
AbSciCon
2019

1
00:00:13,410 --> 00:00:07,320
[Music]

2
00:00:18,730 --> 00:00:16,090
so in front of you right now is the

3
00:00:21,460 --> 00:00:18,740
phylogeny the family tree of the animals

4
00:00:23,530 --> 00:00:21,470
it is the diversity of the nervous

5
00:00:26,760 --> 00:00:23,540
system with the exception of perhaps

6
00:00:28,749 --> 00:00:26,770
porifera the sponges toward the top

7
00:00:30,880 --> 00:00:28,759
despite this diversity the

8
00:00:34,960 --> 00:00:30,890
overwhelmingly preferred model within

9
00:00:38,459 --> 00:00:34,970
the behavioral sciences is here the

10
00:00:41,709 --> 00:00:38,469
vertebrates which includes ourselves as

11
00:00:43,660 --> 00:00:41,719
the mind continues to diversify into

12
00:00:46,630 --> 00:00:43,670
unimaginable forms in the world and

13
00:00:49,180 --> 00:00:46,640

perhaps the universe around us so if we

14
00:00:50,950 --> 00:00:49,190
wish to understand the mind we should

15
00:00:53,230 --> 00:00:50,960
look beyond the vertebrate model to

16
00:00:54,940 --> 00:00:53,240
other forms of thought entirely and for

17
00:00:59,260 --> 00:00:54,950
this reason I have chosen the octopus is

18
00:01:00,610 --> 00:00:59,270
my model organism it has been for over

19
00:01:02,229 --> 00:01:00,620
five hundred million years that the

20
00:01:03,910 --> 00:01:02,239
octopus has been involved in cognitive

21
00:01:05,830 --> 00:01:03,920
complexity in parallel to that of

22
00:01:08,190 --> 00:01:05,840
vertebrates but has done so through

23
00:01:10,899 --> 00:01:08,200
entirely divergent neural architecture

24
00:01:12,910 --> 00:01:10,909
most of the octopuses nervous system

25
00:01:16,570 --> 00:01:12,920
exists within its arms as a distributed

26
00:01:18,340 --> 00:01:16,580
network this allows it to offload a

27
00:01:21,130 --> 00:01:18,350
great deal of computation from its brain

28
00:01:23,200 --> 00:01:21,140
into its arms and this allows it to

29
00:01:26,500 --> 00:01:23,210
process massive amounts of information

30
00:01:29,620 --> 00:01:26,510
in parallel including the information

31
00:01:32,200 --> 00:01:29,630
necessary to control the infinite

32
00:01:34,090 --> 00:01:32,210
degrees of freedom of its arms they

33
00:01:36,340 --> 00:01:34,100
don't really have fixed joints like we

34
00:01:37,780 --> 00:01:36,350
do as well as the massive amount of

35
00:01:41,410 --> 00:01:37,790
sensory information available from their

36
00:01:46,030 --> 00:01:41,420
suckers this is the morphology of the

37
00:01:48,130 --> 00:01:46,040
sucker it can orient and the spherical

38
00:01:51,730 --> 00:01:48,140

muscle you see in the middle when

39
00:01:53,740 --> 00:01:51,740
contracted will make will activate the

40
00:01:57,219 --> 00:01:53,750
adhesion mechanism if the proper seal is

41
00:02:00,399 --> 00:01:57,229
made this is what the innervation of the

42
00:02:01,929 --> 00:02:00,409
sucker looks like on the face of the

43
00:02:05,410 --> 00:02:01,939
sucker disk is where you'll have

44
00:02:12,190 --> 00:02:05,420
mechanical receptors those are dedicated

45
00:02:15,190 --> 00:02:12,200
to processing the shape of the substrate

46
00:02:17,039 --> 00:02:15,200
that's attached to him as well as assess

47
00:02:20,140 --> 00:02:17,049
the integrity of the adhesion mechanism

48
00:02:21,429 --> 00:02:20,150
along the outer rim where it's exposed

49
00:02:23,790 --> 00:02:21,439
to the most number of dissolved

50
