University of Cologne

Saccadic velocity and duration as psychological variables

Standardization procedure

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General rationale

Saccadic velocities (peak & mean) as well as duration rely on saccadic amplitude:

- **a larger amplitude leads to an increased duration**
- **a larger amplitude allows for a longer acceleration phase, i.e. higher peak and mean velocities**

→ to compare saccades of different sizes duration and velocities have to be standardized with regard to saccadic amplitude

Previous standardizations

Collewijn, Erkelens & Steinman (1988): scleral coil; n=4; looking at LEDs;

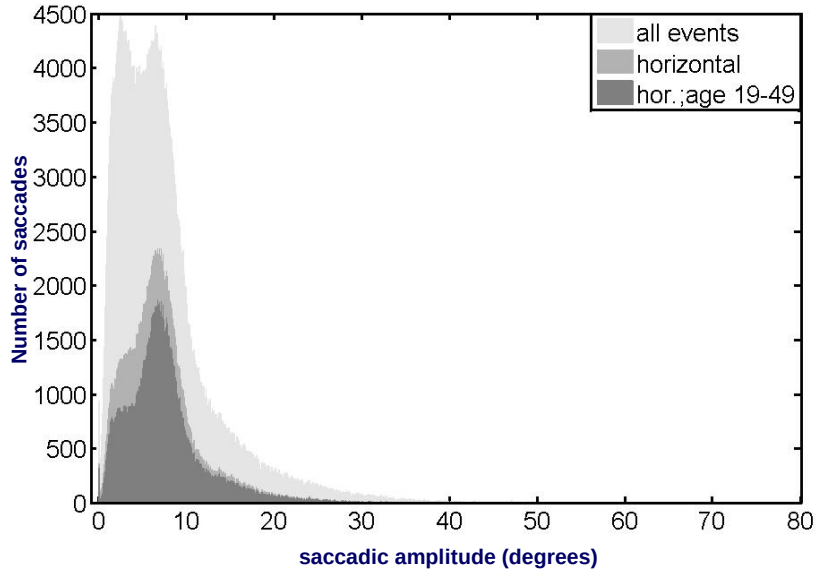
Becker (1989): scleral coil and EOG; n=3-26; various experimental setups;

- main focus on basic research: programming of saccades, differences in medial vs. lateral saccades, errors etc.
- experimental tasks: reacting to appearing or persistent light spots etc.
- small sample sizes
- valuable information on relevant parameters as well as underlying processes
- guidelines for data selection and standardization principles

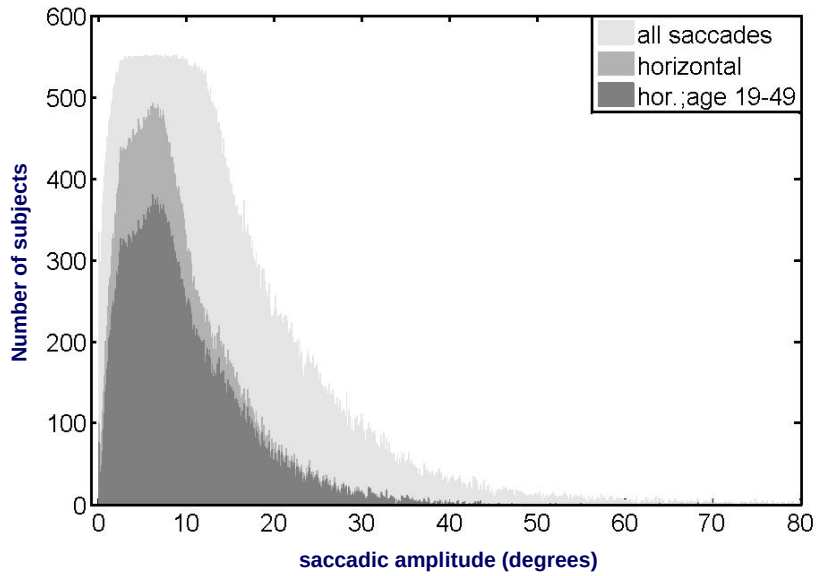
Selected data

- binocular EOG recorded with 1000 Hz
- only horizontal saccades
- only spontaneous, unguided saccades
- no fatigued or otherwise impaired subjects
- 'normal' visual processing (Raven test and picture viewing)
- for curve fitting: horizontal saccades of 413 subjects aged 19-49 (256 m, 145 f) 133587 events
- on average 324 saccades per person, but ± 189 with min=5 and max=1536

