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Motor skills, perceived difficulties and quality of cycling of older adults

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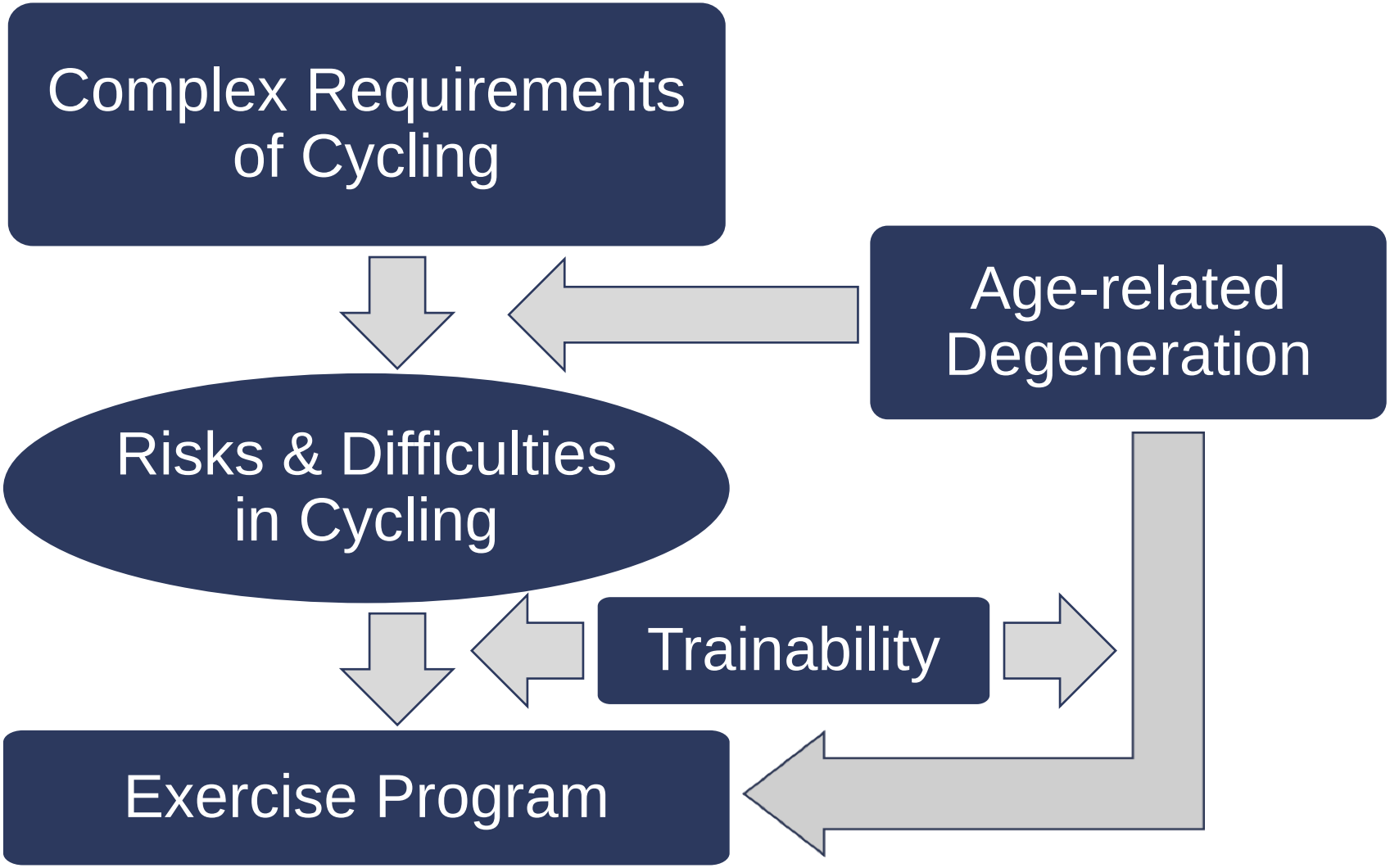
Mobility of Elderly through Cycling – the problem

