From eHealth to mHealth – 24-hours ambulatory assessment under real-life conditions

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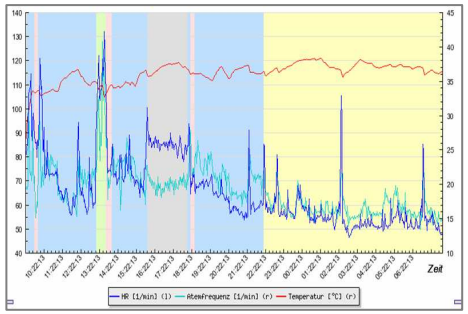
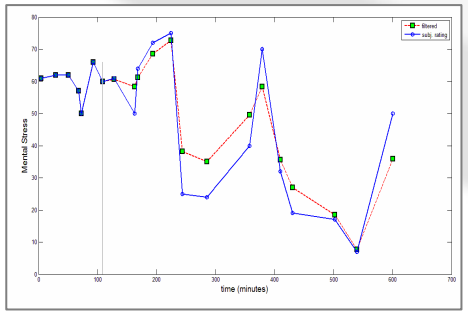
Learning objectives

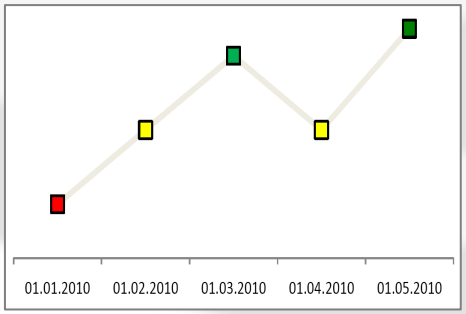
1. Understand that telemedical systems are able to assess complex health related parameters and to collect important health related information
2. Understand that a state of the art-system needs to combine eHealth and mHealth elements and work as distributed system with sensor elements, communication systems as well as complex information systems
3. Be aware that user compliance is an important issue for the applicability of ambulatory assessment in everyday life

Project eHealth MV

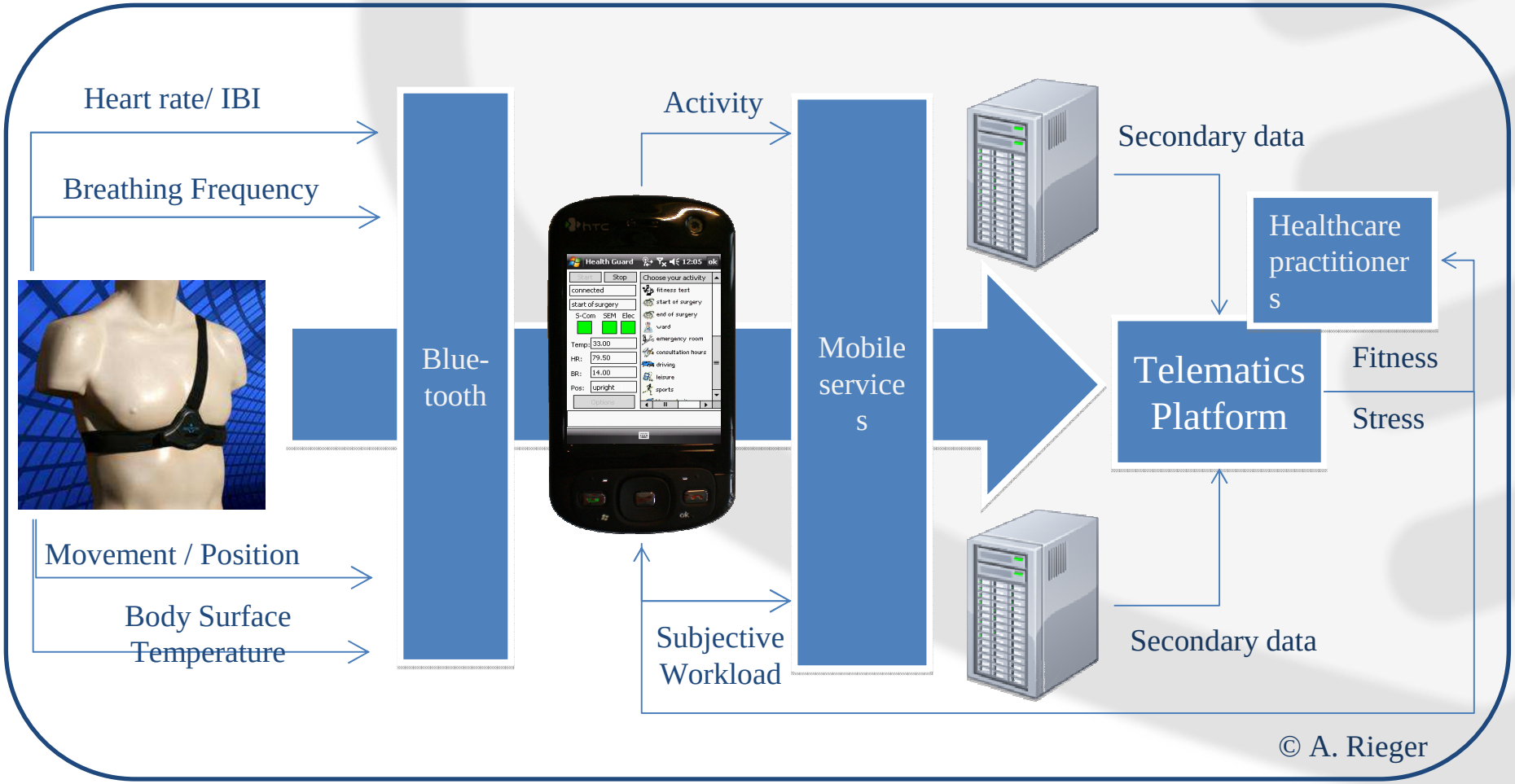
- Aims:
  1. Development of an ambulatory assessment system for individual diagnostics of psychophysiological stress
  2. Development of multiparametric models for stress and fitness estimation







