I: mhm//

361 **TN:** still, there is an issue with the device. so, let's say I implant a device in there and the manufacturer says
362 it's a pacemaker and it-I do everything correctly, but the manufacturer has lied about the device, it
363 doesn't actually do what it says. this is also very highly illegal, that manufacturer will have to shut
364 down, you will say "never sell these devices again," there are very big fines.
365 //I: mhm//

366 **TN:** within the BCI field, there are no such regulations and there have been examples of this, of people taking
367 um, a BCI that was not proven with patients, or a person who didn't have good experience with patients,
368 and misrepresenting uh, that to-to patients, and uh, as an example of this, if you want to look it up: uh,
369 go to a company called [name of the company],
370 //I: mhm//

371 **TN:** and look at their history with the most famous ALS patient in the world, by far, his name is [mister f],
372 **I:** (laugh)
373 **TN:** right?
374 **I:** yeah, I know him, yeah.
375 **TN:** right, so if you look at his website, essentially, and this is just from what I can determine and so, since
376 it's anonymous, I can say this, cause I don't want to get sued if I'm wrong, but-
377 **I:** it is anonymous, yeah.

378 **TN:** yeah it is, okay so, from what I can determine, here is what happened: there was a graduate student
 379 named [mister d]. he had a company and he was trying to make money and get publicity for his
 380 company.

381 //I: mhm//

382 **TN:** he claimed that he had an algorithm called the “[name of the algorithm],” like a [tool],

383 //I: mhm//

384 **TN:** and it could use single-channel EEG and produce the same quality as multi-channel EEG. now, of course
 385 this is ridiculous, but he claimed that. somehow.. and I would say there are ethical issues with [company
 386 name] behavior, [company name] chose him. So [company name] was working on a system for [mister
 387 f], it was uh, a woman named [misses c], as-you can find her online, and she was-and I think still is, the
 388 head of this alternative technology program. so, you have someone who was a graduate student who did
 389 not have a history of using his.. of-of success with patients, or even really healthy people, so I would
 390 say that person was not yet qualified. that is, for someone to work with patients, you should either be
 391 someone who has already experienced, or you have a second person there. so of course you have to train
 392 people somehow, and so the classic training approach that they have in medicine is that, for many years,
 393 uh.. when you gra-I mean after you graduate medical school, the day you get your MD, you can’t see
 394 patients. you have to work underneath a senior doctor and you go to the doc-to the bedside of patients
 395 until that doctor feels that you are qualified to do this on your own. that’s what should’ve happened.
 396 second, his algorithm that he developed, is-nobody uses it now. I mean it’s five years later and nobody
 397 is using this algorithm, and.. if you look there on his website, he has a letter signed by [mister f] that
 398 says [xy] University and he says “you know, we tried this and so on,” then you look at his-there’s-there
 399 are articles about what he actually did, and he said “we found basic indicators of consciousness” and it’s
 400 like, [mister f] is producing books that other physicists agree are advanced physics, so to say that we
 401 found he’s conscious is not very impressive. and it says “we found some activity in the ultra-high
 402 gamma band,” but basically, he failed to create a communication system.

403 //I: mhm//

404 **TN:** here is the other part that nobody knows: after that, I tried to contact [misses c] and succeeded, and I said
 405 “listen, um.. I don’t know how you made the decision to work with this person, but uh, nobody knows
 406 him, we don’t see him at conferences, and so on, and.. we would like to volunteer to come there for
 407 free.” and she conveyed, [mister f] doesn’t like BCIs anymore, uh, it’s all about money, people just
 408 want to get his name and say “oh, we’re the person that did that.” and I said, along with [mister e] who
 409 is also a very established person, I said look,-

410 **I:** I talked with him-

411 **TN:** right,

412 **I:** yesterday, yeah.

413 **TN:** right. he’s an old friend of mine and we’ve worked-

414 **I:** ah, okay.