- *Demographic changes* in Germany: => Increasing percentage of Elderly
- *Mobility* for independence, participation and quality of life
- If elderly are involved in accidents there is a high risk of *heavy injuries and mortality*!
- In Germany, about 50% of cyclist casualties are persons who are *at least 65 years old*!
- *Typical accident reasons* are: ascending on/dismounting from the bike, trail conditions, complex traffic situations (e.g. crossroads, left-turning, gateways; tram tracks)
- Older cyclists have *physical problems* (e.g. motility reduced, balance reduced), => Cycling more difficult; might prevent from using the bike
- *Requirement analysis* of tasks for cyclists from a sports perspective
- Development of an *exercise program* to improve the abilities

(Bauman et al., 2011; Gajewski et al., 2010; Hagemeister & Tegen-Klebingat, 2011; Haustein et al., 2008; Oja et al., 2011; Schlag, 2008; Wagner et al., 2004)

Framework for developing the exercise program



Complex Requirements of Cycling – some examples

Demands in traffic	Skills	Required abilities
Getting off the bike	• Precise stop • Rising from sitting to standing • Standing on one pedal • Lifting the leg over the bike frame	• Anticipation • Reaction • Balance • Flexibility in the trunk-, hip-, and foot joints • Movement coupling
Cycling in a narrow lane	• Keep in lane • Cycle strait on	• Balance • Stabilize the trunk and shoulders • Concentration • Differentiation ability within the upper extremities
Turning	• Indicate turning (cycle one-handed) • Looking over the shoulder while cycling	• Movement coupling • Balance • Torso stability • Flexibility in shoulders and neck joints • Orientation, peripheral seeing

(Bast, 2009; Greule & Friedrich, 2007, Könemann, 1996; Hottenrott, 2001)

Age-related Degenerative Processes

Trainability

- Physical abilities
  - endurance
  - strength (legs, torso, shoulders)
  - flexibility (ankles, torso, neck)
- Coordinative abilities (e.g. balance, reaction, orientation, anticipation)
- Cognitive and sensory abilities (e.g. attention, information processing, decision-making ability)
- Vision and hearing
- Capacity of the vestibular system
- Chronic degenerative diseases
- Medication

➡Excessive demands
➡Anxiety
➡Falls and accidents

The training of endurance, strength and coordinative abilities also improves cognitive abilities

?

(Colcombe & Kramer, 2003; Eichberg & Mechling, 2009; Gajewski, 2010; Granacher, 2011; Granacher et al., 2009, 2012; Granacher & Gollhofer, 2005; Kramer & Erickson, 2007; Lan et al., 1998; Latham et al., 2004; Rinkenauer, 2008; Rosenhall & Rubin, 1975; Schuler et al., 1993; Suomi & Lindauer, 1997; Voelcker-Rehage et al., 2011)

Objectives and Methods of the Study

Objectives

- Examination of the correlation between motor skills, difficulties of cycling, quality of cycling
- Development and evaluation of a structured exercise program to improve
  - motoric and cognitive abilities of older cyclists
  - safety perception
  - quality of life and health

Design

- Random assignment to intervention and control group with adults from 60 years
- Contacts to sports clubs in medium sized cities in Saxony and Saxony-Anhalt (Eastern Germany) with the conditions: - space and time for training; - trainer
- 14 small and medium cities in Eastern Germany with
  - poor public transport
  - population > 10 000 inhabitants
- Pre-, post- and follow-up tests (2013 – 2014)

(Funded by the German Federal Ministry of Transport, Building and Urban Development)

Objectives and Methods

Groups and Intervention

- Intervention Group (IG, n=145, ∅ 67.5 years, 43.4% women) → structured exercise program 6 months, 120 min./week (60 min., 2x/week)
- Control Group (n=162, ∅ 67.4 years, 36.4% women)

