Effects of Aging and Domain Knowledge on Usability in a Diabetes Small Screen Device

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Agenda

Diabetes mellitus

- disease, treatment, social impact

Usability of Diabetes Small Screen Devices

- design of an emprical experiment
- participants
- small screen device simulation
- measured performance criteria

Results

- Effects of Aging on Performance
- Effects of Domain Knowledge on Performance

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- [illegible]

Diabetes mellius

Diabetes is a glucose metabolism dysfunction

- Main symptom: Insulin deficiency
  - Insulin: Glucose from blood -> cells
- High glucose levels cause vascular and neural damge
  - Secondary disorders: Blindness, Renal failure, Amputations, etc.

Type 1 Diabetes

- Autoimmune mediated disease => absolute insulin deficiency

Type 2 Diabetes

- Obesity & Lack of physical exercise => continouus increasing cell insulin resistency => Collapse of insulin metabolism

Diabetes Treatment

Main Task - Controlling:

- stable low blood glucose level

Means:

- low caloric diet, physical exercise, anti-diabetic drugs, subcutaneous insulin injections

Requirements:

- Accurate measurment and tracking of patients health parameters

Usage of mobile electronic living assistants

- customized therapy for highly individual disease patterns

Diabetes is expensive

Forecast for 2010 in Germany (German Diabetes Union 2007)

- 10 Million people affected
  - (1/8th of population)
- 20% of Germanys total health care expenditure
- 40 Billion Euros for secondary disorder treatment

Demographic changes will increase Diabetes incidence

- sedentary lifestyle and high caloric diet increases likelihood
- Diabetes occurance increases with age

Technical solutions become unevitable + Usability

- Diabetes patients rarely use digital diary functions (<10%)
- Effects of diabetes on usability is highly important!

Diabetes Conclusion

Demographic changes concur with higher Diabetes incidence

Secondary disorders

- caused by unsuccessul treatment
- are expensive

Highly individual disease patterns require individual therapy

Patients keep track of their health status -> paperbased

- Bad usability of digital diaries

Better technical solutions are required

- Focus on usability!

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Design of the experiment

Target of the experiment

- measure effects of aging and diabetes on usability
- user centered design approach of a small screen device

Important factors:

- learnability of the device
- one device for all diabetes types
- unbiased participants (no branded device)

Experimental Study (Overview)

Independent Variables

- 1. Participants were surveyed about (paper-based)
  - demographic facts
  - expertise with technology
  - domain knowledge of diabetes

Dependent Variables

- 2. Participants took part in a user test of a simulated device
  - five tasks (available as hardcopy throughout the experiment)
  - Performance was measured along the way
- 3. Participants ranked the Percieved Ease of Use and Percieved Usefulness of the device.