415 **TN:** so I was talking to him and I said “[first name of mister e], this is wrong, I mean, [mister f] hates BCIs
 416 now because he thinks they don’t work, and we know we can do it.” so, I’ve worked with a lot of
 417 patients and so has [fist name of mister e], and the system that he has, called “[name of the system]” has
 418 been successful with patients before, so we conveyed the following: we will come there for free,
 419 completely at our own expense. [company of mister e] will donate a system, which is a lot of money for
 420 G-Tech,

421 //I: mhm//

422 **TN:** we’ll give you a complete system. we will sign a non-disclosure agreement, we will sign that we will
 423 never tell anybody. we will never, ever tell anyone that we helped [mister f], or anything that happened.
 424 The reason that we want to do this is not for our own career or publicity or to sell anything for [name of
 425 the company], but because we have a responsibility as scientists,

426 //I: yeah//

427 TN: and also, this is a-a special case of a scientist, you know, I mean this is someone if we can help him

428 communicate more, he might find the secrets to the universe.

429 I: (laughs)

430 TN: and they-they said no. so, [misses c] was like “no, we don’t want this.” and so, that was a long example

431 of a story to answer this ethical issue that I have, uh, which is, proper use-if someone wants to use a BCI

432 with patients, both the person and the BCI should be adequately qualified and perhaps certified, just like

433 medical doctors, or even at a simpler level, nurses or-or dentists,

434 //I: mhm//

435 TN: massage therapists, chiropractors. a massage therapist is not someone who’s really a medical expert, but

436 if you make a mistake, you could hurt someone seriously, and they go through training for that. you-you

437 cannot become a certified massage expert unless a senior expert sees how you interact and do this.

438 I: (laughs)

439 TN: so, [mister f]-

440 (? additional person in the background speaking, unclear)

441 I: (laughs)

442 TN: [mister f] still can’t use a BCI. (?? speaking to someone else) right, so,

443 I: (laughs) he gave me an interview yesterday

444 TN: yeah, no I know,

445 I: (laugh) yeah yeah. okay, yeah.

446 TN: yeah, so that’s one, but the issue of laziness. I use the example of the remote control

447 //I: mhm//

448 TN: in my lectures. so I’ve given a lot of talks, including my talk at...in [month]. if you look at the remote

449 control, it seems like it could be an assistive technology device. maybe it’s something to help disabled

450 people, so if you’re on a-a couch and you’re not able to stand up, then wonderful, a remote control is

451 giving you a lot more freedom. but of course.. more than 99 percent of the time that someone uses a

452 remote control, it’s not because of any disability, it’s because, for convenience. or, to put it another way,

453 they’re just too lazy to get up and push buttons on the TV. I use them too, I’m not saying it-it makes

454 people look bad. I gave this lecture at [a company] a few years ago and I said “you’re [company], you

455 make TVs. do you make any TVs without remote controls?” and they say “no, like, you have buttons on

456 the TV, but that would be stupid, why would we make a-a remote control is an essential part of a

457 television now, and yet, that has led to a certain level of laziness. people-it’s easier to sit on the couch,

458 it’s easier to be complacent and to get sort of lost in that world, and BCIs could take that to a much

459 more extreme level, where you, if you can sit there and you could control a smart home, you could play

460 games, you could-they already have robots that can bring you food and drink and things,

461 //I: mhm//

462 TN: um, so I think that’s.. uh, an ethical concern.

463 I: and, uh, in the military field,

464 //TN: mhm//

465 I: I think in Europe,

466 //TN: mhm//

467 I: I don’t know anything, uh, right now, but I think in the United States,

468 //TN: mhm//

469 I: there is like a huge development.

470 TN: the interesting thing with the military BCI stuff in the United States, and I, you know, I’ve.. I don’t

471 encourage war or violence or anything, but I used to think, you know, well the military BCI research is

472 uh, it could be scary,

473 //I: mhm//

474 **TN:** there could be some worries, some applications.. and that is true, it is something to watch, but some of
475 the projects that I've learned about are not-are not like that. they're not as-as scary as some people
476 would think, so for example, a lot of the military work has been to detect operator alertness, you know,
477 so for example, you are um. you are a pilot, and you are on a very long mission and you have to release
478 some bombs, and shortly before then, you are falling asleep. if you have a BCI that can detect that, you
479 could reduce the chance of-of an error.