00:02:26,760 --> 00:02:23,800
chemicals is naturally the Kimura

51
00:02:28,980 --> 00:02:26,770
system there are tens of thousands of

52
00:02:31,410 --> 00:02:28,990
both chemical and mechanical receptors

53
00:02:33,360 --> 00:02:31,420
in each sucker to put that into

54
00:02:35,930 --> 00:02:33,370
perspective each one of your fingertips

55
00:02:39,600 --> 00:02:35,940
has a few hundred mechanical receptors

56
00:02:40,950 --> 00:02:39,610
so it's a lot of information that these

57
00:02:43,320 --> 00:02:40,960
suckers are processing and the way

58
00:02:45,990 --> 00:02:43,330
they're able to do that is that each one

59
00:02:48,150 --> 00:02:46,000
has been delegated a cluster of neurons

60
00:02:50,870 --> 00:02:48,160
that serves as a local sensory and motor

61
00:02:56,220 --> 00:02:50,880
computation Center called a ganglion

62
00:02:58,560 --> 00:02:56,230
these ganglia are among a chain that

63
00:03:01,470 --> 00:02:58,570

projects toward the brain so the brain

64
00:03:03,840 --> 00:03:01,480
is where the eight arms converged and at

65
00:03:05,310 --> 00:03:03,850
the base of each arm there is a neural

66
00:03:07,560 --> 00:03:05,320
ring that serves to unite them that

67
00:03:08,700 --> 00:03:07,570
serves as a means by which the arms can

68
00:03:12,950 --> 00:03:08,710
communicate with each other without

69
00:03:21,150 --> 00:03:14,780
what you see here is a cross-section

70
00:03:22,770 --> 00:03:21,160
with the neurons stained in black like I

71
00:03:24,480 --> 00:03:22,780
said each sucker has its own ganglion

72
00:03:26,460 --> 00:03:24,490
each one of those ganglia wallet

73
00:03:28,410 --> 00:03:26,470
projects to each sucker shares

74
00:03:29,729 --> 00:03:28,420
information likewise with the arm

75
00:03:32,670 --> 00:03:29,739
musculature surrounding it

76
00:03:34,380 --> 00:03:32,680
so each ganglia processes the

77
00:03:36,330 --> 00:03:34,390
information from the local sucker from

78
00:03:38,160 --> 00:03:36,340
local musculature and as well controls

79
00:03:40,560 --> 00:03:38,170
that segment of the musculature and the

80
00:03:43,080 --> 00:03:40,570
sucker itself most of this information

81
00:03:44,670 --> 00:03:43,090
doesn't make it to the brain at all the

82
00:03:46,830 --> 00:03:44,680
brain receives but a very highly

83
00:03:48,990 --> 00:03:46,840
abstracted sense of what's going on out

84
00:03:51,270 --> 00:03:49,000
in the world and it will respond with a

85
00:03:54,180 --> 00:03:51,280
very generalized motor plan that will

86
00:04:01,310 --> 00:03:54,190
get specified based on this very densely

87
00:04:03,360 --> 00:04:01,320
innervated sensory field here is a

88
00:04:07,920 --> 00:04:03,370

simplified schematic of the cross

89
00:04:09,600 --> 00:04:07,930
section of the arm in a way the octopus

90
00:04:11,729 --> 00:04:09,610
has sent its mind down to the

91
00:04:13,650 --> 00:04:11,739
environment to meet halfway so it's a

92
00:04:17,039 --> 00:04:13,660
very different way of thinking about the

93
00:04:19,710 --> 00:04:17,049
world so what we're doing is we're using

94
00:04:21,150 --> 00:04:19,720
behavioral tracking to characterize how

95
00:04:23,100 --> 00:04:21,160
the suckers and the arms are

96
00:04:24,330 --> 00:04:23,110
collectively acquiring integrating and

97
00:04:27,300 --> 00:04:24,340
responding to information in the

98
00:04:30,240 --> 00:04:27,310
environment which I'm going to walk you

99