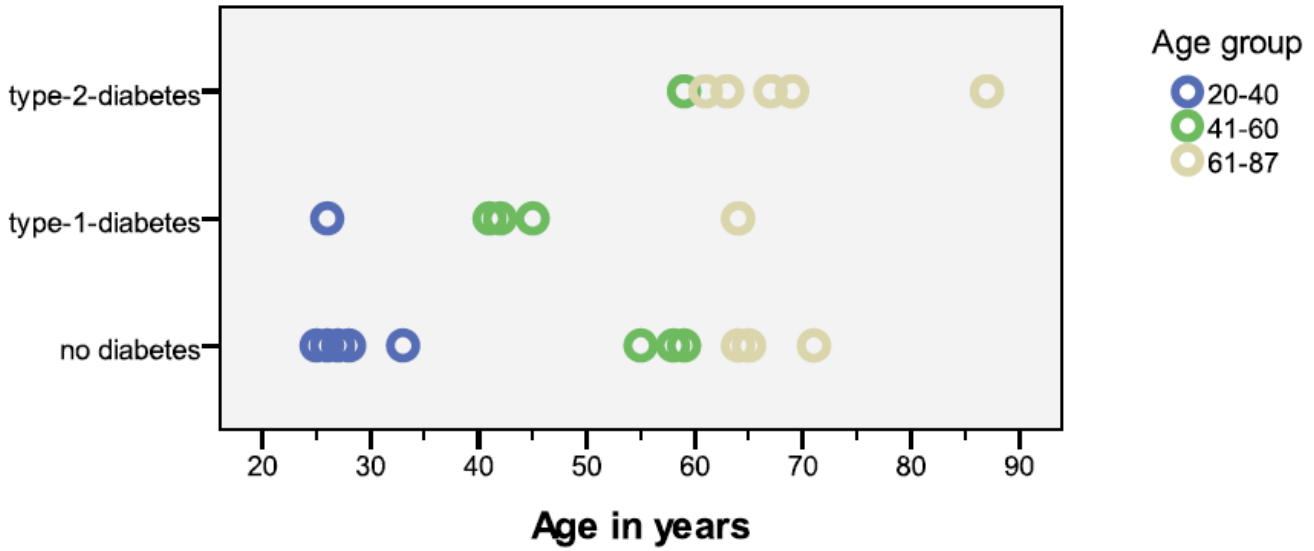
User Diversity and Participants

Diabetes patients range from young kids to the elderly

Participants for user study selecteded prototypically

- Best case patients - „healthy diabetics“

Group of 23 participants (16 female, 7 male)



Dependent Variables

Assessment of Domain Knowledge

- survey knowledge of four key health factors
  - blood sugar
  - HbA1c
  - blood pressure
  - body fat percentage

Assessment of Technical Experience

- Survey of Percieved Ease of Use (PEU) and Usage Frequency (UF)
  - for everyday technology, mobile phone, medical technology