480 **//I:** mhm//

481

482 **TN:** now, the bigger issue is of course, it would be nice to just never bomb anybody, but that's not an
483 application that really increases killing people, or increases the potential to cause harm. if anything, it's
484 reducing the chance of accidentally, you know-you wanna just build up a big radar dish and you
485 accidentally blow up a building or a school, th-it could actually lead to reduced death. it's not a great.. I
486 mean, again, it would be better to just not bomb anybody,

487 **//I:** mhm//

488 **TN:** but that's one example. or another one that they'll work on is target detection,

489 **//I:** mhm//

490 **TN:** so the military is very interested in-if you, let's say you're sitting here and there's a screen and you have
491 all kinds of little dots that are moving around. another example that is not really military but is related is
492 air traffic control.

493 **//I:** mhm//

494 **TN:** so, in air traffic control, you have a classic case, where a very small mistake-a small loss of alertness can
495 be a-a disaster, you know. so imagine that there is an air traffic controller and things are extremely busy
496 and that person doesn't notice one of the airplanes,

497 **//I:** mhm//

498 **TN:** just one of those little blips, well that could lead to an accident and so there has been work to try to-to
499 first see if they're tired, like I was saying, but also more specifically, to determine if they have seen each
500 of those items.

501 **//I:** mhm, mhm//

502 **TN:** and that's another example where it's not really unethical. (laughs)

503 **I:** it's more in a positive way, to-

504 **TN:** right, right,

505 **I:** to help people and not to make errors, or-

506 **TN:** right

507 **I:** to reduce the error rate. okay.

508 **//TN:** mhm//

509 **I:** okay, cool. now, um.. have we missed something? something important? (laughs) I'm just-

510 **TN:** I'm thinking, I-

511 **I:** having a look now, uh just, one last uh, last question.

512 **//TN:** mhm//

513 **I:** uh, what do you think, um, a human being using a BCI, is still the human being active or more imagined, or
514 more a mixture? what do you think in your personal opinion?

515 **TN:** this is an emerging issue with respect to ethical things of BCIs, uh so, to what extent to people give up
516 control and lose the ability to make their own decisions? that maybe a BCI makes the decision for them.

517 **I:** mhm. exactly.

518 **TN:** and I think this is more in the longer term, I think in the near future, with the directions that BCIs are
519 going, people have control. BCIs are voluntary devices, they're-there's not-in the next few years, I don't
520 see a lot of ways you could use them against the will of people. you know, to do things where it's not

521 intentional. among other challenges, people know when they have a hat on their head. I mean, there's no
522 way I can detect brain activity from far away.

523 //I: mhm//

524 **TN:** and so that, it doesn't completely eliminate ethical concerns, there's still the risk you put a hat on
525 someone's head and then you can trick them or something, but it makes it a lot more difficult. and then,
526 I mean, another related issue is, let's say you do put a hat on someone's head, someone voluntarily says
527 "yes, I agree, you're going to look at my brain waves so I can play this computer game. I agree, that's
528 fine." and you-your EEG gets recorded and that's used to play a game, and then, perhaps a hacker steals
529 your information or something, or the company that you send it to is not ethical and they sell it to
530 someone, and they say "hey, here's the raw EEG data from this person and that person believed that it
531 was just being used to play a game, but we have a different algorithm and it can tell you who they will
532 vote for, for example,

533 //I: mhm//

534 **TN:** or it can tell you private details about their medical history, so suddenly you start getting letters in the
535 mail encouraging you to vote for a certain person or saying "oh, if you have Alzheimer's disease, talk to
536 us." that's an example of an unethical use, where even though someone's wearing a hat on the head, uh,
537 you're getting information that people don't-don't want.