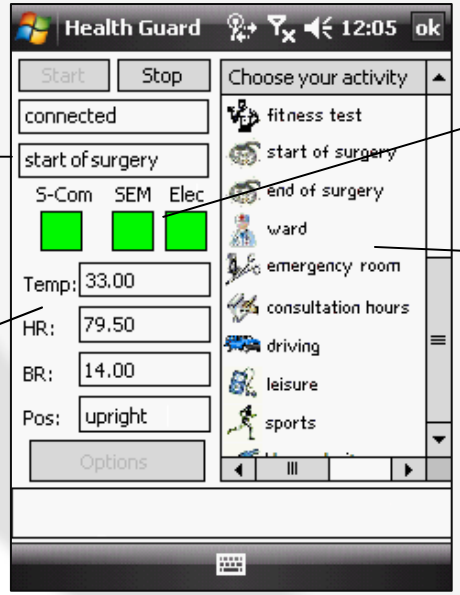
Communication structure



User Interface of the mobile device

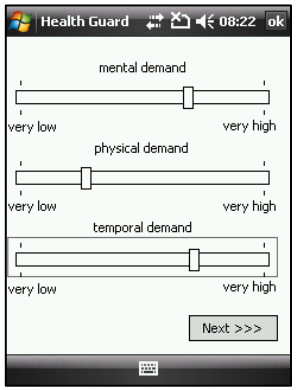
Choosen category

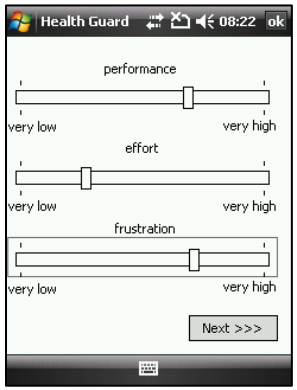
Current measurands

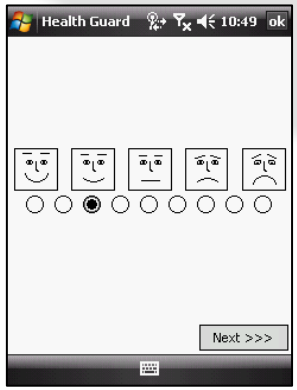


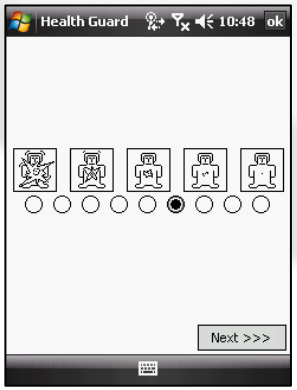
connectivity

Occupations (e.g. work, driving, sports, leisure)