Fitness Tests

Abilities		Tests
Endurance		Six-minute walk test
Muscle strength	Hand-grip strength	Citec-handheld-dynamometer
	Knee extension	
Coordination	Reactivity	Rolling ball
	Balance	Balance track
	Postural stability	Functional Reach and Lateral Reach Test
	Functional mobility	Timed-Up-and-Go Test
Flexibility	Torso and hamstrings	Sit-and-Reach Test
	cervical spine	CMS pro

Objectives and Methods of the Study

Questionnaires

- physical activities, mobility habits,
- quality of life, health status, perceived complaints,
- self-efficacy, safety perception etc.

cognitive tests (mental rotation, perceptual speed)

Bike course – quality of cycling (Heidemann, Hufgard, Sindern, Riek & Rudinger, 2009)

Assessment	Rating scale
Slalom	1 – 2 faults
Slow riding	1 – 2 faults
Dismounting (left/right)	correct/false
Narrow lane	correct/false

Assessment	Rating scale
Precise stop	1 – 3 faults
Left turn	1 – 4 faults
One-handed driving figure eight	1 – 3 faults

Sample in t1

n= 307		
age:	over all	Ø= 67.4 (SD= 5.4); > 70 years: 34.5%
	♂ (n=185)	Ø= 68.2 (SD= 5.5)
	♀ (n=122)	Ø= 66.3 (SD= 5.0)
sex:		♂= 60.3%
activity (h/week):	basic (n=276)	Ø= 13.2 (SD= 10.5)
	leisure (n=269)	Ø= 6.0 (SD= 5.5)
	sport (n=291)	Ø= 2.7 (SD= 3.1)
activity (frequency)		median=3 (1-2 times/week)

Inclusion criteria:

- age > 60 years
- regularly biking
- from rural and suburban areas (< 30,000 inhabitants)

Selected Results

Frequency of bike use, Test Session 1

	Intervention group (N=146)	*Control group (N=167)*
Less than 1-2 times per month	*2.1%*	*3.6%*
1-2 times per month	*2.1%*	*3.6%*
1-2 times per week	*16.4%*	*22.2%*
3-4 times per week	*32.2%*	*22.8%*
Daily or nearly daily	*46.6%*	*51.5%*

Distance cycled between Test Session 1 and 2 (bicycle computer)

Group	Mean	Standard deviation
Intervention (n=122)	1,017 km	1,057 km
Control (n=127)	918 km	895 km

No difference between groups, t-test for independent samples: p=.82
=> no effect of training

Bike course - quality of cycling

- Example of task
- Turning to the off-side
- Potential faults
- - no turn around the shoulder
- - no hand-sign
- - not naming the number
- - touching the line with the front wheel

Selected Results at t1

Most single errors in the bicycle course

Failed to…	% of subjects
one handed driving the figure eight (n=162)	43.8%
dismounting right (n=250)	33.2%
driving through a narrow lane (n=249)	28.9%
dismounting left (n=248)	27.8%
precise stop (n=248)	23.8%
turning the head when turning left (n=246)	23.6%
touching or knock over slalom pylons (n=248)	23.0%

Most common incorrect overall task: pricise stop, slow riding, One-handed driving figure eight