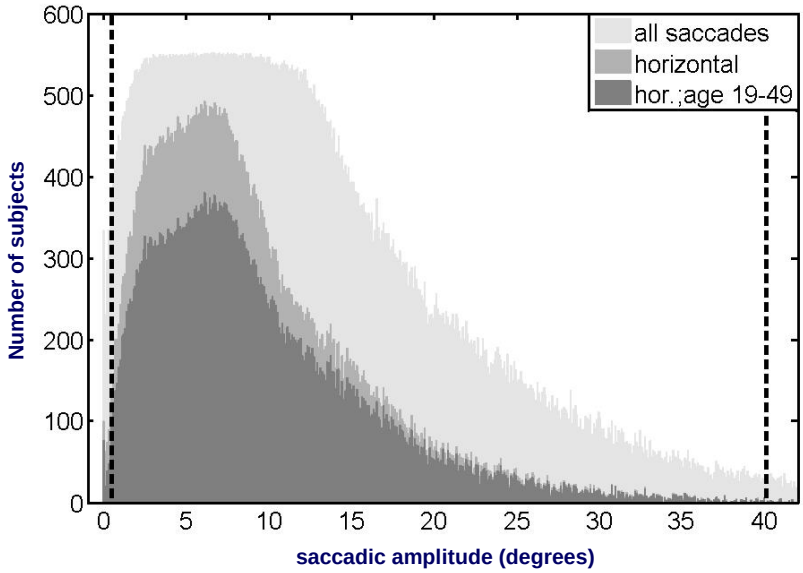
Number of saccades per amplitude step



Number of subjects that showed saccades in a certain amplitude step



Number of subjects per amplitude step: used amplitude range



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Procedure

selected saccades

↓

amplitude rounded to one digit after decimal point

↓

for each subject for each amplitude step:
individual median of velocities and duration