538 //I: mhm. you think like, uh, reading the thoughts would be possible one day? because-

539 **TN:** yes.

540 **I:** yes-

541 **TN:** yes, and I-in most interviews, I said it is possible one day, but I don't see how. like, eventually, a lot of
542 things will be possible,

543 //I: yeah//

544 **TN:** but recent work, largely from [name unclear??] and his colleagues, where they can look at these imagined
545 words and imagined music. so they can play Pink Floyd at a patient, they play a song from Pink Floyd,
546 and then they say "okay now, imagine that song" and that reconstructs the song from the EcoG data.

547 //I: mhm//

548 **TN:** now, this is an invasive BCI, but this gets toward the direction of..of a-a true semantic BCI. in other
549 words, you just think something and it happens. and you've seen some of the talks here looking at
550 semantic BCIs.

551 //I: yeah//

552 **TN:** so yes, I do think that's ultimately possible, some kind of direct language reading or thought-reading. it
553 also gets to the question of if you can read someone's thoughts, what-what do you see, I mean what's
554 really going on in your brain right now?

555 //I: yeah//

556 **TN:** you know, there's a lot going on that you're maybe only semi-conscious of, or you don't think about, and
557 I might think words sometimes that don't mean anything, I mean I-"apple," I think the word "apple"
558 right now, so what? does that mean I want an apple, does that mean-

559 **I:** yeah, yeah

560 **TN:** I'm sick because I had an apple, it doesn't mean anything.

561 **I:** because normally we having, in my case (laugh) a lot of different thoughts, so a lot of ideas and-

562 //TN: mhm//

563 **I:** it doesn't make sense for somebody else maybe, so

564 **TN:** right

565 **I:** it's not really, it doesn't make sense in some cases.

566 **TN:** if you can read someone's thoughts, so what.

567 //I: yeah//

568 **TN:** like, you were probably sitting there thinking about the names of people that you have to interview and
569 what were the questions from before,
570 //I: yeah, yeah, yeah, uh-huh//
571 **TN:** if you did have a BCI that could detect that, so what. what-what good does it do? how is it giving you any
572 helpful new information?
573 **I:** that's true.. okay, good. no, um, just one-
574 **TN:** sure
575 **I:** thing um, about responsibility,
576 //TN: mhm//
577 **I:** do you think people who are using a BCI are responsible for their actions? like BCI-modulated actions?
578 **TN:** I would sa-okay, that's an excellent question and I-I see a parallel to other technologies with this.
579 //I: mhm//
580 **TN:** so.. let me ask a related question, if you're using a keyboard and a mouse, are you responsible for your
581 actions? so, let's say for example, you go onto amazon.com and you have a-an item there and you're
582 thinking about purchasing it and you decide "no, I don't want to buy a-a 500 dollar jacket." you decide
583 not to, and then a few weeks later, the jacket arrives in the mail and they billed your credit card. and you
584 say, "what happened?" well, maybe you accidentally clicked the button. you fell asleep, you clicked the
585 button.
586 //I: mhm//
587 **TN:** in that case, who is responsible? maybe it's not your fault. maybe you did not click the button, but
588 amazon made a mistake and you look over it and it says "yeah, you're right, you put it in your cart but
589 you did not buy it, it's our mistake." ..you get similar issues with BCIs, that is, in some cases you-you
590 really can clearly blame the user or you can clearly blame the BCI or the other system. there will be a
591 lot of problems where it's fuzzy. so, your coat arrives and you say you didn't do it and amazon says you
592 did do it, well then who do you blame?
593 //I: mhm//
594 **TN:** and this issue also comes up as a parallel with unwanted information. so I was talking about this example
595 of.. you know, what if you get unwanted information from the EEG? well, here is a parallel and
596 modern.. uh, news is.. you go onto Facebook or something and you, uh, you have certain friends and
597 somebody posts a-a political thing or maybe, uh, it says "hey, I got these sunglasses" and you click
598 "like," and then suddenly you log onto Facebook again and there's a political ad and-and sunglasses.
599 //I: mhm//
600 **TN:** that's another-that's-that's not all that different from-from the case where you get EEG and you send it
601 somewhere and then they say "ah, if you have Alzheimer's disease, talk to us." it's another case where
602 the.. the user does not want you to get certain information, but they're getting it anyway. now, who is
603 responsible for that? and it's the same question, who do you blame if Facebook or Google is searching
604 your user data and is getting all kinds of secrets about you that you don't want? who's fault is that?
605 **I:** hmm. you are providing the information, yeah
606 **TN:** right. well, and you-I-I mean I can give you an answer, but it's the sa-it's nothing new. like, you'd say
607 "this is the same answer as anything," you could say, on the one hand, you could blame the user because
608 you could take the time to deactivate that, you could take the time to spend hours reading what they do
609 and clicking on privacy policies and-and making that impossible, to some extent. you can also blame the
610 company because they don't make this easy, and you could say "hey, why does Facebook do this? why
611 don't they just let me log on for free and go around and not sell my data and all these things?" so, I can't
612 give you an answer to that, but it's the same thing that's going to happen with EEG. who do you blame?
613 //I: yeah//
614 **TN:** who's-you know,so-