Bike course - quality of cycling

Proportion of participants accomplishing task correctly

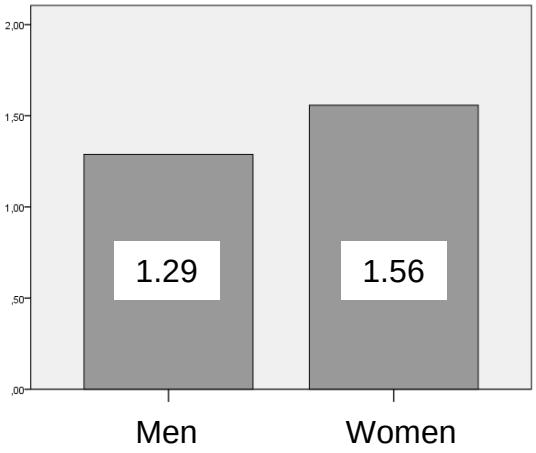
Examples of tasks	*Intervention group* Test session 1	*Intervention group* Test session 2	*Control group* Test session 1	*Control group* Test session 2
Dismounting to the left into a hula hoop	69%	72%	67%	72%
Dismounting to the right into a hula hoop	71%	82%	74%	80%
Turning to the off-side	61%	69%	43%	64%

GLM: no interaction between test session and group: no effect of training

Selected Results

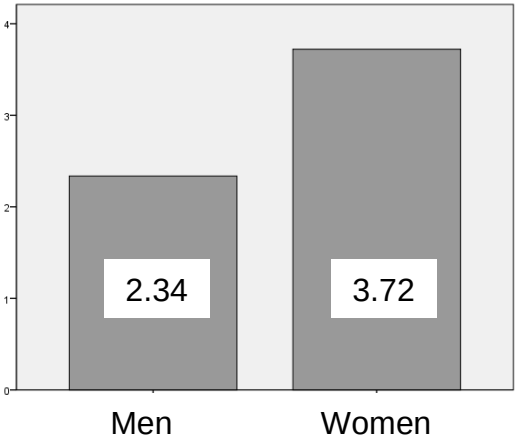
Sex differences?

Perceived difficulties



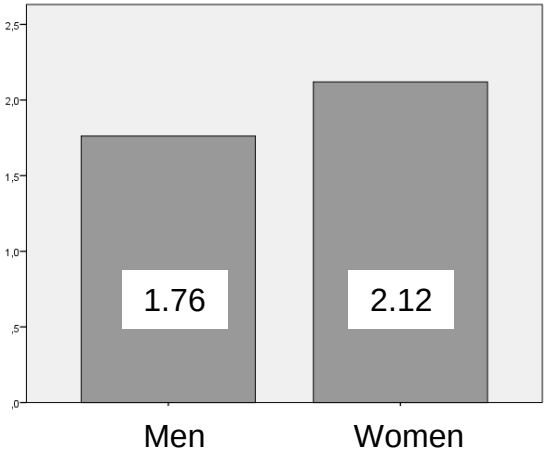
n=267; U=5666.0; p ≤ .000

Total number of errors in the bike course



n=153; U=1732.0; p ≤ .000

Feeling of uncertainty



n=153; U=1732.0; p ≤ .000

But: Men plunged more than women!
n=183; U=3093.5; p ≤ .000

- Women perceive significantly more difficulties, make more mistakes in the bike course and feel more insecure than men.
- Men are more likely plunged since the 59th years.

Selected Results

- Correlation between perceived difficulties of cycling and selected qualities of cycling?

Perceived difficulties[b] in …	Errors while …	n	r [a]
… dismounting	… dismounting (left/right)	254 257	.206** .132*
… guiding with one hand	… one-handed driving figure eight	290	.221***
… driving curves	… slalom	290	.157**

a: Spearman rank correlation

b: perceived difficulties from 1= not at all difficult to 5= very difficult

* p≤.05, ** p≤.01, ***p≤.001

➢ There are low correlations between the perceived difficulties of cycling and selected qualities of cycling

Selected Results

Correlation between the quality of bike course and selected motoric abilities?

Bike course-Total number of errors	r[a]
6-Minute-walking (n=153)	-.170*
Lateral Reach Test, left (n=153)	-.249**
Sit-and-Reach-Test (n=151)	-.176*
Balance Track, (n=143)	-.243**
Hand-grip-strength (n=151)	-.310***
Timed-Up-and-Go Test (n=152)	.229**
Rolling ball Test (n=136)	.246**

a: Spearman Rangkorrelation; * p≤.05, ** p≤.01, ***p≤.001

- no correlation with the cervical spine!

➢ There are low correlations between total number of errors and selected motoric abilities

Selected Results

Correlation between perceived difficulties of cycling and motoric abilities?

perceived difficulties [a]	r[b]
6-Minute-Walking (n=266)	-.345***
Lateral Reach Test, left (n=267)	-.309***
Sit-and-Reach-Test (n=262)	n.s.
Balance Track (n=255)	-.149**
Hand-grip-strength (n=264)	-.278***
Knee extension, right (n=264)	-.311***
Lateral Reach Test, right (n=267)	-.190**
Timed-Up-and-Go Test (n=266)	.268***
Rolling Ball Test (n=246)	.183**

a: perceived difficulties range from 1= not at all difficult to 5= very difficult; n=267; ∅ =1.4, SD=.44

b: Spearman Rangkorrelation * p≤.05, ** p≤.01, ***p≤.001

- There are low but significant correlations between perceived difficulties and selected motoric abilities for the all over index as well as the single items.

Selected Results

Predictors of the total number of errors at the bike course?

Model	Not standardised coefficient		Standardised coefficient	T	p
	Regression-coefficient B	Standard-error	Beta		
(constant)	3.714	.696		5.336	.000
Knee extension left in N	-.003	.001	-.171	-2.818	.005
Lateral Reach Test left in cm	-.030	.014	-.128	-2.217	.027
Timed-Up-and-Go in Sec	.156	.076	.121	2.053	.041

Explained variance: 8.4% **F=10.234; df=3,301; p=.000**

- Few motoric abilities are significantly explaining the variance of the total number of errors at the bike course.

Selected Results

Predictors of the safety perception?

Model	Not standardised coefficients		Standardised coefficients	T	p
	Regression-coefficient B	Standard-error	Beta		
(constant)	2.573	.546		4.708	.000
bike-orientated self-efficacy	-.326	.066	-.290	-4.918	.000
perceived difficulty	.402	.078	.298	5.163	.000
balance left (in sec.)	-.009	.005	-.110	-2.006	.004
hand-grip-strength (in N)	.003	.001	.180	2.626	.009
Knee extension strength left (in N)	-.002	.000	-.205	-3.114	.002

Explained variance: 29.6% **F=8.989; df=16,288; p=.000**

- Additionally to some aspects of motoric abilities, perceived difficulty and bike orientated self-efficacy are important predictors of the safety perception.

Summary and conclusions

- There were low to medium correlations between quality of cycling (total number of errors) and selected motoric abilities and selected psychosocial factors.
- Over all the strongest relation between motoric abilities and cycling skills (qualities) we found for: balance, functional stability, muscle strength and reaction.