↓

for each amplitude step:
median of ind. medians of velocities and duration

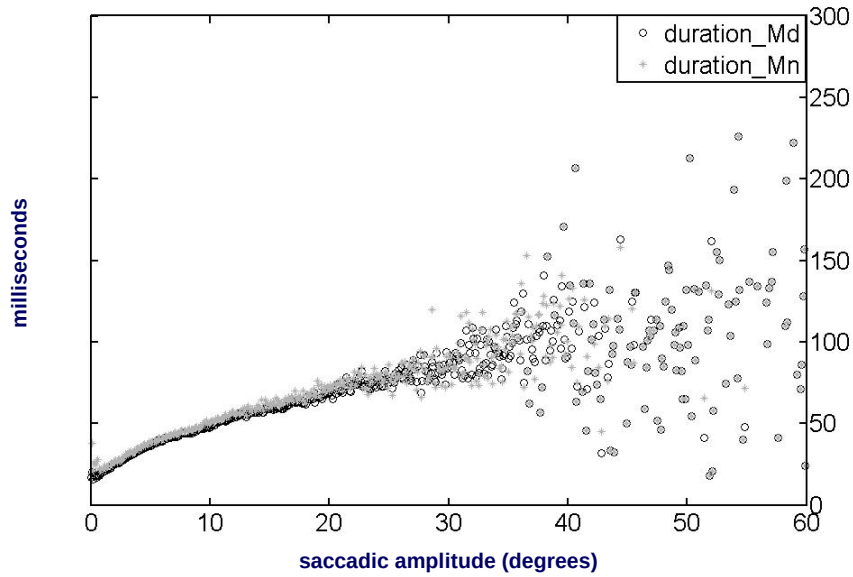
↓

scatterplot over amplitude steps:
median of velocities and duration

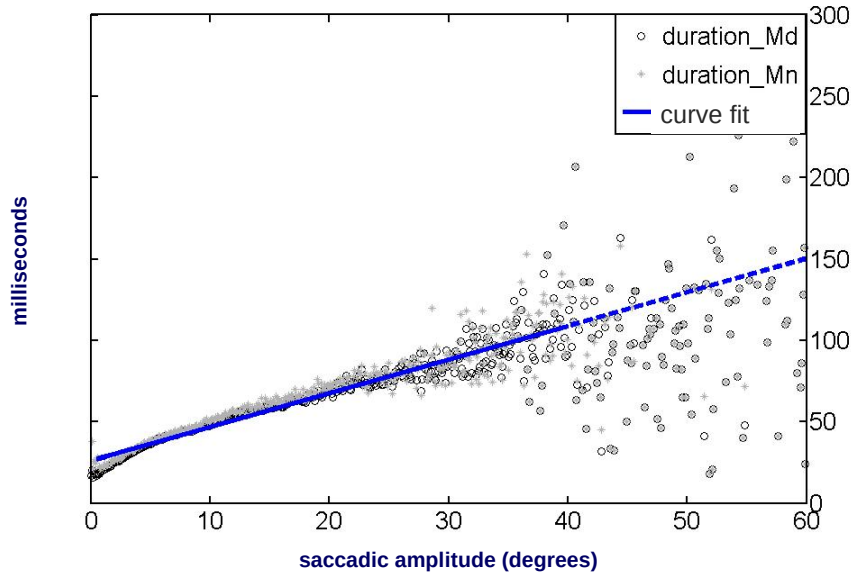
↓

curve fitting with MATLAB curve-fitting-toolbox

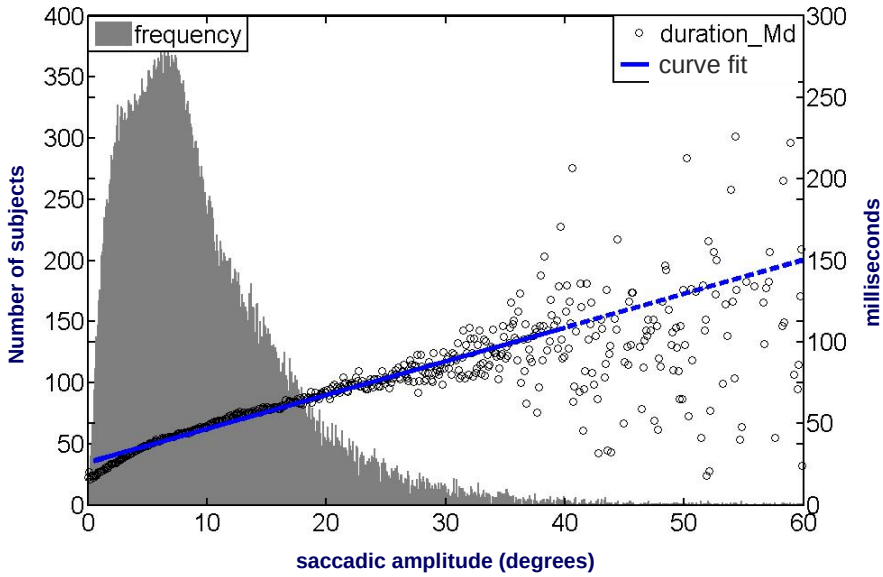
Duration: median and mean over amplitude steps



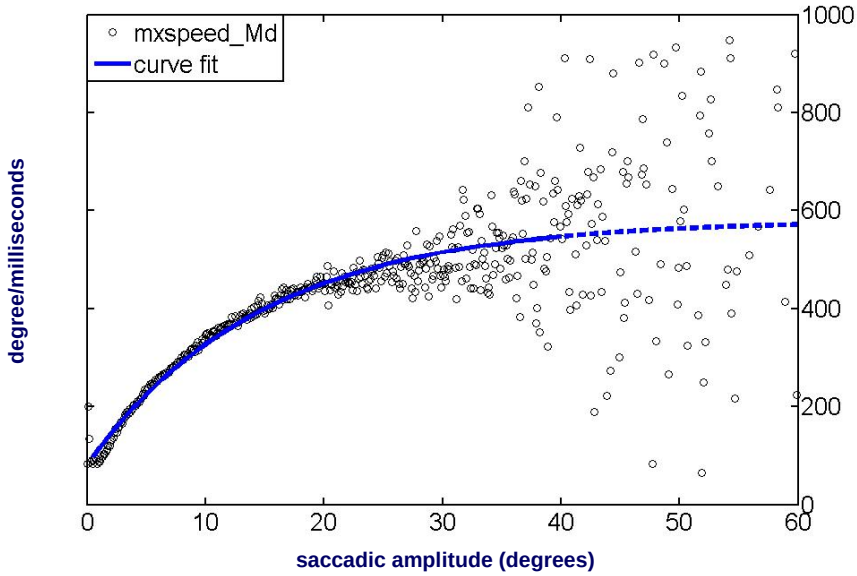
Duration: standardization function (R^2=0.88)



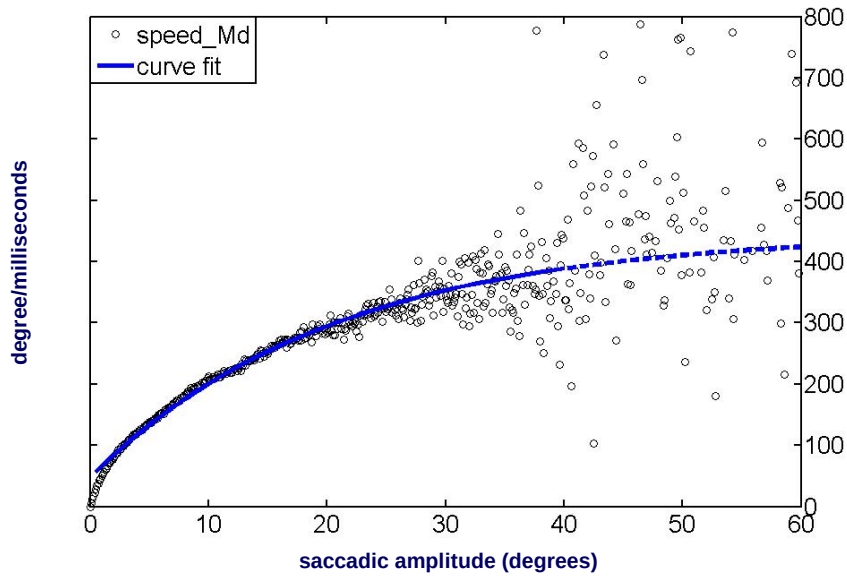
Duration: standardization function & number of probands



