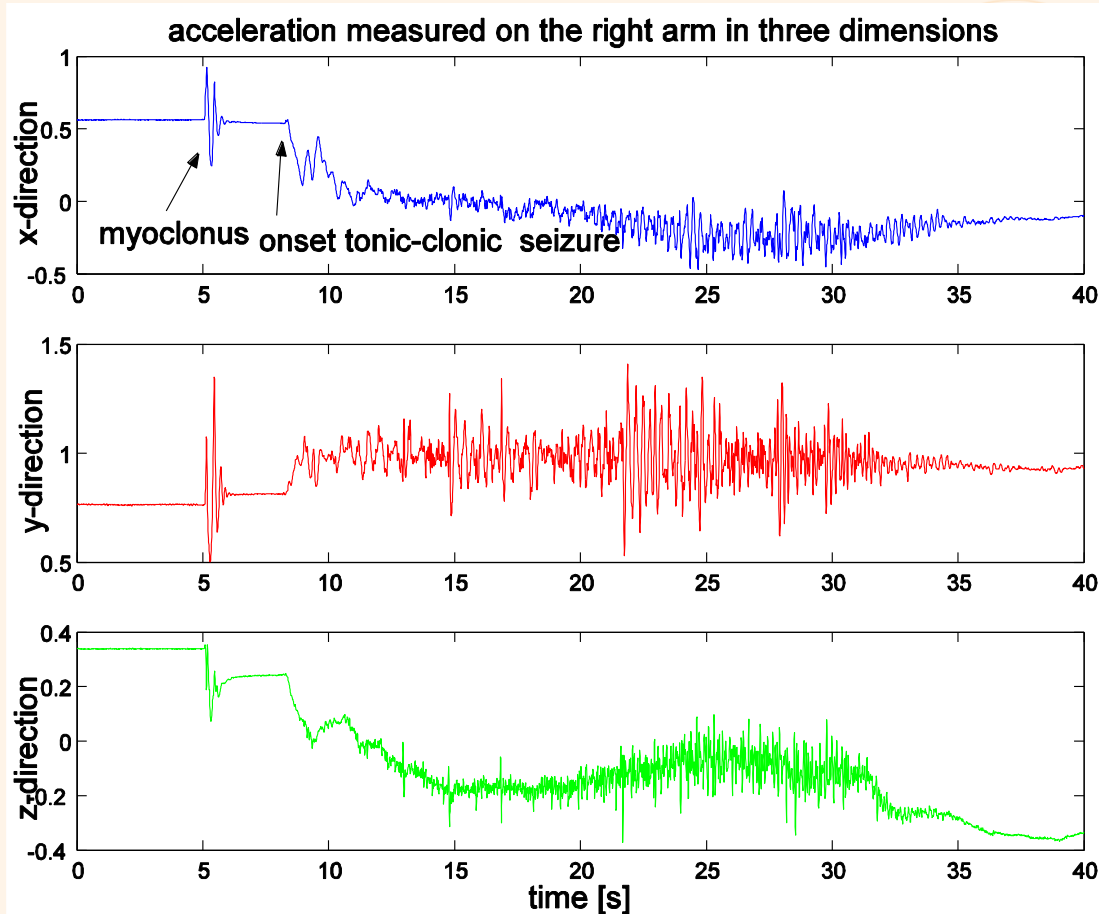


# Movement-based seizure detection



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*Copenhagen, july 7 2017  
Mobile Health Devices*

# Topics

- Rhythmic movements - physiology
- Movement sensors- mechanism
- Results in EEG/video units and 'in the field'
- Experimental use
- Highlights

# Rhythmic elementary movements

- Myoclonic



- Clonic (photo)



- Tonic (film)