00:04:33,570 --> 00:04:30,250
guys through right now so from the level

100
00:04:37,070 --> 00:04:33,580
of the suckers what we can do is provide

101
00:04:39,529 --> 00:04:37,080
an arm with a simple puzzle or

102
00:04:42,830 --> 00:04:39,539
by which it's able to extract some food

103
00:04:50,809 --> 00:04:42,840
and we can simply characterize the

104
00:04:52,670 --> 00:04:50,819
strategies that's using to do this what

105
00:04:56,779 --> 00:04:52,680
becomes immediately apparent to us is

106
00:04:59,149 --> 00:04:56,789
that once a sucker makes contact with a

107
00:05:02,779 --> 00:04:59,159
stimulus it immediately recruits its

108
00:05:05,270 --> 00:05:02,789
immediate neighbor to joining it what

109
00:05:07,399 --> 00:05:05,280
you see here is the segment's lighting

110
00:05:08,779 --> 00:05:07,409
up proportionately to their angular

111
00:05:12,860 --> 00:05:08,789
speed during the course of this behavior

112
00:05:15,920 --> 00:05:12,870
so this is consistent with research that

113
00:05:18,260 --> 00:05:15,930

was done before me and what is showing

114
00:05:19,790 --> 00:05:18,270
us is that once the sucker makes contact

115
00:05:22,430 --> 00:05:19,800
with the stimulus it is recruiting the

116
00:05:24,409 --> 00:05:22,440
next sucker over to bend it toward the

117
00:05:25,879 --> 00:05:24,419
source of that stimulus once it makes

118
00:05:28,219 --> 00:05:25,889
contact with that stimulus it will do

119
00:05:30,559 --> 00:05:28,229
the same thing for the next sucker until

120
00:05:34,309 --> 00:05:30,569
it propagates the signal down the length

121
00:05:36,290 --> 00:05:34,319
of the arm and again the information

122
00:05:39,860 --> 00:05:36,300
acquired from the stimulus is highly

123
00:05:41,420 --> 00:05:39,870
abstracted on its way to the brain this

124
00:05:43,339 --> 00:05:41,430
dot is highlighting the different parts

125
00:05:45,920 --> 00:05:43,349
of the arm or the different segments and

126
00:05:48,740 --> 00:05:45,930
it's showing based on color coordination

127
00:05:50,570 --> 00:05:48,750
how the other segments are correlated

128
00:05:52,459 --> 00:05:50,580
with that one in terms of its angular

129
00:05:56,209 --> 00:05:52,469
speed what becomes apparent is that

130
00:05:57,589 --> 00:05:56,219
there is accordingly this symmetry

131
00:06:01,809 --> 00:05:57,599
around the point of original point of

132
00:06:04,159 --> 00:06:01,819
contact showing both distal and proximal

133
00:06:06,649 --> 00:06:04,169
recruitment of suckers and toward the

134
00:06:10,189 --> 00:06:06,659
tip of the arm where the arm is actually

135
00:06:11,809 --> 00:06:10,199
wrapping around the stimulus what you

136
00:06:14,629 --> 00:06:11,819
see here is how the strategy actually

137
00:06:16,760 --> 00:06:14,639
changed over time we recognized that

138
00:06:20,080 --> 00:06:16,770

there was two strategies that the arm

139
00:06:23,540 --> 00:06:20,090
was mainly using one was really the arm

140
00:06:26,480 --> 00:06:23,550
feeling around in the water column and

141
00:06:28,369 --> 00:06:26,490
the other one as a direct consequence of

142
00:06:29,629 --> 00:06:28,379
the mechanism I just described to you go

143
00:06:31,670 --> 00:06:29,639
straight for the wall and so it's

144
00:06:33,050 --> 00:06:31,680
following the wall like you might amaze

145
00:06:37,399 --> 00:06:33,060
if you wanted to get out of it

146
00:06:39,409 --> 00:06:37,409
interestingly enough the highlighted

147
00:06:42,709 --> 00:06:39,419
images are when there actually is no

148
00:06:44,809 --> 00:06:42,719
food in the box and what we started to

149
00:06:46,629 --> 00:06:44,819
notice was that while following was

150
00:06:49,129 --> 00:06:46,639
overwhelmingly preferred in these cases

151
00:06:49,430 --> 00:06:49,139
so in lack of chemical information in

152
00:06:53,180 --> 00:06:49,440
other

153
00:06:54,530 --> 00:06:53,190
words for the next task we made it a

154
00:06:57,050 --> 00:06:54,540
little bit more interesting by added a

155
00:06:58,670 --> 00:06:57,060
texture on one side by the way you're

156
00:07:01,390 --> 00:06:58,680
looking at this sideways but I couldn't

157
00:07:09,310 --> 00:07:01,400
bear to show you guys a vertical video

158
00:07:11,960 --> 00:07:09,320
so this showed a very similar pattern

159
00:07:14,600 --> 00:07:11,970
but it was particularly strong in the

160
00:07:18,260 --> 00:07:14,610
direction of the texture itself as you

161
00:07:20,600 --> 00:07:18,270
can see so what was the arm doing during

162
00:07:26,180 --> 00:07:20,610
this time it was literally just feeling

163
00:07:27,770 --> 00:07:26,190

up the texture so what it what seems to

164
00:07:29,720 --> 00:07:27,780
be the case is that the arm uses the

165
00:07:31,430 --> 00:07:29,730
chemical and mechanical composition of

166
00:07:35,360 --> 00:07:31,440
the environment as a framework upon

167
00:07:37,850 --> 00:07:35,370
which to behave the brain doesn't need

168
00:07:43,160 --> 00:07:37,860
to choose where the arm bends that's the

169
00:07:45,260 --> 00:07:43,170
environment doing that this is probably

170
00:07:47,510 --> 00:07:45,270
an intrinsic property of the soft bodied

171
00:07:49,510 --> 00:07:47,520
intelligence it's using the environment

172
00:07:51,530 --> 00:07:49,520
as a computational resource and

173
00:07:53,450 --> 00:07:51,540
mechanical novelty is a particularly

174
00:07:59,680 --> 00:07:53,460
strong reference by which is able to do

175
00:08:03,409 --> 00:08:02,030
drawback of this different kind of

176
00:08:05,000 --> 00:08:03,419
intelligence is that sometimes there's

177
00:08:11,330 --> 00:08:05,010
not always a consensus in the arm will

178
00:08:12,770 --> 00:08:11,340
play tug-of-war with itself but there

179
00:08:14,480 --> 00:08:12,780
are drawbacks to our kind of

180
00:08:17,710 --> 00:08:14,490
intelligence too but that's going to be

181
00:08:23,060 --> 00:08:21,080
all right let's reorient ourselves so

182
00:08:25,850 --> 00:08:23,070
what this mechanism allows it to do is

183
00:08:27,590 --> 00:08:25,860
it maximizes both the amount of control

184
00:08:29,659 --> 00:08:27,600
that the arm has over a given stimulus

185
00:08:31,610 --> 00:08:29,669
as well as the amount of increment

186
00:08:33,260 --> 00:08:31,620
information gathered from that stimulus

187
00:08:36,020 --> 00:08:33,270
so this is particularly a particularly

188
00:08:38,329 --> 00:08:36,030

important time for a pert particularly

189
00:08:40,909 --> 00:08:38,339
interesting stimuli as well as stimuli

190
00:08:42,140 --> 00:08:40,919
that might be struggling for its life so

191
00:08:47,420 --> 00:08:42,150
if you ever feel an octopus grabbing on

192
00:08:48,740 --> 00:08:47,430
to you don't struggle so what's actually

193
00:08:50,390 --> 00:08:48,750
happening at the system's level and this

194
00:08:52,790 --> 00:08:50,400
is happening well when one sucker grabs

195
00:08:55,490 --> 00:08:52,800
on to an object it sends a signal to the

196
00:08:57,350 --> 00:08:55,500
brain again a very abstracted signal but

197
00:09:00,110 --> 00:08:57,360
then as a next sucker over also gains

198
00:09:01,940 --> 00:09:00,120
access to that signal or stimulus that

199
00:09:04,160 --> 00:09:01,950
signal is going to be a lot stronger

200
00:09:06,110 --> 00:09:04,170
until it reaches a certain threshold at

201
00:09:09,080 --> 00:09:06,120
which point the brain is recruited the

202
00:09:11,210 --> 00:09:09,090
brain is the node by which the arms vie

203
00:09:15,080 --> 00:09:11,220
for control over the others and a

204
00:09:17,540 --> 00:09:15,090
winner-take-all fashion at that point

205
00:09:19,790 --> 00:09:17,550
the brain will update the motive

206
00:09:22,040 --> 00:09:19,800
strategy of the arms and again that

207
00:09:24,200 --> 00:09:22,050
information that is in the peripheral

208
00:09:27,020 --> 00:09:24,210
nervous system will be used to specify

209
00:09:32,800 --> 00:09:27,030
that information or specify that motor

210
00:09:37,670 --> 00:09:36,260
so we can track this as well and and the

211
00:09:39,020 --> 00:09:37,680
way we're able to do this is by looking

212
00:09:42,110 --> 00:09:39,030
at synchronous versus asynchronous

213
00:09:44,000 --> 00:09:42,120

movement in the arms because what

214
00:09:46,250 --> 00:09:44,010
synchronous movement will tell us is

215
00:09:48,200 --> 00:09:46,260
that it's not the arms really doing this

216
00:09:49,670 --> 00:09:48,210
it's that the brain is intervening to be

217
00:10:00,460 --> 00:09:49,680
able to update the motor plan of the

218
00:10:06,660 --> 00:10:03,160
this broad motor plan generated from the

219
00:10:09,160 --> 00:10:06,670
brain can be very dramatic in this case

220
00:10:14,350 --> 00:10:09,170
you can see how all the arms have been

221
00:10:16,360 --> 00:10:14,360
told to reach at the same time and again

222
00:10:18,009 --> 00:10:16,370
it's the information that never makes it

223
00:10:20,110 --> 00:10:18,019
to the brain at all that is being used

224
00:10:24,069 --> 00:10:20,120
to locally modify that behavior to fit

225
00:10:32,139 --> 00:10:24,079
the conditions at that time and we can

226
00:10:33,850 --> 00:10:32,149
track that too for now so we are also

227
00:10:35,500 --> 00:10:33,860
seeing this other kind of recruitment

228
00:10:35,829 --> 00:10:35,510
strategy I've talked about sucker to

229
00:10:39,550 --> 00:10:35,839
sucker

230
00:10:41,079 --> 00:10:39,560
I've talked about armed brain we can see

231
00:10:43,269 --> 00:10:41,089
that the arm will actually create its

232
00:10:44,860 --> 00:10:43,279
neighbors but this happens a lot more

233
00:10:47,259 --> 00:10:44,870
turbulent environments because obviously

234
00:10:48,850 --> 00:10:47,269
the arms from all sides are now getting

235
00:10:50,590 --> 00:10:48,860
a lot more information it's not a simple

236
00:10:54,790 --> 00:10:50,600
just like one object one behavior kind

237
00:10:57,930 --> 00:10:54,800
of task so you saw it there you can see

238
00:11:00,280 --> 00:10:57,940

it again here and it's not hard to watch

239
00:11:05,439 --> 00:11:00,290
I've had them described to me as living

240
00:11:09,370 --> 00:11:05,449
lava lamps okay so what do we think is

241
00:11:11,380 --> 00:11:09,380
happening here well through the ganglia

242
00:11:13,269 --> 00:11:11,390
so a separate pathway and then through

243
00:11:14,769 --> 00:11:13,279
the ring which is called the inter

244
00:11:17,889 --> 00:11:14,779
brachial commissure which is a bit of a

245
00:11:19,480 --> 00:11:17,899
mouthful a signal will be sent to the

246
00:11:21,460 --> 00:11:19,490
neighboring arms those arms will

247
00:11:23,910 --> 00:11:21,470
actually join the one that sent the

248
00:11:25,990 --> 00:11:23,920
signal to begin with and then now the

249
00:11:27,910 --> 00:11:26,000
representation of that stimulus now

250
00:11:29,829 --> 00:11:27,920
being handled by three arms will have

251
00:11:32,079 --> 00:11:29,839
the maximized amount of representation

252
00:11:39,550 --> 00:11:32,089
and the narrow system and that will

253
00:11:42,430 --> 00:11:39,560
recruit the brain so characterizing

254
00:11:44,050 --> 00:11:42,440
these strategies these recruitment

255
00:11:47,199 --> 00:11:44,060
strategies sucker to sucker arm to arm

256
00:11:49,240 --> 00:11:47,209
and arm to brain will give us a sense

257
00:11:51,519 --> 00:11:49,250
for how the suckers and arms are

258
00:11:52,750 --> 00:11:51,529
collectively acquiring integrating and

259
00:11:55,090 --> 00:11:52,760
responding to information in the

260
00:12:00,890 --> 00:11:55,100
environment and to what extent the brain

261
00:12:05,690 --> 00:12:04,400
our methods starting with

262
00:12:08,180 --> 00:12:05,700
two-dimensional tracking have become

263
00:12:12,950 --> 00:12:08,190

more sophisticated now we move into

264
00:12:14,990 --> 00:12:12,960
three-dimensional tracking now for the

265
00:12:16,579 --> 00:12:15,000
first time ever we can completely

266
00:12:19,010 --> 00:12:16,589
characterize the movement patterns of

267
00:12:21,769 --> 00:12:19,020
the octopus and its arms and all their

268
00:12:23,840 --> 00:12:21,779
infinite degrees of freedom allowing us

269
00:12:26,570 --> 00:12:23,850
to characterize the strategies that the

270
00:12:35,960 --> 00:12:26,580
octopus is using to coordinate its

271
00:12:37,370 --> 00:12:35,970
distributed mind characterizing the

272
00:12:40,040 --> 00:12:37,380
computational strategies of these

273
00:12:42,920 --> 00:12:40,050
alternative models of intelligence are

274
00:12:46,370 --> 00:12:42,930
using will give us a perspective on the

275
00:12:55,519 --> 00:12:46,380
forms of intelligence we can expect from

276
00:12:57,110 --> 00:12:55,529
worlds beyond our own so this was

277
00:12:59,570 --> 00:12:57,120
obviously a team effort I can possibly

278
00:13:02,000 --> 00:12:59,580
do this alone

279
00:13:04,940 --> 00:13:02,010
so I'd like to thank my research

280
00:13:06,620 --> 00:13:04,950
assistants everyone in my lab I'd like

281
00:13:07,910 --> 00:13:06,630
to thank the University of Washington

282
00:13:10,070 --> 00:13:07,920
Institute for Near Engineering who has

283
00:13:11,420 --> 00:13:10,080
funded mean is currently funding to my

284
00:13:12,800 --> 00:13:11,430
research assistants Friday Harbor

285
00:13:13,970 --> 00:13:12,810
laboratories which is where I'm

286
00:13:16,130 --> 00:13:13,980
currently doing my research for the

287
00:13:18,019 --> 00:13:16,140
summer and of course University of

288
00:13:19,519 --> 00:13:18,029

Washington master biology program if it

289
00:13:19,760 --> 00:13:19,529
weren't for them I wouldn't be here at

290
00:13:22,960 --> 00:13:19,770
all

291
00:13:24,620 --> 00:13:22,970
[Applause]

292
00:13:28,880 --> 00:13:24,630
[Music]

293
00:13:30,510 --> 00:13:28,890
[Applause]

294
00:13:37,410 --> 00:13:30,520
Thank You Domini

295
00:13:40,350 --> 00:13:37,420
do we have any questions I didn't get to

296
00:13:41,850 --> 00:13:40,360
comment on it so uh you know when you

297
00:13:43,980 --> 00:13:41,860
read anthropological literature that a

298
00:13:45,360 --> 00:13:43,990
lot of explanations for why we have such

299
00:13:47,490 --> 00:13:45,370
a big brains you know the expensive

300
00:13:50,310 --> 00:13:47,500
tissue hypothesis or sexual selection

301
00:13:53,370 --> 00:13:50,320
and in I'm wondering in the octopus

302
00:13:55,410 --> 00:13:53,380
community what hypotheses have been put

303
00:13:58,950 --> 00:13:55,420
forward as to explain why that octopus

304
00:14:01,140 --> 00:13:58,960
has such a big brain so I'm gonna repeat

305
00:14:03,000 --> 00:14:01,150
the question just to contextualise it so

306
00:14:05,430 --> 00:14:03,010
what did select for the octopus's brain

307
00:14:07,500 --> 00:14:05,440
as opposed to like our brain right it's

308
00:14:08,880 --> 00:14:07,510
or as opposed to other invertebrate

309
00:14:09,210 --> 00:14:08,890
brains that aren't as big as octopus

310
00:14:12,720 --> 00:14:09,220
brains

311
00:14:13,710 --> 00:14:12,730
ah yes okay so that's a really relevant

312
00:14:15,540 --> 00:14:13,720
question and we don't have all the

313
00:14:17,610 --> 00:14:15,550

answers we weren't there during their

314
00:14:21,120 --> 00:14:17,620
evolution nor were we here for our

315
00:14:23,130 --> 00:14:21,130
evolution and our intelligence was

316
00:14:25,710 --> 00:14:23,140
selected by our environment we don't

317
00:14:28,230 --> 00:14:25,720
have a generalized intelligence we have

318
00:14:30,390 --> 00:14:28,240
a repurposed intelligence that seems

319
00:14:34,170 --> 00:14:30,400
more generalized than what it was

320
00:14:36,980 --> 00:14:34,180
probably used best for at the time if I

321
00:14:40,380 --> 00:14:36,990
were to speculate the octopus probably

322
00:14:43,050 --> 00:14:40,390
had extracted foraging as its most

323
00:14:46,920 --> 00:14:43,060
overwhelmingly selective pressure so it

324
00:14:48,750 --> 00:14:46,930
had to find and extract food and so

325
00:14:50,490 --> 00:14:48,760
that's why you get this while following

326
00:14:53,280 --> 00:14:50,500
this is why you get this preference for

327
00:14:56,070 --> 00:14:53,290
novelty for instance the arms are

328
00:14:58,520 --> 00:14:56,080
sampling and even with the brain removed

329
00:15:01,230 --> 00:14:58,530
or even with the arm removed this

330
00:15:03,600 --> 00:15:01,240
exploration strategy that you guys saw

331
00:15:06,240 --> 00:15:03,610
in front of you happens so it is

332
00:15:07,740 --> 00:15:06,250
embedded within the nervous system of

333
00:15:10,290 --> 00:15:07,750
the arms and it will activate even

334
00:15:14,670 --> 00:15:10,300
without the brain at all but it's

335
00:15:16,560 --> 00:15:14,680
important because we have with us the

336
00:15:18,540 --> 00:15:16,570
consequences of the Selective pressure

337
00:15:20,570 --> 00:15:18,550
for our intelligence as do they and as

338
00:15:23,190 --> 00:15:20,580

well whatever evolves to intelligence

339
00:15:26,430 --> 00:15:23,200
anywhere out there in the universe is

340
00:15:28,110 --> 00:15:26,440
that if your answer there are lots of

341
00:15:30,030 --> 00:15:28,120
other vertebrates who also have that

342
00:15:33,740 --> 00:15:30,040
living strategy whose brains are much

343
00:15:36,330 --> 00:15:33,750
smaller than the octopus that's true

344
00:15:39,349 --> 00:15:36,340
yeah but they figured it out in a very

345
00:15:42,829 --> 00:15:39,359
different way the size of the brain does

346
00:15:44,569 --> 00:15:42,839
I like to make the point that more

347
00:15:46,969 --> 00:15:44,579
important than the question how

348
00:15:48,559 --> 00:15:46,979
intelligent are they is how are they

349
00:15:52,340 --> 00:15:48,569
intelligent and we can ask that question

350
00:15:54,319 --> 00:15:52,350
to anything that's out there somewhat

351
00:15:55,400 --> 00:15:54,329
related but one of the paradoxes well

352
00:15:57,409 --> 00:15:55,410
one of the things that's often presented

353
00:15:59,659 --> 00:15:57,419
as a paradox of octopus intelligence is

354
00:16:01,699 --> 00:15:59,669
the relatively short life span like some

355
00:16:03,619 --> 00:16:01,709
species only one or two years so I was

356
00:16:05,659 --> 00:16:03,629
wondering in terms of memory with this

357
00:16:08,389 --> 00:16:05,669
distributed intelligence do you is there

358
00:16:10,039 --> 00:16:08,399
evidence that the arms maintain some

359
00:16:12,139 --> 00:16:10,049
kind of memory of their environment and

360
00:16:14,179 --> 00:16:12,149
how long that persists and how that's

361
00:16:17,299 --> 00:16:14,189
transmitted if we can show that it would

362
00:16:22,039 --> 00:16:17,309
change the field forever there a good

363
00:16:23,419 --> 00:16:22,049

question that was a lot of fun um

364
00:16:25,639 --> 00:16:23,429
there's a lot of other cephalopods

365
00:16:27,799 --> 00:16:25,649
besides octopi mm-hmm

366
00:16:28,909 --> 00:16:27,809
how similar are different are they given

367
00:16:32,419 --> 00:16:28,919
that they have different completely

368
00:16:34,759 --> 00:16:32,429
different life styles yeah so they're

369
00:16:36,619 --> 00:16:34,769
yeah their mode of lifestyle is very

370
00:16:38,479 --> 00:16:36,629
different as you mentioned in terms of

371
00:16:43,069 --> 00:16:38,489
their neural Anatomy what you'll get is

372
00:16:44,599 --> 00:16:43,079
that the the peripheral nervous system

373
00:16:46,489 --> 00:16:44,609
for the squid cuttlefish is not as

374
00:16:48,019 --> 00:16:46,499
distributed as that for the octopus but

375
00:16:49,879 --> 00:16:48,029
the brain itself is more distributed

376
00:16:52,309 --> 00:16:49,889
which is interesting in the case of

377
00:16:54,139 --> 00:16:52,319
squid you'll actually have more

378
00:16:56,679 --> 00:16:54,149
sophisticated optic lobes which is

379
00:16:59,119 --> 00:16:56,689
something I did not talk about so it's

380
00:17:01,039 --> 00:16:59,129
supposedly suggesting that the eyes are

381
00:17:02,329 --> 00:17:01,049
more sophisticated than that of the

382
00:17:04,399 --> 00:17:02,339
octopus which is interesting because the

383
00:17:06,649 --> 00:17:04,409
octopus during the day is primarily a

384
00:17:07,850 --> 00:17:06,659
visual hunter and this probably has

385
00:17:09,049 --> 00:17:07,860
something to do with the squids pelagic

386
00:17:10,669 --> 00:17:09,059
lifestyle so they live in the water

387
00:17:17,829 --> 00:17:10,679
column they probably need to see farther