615 **I:** yeah, that's true.. okay, so.. good. and do you think for the general, uh, public there will be like a..a great
616 development in the future with BCIs, like for everyone?

617 **TN:** yes, I think that.. I think BCIs will follow the same hype cycle and adoption cycle as other, uh,
618 technologies. so cellphones are a classic example. there was a time in the 1980s for example, when
619 nobody had cellphones,

620 **//I:** mhm.. yeah//

621 **TN:** and I remember very well the first time I saw one and it was because a friend of mine's father worked for
622 a telephone company, and so one day, he uh.. his son was over playing with me and he called and my
623 mom answers and uh, he says "hey, I'm on my way to pick him up, I'll be there in about five minutes,"
624 and she says "but you live twenty minutes away, that's impossible-(laughs)-are you at a payphone?" he
625 says "no, I'm calling you from my car phone, I'm in a car-

626 **//I:** mhm//

627 **TN:** and I'll be there in five minutes"

628 **//I:** mhm//

629 **TN:** and we couldn't believe it, but there he is five minutes later, and I said, "can I see your car phone?" and it
630 was this big thing and a big phone,

631 **//I:** (laughs)//

632 **TN:** so that was the initial.. stage, it was-it was exotic, it was crazy.

633 **//I:** mhm//

634 **TN:** a few people had it, only people who were insiders with strong technical skill, and they were mostly
635 impractical. in other words, they were so big and so expensive and they required a-there was no
636 cellphones, so they required, you know, a centralized-single centralized entity, so he says "yes, this only
637 works when I'm within ten miles of the cellpho-of the telephone company"

638 **//I:** mhm//

639 **TN:** but then, the technology advanced, they become smaller, more inexpensive, more practical. then, the next
640 stage from exotic is it's something that's actually becoming practical and everybody wants them. look
641 how quickly they-they developed.

642 **//I:** yeah//

643 **TN:** and then cellphones become common and even boring, and so this was a-a great quote from someone at
644 [company], I don't remember exactly what, but he says something to the effect of, uh "the best
645 technology is technology that's invisible."

646 **//I:** mhm//

647 **TN:** and this is where cellphones are going. so right now, everybody has a cellphone and they're usually
648 smartphones and they have all kinds of capabilities, and.. nobody is excited by this anymore. nobody
649 says, "oh, I got a cellphone!"

650 **I:** it's normal, yeah

651 **TN:** if you see someone saying "hey, look, I have a cellphone!" you say, "well, good, so do I, so does
652 everybody"

653 **I:** (laughs)

654 **TN:** that's where BCIs will be eventually,

655 **//I:** mm//

656 **TN:** someday.

657 **I:** or maybe, uh, chips,

658 **TN:** chips?