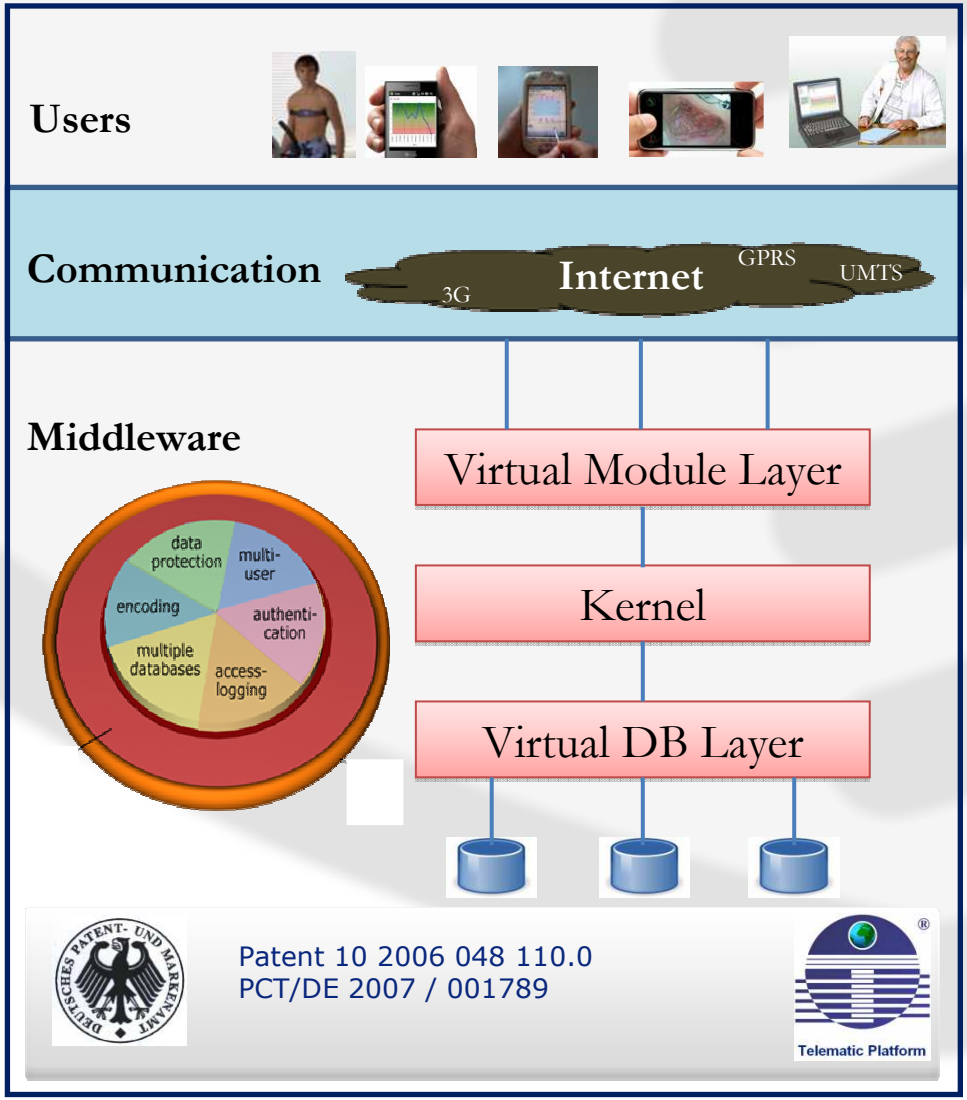






Telematics Platform

- Client-server architecture (x86, x64)
- Communication Clients-Server (HTTP/HTTPS)
- Ability to form clusters: simultaneous data processing from multiple clients
- Data security and privacy (Anonym, Encryption, Session models, Authentication)
- Online Web-based Portals integration (Admin, Center Admin, Coach and Vital web-based portals)
- Integration of hierarchical model (e.g. Admin → Center Admin → Coach/Doctor → Patient)
- Connection of mobile applications (Android, WM, Java and iPhone-based)
- Hosting of telemedical applications (Diabetes/Dermatology/Fitness/Stress, etc…)
- Scalable and extension ability of its core functionalities



Feasibility study in the framework of the project eHealth MV

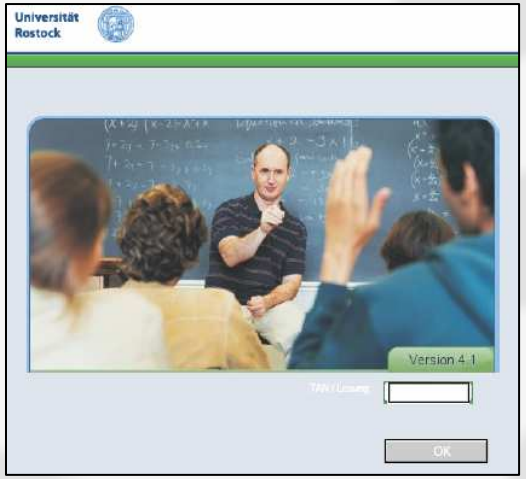
Rieger, A. et al. (2011) Ambulatory real-time assessment - A Feasibility study on 24-hours automated stress detection under real-life conditions. European Journal of Psychological Assessment (under review)

Aims of the feasibility study

1. Practicability
   - Usability
   - Wearing comfort
   - Suitability for daily use
2. Compliance/ Response Rates
3. Errors

Study design and study sample

- Ambulatory assessment up to 24 hours under real-life conditions
- Combined measurement of objective and subjective data (EMA)
- Follow-up survey
- Study period: August 2010 - March 2011
- 103 participants (58 men, 45 women)
- age: 27 ± 6 years; 84 % students
- Length of monitoring: Ø 19,5 hours
- 35,0 ± 10,0 self-reports per monitoring initiated by smartphone
- 30,6 ± 10,4 self reports per monitoring answered



Practicability

Handling of the System:

- 88 % „very easy“ or „easy“ to handle (others: „okay“)

Handling of self-reports:

- No problems with answering questionnaires on the touch screen

Wearing comfort of the belt

- not distracting (95 %)

Disruption by vibration

- 97,5 % not disrupted

Suitability for daily use

- 90 % did not feel bothered by the system

Compliance

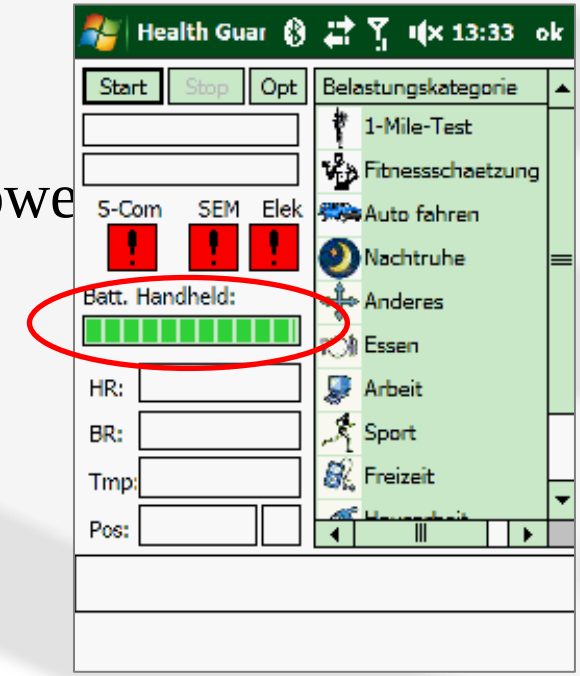
	Min	*Max*	*Sum*	*M*	*SD*
Released self-reports	7	58	3565	34.95	10.04
Physiological determined self-reports	3	48	2001	19.62	8.84
Regularly released self-reports	4	26	1561	15.30	4.62
Completed self-reports	6	52	3116	30.55	10.38

Response Rate: 87.6 %

→ Participants (not compensated for their attendance) showed response rates that can be compared to paid samples or patients ←

Mentioned problems

1. Relatively low battery power of smartphones
2. Missing announcement of battery powe (at the beginning of the study)
3. Problems with the operating system (Windows Mobile)
4. Interruptions in mobile services
5. Involuntary deactivation of key lock



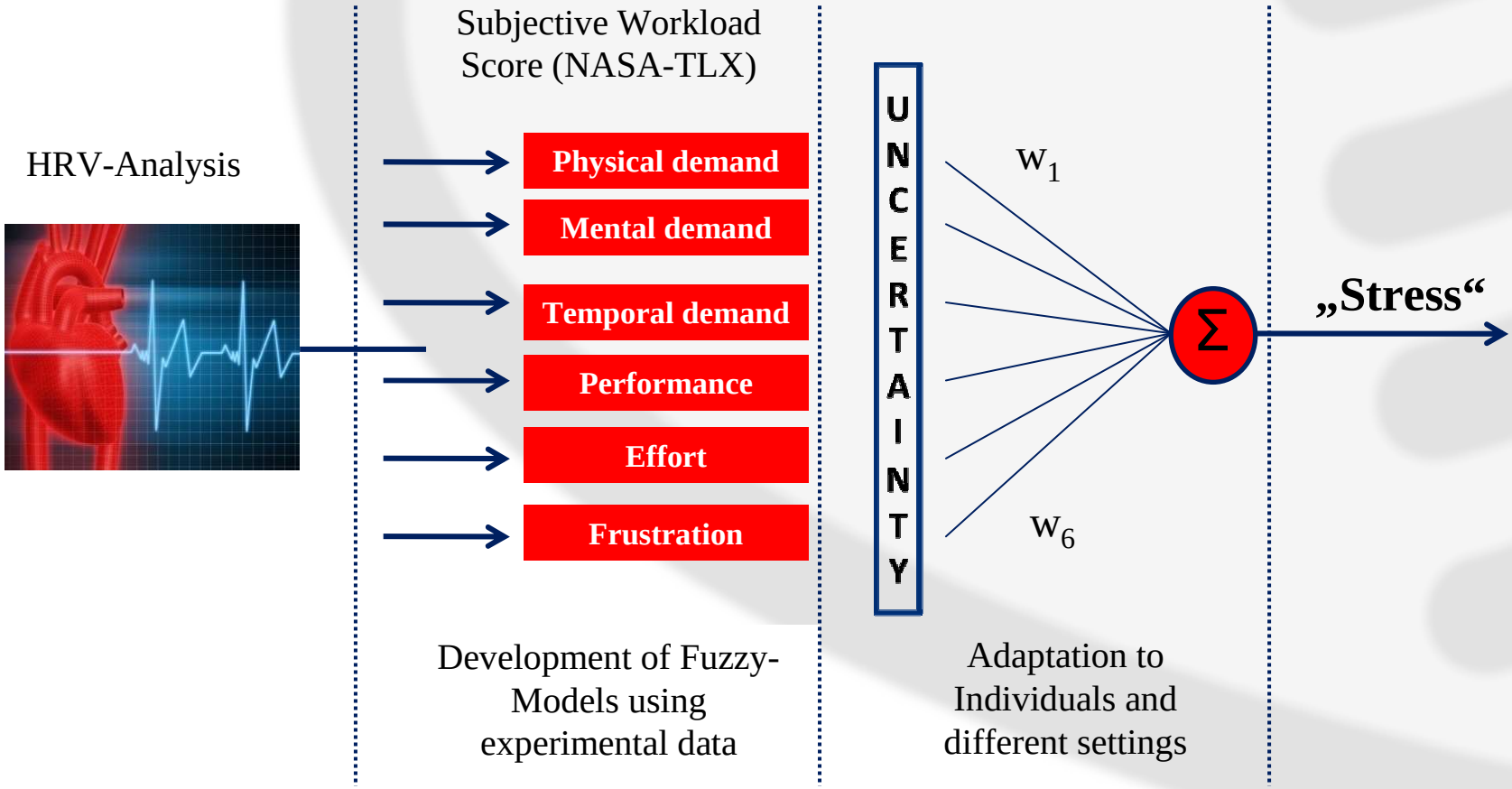
Real-time stress assessment

Kumar et al. (2011) Stress Monitoring Based on Stochastic Fuzzy Analysis of Heartbeat Intervals. *IEEE Transactions on Fuzzy Systems* (under review)

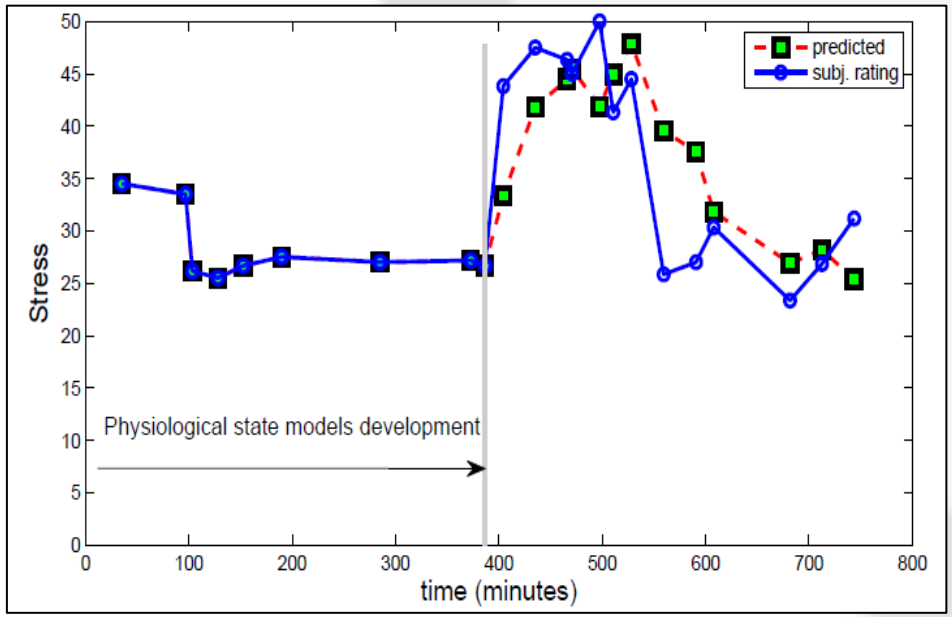
Background

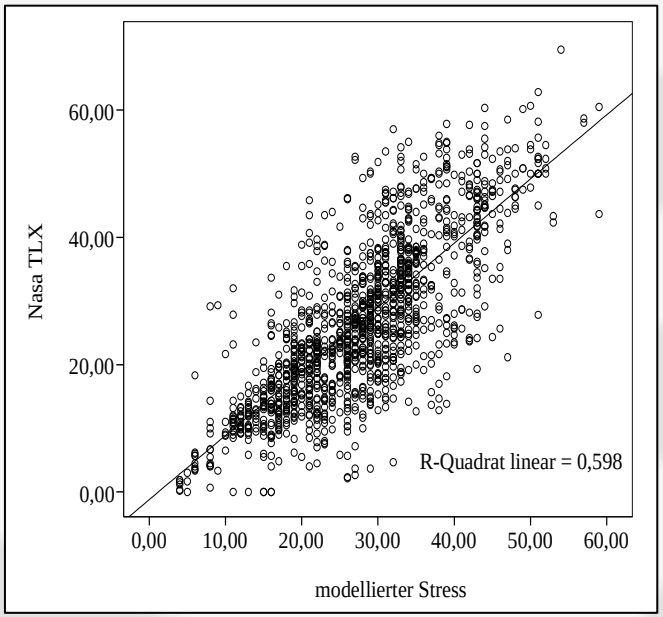
- Stress can have serious health consequences
- Link between work stress and diseases
- In today‘s society 40-50 % of all work-related absences are related to stress
- There is a need for a real-time personal stress monitoring over extended periods to detect health risks
- Challenge: Quantifying stress levels of an individual based on real-time physiological data analysis

HRV-based subjective workload modelling



Correlation between subjective and fuzzy-modelled stress





→ Adequate stress prediction alorithm ←

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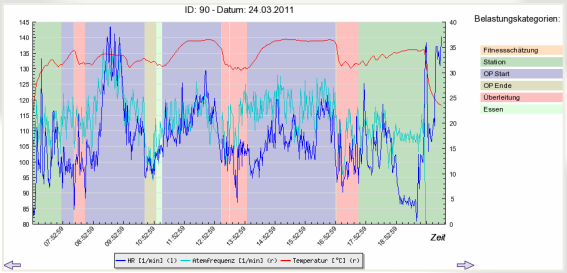
Ambulatory assessment at the workplace – Intraoperative stress of surgeons