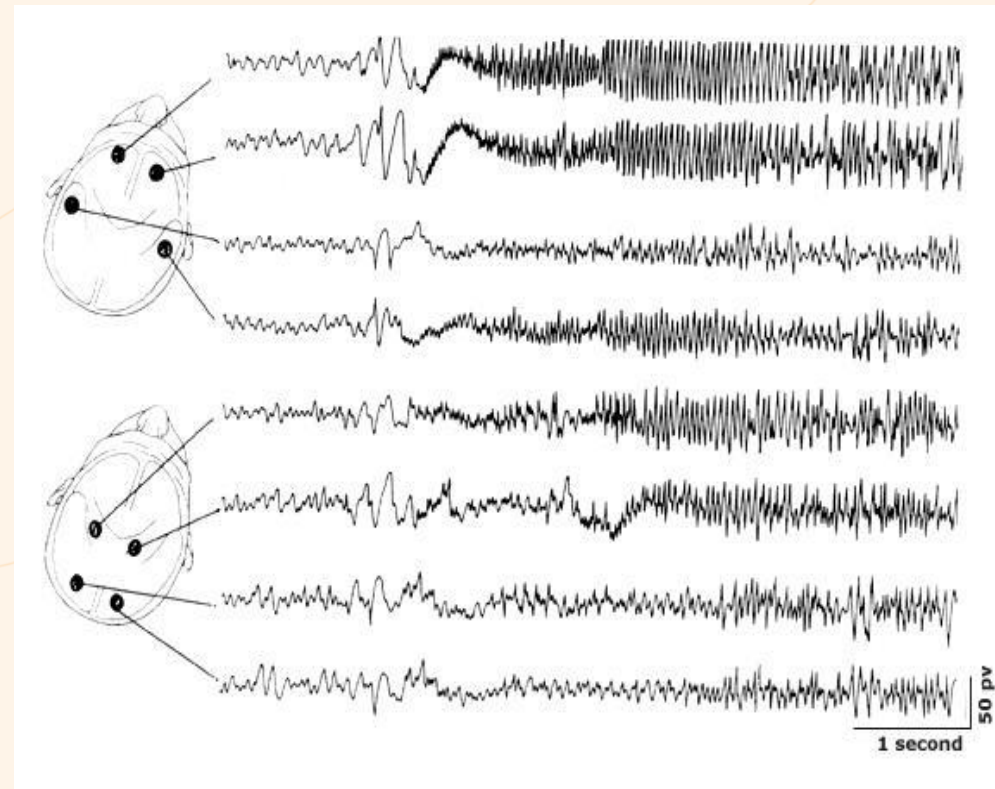


# Level of epileptogenesis

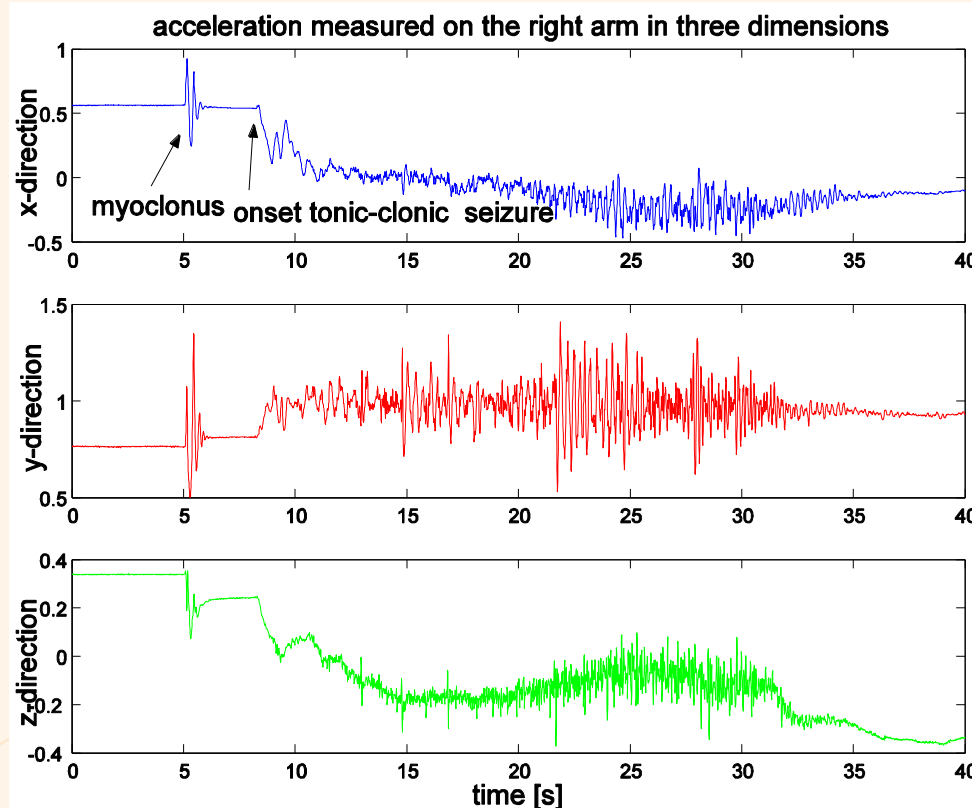
- (myo)clonic




- tonic



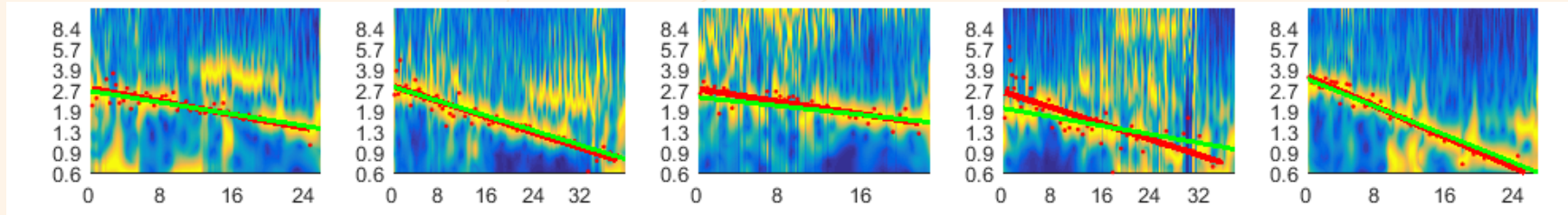
# Rhythmic movement



  
Rhythmic movement

# Clonic frequency

Non-contact sensor: Video

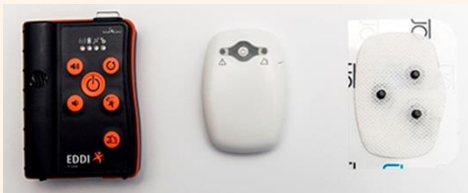
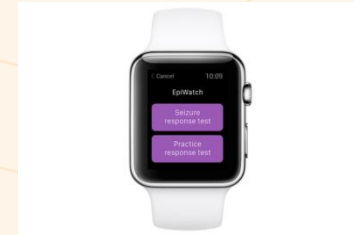


Systematic decreasing frequency of (myo)clonias, increasing amplitude, variable duration

# Sensor types

- Contact sensor (obtrusive)
  - Accelerometry (**acceleration**)
  - Magnetic sensors (**position, direction**)
  - Piezo-electric (**pressure**)
  - Electromyography (**muscle tone**)
- Non contact sensor (unobtrusive)
  - Video (**optic flow**)
  - Radar (**reflections**)