659 **I:** like, invasive chips as well.

660 **TN:** invasive chips are another one,

661 **//I:** yeah//

662 **TN:** and, you know, another issue with invasive BCIs that comes up is the.. the change in... societal morality
663 about these things is also-it's another case where you can look at what already happened. so, look at
664 what happened-and this-I gave some examples with, um.. in my lecture in July, and you know, these
665 were awkward cases, but look at-look at examples with cosmetic surgery for breast size or-or penis size.
666 //I: mm//

667 **TN:** so, when these were first invented, another example is, uh, nose surgery to change your nose, when these
668 first came about, it was considered non-necessary surgery, so you could go and you could get breasts
669 that are larger or smaller,
670 //I: mhm//

671 **TN:** or have a different shape or something, and people would say "oh, you know, well that's your.. that's
672 your thing, but it's not-there's no medical need for it," and so we're mostly not gonna do it unless, you
673 know, rare cases where you-you need the surgery from cancer,
674 //I: mhm//

675 **TN:** initially rare cases. and then things changed. first, a lot of cancer doctors started saying "this is not a-a
676 choice. this is not a choice. if you remove a woman's breast and you can reconstruct that, this is.. you
677 know, this is not like someone in Hollywood who just wants to have larger boobs,
678 //I: mm, mm//

679 **TN:** this is not correct to look at it this way," and then other people would say "yeah, there are cases, uh,
680 where, uh, women-one breast is much smaller than the other one"
681 //I: mhm//

682 **TN:** uh, with penis, you know, some people would be very uncomfortable with that. and with the nose, people
683 would say, "you know, everybody told me that if I go get surgery to fix my nose, then I'm just a shallow
684 person, I just care about appearance, but this changed my life, I-I used to have a big ugly nose and I was
685 ashamed of it and now.. I feel much more comfortable." so, is this going to happen with invasive BCIs?
686 that is, right now everybody agrees, and I certainly agree as well, it's completely inappropriate to drill a
687 hole in someone's head unless there is a strong medical need for it, but might people start to see it
688 differently over time, so maybe for example, they find that.. this can be very helpful for neurofeedback.
689 that if you put a little chip in your head, you could learn to relax much more effectively than you could
690 with an electrode cap, and people start to say, "well, relaxation *is* health," I mean, if you can reduce
691 stress,
692 //I: mhm//

693 **TN:** people might live longer,
694 //I: mhm//

695 **TN:** they don't have heart attacks, then it's not so different from a nose job or a breast job or something, and
696 that could be the beginning of a change, where, in the most extreme case, which I think right now would
697 be horrifying, but it could change, it becomes routine. people do it and you say "yeah, I ne-I need to be
698 able to control my cellphone with a device in my head. if I don't have this, I'm inferior to everyone
699 else."
700 //I: mhm//

701 **TN:** so..
702 **I:** yeah, I agree, and even people, for example with uh depression, or
703 **TN:** that's another great example
704 **I:** parkinson's, yeah
705 **TN:** right
706 **I:** they really need this technology, so it's up to everyone, so you can't decide for the general public
707 **TN:** right
708 **I:** if it's necessary or not
709 **TN:** right

710 //I: yeah//
711 TN: that's an excellent example. it's-it used to be that persons with mild depression, they would not give them
712 Prozac or Paxil, they would say, "you know, mild depression is not so bad,
713 //I: mhm//
714 TN: you can go to a therapist,
715 //I: mhm//
716 TN: maybe you just need some more exercise or something,
717 //I: mhm//
718 TN: this drug is new, it's risky," but over time, they say this drug is not so new and risky
719 //I: mhm//
720 TN: and mild depression is.. is real, it still hurts,
721 //I: yeah//
722 TN: a lot of people have their lives changed
723 //I: yeah//
724 TN: because they take medication
725 //I: mhm. that's true. okay, good. now, thank you very much for your time!
726 TN: I appreciate it
727 I: just uh.,