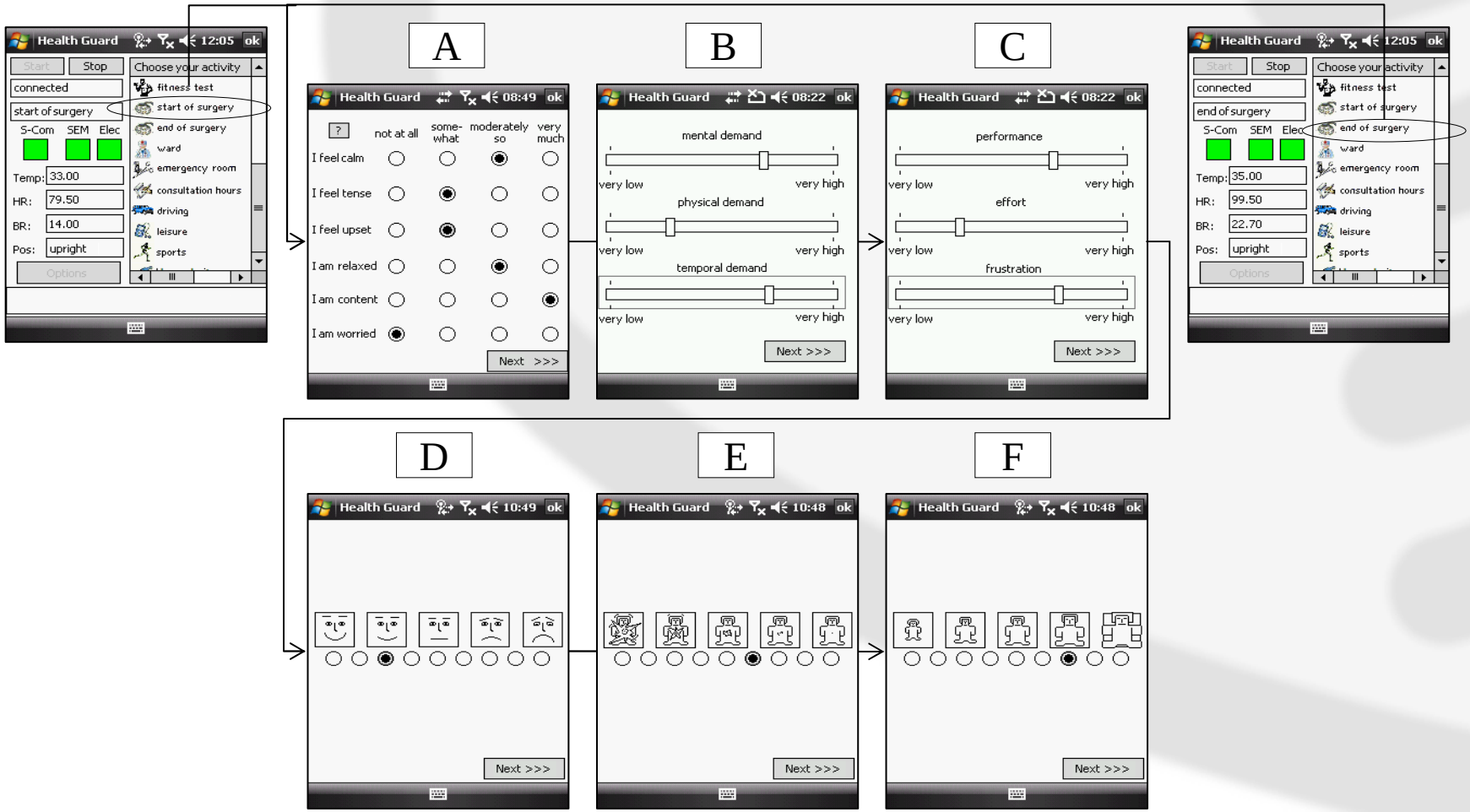
Rieger, A. et al. (2011) Psychophysiological stress detection in surgeons‘ by means of ambulatory assessment. World Journal of Surgery (under review)

Study design and study sample

- Prospective cross-sectional study
- Period of investigation: April 2011 - June 2011
- 25 physicians (trauma/orthopedic/general/neurosurgery)
- 4 MS4, 6 residents, 5 fellows, 6 attendings, 4 chiefs of medicine
- Duration of monitoring: 16.9 ± 4.8 hours including work and leisure time
- Documentation of occupations, function during surgery, wear of lead aprons, level of complication, type of surgery
- Psychophysiological measures: HR, BR, ST, STAI, NASA TLX, SAM