Ranking on a Six-Point-Likert-Scale

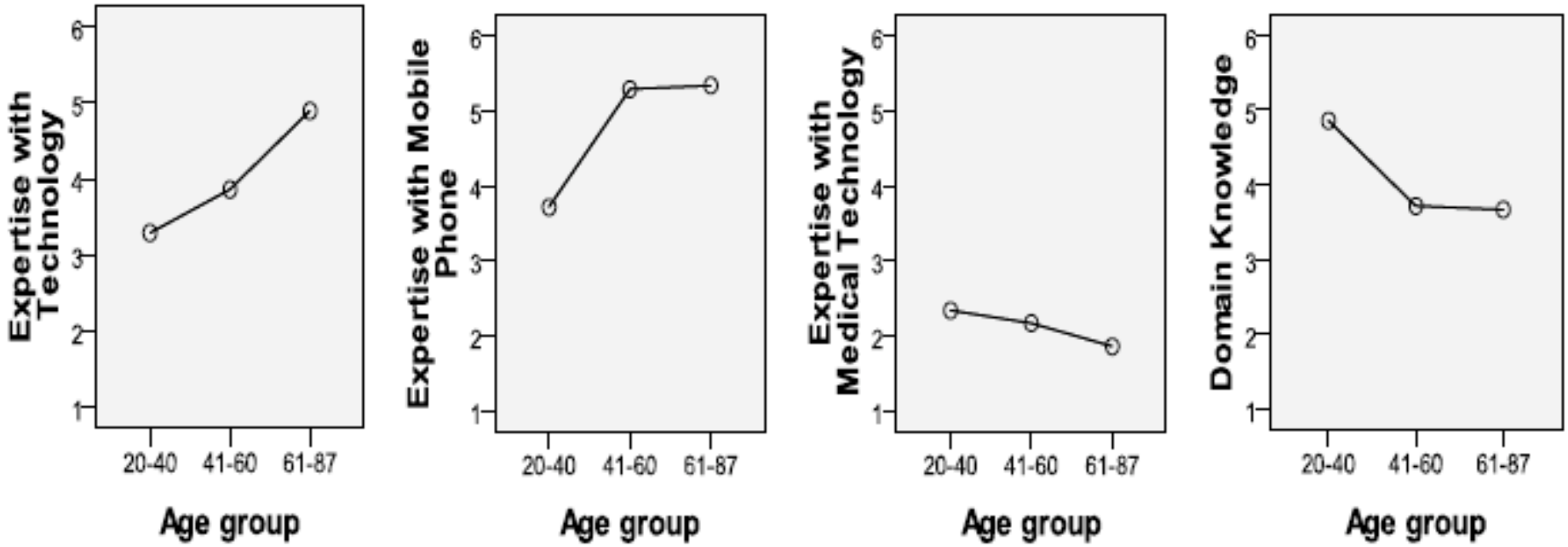
Relationship of expertise and age

Highly significant correlation between technical expertise and age

- everyday technology and mobile phones

No significant correlation

- age and expertise in medical technology/domain knowledge



Diabetes Living Assistant

Self-developed user-centered Prototype

- JavaME based
  - PC/MAC/Mobile Phones, PDAs
  - logging function via Jacareto/CleverPHL
- Screen design similar to paper based solutions
- five core functions
  - Diabetes diary, BE-Calculator, Health-Pass, Medicine, Value-Plotter

Simulation on a touch-enabled 15“ TFT-Screen

Rating user performance

Five performance criterias were measured

- total amount of time
- total success rate (in percent)
- total steps
- detour steps
- time per step (navigational pace)

Performance measures are corrected against success rate

- prevents overrating participants that give up early, taking less time.

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Hypotheses

Older users are outperformed by younger users

- higher technical expertise
- effects of aging on perfomance
  - (mental processing speed, psychomotor-skills)

Diabetes patients outperform non-diabetics

- Domain Knowledge could help in construction of mental models

Diabetes Type 1 patients outperform Diabetes Type 2 patients

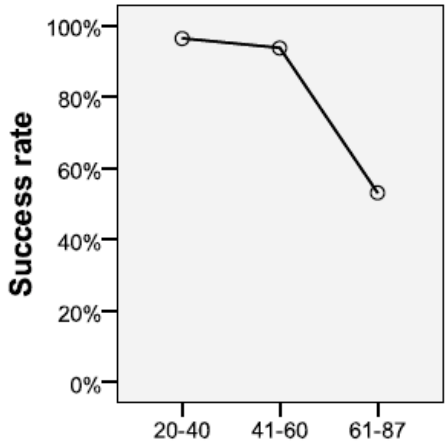
- higher domain knowledge
  - comprehension of the disease is critical for success of long term treatment