# Contact Sensor types



# Recent reviews

- Jory et al 2016
- Van de Vel et al 2016
- Ulate Campos et al 2016

# Population differences (bias)

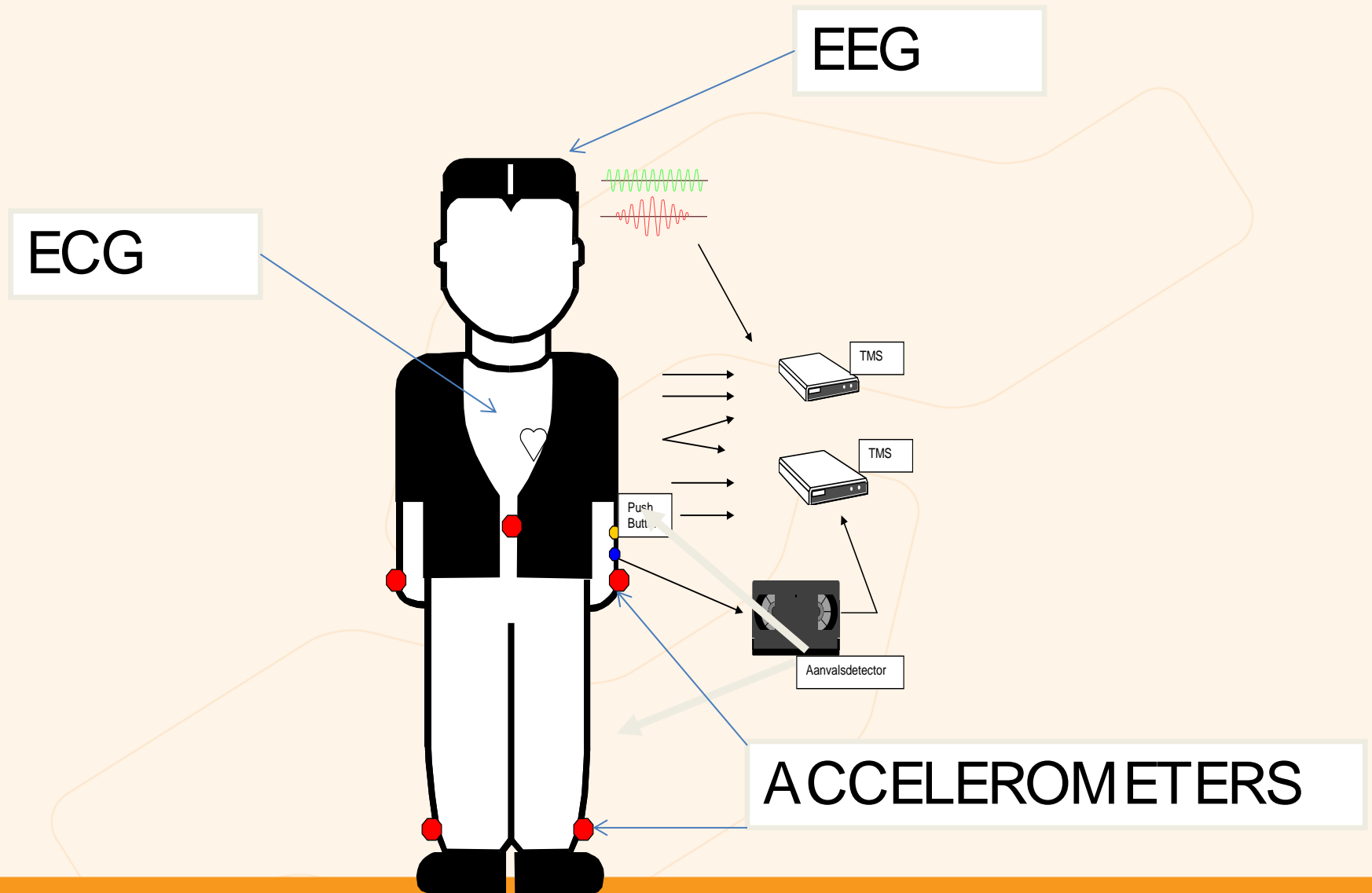
## sensitivity rhythmic movements sensors

	Sensitivity tonic-clonic(%)
• EEG/video unit	
– Bed sensor	
• Nareschania, 2013	89
• Poppel et al, 2013 (30% of seizures)	85
– Wrist watch	
• Beniczky et al, 2013	91
• Cuppens et al, 2014 (4 sensors, hypermotor seizures)	95
• Lockman et al, 2011 (many false positives)	87
• Patterson et al, 2015 (children, young)	31
• 'at home' (video control)	
– Bed sensor	
• (own results, 21% of seizures) no false positives ! 15 second window	14