Maximal speed: standardization function (R^2=0.81)



Average speed: standardization function (R^2=0.80)



Saccadic duration and velocities as a function of amplitude

Our results:

- **duration = 2.07*amplitude +26**
- **maxspeed = 580.4*(1 - exp(-0.06771*amplitude - 0.1498))**
- **(average) speed = 445.9*(1 - exp(-0.04844*amplitude - 0.1121))**

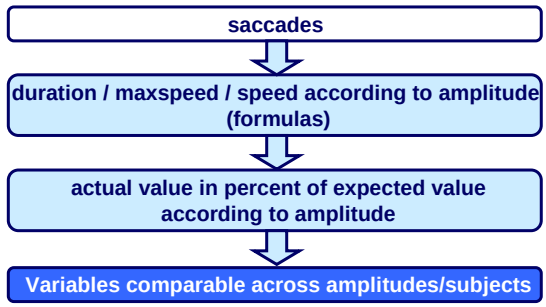
Suggestions from Becker (1989):

- **duration ~ [1.5-3.0]*amplitude +[20-30]; *using 2.5*amplitude***
- **maxspeed ~ [1.38-1.9]*speed; *using 1.64*speed***

Formulas from Collewijn et al. (1988):

- **duration = 2.7*amplitude +23**
- **maxspeed =**
  - **520*(1 – exp(-0.0893*amplitude)) for amplitudes>30°**
  - **450*(1 – exp(-0.1266*amplitude)) for amplitudes<=30°**

Procedure II



Conclusions

- Clear relationship between amplitude and duration or velocities
- Results comparable to previous standardizations
- Functions obtained from a large sample
- Tasks required natural gaze behaviour
- Functions can be used to evualuate deviations due to fatigue, lesions etc.
- Starting point for age-related standardizations/norm-curves?

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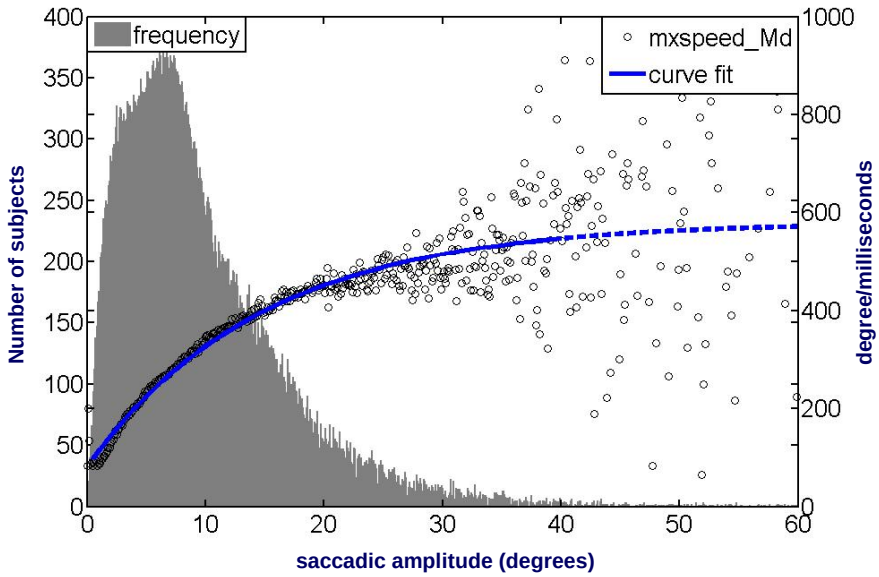
Thank You

Becker, W. (1989). Metrics. The neurobiology of saccadic eye movements. In R. H. Wurtz & M. E. Goldberg. Amsterdam, Elsevier: 13-67.

Collewijn, H., C. J. Erkelens, et al. (1988). "Binocular co-ordination of human horizontal saccadic eye movements." Journal of Physiology 404: 157-182.

Maximal speed: curve fit & number of subjects



Average speed: curve fit & number of saccades