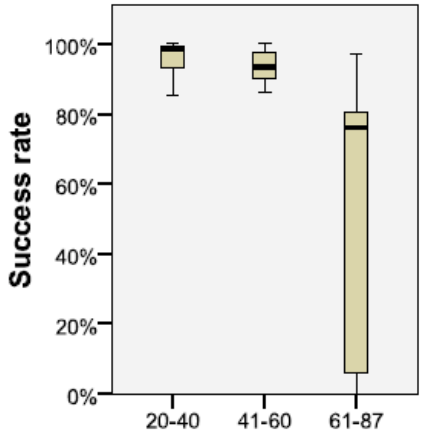
Performance Results

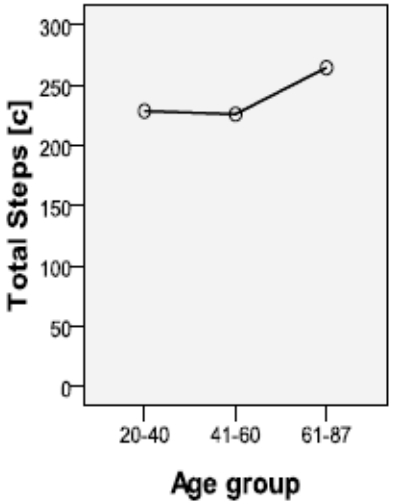
Bivariate Correlations

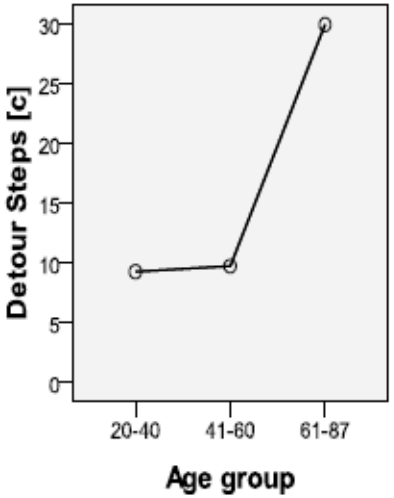
	Success Rate	*Total steps*	*Detour Steps*	*Total Time*	*Time per step*
Age	-0.664**	0.616**	0.472*	0.231	0.693**
Expertise with technology	-0.449*	0.330	0.244	0.476*	0,320
Expertise with medical technology	0.251	-0.266	-0.146	0.101	-0.342
Mobile Phone Expertise	-0.339	0.295	-0.006	0.393	0.301
Health Status	-0.179	0.342	0.181	-0.102	0.421
Domain knowledge	-0.53	-0.167	0.097	0.314	-0.244