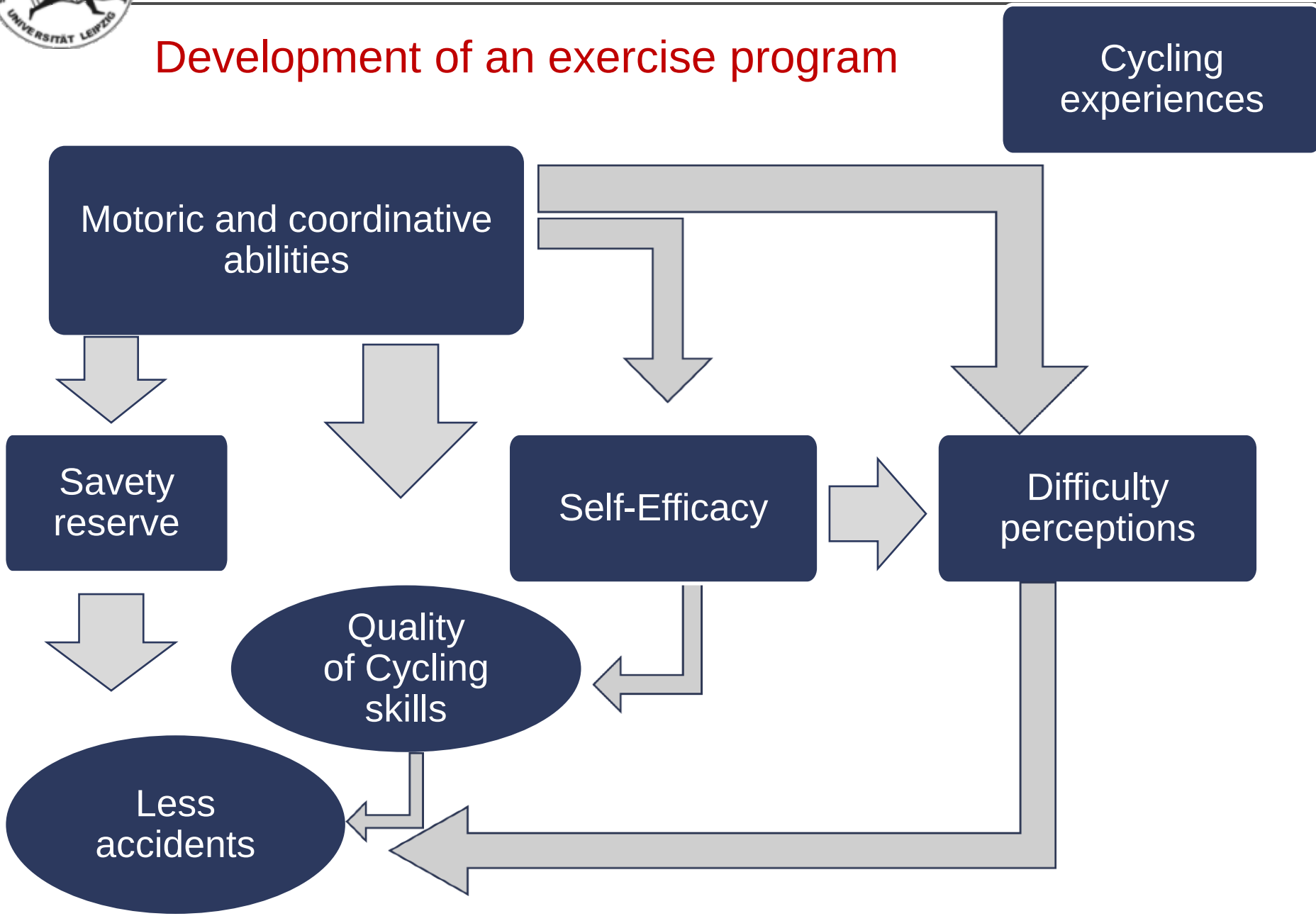
- These correlations between motor skills and reported difficulties when cycling as well as the performance in the cycling course are the reasons that we propose that an improvement of basic motor skills required for cycling should contribute to a secure cycling-behavior and facilitate the daily use of bicycles for the elderly.

BUT for the longitudinal study we have to consider that:

- Ceiling effect for the distance cycled: participants had cycled already very much before the intervention;
  same for the exercise and physical activity level and the for the bike use,

- besides the analyses of the effects of the exercise program, we need more research to understand the potential transfer from the training to cycling use or to quality of cycling.

Development of an exercise program



Perspectives for the future (research)

- Therefore we have to focus on:
  - the relevant/valid indicators for the danger potencial (errors in combination with subjective aspects),
  - composition of the sample (analysis of subgroups),
  - what are the relations (model of causality, relevant predictors),

- Subgroups with specific /risks need adequate training programs (e.g. gender, age, physical situation at beginning) or a combination of physical training with safety training;

→ Because a structured exercise program may contribute to a secure cycling-behavior in everyday traffic situations and also enhances a physical active way of life and health, lets work together with Sport & Exercise Science and also with organizations of sport & exercise!

Thank you for your attention!

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