# Analytical models

- Elementary movements
- Complex movements
- Seizure semiology and evolution

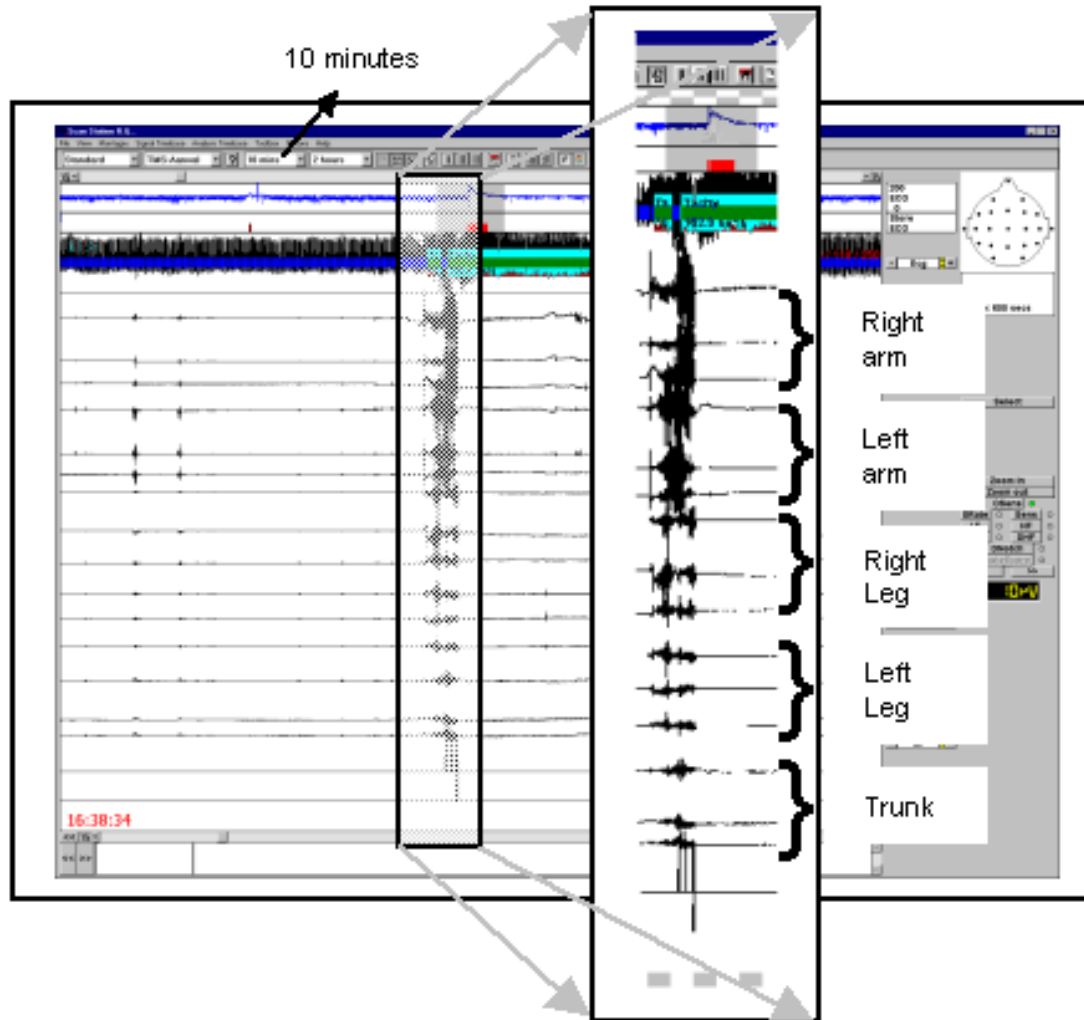
# Experimental models



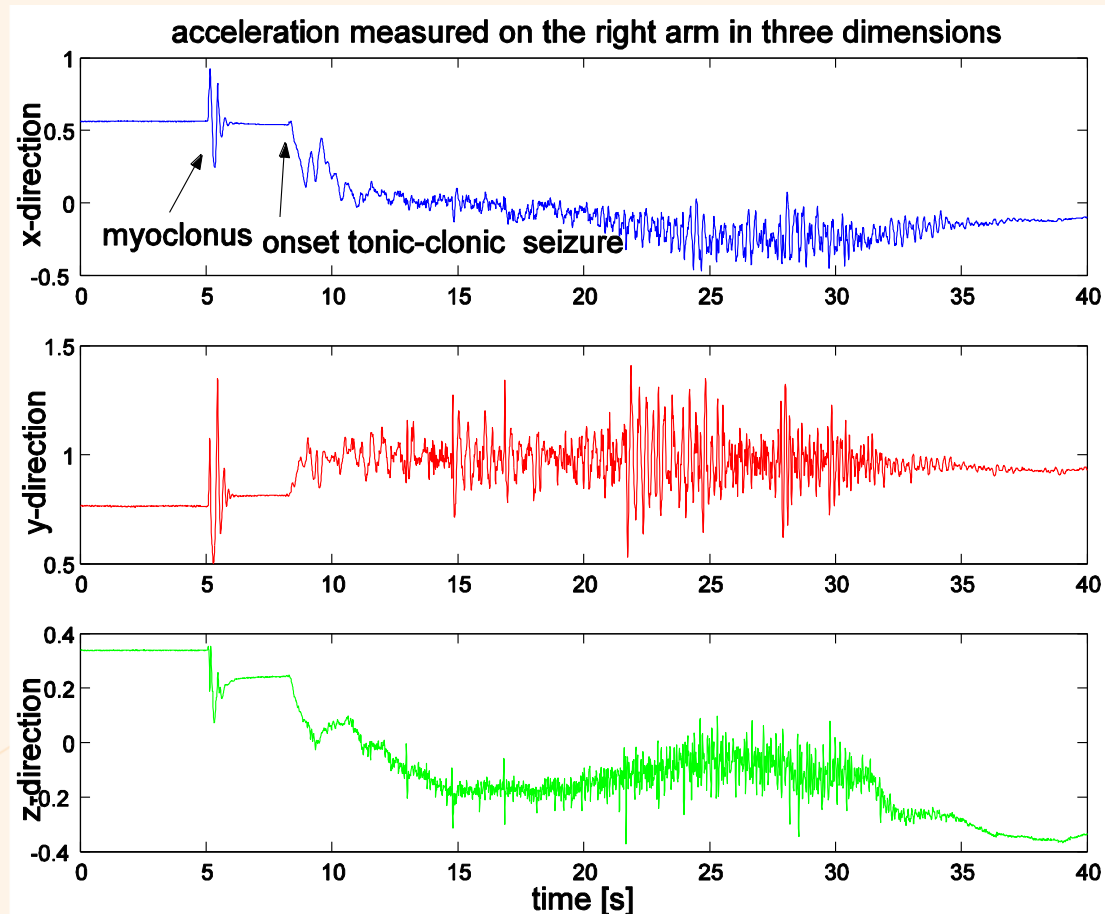
# Elementary movements

**Tonic Clonic Seizure** starting with a myoclonic jerk (3-D accelerometry)

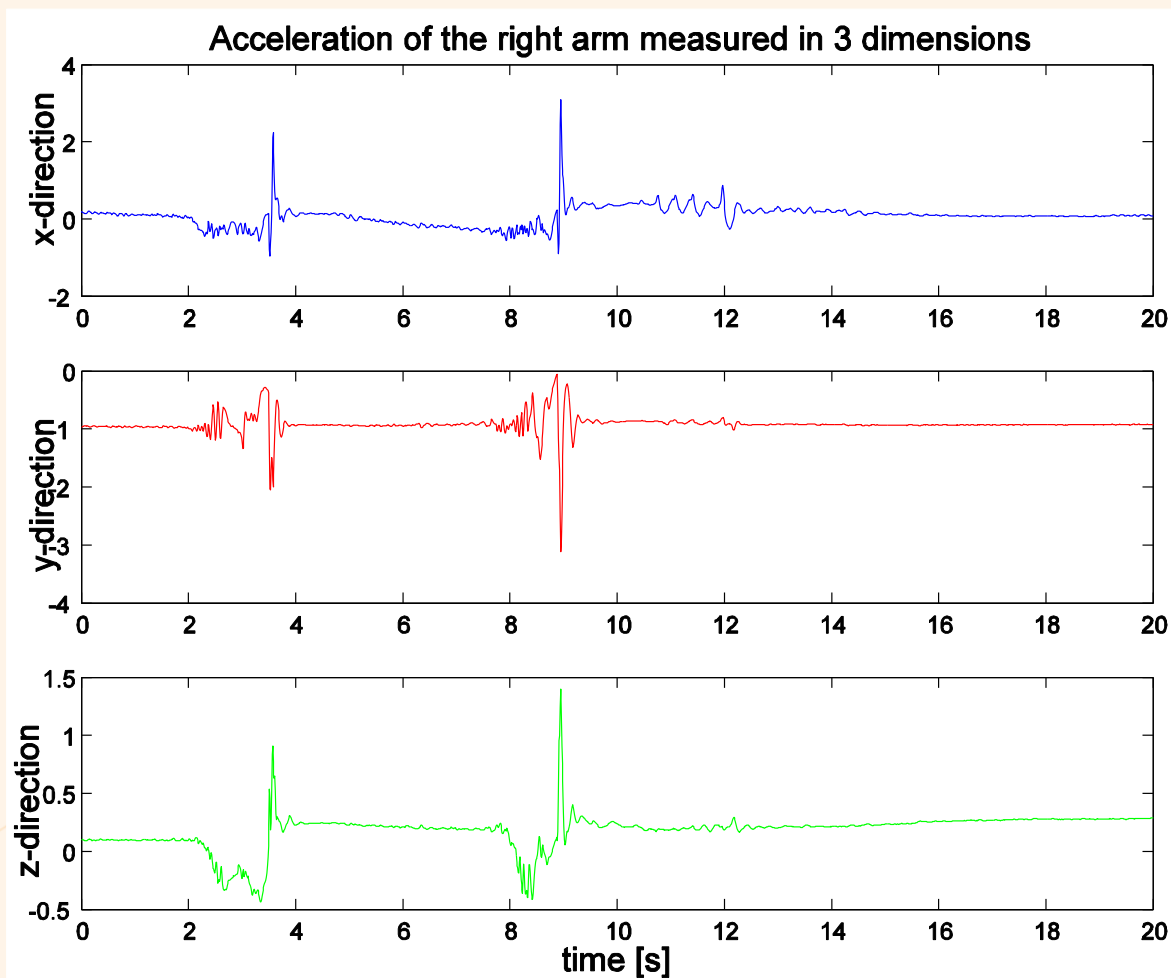
10 minutes