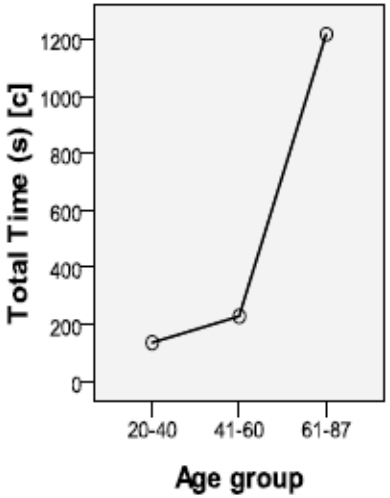
Effects of Aging

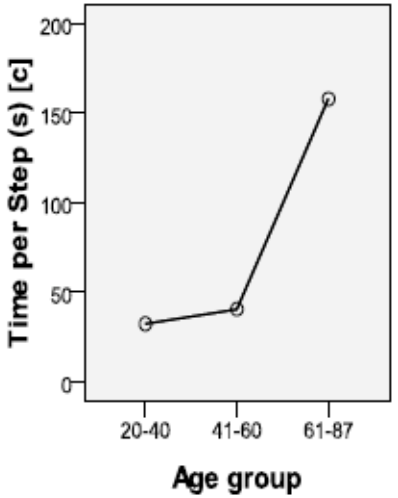




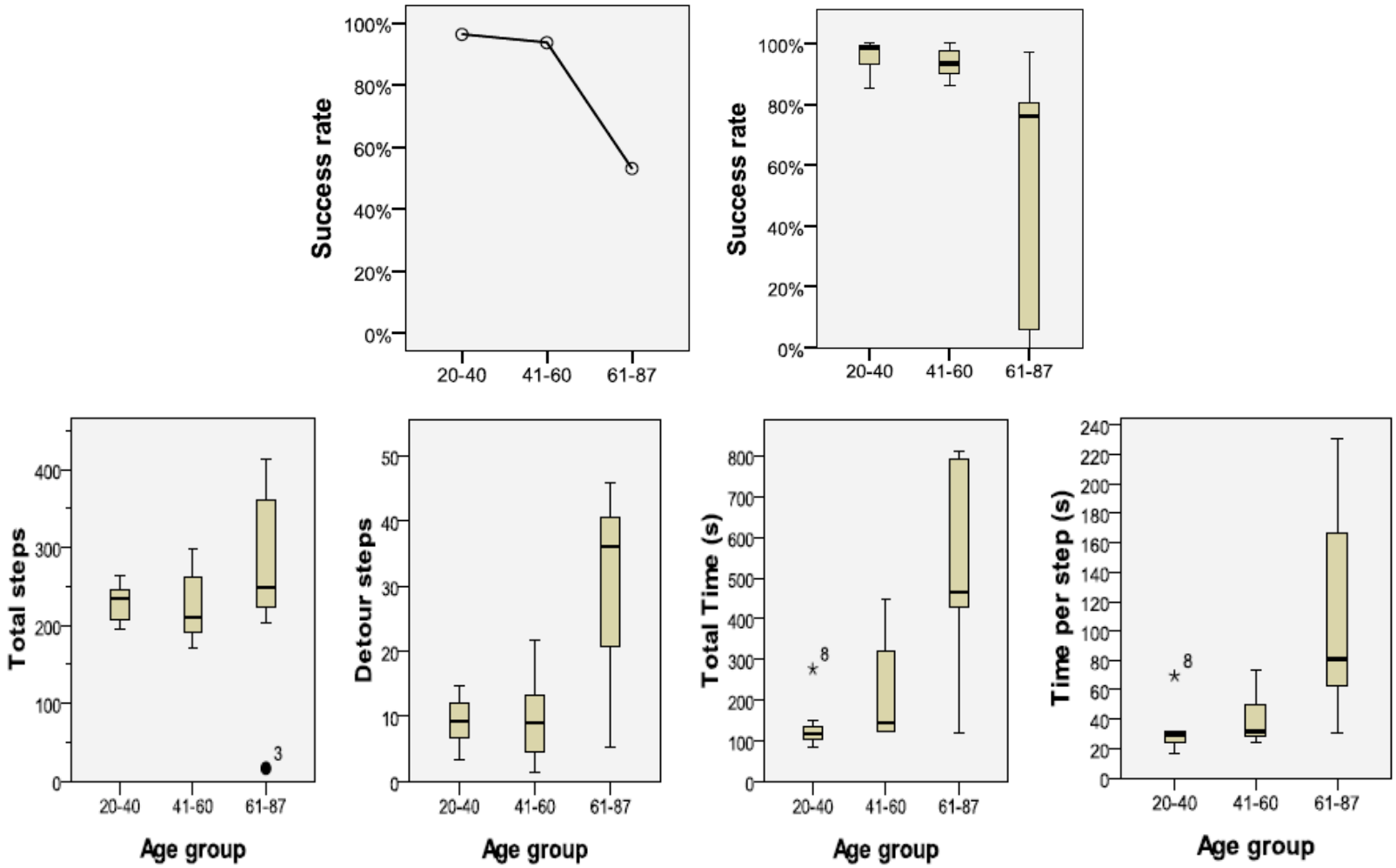








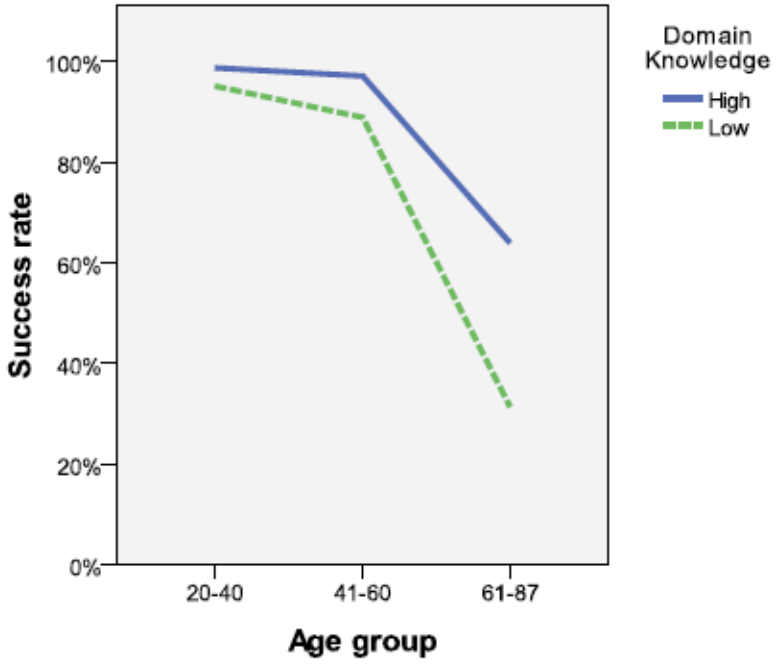
Effects of Aging

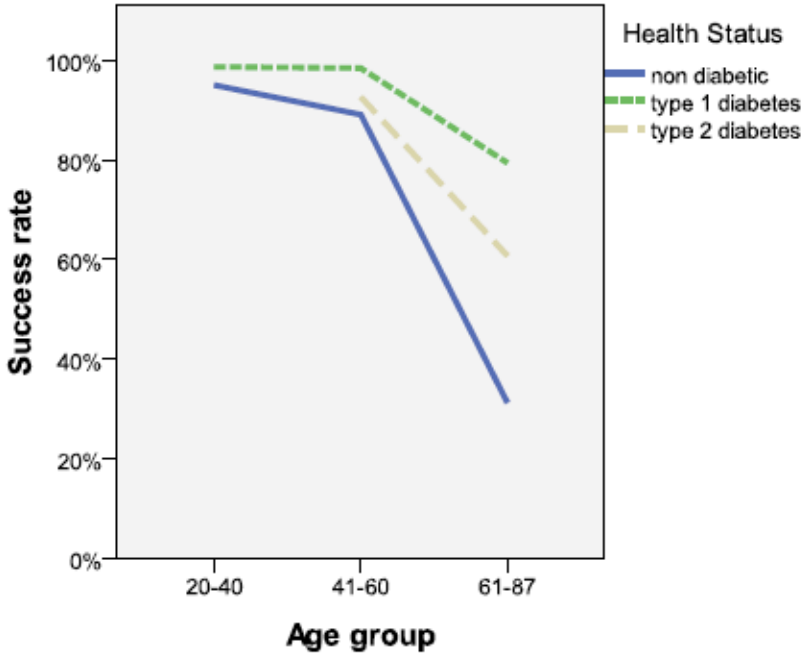


Effects of Health and Domain Knowledge

Analysis of Covariance

- Domain Knowledge median split groups
- Different health status types
- fails to reach significance





Device Acceptance

Correlations between Acceptance, Expertise, Age and Success

	Age	*DK*	*HS*	*TE*	*MTE*	*MBE*	*Success rate*
Acceptance	-0.460*	0.200	0.027	0.276	0.409	0.287	-0.507*

*$p < 0.05$

- Low Value for Acceptance = Good acceptance rating