Design of user interfaces



Time points of self reports

Assessment of stress via NASA TLX, SAM and STAI

Monitoring of physiological parameters via Equivital sensor

Assessment of stress via NASA TLX, SAM and STAI

preoperatively intraoperatively postoperatively

Work-Specific information

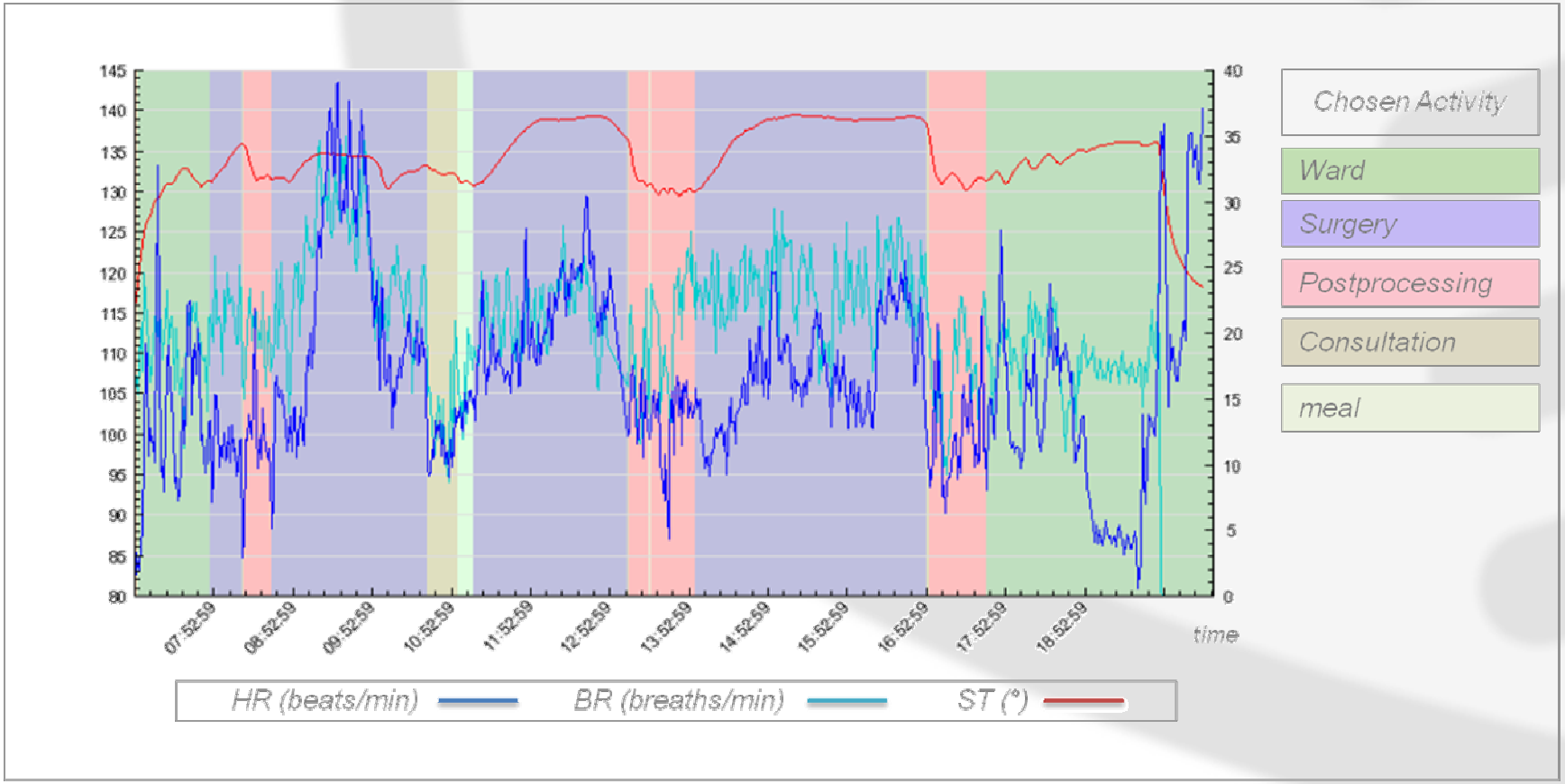
Grade		Age	Working hours/week	Years of practice
	n	Yrs	Mean ± SD	Mean ± SD
MS4	4	25.8 ± 0.5	36.0 ± 5.4	0.4 ± 0.1
Residents	6	31.2 ± 2.9	61.6 ± 6.7	3.8 ± 1.9
Fellows	5	37.0 ± 2.7	62.2 ± 10.2	8.4 ± 2.9
Attendings	6	40.0 ± 1.7	54.8 ± 3.3	12.1 ± 2.1
Chiefs of medicine	4	47.8 ± 9.0	59.2 ± 6.3	17.7 ± 9.0
Total	25	36.2 ± 8.0	55.5 ± 11.4	7.8 ± 6.5

Surgery	Number of procedures
trauma/ orthopedic	34
neurosurgical	15
vascular	1
abdominal	1

Psychophysiological Analysis

	Stress	**No Stress**	**t**	**p**
	Mean ± SD	Mean ± SD		
STAI pre	11.00 ± 1.10	12.91 ± 2.60	2.85	< 0.001
STAI post	13.14 ± 1.45	10.73 ± 2.13	-3.33	< 0.001
NASA pre	34.91 ± 15.69	42.47 ± 13.97	1.79	n.s.
NASA post	46.83 ± 22.89	33.65 ± 14.11	-2.46	< 0.05
SAM pre	14.00 ± 1.77	17.00 ± 1.53	6.36	< 0.001
SAM post	17.21 ± 1.72	15.32 ± 2.39	-3.16	< 0.01
HR intraoperative	94.5 ± 13.6	82.8 ± 11.4	-3.10	< 0.01
BR intraoperative	22.3 ± 2.9	21.3 ± 3.9	-0.92	n.s.

Real-time visualization



Summary

→ Proven feasibility and practicability in a concrete field of work with high demands

→ No negative influence on the work

→ Subjective ratings were neither time-consuming nor distracting

→ Significant differences between the 2 stress groups

→ All 25 participants declared their willingness to contribute their part to future investigations

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