# Accelerometry: Tonic-clonic



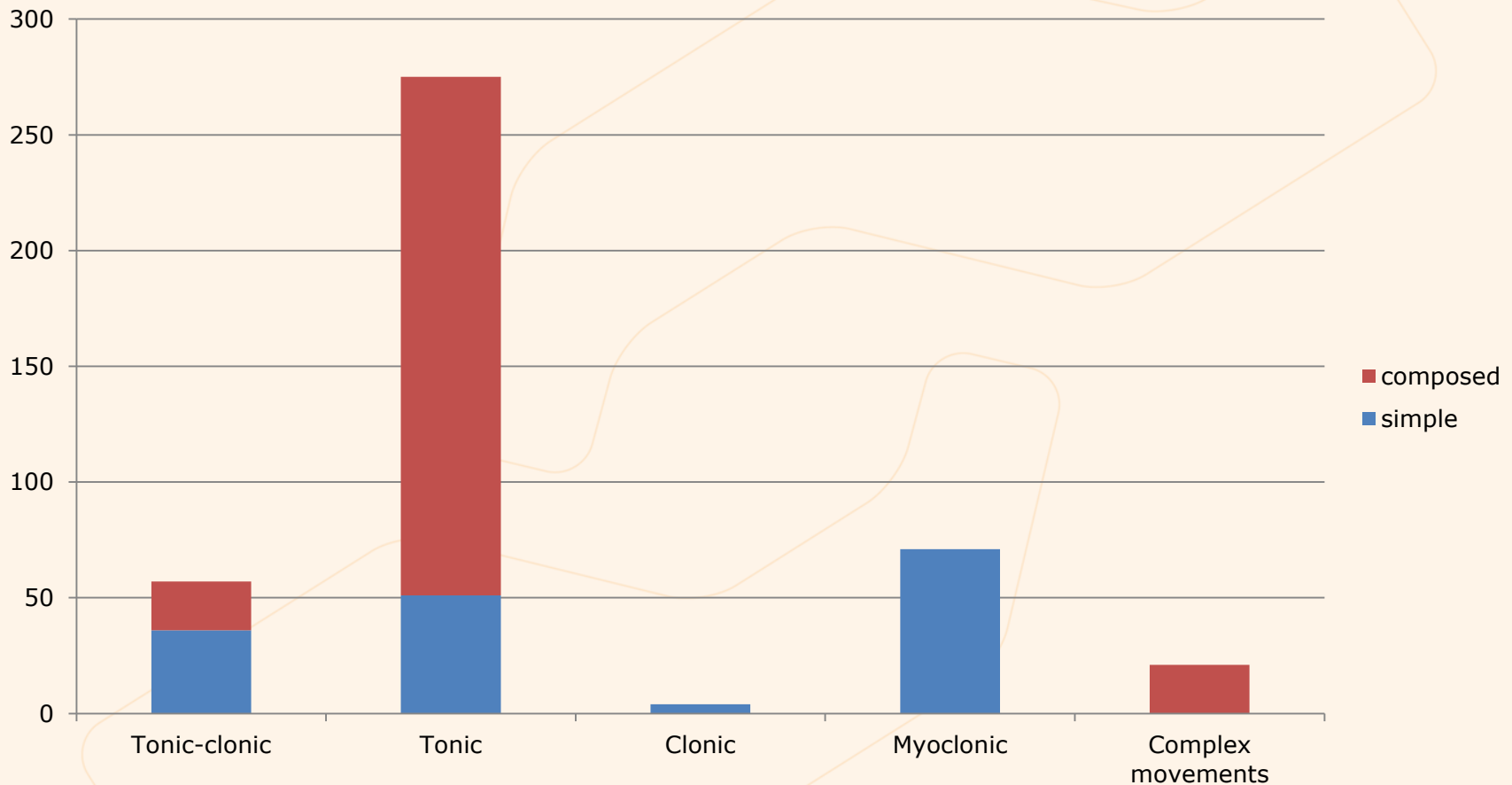
# Accelerometry: Myoclonia



# Results of epileptic movements

	SENS(%)	PPV(%)
• Myoclonic movements – Nijssen et al 2010	80	<16
• Tonic 'movements' – Nijssen et al 2008	80	35
• Hyperkinetic movements – Van de Vel et al 2013	96	58
• Summary	high	moderate to low

# Seizure evolution (n= 18, 428 seizures, 48%)



# Potential experimental applications

- Prediction within time series Matthijssen 1996
  - 80% detection per type needed (ARIMA model)
- Preventive intervention (inhibitory central feedback) if myoclonia preceeds
  - fast and more reliable algorithms
- Measurement of drug effects (Na-blockers)
  - substitution of tonic by (myo)clonic seizures

# Highlights

- Many sensor systems available
- Many EEG/video and few field studies
- Results dependent on population and seizure evolution
- Rhythmic Movement algorithms useful and stable, but miss less typical seizure patterns in the 'field'
- More experimental research (seizure semiology, feedback systems, predictability) is needed

# Questions?

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