  - DK = Domain Knowledge, HS = Health Status, TE = Technical Expertise, MTE = Medical Technical Expertise, MBE = Mobile Phone Expertise

Linear Regression

- 65% of variance are explained by age and success rate
  - success rate stronger predictor than age (2x)

Conclusion

Our studies confirmed earlier research

- older users make more navigational errors
- older users have a slower navigation pace

Domain knowledge and diabetes type might have an impact on usability

- elderly users might use DK to make up for effects of aging
- further research is required

Successful initial usage of the device => better acceptance

Thank you for your attention!

Example Tasks

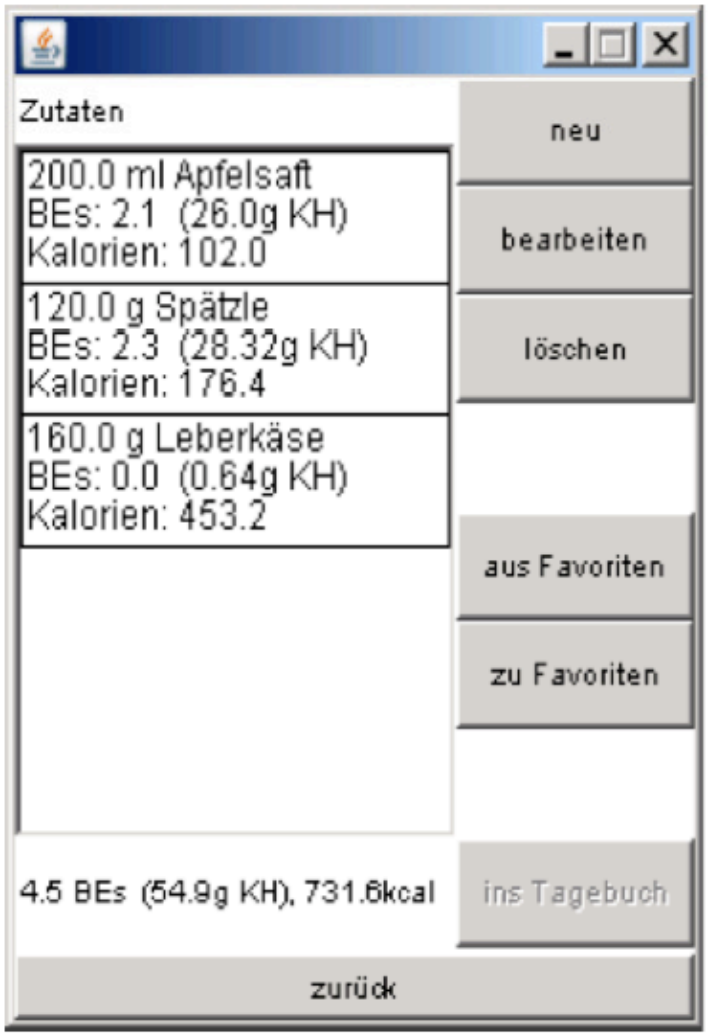
Digital-Diary Task:

