PreCure Elbow: EMG using a wearable device

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EMG

- Electromyography (EMG) is a difficult signal to work with
- Used in the lab

“Mouse injury/tennis elbow”

- Epicondylitis lateralis
- Painful, reoccurring condition
- Caused by powerful repetitive or static loads
  - Back hand tennis, computer mouse, butchers
- Incidence ~ 1% (higher in at-risk groups)
- Treatment with physiotherapy (or steroids)

The problem

1. You get the injury – not so good
2. You get rid of your injury – very good
   - Physiotherapy
   - Adjustment of working routines
3. You stay injury-free – very good
4. The injury reappears – bad and avoidable

The solution

- PreCure Elbow alerts you when you perform work routines that may lead to an injury
- This leads to adjusted work routines

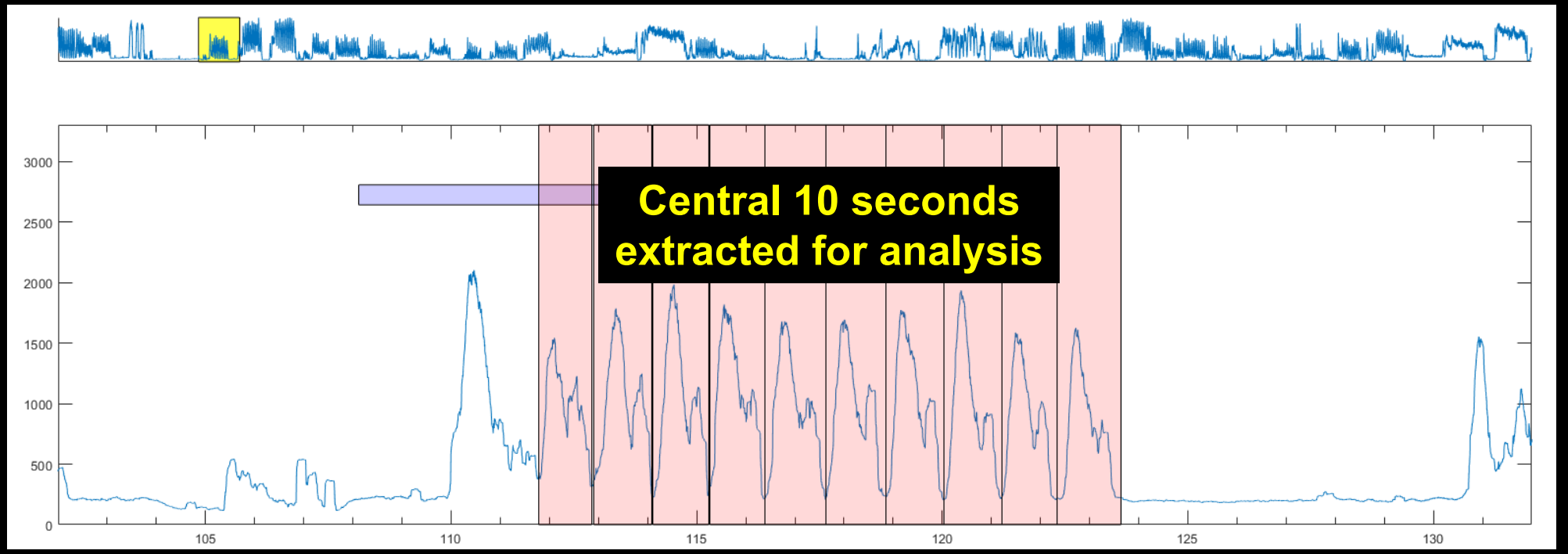
Aim

To assess to what degree EMG from PreCure Elbow can be used to differentiate between hand movements

Methods

- 52 participants (33 women, 15 with injury) aged 18-67, currently working
- 24 exercises using instruction video (30 minutes)
  - Extensions, flexions, rotations, lateral movements, static hold, mixed tasks
  - 0 kg, 2 kg, and 5 kg load for many exercises
- Conditional inference tree for classification

The EMG data


Central 10 seconds
extracted for analysis
3000
2500
2000
1500
1000
500
0
105
110
115
120
125
130

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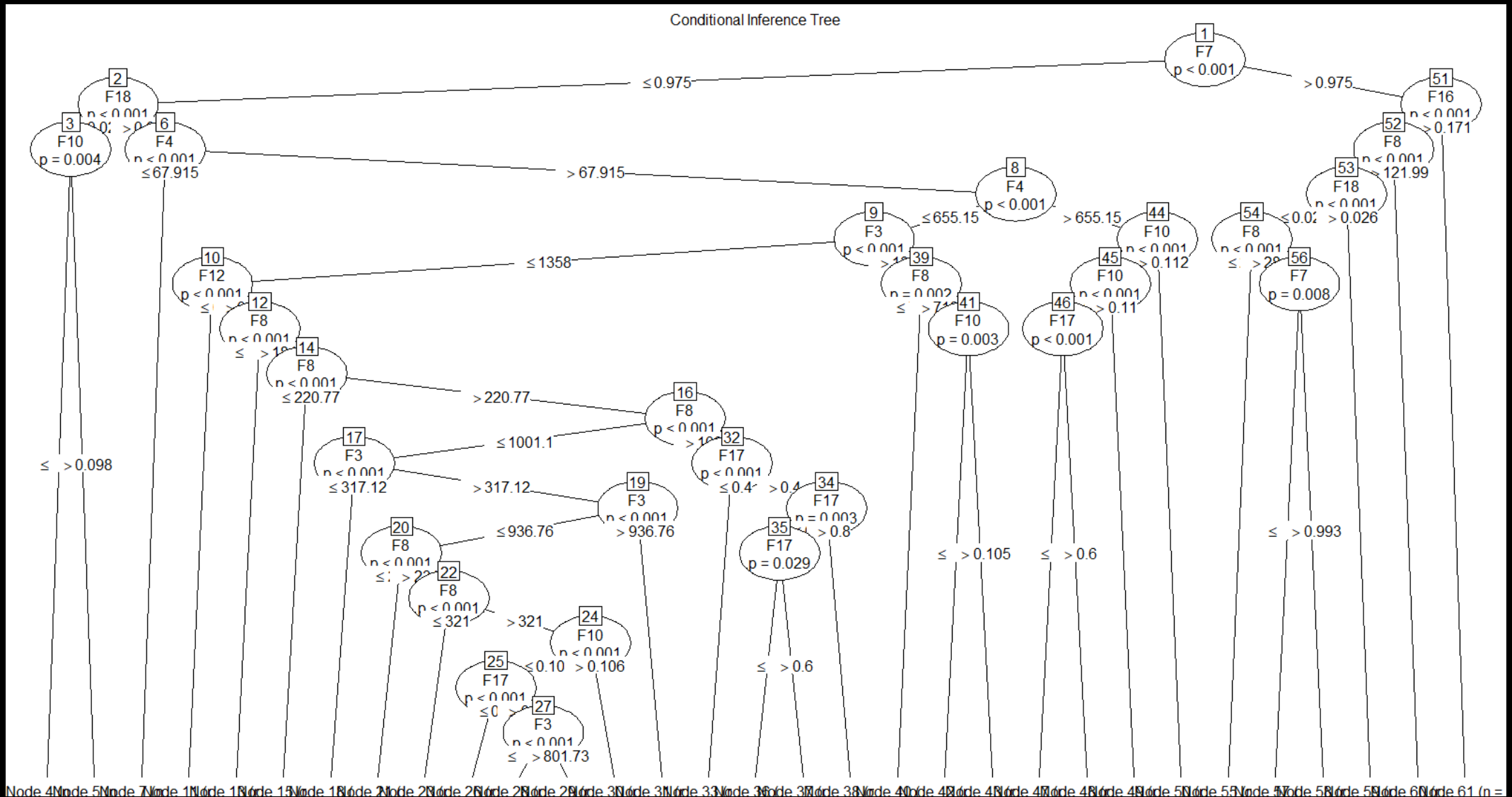
Features

- Mean and standard deviation of envelope
- Time in rest
- P90-P10 (measure for EMG amplitude)
- Relative power in various frequency bands
- Low-frequency precision analysis
- …

Results - tree



Results – confusion matrix

	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	Ø10	Ø11	Ø12	Ø13	Ø14	Ø15	Ø16	Ø17	Ø18	Ø19	Ø20	Ø21	Ø22	Ø23	Ø24	Ø25
P2	**19**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
P3	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
P4	0	0	**4**	5	1	0	0	1	0	1	1	1	0	0	0	0	4	0	0	0	0	1	0	0
P5	0	0	1	**3**	0	3	0	1	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0
P6	0	0	0	1	**10**	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0	2
P7	0	0	6	1	0	**4**	7	4	2	1	1	3	0	0	0	0	1	0	0	0	3	0	7	0
P8	0	1	0	0	0	2	**2**	0	0	0	1	5	1	0	0	1	0	1	0	1	1	1	2	1
P9	0	0	0	1	0	1	0	**0**	3	2	0	1	0	1	0	7	1	0	0	2	0	0	0	1
P10	0	1	2	0	0	2	1	5	**3**	3	6	0	1	0	0	0	0	1	0	1	0	0	0	5
P11	0	1	1	0	0	0	1	1	3	**2**	3	1	1	0	0	0	0	0	0	0	1	0	0	1
P12	0	0	0	0	0	0	4	0	2	0	**1**	0	0	0	0	0	0	1	0	2	0	0	0	0
P13	0	0	0	0	0	0	1	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0
P14	0	0	0	4	0	0	0	1	0	0	0	1	**10**	0	0	3	1	0	0	0	0	2	4	1
P15	0	1	0	0	0	0	0	0	0	0	0	0	0	**2**	0	0	0	0	1	2	0	0	0	0
P16	0	1	0	0	0	0	0	1	1	0	1	0	0	0	**1**	0	0	0	0	3	0	0	0	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	**3**	0	0	0	0	0	0	0	0
P18	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	1
P19	0	3	0	0	0	0	0	3	0	0	2	1	0	7	1	1	0	**6**	5	1	0	0	1	0
P20	0	2	0	0	0	0	0	1	0	0	0	0	0	5	8	0	0	3	**8**	4	0	0	0	0
P21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0

Results and discussion

- 1205 of 1248 (96.6%) exercises available for analysis
- 25 % “spot-on” correct prediction
- Some exercises very well identified, some not so well

Discussion

Worked well:

- Maximal extension
- Extensions
- Static holds
- Distinguishing heavy exercises (5 kg) from others

Did not work well

- Flexions
- Mixed exercises
  - Use of tweezers, pipettes, torque of cloth
- Distinguishing light and medium exercises (0 kg vs 2 kg)
- Computer mouse operations

Conclusions

- EMG obtained using the wearable device PreCure Elbow can be used to characterize hand movements
- Works well for extensions, static work, and heavy exercises

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Thank you for your attention