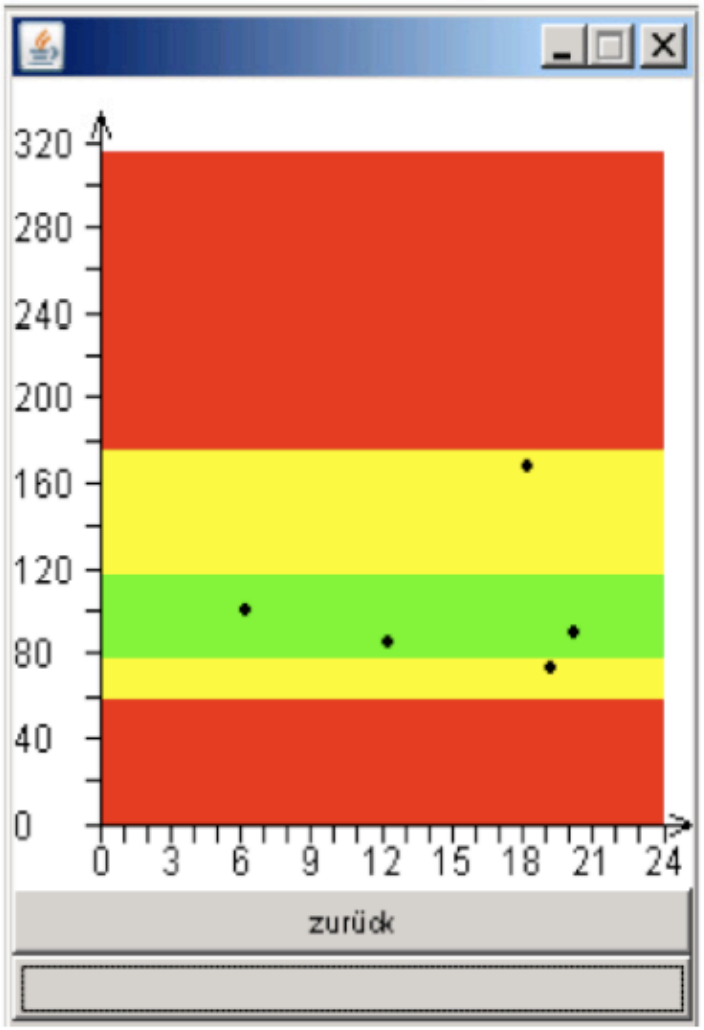
- After finishing configuration of your device, daily blood glucose measurements can be stored in the devices digital diary. Please enter the following measurement into the digital diary:
  This morning 9:20 am: Blood Glucose level 123, consumed 3 bread units, no correction of insulin dosage, no basal-insulin dosage, no hypo- or ketoacidosis measured

BE-Calculator Task:

- You are hungry and want to eat some fish sticks (200grams) and have a glass of apple juice (200ml). Please calculate the bread units for this meal using the BE-Calculator of the device

Example Screens





Example Screen: Learnability

Datum: 12.3.	Arbeitstag X	Urlaubstag ☐	Mo ☐	Di ☐	Mi ☐	Do ☐	Fr X	Sa ☐	So ☐	
Uhrzeit	630	1230	1800	1930	2000	200				Gesamt
BZ	104	89	172	77	94	113				
HZ/Az.										
BE	8	7			11					26
BE-Faktor	2,5	2			2					
Bolus	20	14			22					56
Basis					30					30
Blutdruck/ Puls	Sport									Korrektur-Regel: