Posterbook
Master graduation symposium
Human Movement Sciences & Sport Sciences
2018-2019
Poster presentations
2018-2019

Masters degree programme
Human Movement Sciences &
Sport Sciences

Specializations:
Motor function and cognition in healthy ageing
Rehabilitation and functional recovery
Sport, learning and performance
PREFACE

This book contains the work of students who performed a master’s degree programme in Human Movement Sciences or Sport Sciences. These master’s degree programs are provided by the Department of Human Movement Sciences which is part of the Medical Faculty of the University of Groningen, The Netherlands. They are science-oriented multidisciplinary two-year programs, with a main focus on concepts such as behavior and cognition, perception and action, motor control and learning, and load and recovery.

The Department of Human Movement Sciences targets to increase our understanding of all the aspects involved with human movement and to apply the obtained results in the fields of sports, rehabilitation and healthy ageing. The students in the master’s degree programs can choose one or more of these areas of specialization, which will form the basis of their theses. The specialization 'Motor function and Cognition in Healthy Ageing' explores how physical activity can prevent chronic diseases, preserve cognitive function, and how innovative solutions can promote mobility and independence at older ages. The specialization 'Rehabilitation and Functional Recovery' aims to improve our understanding of impaired movement and the mechanisms of mobility restoration and functioning in the rehabilitation practice. Students who choose to specialize in the area of 'Sport, Learning and Performance' can explore the cognitive, psychological and physiological aspects of sports behavior.

The courses and projects of the master’s degree programs let the students acquire skills that are essential for an academic career. In the second year of the master’s degree programs, students perform a graduation project, conducting research related to their area of specialization. To complete this graduation project all students need to successfully write a scientific article, give an oral presentation and design and present a scientific poster.

The presentation of a scientific poster belongs to the essential skills for an academic career. It provides a visual condensation of the most important aspects of the performed study. This book presents all the posters that were created by the master students in the academic year of 2018-2019.

With this book we want to provide insight into the subjects and types of studies that are performed as graduation projects during the master’s degree programs in Human Movement Sciences and Sport Sciences. We hope that this book will help future students with their decision-making for future research projects, and creates a general interest in the studies performed by Human Movement Scientists and Sport Scientists.

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**Posters Master's programme Sport Sciences**

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Abstracts and posters
master's programme

Human Movement Sciences
Introduction: It is unclear how rapidly healthy humans can learn a complex balance skill. We examined the effects of a short bout of unstable balance-board training on balance skill acquisition, retention, specificity, and transferability and probed the underlying neural plasticity using transcranial magnetic stimulation (TMS).

Methods: Healthy young adults (n=36, age 20.9, 18M) were randomly assigned to learn balancing on an unstable board (BAL), cycle while seated (CYC) or sit and rest (CON) for 20 minutes. Before, immediately and one week after the exercise session, we assessed performance of the trained and several untrained balance tasks and probed potential underlying neural mechanisms by TMS.

Results: BAL but not CYC or CON improved in the trained balance task by 338.9% (±257.2, effect size [ES]: 1.94), 21.5% (±70.3, ES: 0.07), and 25.8% (± 85.3, ES: 0.05), respectively and BAL (256.0% ±165.5) retained the acquired skill after a 1-week-long off-line, no-training period. No changes occurred in 12 measures of untrained balance outcomes or in 4 TMS measures of supra-spinal excitability (all p>0.05).

Conclusions: A single unstable balance-board training session but not cycling or rest improved balance skills by margins observed in long term studies without transfer to other balancing skills or related change in neural excitability. Future studies will examine in more detail and by additional methods the neuromechanical mechanisms and the time course underlying the remarkable level of specificity of learning a balance skill.
Introduction

- Motor skill acquisition is a rapid process that relies on neural plasticity.
- It is unclear how rapidly healthy adults can learn a complex balance skill and if learning will be retained.
- There is much inconsistency concerning the specificity and transferability of balance learning.

Aim: To examine the effects of a short bout of unstable balance-board training on balance skill acquisition, retention, specificity, and transferability and investigate the underlying neural plasticity by TMS.

Methods

36 participants (age 20.9 ± 1.9 years) randomly assigned to:
- Balance training (n=12)
- Cycling training (n=12)
- Control group (n=12)

Day 1
- Baseline
- Intervention
- Post-test (1 week)
- Day 2 Retention

Outcome measures:
- Balance performance:
  - Balance Board % in balance
  - Balance Beam, distance walked
  - COP velocity
- Underlying neural mechanisms (TMS):
  - MEP
  - SICI/LICI
  - ICF

Results

1. Substantial increase and retention in task-specific balance
2. No transfer of trained balance skill to untrained balance tasks
3. Small association between balance tasks at baseline
4. No changes in TMS measures of supra-spinal plasticity
5. No association between improvement in balance skill and measures of neural plasticity

Conclusion

A short bout of unstable balance-board training but not cycling or rest improved balance skills by margins observed in chronic studies without transfer to other balancing skills or changes in neural plasticity. Future studies will examine in more detail and by additional methods the neuromechanical mechanisms and the time course underlying the remarkable level of specificity of learning a balance skill.

References

Abstract

**Background:** Eating disorders have a high prevalence in young females and show high mortality rates. Difficulties with emotion regulation are associated to these disorders, with high levels of anger and aggression suppression playing a key-role. In clinical practice, emotional assessment is often performed by subjective measures. These self-report measures have received several critiques for this population, because of patients' personality traits and social desirability in answering. Recently, a new objective instrument has been developed to use in addition to subjective measures of emotion regulation, called the Method of Stamp, Strike, Shout (MSSS). This instrument uses force production as a behavioral measure of anger and aggression regulation. This study examines the feasibility and first test results of the MSSS in a small clinical sample of patients with eating disorders.

The aim is to examine the relation between the MSSS and anger coping style of patients in comparison to a matched control sample of healthy students. **Method:** The MSSS consists of three subtests, including stamping on a force plate, striking a punching bag instrumented with an accelerometer, and shouting into a microphone. Participants were asked to increase and decrease their force production, thereby producing a four-step force pyramid on each subtest. The method is developed as an addition to self-report measures. Anger coping style is assessed using the Self-Expression and Control Scale (SECS). When examining the feasibility of the measure in the clinical sample, both patients' and researchers' measurement experiences were evaluated. Overall, a critical analysis of measurement procedures, data analysis and outcome measures is performed to examine the feasibility and first associations between test results of the clinical and control sample. **Results:** Seven participants with eating disorders were included and compared to a sample of matched controls (n=21). Both patients' and researchers' experiences, procedures, and data analysis methods were positive or showed possibilities for improvements regarding, the feasibility of the measure. First, the anger coping styles of the groups were analyzed. As expected, patients scored higher on the SECS internalization of anger (AI) and AI was the preferred coping style of 6/7 patients. Visual inspection showed lower values of shout subtest for patients compared to controls. Both the MANCOVA and regression analysis showed that the shout subtest was most discriminative between groups. A significant interaction was found between group and coping style for the shout subtest in the repeated measures MANCOVA. With the regression analysis, AI-coping style was recognized as a significant negative predictor for the shout sum score. Overall, the stamp and strike subtests did not show significant results of either MANCOVA or regression analysis. At this time, there is insufficient evidence to relate the shape of the stamp and strike force pyramids to either group or anger coping style. **Discussion:** The measure appears feasible in a clinical sample of patients with eating disorders. However, several improvements are recommended to fit the clinical sample. Because of the small sample size and violated assumptions, no conclusions can be made on the initial analyses with the current sample. However, there appears to be a trend of the shout subtest's ability to distinguish between groups or coping style, in line with previous test results in a student sample. The anger-performance relation in eating disorder patients is complex and should be carefully re-examined in a much larger sample with sufficient power, before conclusions can be made.

**Keywords:** MSSS, Method of Stamp Strike Shout, psychomotor therapy, force production, eating disorders, anger coping, anger internalization.
Examining the Method of Stamp Strike Shout in eating disorder patients

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INTRODUCTION

- Eating disorders have a high prevalence in young females.  
- Anorexia Nervosa has the highest mortality rate of all mental disorders.  
- Patients with eating disorders show difficulties with emotion regulation --- anger and aggression in specific,2,3,4  
- Anger presence and pervasiveness should be addressed in assessment 5,6 and body oriented treatment.7  
- Self-report measures are limited by response biases, f.e. social desirability & lack of body consciousness in ED. 5,6  
- The new Method of Stamp Strike Shout (MSSS) uses force production as behavioral measure of anger and aggression regulation.8  
- The MSSS can be used in addition to subjective measurements.8

METHODS

The MSSS measured the increase and decrease of force production in
1) Stamping on a force plate
2) Striking a boxing bag instrumented with accelerometer
3) Shouting into a microphone
A four-step force pyramid of 25 – 50 – 75 – 100 – 75 – 50 - 25% of their maximum force is produced.
Performance was compared to anger coping style, as measured with the Self-Expression and Control Scale (SECS).
This study examined the first associations between the test results of a clinical sample.

RESULTS

Patients (n=7) with eating disorders were compared to matched controls (n=21) and general reference sample (n=56).

Patients scored higher on the internalization of anger as measured by the SECS (Patients 30.7 ± 6.0; Matched controls 22.3 ± 4.5).
The results of the stamp, strike and shout subtest can be found in the figures.

- Stamp: both patients and matched controls show similar force productions.
- Strike: patient sample shows a different shape of the force pyramid.
- Shout: appears to be most distinctive between patients and controls. Patients produce less vocal force.

→ Found SECS internalizing anger as significant predictor of the shout sum score.
→ Significant interaction between internalizing anger and group (patient/controls) in the shout subtest.

CONCLUSION

1. Trend of the shout subtest’s ability to distinguish between groups or coping style.
2. In line with previous test results in a student sample.8
3. The anger-performance relation in eating disorder patients is complex and should be carefully re-examined in a much larger sample with sufficient power, before conclusions can be made.

REFERENCES

Assessment of Muscle activation of Caregivers Performing Dependent Transfers with a Novel Robotic Assisted Transfer Device Compared to the Hoyer Advance

Objective: Caregivers performing dependent wheelchair transfers are at a high risk for low back and shoulder pain. A novel robot assistive transfer device, called Strong Arm, was developed to alleviate caregiver strain. The purpose of this study was to assess the necessary muscle activity in caregiver while using a Strong Arm compared to a clinical standard of care (Hoyer Advance).

Design: Cross-sectional comparison study. Setting: Laboratory testing in a controlled setting simulating three common transfer surfaces. Participants: Twenty caregivers (5 men, 15 women, 33 ±15 years old). Main Outcome Measures: transfer completion time in seconds, peak percentage surface electromyography (EMG) (%Maximum voluntary contraction (MVC)) and integrated EMG (%MVCs) of the left and right erector spinae, latissimus dorsi, pectoralis major and anterior deltoid at three different transfer situations. Interventions: Novel Robotic Transfer Device. Results: Caregivers required significantly less transfer time when transferring from wheelchair to surface using the Hoyer Advance (p=.011). However, significant lower EMG values using Strong Arm were found in 15/32 (47%) of the measured muscles situations, while 4/32 (12.5%) favoured the Hoyer Advance. Overall, caregivers were found to have lower EMG activity in the left and right erector spinae, latissimus dorsi and pectoralis major using Strong Arm during placement phases and transfers from and to the accessible toilet. Conclusion: In general, lower peak and integrated muscle activation were found in the back and shoulder muscles in caregivers using the Strong Arm. This provides evidence that Strong Arm has the potential to reduce risks for low back and shoulder pain in caregivers.

Key words: Moving and Lifting Patients, Electromyography, Back injuries, Self-Help Devices, Wheelchairs
Assessment of Muscle activation of Caregivers Performing Dependent Transfers with a Novel Robotic Assisted Transfer Device Compared to the Hoyer Advance

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INTRODUCTION
63.1% of caregivers develop low back pain while 37.8% develop shoulder pain. 43.4% of all developed musculoskeletal injuries in caregivers occur due to transfer related activities, including lifting (27.9%) or transferring a patient (15.5%). Mechanical lifts do not completely eliminate overexertion, awkward biomechanical positioning, space constraints, and transfer distance that are required to complete an assistive transfer.

The Strong Arm, a portable robotic transfer device, was designed on the premise of relieving transfer related ergonomic barriers. The Strong Arm can be attached to a powered wheelchair.

PURPOSE
Compare the muscle activation of caregivers performing dependent transfers using a novel robotic assistive transfer device (Strong Arm) and a clinical standard of care (Hoyer Advance).

METHODS
Design: Cross-sectional comparison study.
Participants: Twenty caregivers (15 female, 5 male, 33±15-year, experience with transfers 9±12-year).
Main Outcome Measures: Maximum voluntary contraction (MVC), Time, Peak (%MVC) and Integrated (%MVCs) percentage surface electromyography (EMG) of bilateral Erector Spinae, Latissimus Dorsi, Pectoralis Major and Anterior Deltoid.

Protocol: Caregivers performed 36 transfers (18 with Strong Arm, 18 with the Hoyer Advance) at three transfer stations with a 75kg rescue dummy.

Data Analysis: Each transfer split in three phases (Figure 1) 1. Lift 2. Transport 3. Placement

EMG data was post processed via custom MATLAB code with 4th order Butterworth bandpass and lowpass rectification. %MVCs and %MVCs were found in 15/32 using Strong Arm. Placement showed significantly lower EMG in 16/32 transfer situations using Strong Arm. Significant lower standard deviations using Strong Arm.

RESULTS
In general, lower peak and integrated muscle activation was found in the back and shoulder muscles when caregivers conducted transfers using the Strong Arm compared to the Hoyer Advance. Future Research: Modifications to the Strong Arm based on the study results will be made to further assist the caregivers performing transfers.

REFERENCES

CONCLUSION

In general, lower peak and integrated muscle activation was found in the back and shoulder muscles when caregivers conducted transfers using the Strong Arm compared to the Hoyer Advance. Future Research: Modifications to the Strong Arm based on the study results will be made to further assist the caregivers performing transfers.

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**Poster Abstract**

Siblings may have a substantial effect on the development of executive functioning (EF) and motor skills of a child, due to the large amount of interactions siblings have with the child. Furthermore, some evidence suggests that EF and motor performance are related, although the exact nature of this relationship is not clear yet. Since both EF and motor skills develop rapidly during the preschool years, it is important to identify risk- or enabling factors such as the presence or absence of siblings, so that children at risk can be recognized and monitored. Therefore, the aims of this study were to investigate the relationships between the presence of siblings on the one hand and performance-based EF and motor skills on the other hand and to further elucidate the relationship between EF and motor skills. The sample consisted of 174 3- to 5-year old children (53.4% boys), who performed the Movement Assessment Battery for Children-2 (MABC-2) and five performance-based EF tasks measuring inhibition and working memory. In addition, information regarding ADHD symptomatology, IQ, socioeconomic status and siblings was gathered. The hierarchical regression analyses performed, revealed a nearly significant relationship between being a middle child and working memory ($\beta = 0.36, p = .054$) and between manual dexterity and inhibition ($\beta = 0.20, p = .074$). This study shows that at least some domains of EF performance, motor performance and the presence of siblings are related. Future studies should further elucidate these relationships by including additional sibling variables such as gender, EF proficiency, and motor proficiency of the siblings and the quality of the sibling relationship.
The relationships between siblings, executive functioning and motor skills

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INTRODUCTION

Siblings may have a substantial influence on the development of 3-5 year old children. They can positively: acting as models and providing a safe environment to practice\(^1,2\), or negatively: competing for parent’s time and care (dilution of parental resources theory)\(^3,4\). Some evidence suggests that executive functioning (EF) and motor performance are related. For example, neuroimaging research has shown the same brain areas to be activated during both EF and motor tasks\(^4\). However, the exact nature of this relationship is not clear yet.

Aims

To examine the relationship between the presence of siblings on the one hand and performance-based EF and motor performance on the other hand and to further elucidate the relationship between performance-based EF and motor performance.

METHODS

- This study was part of a larger longitudinal study, called the MELLE project.
- Sample: 174 children (53.4% boys) with a mean age of 50.0 months.
- Hierarchical regression analyses were performed to investigate the research questions while controlling for the confounding variables.

RESULTS

Executive functioning

5 tasks measuring:
- Inhibition
- Working memory

Motor skills

Movement Assessment Battery for Children-2
- Manual dexterity
- Aiming and catching
- Balance

Siblings

- Number of siblings
- Age difference
- Birth order position (youngest, middle, oldest, twin or only child)

Confounding variables

Age, gender, ADHD, symptomatology, IQ, and socio-economic status (SES)

Confounders included:

- Age, gender, ADHD, symptomatology, IQ, and socio-economic status (SES)

Results:

Middle children have more siblings close in age. Social learning theory states that similarity between individuals strengthens imitation\(^5\).

Approached significance

(\(\beta = 0.36, p = .054\))

No significant relationships

Working memory

Inhibition

Executive functioning

- Meeting other peers to imitate at school/day-care diminishes positive influence of siblings\(^6\)
- High SES of sample diminishes negative influence of siblings\(^4\)

Manual dexterity has a high cognitive demand and may thus be related to higher cognitive skills such as EF\(^7\).

Approached significance

(\(\beta = 0.20, p = .074\))

No significant relationships

Non-linear development in young children, diverting all energy toward improving one skill while temporarily ignoring others, may prohibit finding cross-sectional relationships\(^6\).

No significant relationships

CONCLUSION

- At least some domains of EF performance, motor performance and siblings are related.
- Future research should further elucidate these relationships by including additional sibling variables such as gender, EF proficiency, and motor proficiency of the siblings.

REFERENCES

Abstract of: The feasibility of a home-based exergame balance training and effect on motor performance in early onset ataxia
A pilot feasibility study

Abstract

Children with Early Onset Ataxia (EOA) experience impaired coordination of voluntary movements due to damage of the cerebellum and its associated pathways. Although interventions using exergames are becoming more prominent to improve balance and health outcomes, the effectiveness of home-based exergame interventions is not widely reported. The aims of this study were to investigate the feasibility of a home-based ice-skating exergame training of six weeks in children with EOA and in age-matched healthy control children and to investigate the effects on motor performance.

In the current pilot study, five EOA patients and six healthy controls (aged 4-12, mean 8.1 ± 2.4 years) participated in the study, playing half an hour per day, three times per week, for six weeks. Feasibility was evaluated using logbook data from the ice-skating exergame, an enjoyment scale taken at three and six weeks and a goal attainment score for the EOA participants, who filled in one or more goals prior to the intervention that they wanted to achieve by following the ice-skating exergame training. Motor performance was measured using the Scale for Assessment and Rating of Ataxia (SARA) and Paediatric Balance Scale (PBS) at pre- and post-measurements and movement analysis to assess dynamic postural control was measured during game play. Results showed that the prescribed intensity of playing the ice-skating exergame was not reached, but participants enjoyed the exergame and patients showed improvements in daily life, assessed with the goal attainment score. With respect to the effect of the exergame on motor performance, clinically relevant improvements in SARA and PBS were shown. The results of the movement analysis showed improvements in dynamic postural control over time. To conclude, a home-based exergame seems feasible in young children since it is fun to do and improvements in daily life and motor performance were found.
Introduction

Children with Early Onset Ataxia (EOA) experience impaired coordination of voluntary movements due to damage of the cerebellum and its associated pathways [1]. EOA is progressive and effects of therapy on reducing ataxic symptoms are limited. Exergames seem to have beneficial effects on ataxia and on functional outcomes in children and adults with ataxia [2-4].

Objective: to evaluate the effects of a home-based exergame intervention on motor performance in children with EOA.

Methods

In total, five patients (three boys) and six controls (three boys) followed the ice-skating exergame intervention (age 4-12, mean 8.1±2.4 years) at home. A minicomputer and Kinect were connected to their television screen, see Figure 1 for the set-up. Participants played the game for six weeks, half an hour per day, for three days per week. Participants were measured before and after the intervention on the Scale for Assessment Rating of Ataxia (SARA) and Paediatric Balance Scale (PBS) at the hospital. These tests were video recorded and later qualitatively scored by two experienced assessors. Written consent was obtained from one of the parents for every participant.

Results

Results of the SARA scores, SARA gait & posture subscale and PBS are shown in Table 1 and Figure 2. In Table 1, clinically relevant improvements are highlighted with a red box. The graphs show the difference between the two groups and improvements in motor performance. Lower SARA scores and higher PBS score indicate better motor performance.

Table 1. Motor performance of the SARA, SARA gait & posture subscale and PBS.

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<th>SARA gait &amp; posture M1</th>
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Abbreviations. PP = Participant; M1 = Pre-test; M2 = Post-test; d = difference between M1 and M2.

Figure 2. Results of SARA, SARA gait & posture and PBS scores.

Discussion

The results showed that respectively, two, three and four out of five EOA patients had clinically relevant improvements on SARA score, SARA gait & posture sub score and PBS score after six weeks of playing. The youngest control showed clinically relevant improvements on SARA scores, suggesting an influence of motor learning on age. A larger sample size would increase power to do statistical analyses to further evaluate these effects. In addition, a follow-up measure should investigate long-term effects.

Conclusion

Most EOA patients showed clinically relevant improvements on two different motor performance scales, SARA and PBS. These results indicate that a home-based exergame training improves motor performance in children with EOA.

References

The influence of an enriched environment on patient activity on a nephrology ward

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28 May 2019

Abstract
Aim: To explore patient activity on a nephrology ward and investigate the effect of an enriched environment on the patients’ (a) physical activity, (b) time spent out of bed and in their own room and (c) time spent alone. Background: Physical activity has significant physical health benefits and may contribute to prevention of the adverse effects of bedrest. Research suggests that hospital patients spend half of their awake time in bed. An enriched environment positively affects the activity of patients. Method: Behavioural mapping was used to record, activity, social interaction and location of independently ambulating patients that stayed at the nephrology ward during observation times before (n=15) and after (n=15) environmental modifications. The modifications consisted of placing exercise bikes and visual art. Results: Patients spend most of their time in minimal to low activity (before, 85.33%; after, 78.96%), when out of bed, in their own room (before, 31.41%; after, 33.34%), and alone (before, 66.79%; after, 62.54%). Contrary to our expectation, this environmental modification did not significantly increase the time in physical activity. It did not encourage spending time outside the room or bed and did not decrease the time spent alone. Conclusions: This study provided a relevant description of patient activity on a nephrology ward. The lack of significant differences in outcomes before and after the redesign tentatively suggests that the implemented environmental modifications were not enough to positively persuade patients to become more active. Staff support may be instrumental to promote physical activity in hospital settings.
The influence of an enriched environment on patient activity on a nephrology ward

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AIM

To explore the patient activity on a nephrology ward and investigate the effect of an enriched environment on the patients’ (a) physical activity, (b) time in spend out of bed and in their own room and (c) time spend alone.

BACKGROUND

• Hospital patients spend half of their awake time in bed
• Bed rest may harm patient outcomes
• An enriched environment positively influences patient activity in stroke patients but an enriched environment may also promote activity in patients with other diseases
• Is placing exercise bikes with Virtual Reality screens in the communal area and visual in the corridors enough environmental enrichment to positively persuade ambulating nephrology patients in an acute care setting to become active?

Methods

• Behavioural mapping was used to observe patients before and after environmental design changes (see figure 1)
• Patients were observed between 08.30 a.m. – 1.00 p.m. or between 1.30 p.m. – 6.00 p.m. for six weeks during three weekdays
• Percentages of time spent in level of activity, location and social interaction were calculated

RESULTS

• 30 patients with nephrology related diseases were included in the study before (n = 15) and after (n = 15) the environmental modifications
• Patients spend most of their time in low and minimal activity, physical activity did not significantly increase over time (p = 0.18) (see figure 2A)
• When patients were out of bed they spent most of their time in their own room (see figure 2B). Time spent out of bed and in the patients’ own room was not significantly reduced after the environmental modification (p = 0.49)
• Patients spend most of their time alone (see figure 2C), this was not significantly decreased after the environmental modifications (p = 0.37)

CONCLUSION

This study provided a rich and relevant description of patient activity on a nephrology ward. The lack of significant differences in outcomes before and after the redesign tentatively suggests that the implemented environmental modifications were not enough to positively persuade patients to become more active. Staff support may be instrumental to promote physical activity in hospital settings.

REFERENCES

Abstract

Movement variability at the joint level can be twofold. There are variable joint-angle combinations that affect the movement outcome (task-relevant variability in joint-angles) and do not affect the movement outcome (task-irrelevant variability). Whereas recent studies tested how these two types of variability relate to motor learning, none have manipulated the number of joints involved in movement control. Since the number of joints (i.e. the extent of redundancy) should theoretically affect joint-angle variability and therefore motor learning, we investigated how constraining joint redundancy affects motor learning rates. Therefore, thirteen participants performed reaching movements over one experimental session. First, baseline variability was obtained. During the training session, participants were perturbed by attaching a weight to their forearm to change reaching kinematics. Participants in the experimental condition were restricted in wrist movement through a wrist brace, participants in the control condition were not. All participants performed 6 blocks of 30 reaching during training. We compared motor learning rates between the experimental and the control group while controlling for baseline variability as well as correlated baseline variability with motor learning rates. We hypothesized a positive relationship between baseline variability and motor learning rates. Also, we hypothesized that participants that could use more joints (control group) would learn faster, and that this effect interacted with baseline variability. The results disconfirmed all hypothesized effects, possibly because our experimental manipulation did not effectively change joint-angle coordinative patterns between groups. Future studies should employ different experimental manipulations to investigate the relationship between joint redundancy and motor learning.

Keywords: joint redundancy, exploration, motor learning
Does using more joint-angles make people learn faster? Effects of constraining redundancy

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INTRODUCTION

Two recent studies (Singh et al., 2016 & Cardis et al., 2018) investigated the relationship between task-relevant and task-irrelevant variability (cf. Latash, 2007) and motor learning. However, the experimental designs differed in the number of joint-angles that controlled movement, which should affect these two types of variability and therefore motor learning.

Aim: To test the effects of restricting joint-angles on motor learning rates

Hypothesis: Being able to use more joint-angles leads to faster motor learning, i.e. higher motor learning rates.

Methods

Seven male and six female students participated in one experimental session.

To test motor learning effects, participants performed reaching movements which were perturbed (Singh, 2016) using a weight brace.

In the experimental group, we restricted joint-angles of the wrist using a wrist brace, whereas participants in the control condition were not restricted (Fig 1).

Motor learning rate was defined as the difference in end-effector error (cf. Valk et al., 2016) between the beginning and end of the training session.

Motor learning rates for both groups were compared.

To test for the effects of our experimental manipulation, we compared end-effector kinematics (Valk, 2016) and joint-angle ranges between groups.

There were no differences in motor learning rates between groups, $F(1,6) = 0.70, p = .43, n^2_p = .10$, see Figure 2.

Additional analysis of the differences in end-effector kinematics (peak velocity, deceleration time, acceleration time, movement time, horizontal and vertical curvature) between groups showed no differences for any of the measures, all $p > .05$. Comparing the total range for each joint-angle during training (range between maximum flexion and maximum extension) showed no differences between groups, all $p > 0.5$.

Discussion

Contrary to our hypothesis, the number of joint-angles was not related to motor learning rates. Several potential reasons might explain why no effect was observed: First, not all participants showed motor learning (i.e. decrements in error), potentially due to a) physical fatigue and or b) the size of our target confounding the accuracy of our error measure, which is generally quite low in comparable experiments (Valk et. al., 2016). Comparisons of end-effector kinematics between groups (no differences) might indicate that our manipulation did not change joint-coordinative patterns between groups. Comparison of total range of joint-angles (no differences) confirmed this assumption, indicating that the total range of movement in the joint-angles of the wrist was generally quite low in our experiment, which might explain no differences.

CONCLUSION

Administering a wrist brace did not effectively change joint-angle coordinative patterns in a reaching task. Whether the number of joint-angles relates to motor learning rates should be re-examined using a different experimental manipulation. Furthermore, the use active markers as well as a non error-based measure of motor learning rates might be more suitable to detect any possible effects.

References

Assessing the quality of upper limb behaviour in activities of daily living using wearable sensors

Student: Karolina Kulbytė (s3524353)
Supervisors: dr. R. M. Bongers, A. W. Franzke

**Poster abstract**

*Background.* This study investigates if the quality of upper limb behavior during activities of daily living can be evaluated using ambulatory measurement of one acceleration signal obtained during daily life. *Methods.* The signals obtained with accelerometer during 6-hour daily life activities in two (free and splinted wrist) conditions are analysed using detrended fluctuation analysis (DFA) and various entropy measures. *Results.* DFA was able to distinguish between the wrist conditions; entropy measures showed no difference. All analyses showed different values compared to previous research. *Discussion.* Such outcomes could have resulted from the structure of the analysed signals – they contained relatively many rest periods. *Conclusions.* With further research, non-linear methods could potentially be applied in evaluating upper limb behaviour during daily life, however, a lot attention should be drawn to signal collection.
Assessing the quality of upper limb behaviour in activities of daily living using wearable sensors

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INTRODUCTION
• In the presence of impairments, UL usage becomes less proficient, thus affecting quality of movements.
• To evaluate these effects the measurements should be taken in real-life environment during activities of daily living (ADL).
• Possibility – analyse UL acceleration signals using non-linear tools (detrended fluctuation analysis (DFA) and entropy measures).

Aim: to investigate whether the quality of UL behaviour in ADL can be evaluated using ambulatory measurement of one acceleration signal obtained during daily life

Research question: are the long-term correlations (indicated by DFA) and predictability (revealed through entropy measures) of the signal different between acceleration signals obtained during splinted and free wrist conditions?

Hypothesis: DFA analysis will yield a smaller value and entropy analyses will give higher score for free wrist signals, showing that they are less regular than splinted wrist signals.

METHODS
• 20 able-bodied people, measured in two conditions
• To simulate upper limb impairment (unhealthy conditions), able-bodied people wore a wrist splint (Fig. 1).
• An accelerometer was worn for 6 hours during ADL.
• Only active parts of the signals were taken for the analysis.

Signals were analysed using detrended fluctuation analysis, approximate entropy, sample entropy and multiscale sample entropy.

Fig. 1. Measurement set up for splinted wrist condition

RESULTS
• DFA was able to distinguish between the wrist conditions (p<0.05).
• The scores for approximate entropy and sample entropy analyses were not different between the wrist conditions.
• In multiscale sample entropy the steepness of the linear trend fitted through the data (Fig. 2) was not significantly different between the wrist conditions.

Fig. 2 Example plot (r=0.1*std(data), m=15) of Multiscale Sample Entropy results with fitted lines

CONCLUSION
DFA showed that splinted wrist signal had higher degree of long-term correlations in comparison with the free wrist signal. In addition, careful consideration is needed in terms of measuring – the signals should not contain too many rest periods, which make them more regular.

REFERENCES
1Carrey et al. (2008); 2Chadwell et al. (2018); 3Harbourne (2009); 4Ihlen (2012); 5Mell et al. (2005); 6Rhea (2014)
Abstract

Introduction: External forces perturb our motor actions while performing ADL leading to injuries and accidents. Motor skill automatization is believed to help us cope with these physical perturbations by making us more robust against them. In the current study it is investigated how practice conditions, specifically experienced task difficulty, influence visuomotor learning and resistance against unexpected force perturbations. Methods: Healthy young participants (N=20) learned to trace a star as fast and accurate as possible in easy and hard conditions determined by the star bandwidth. Before and after practice, performance (i.e. movement time, percentage of errors, normalized jerk) was measured during the tracing of a neutral star. To assess the robustness of performance we simulated a physical perturbation during the neutral star tracing task by introducing a sudden force field produced by the joystick participants used to perform the task. Results: Task difficulty affected the experienced cognitive load during practice as indicated by the NASA-TLX. No significant differences in motor acquisition and resistance against the perturbation were found between the easy and the hard group. Both groups improved performance with and without perturbation over time. Conclusions: Task difficulty during practice did not have a mediating role on motor learning and robustness against external force interference. Learning without (or less) errors seems equally effective as learning with errors. Both learning with and without (or less) error seems equally effective. It seems that the optimal challenge framework fails to explain how learning occurs. The learning processes should focus on how much information is processed by the learners instead of focusing how much information the task offers.

Keywords: Motor Learning, Task Automatization, Robustness Against Perturbation, Fine Motor-Task
The Effect of Learning at Different Task Difficulties on Resisting a Perturbation

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Purpose

To study the effect of task difficulty on motor task Automatization and Robustness
We expect the harder difficulty learning to produce more resistance against the perturbation

Methods

Baseline
Medium width
No Perturbed(NP) x 10
Perturbed x 5/20

Intervention
Easy or Hard width
NP 4x30

Post-test
Medium width
NP x 10
Perturbed(P) x 5/20

Retention
Medium width
No Perturbed x 10
Perturbed x 5/20

Results

1. No interaction between task difficulty and Robustness against a perturbation
2. The optimal challenge framework partly fails to explain how learning occurs
3. Future research: from info. the task offers to how info. much is processed

References

Abstract

Motor adaptation is defined as a change in motor performance following a change in task or environmental constraints, where motor performance is often described through changes in end-effector kinematics and where the end-goal of the adaptation is motor performance of a level similar to before the changes in constraints. We argue that, underlying these changes in end-effector kinematics, are changes in joint-angle synergies. To understand how changes in end-effector kinematics follow from changes in synergies, we employed a visuomotor rotation paradigm. To describe changes in end-effector kinematics we used the directional error, to assess synergistic organization of joint angles we used the UnControlled Manifold analysis and to assess changes in joint angle synergies we compared joint angle configurations that were used during visuomotor rotation trials to clusters of joint angle configurations that were used during baseline trials, where no visuomotor rotation was present. We found that the reduction in directional error during learning to adapt to a visuomotor rotation was gradual and that joint angles were organized synergistically during all experimental conditions. Joint angle configurations that were used during visuomotor rotation trials differed from the clusters of joint angle configurations that were used during the baseline, implying that new synergies emerged. Furthermore, we found that the gradual change at the level of the end-effector kinematics does not map one-to-one to the emergence of a new synergy. This suggests that motor adaptation manifests itself at joint-angle synergy level in two steps: (1) the change in constraints following the introduction of a visuomotor rotation condition lead to the emergence of a new synergy and (2) the changed interaction of constraints following the introduction of a visuomotor rotation confine the newly emerged synergy to produce the gradual change that can be observed at the level of the end-effector.

**Keywords:** synergies, dynamical systems, adaptation, kinematics, UCM, visuomotor rotation.
The Changes at Joint-Angle Synergy Level That Underlie Changes in End-Effector Kinematics During Motor Adaptation

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INTRODUCTION

- Motor adaptation is the process of reducing systematic motor performance errors that follow from changes in task or environmental constraints.
- Adaptation has previously been described through changes in end-effector kinematics.
- End-effector kinematics are the result of coordination of joint angles.
- Joint angles are organized into synergies during reaching movements, which were used in this study.
- Joint-angle synergies are likely to change following changes in constraints.
- AIM: To add to the understanding of the phenomenon of motor adaptation by not just examining motor performance in terms of end-effector kinematics, but by also focussing on the changes in joint angle synergies during adaptation.
- RQ: How do changes at the level of the end-effector kinematics during motor adaptation follow from changes at the synergy level?

Methods

- 12 able-bodied adults (22±2 yrs) performed a visuomotor rotation task where they controlled a cursor on a screen by moving a stylus on a graphics tablet.
- During visuomotor rotation trials, a rightwards movement of the stylus moves the cursor to the upper-right corner of the screen.

Analysis

(1) Motor adaptation at end-effector level?
(2) Synergic organization of joint angles?
(3) Motor adaptation at synergy level?
(4) Similar patterns of change?

Change in directional error of end-effector
UCM analysis
Analysis of clusters of joint angle configurations

Use exponential functions to describe changes at both levels and compare function parameters

Results

(1) Motor adaptation at end-effector level: exponential decrease in directional error over repetitions of the task. Exponential function provided good fit to directional error averaged over participants (R² = .88).

(2) VUCM>VORT for all conditions and all phases of the movements, indicating that joint angles were organized in synergies.

(3) Motor adaptation at synergy level: joint angle synergies that were used during visuomotor rotation trials (yellow-red) differed from the joint angle synergies that were used during the baseline (95% confidence interval of baseline joint angle synergies indicated by blue lines). We interpret this finding as the emergence of a new synergy during learning to adapt to a visuomotor rotation.

(4) Change at joint configuration level could not be described with exponential function due to poor fit (R² = 47 for UCM projection lengths and R² = 17 for ORT projection lengths). So, the gradual change at the level of end-effector kinematics does not map one-to-one to the emergence of a new synergy.

Discussion

Kay’s two-step framework provides a possible dynamical systems explanation for our findings:
1. Constraints act on joint angles to coordinate them into a synergy
2. Constraints confine the synergy to produce the actual behaviour

This framework allows for different patterns of change at the end-effector and at the joint-angle synergy level

CONCLUSION

A new synergy emerged during learning to adapt to a visuomotor rotation, but the gradual change at the level of the end-effector kinematics does not map one-to-one to the emergence of a new synergy. Rather, the changed interaction of constraints following the visuomotor rotation confines the newly emerged synergy to produce the gradual change that can be observed at the level of the end-effector.

References

1: Shmuelof et al., 2012; 2: e.g. Mattos et al., 2011, Valk, Mouton & Bongers (2016); 3: Newell & Vaillancourt (2001); 4: Kay (1988)
Title: The relation between the Preoperative Physical Functioning and the Functional Recovery in patients undergoing a liver or pancreatic resection

Background: The relation between the preoperative physical functioning and clinical outcomes after major abdominal surgery is relatively well established. However, these clinical outcomes are not a good measure for functional recovery as they are influenced by several non-clinical factors. Therefore, the aim of this study was to explore the relation between the preoperative physical functioning and the postoperative functional recovery.

Method: Patients who underwent a major curative resection for a liver or pancreatic malignancy were included in the study. Preoperative the 6 minute walk test (6MWT) and timed up and go test (TUG) were performed to assess the preoperative functional status. Postoperative functional recovery was followed from the medical records and was defined as the first day patients had been able to tolerate solid food, mobilize and had defecation. Length of stay (LoS) was a secondary outcome measure. Factors relating significantly on the univariate multiple regression analysis were used in the multiple linear regression analysis.

Results: Thirty-four patients were included in the analyses. The 6MWT and TUG did not relate significantly to the functional recovery in the multivariate analysis. Having a laparoscopic or robot surgery related on the postoperative functional recovery and resulted in a shorter duration to functional recovery. Considering the LoS stay, having a laparoscopic or robot surgery and walking a lower percentage of the predicted distance on the 6 minute walk test also resulted in a shorter LoS.

Conclusion: A higher score on the 6MWT and timed up and TUG was not related to a better functional recovery. Scores on the TUG were low compared to the previous found cut-off point of 20 seconds, and thus the TUG might not be suitable for this population. A larger study sample is needed to establish the possibility of the 6MWT to predict the functional recovery.
The relation between the **Preoperative Physical Functioning** and the **Functional Recovery** in patients undergoing a liver or pancreatic resection

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**CONCLUSION**
- Surprising is that walking more of the predicted distance leads to a longer hospital stay, this is due to 2 outliers. A bigger sample size would mediate the effects of individual data points.
- A larger population is needed to find out whether the 6MWT can predict functional recovery.
- The TUG seemed not suitable predicting the functional recovery in this population.

**References**
Abstract. Lowering cognitive demand of a motor task by means of automatizing it, can influence the impact of an external interference on the performance of the respective motor task. Current research does not give a straight conclusion as to whether older adults are still able to successfully learn a new task to the level of automatizing it, such that they become more resistant against external interferences. In the current study, healthy younger (n=20) and older (n=15) righthanded adults learned to perform a tracing task. Before and after learning the task, participants were exposed to an external interference in the form of a force field. Older adults improved their resistance against the external interference. In addition, older adults improved performance at a similar rate as younger adults. However, older adults performed worse in terms of movement time and resistance against the external interference compared to younger adults. It is suggested that older adults might be able to improve their resistance against external interferences to a similar level as younger adults, provided they practice for a longer time period than the two-day period in the current study.
The Effect of Age on the Ability to Automatize a Fine Motor Task

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Introduction

Stages of Learning

- Cognitive
- Associative
- Autonomous

Effect of Age

- Automatizing motor tasks may increase resistance against external interferences2.
- Goal: To examine the hypothesis that older adults are able to increase resistance against an external interference.

Methods

Study Design

- 20 younger (age: 22.5 ± 2.48) and 15 older (age: 72.7 ± 7.07) righthanded adults

Data Processing

- Collected Data: Positional Data, Velocity Data
- Outcome Measures: Mean Movement Time per Trial (MT), Error Percentage, Log Dimensionless Jerk (LDLJ)

Task

- Day 1: Pre – Test 10+20 Trials, Learning Block 1 30 Trials, Learning Block 2 30 Trials, Learning Block 3 30 Trials, Learning Block 4 30 Trials, Post – Test 10+20 Trials
- Day 2: Learning Retention 30 Trials, Retention Test 10+20 Trials

Results

Unperturbed Trials

- Learning effect on Movement Time
- Fig 1 Distribution of 2 outcome variables of unperturbed trials for pre-, post- and retention test. Long bars represent mean values, short bars represent SD (*indicates significant difference between means at α = 0.05). A) Learning effect on Movement Time, B) Learning effect on LDLJ

- Main Effect of Time: Mean Movement Time per Trial ($F_{1.30}, 4.45 = 117.6, p<0.001$)
- Percentage of Error ($F_{1.30}, 4.45 = 6.15, p<0.05$)
- LDLJ ($F_{1.30}, 36.3 = 5.18, p<0.05$)

Perturbed Trials

- Learning effect on Movement Time
- Fig 2 Distribution of 2 outcome variables of perturbed trials for pre-, post- and retention test. Long bars represent mean values, short bars represent SD (*indicates significant difference between means at α = 0.05). A) Learning effect on Movement Time, B) Learning effect on LDLJ

- Main Effect of Time: Mean Movement Time per Trial ($F_{1.30}, 4.45 = 117.6, p<0.001$)
- Percentage of Error ($F_{1.30}, 4.45 = 6.15, p<0.05$)
- LDLJ ($F_{1.30}, 36.3 = 5.18, p<0.05$)

Conclusion

1. Older adults increase resistance against external interference.
   Older adults improved movement smoothness after learning.

2. Older adults performed worse compared to younger adults.
   Corresponding to previous research into motor learning and ageing4,5

3. Older adults improve at a similar rate as younger adults.
   Older adults may become equally resistant to external interferences as younger adults.

References

Abstract

Background: Individuals post-stroke often have difficulties with walking. Muscle weakness is one of the main factors slowing down recovery and results among others in decreased leg flexion during the swing phase. The use of a unilaterally applied resistance during the swing phase might be a way to improve locomotor function. In order for training to be effective it is important that patients are able to learn from it. Therefore, adaptation to a unilateral swing resistance during treadmill walking was assessed.

Methods: Fourteen healthy participants walked on a motorized treadmill, with and without a unilateral resistance. First, there was a 5 minute baseline phase without resistance load, then unilateral resistance was applied for 10 minutes, and after that participants walked 5 minutes without resistance load. The unilateral resistance was applied using a custom-built pulley system with weight at its end. Position data and ground reaction forces were used to make comparisons between experimental phases (late baseline, early adaptation, late adaptation, and early washout) for peak joint angles and gait phase durations.

Results: Differences between experimental phase were found for perturbed swing times, double support times, and peak knee flexion. The unilateral resistance led to increased swing times, and decreased double support times during early adaptation compared to late baseline. Furthermore, peak knee flexion angle of the perturbed leg decreased when the unilateral resistance was applied. However, during adaptation the peak knee flexion angle gradually increased, but still less flexion than during late baseline. For both peak angles and gait phase durations, there were no aftereffects.

Conclusions: This was the first study to bilaterally assess the effects of a unilateral swing resistance, applied by a pulley system, in all joint angles of the lower extremity. No aftereffects were induced by the unilateral resistance. This suggests that applying a unilateral resistance may not be useful for clinical gait training. However, our results conflicted with previous studies and more research is needed to exploit possibilities of applying a unilateral resistance with a pulley system.
A study on lower limb kinematics during adaptation to a unilateral swing resistance

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Introduction
• A main goal in the rehabilitation of stroke patients is improvement in walking.[1]
• Training in a task-specific context is beneficial to facilitate transfer to daily life activities.[2]
• Applying a unilateral resistance during treadmill walking may have potential for rehabilitation of stroke patients.

Aim: To examine limb kinematics during adaptation to a unilateral applied resistance during the swing phase.

Methods
• Participants: 14 healthy participants (4 male, 22.5 ± 2.5 years, 1.75 ± 0.09 meter, 68.1 ± 9.5 kg).
• Protocol: Participants walked on a treadmill in three consecutive conditions: baseline (5 min), adaptation (10 min), and washout (5 min). Baseline and washout both consisted of 5 minutes walking without perturbation.

During adaptation, gait resistance was applied using a custom-built pulley system (see figure 1).

Results

Results gait phase durations
• Perturbed swing time increased when unilateral resistance was applied.
• The first double support phase decreased when the unilateral resistance was applied. During the adaptation phase there was an increase in double support time observed.
• The second double support phase decreased between late baseline and early adaptation.

Results joint angles
• Lower peak knee flexion during early adaptation compared to late baseline (fig. 3). An adaptive change was observed during the adaptation phase, peak knee flexion increased.
• No differences were found for the hip and ankle of the perturbed leg. Also, no differences were found for the unperturbed leg.

Conclusion
The unilateral resistance induces initial effects and adaptation, but no aftereffects. More research is needed to establish if a unilateral resistance applied by a pulley system may be a useful addition to clinical gait training.

References
The effect of tyre pressure on the wheelchair mobility performance of elite wheelchair tennis players

Running title: Tyre pressure in wheelchair tennis

Abstract

The purpose of the current study was to study 1) the effect of tyre pressure on the rolling resistance and 2) wheelchair mobility performance of elite wheelchair tennis players. Seven highly trained wheelchair tennis players, using their own tennis wheelchair and racket, completed multiple coast down tests, 10m Sprint tests and Butterfly Sprint tests on a hardcourt surface. All tests were conducted at five different tyre pressures, ranging from -30% till +10% of the recommended pressure. During the whole test protocol three Inertial Measurement Units (IMUs) were attached to both wheels and frame of the athlete’s wheelchair. The IMUs enabled analyses of decelerations for the coast down trials, linear velocity/accelerations for the 10m Sprint and rotational velocity/acceleration for the Butterfly Sprint. Coast down testing showed a lower rolling resistance with a higher tyre pressure \( (F(4,3) = 44.63, P < 0.001) \). Rolling resistances ranged from 6.37 (0.74) N for the lowest pressure (-30%) level till 5.61 (0.70) N for the highest pressure (+10%) level. Post hoc analysis revealed differences among all tyre pressure levels, except for -10% vs. -20% of the recommended pressure. Yet, no effects of the different tyre pressures were found on both the 10m Sprint and the Butterfly Sprint test. It can be concluded that there is an influence of tyre pressure on the rolling resistance, but an effect on the linear sprinting and turning performances, i.e., wheelchair mobility performance, was not found in the current study.

Keywords: Rolling resistance, sprinting, turning, inertial measurement units, coast down test
The effect of tyre pressure on the wheelchair mobility performance of elite wheelchair tennis players
Rietveld Thomas¹,²

INTRO
• Wheelchair tennis on Wimbledon and Rolland Garros
• A lot of research on tyre pressure with daily life wheelchairs
• Tyre pressure is one of the most important aspects to monitor

METHODS
1. 7 highly trained participants
2. Coast down test (deceleration)
3. Inertial measurement units (IMUs) (gyroscope and accelerometer) on each wheel and frame (figure 1)
4. Five different tyre pressures (-30% till +10% recommended pressure)
5. 10m Sprint & Butterfly-Sprint test, (rotational) acceleration/velocity using IMUs (figure 2)
6. Data analysis MATLAB
7. Repeated measures ANOVA

RESULTS
• Higher pressure → lower rolling resistance (Figure 3) (F(4) = 44.63, P < 0.001)
• No differences on 10m Sprint & Butterfly Sprint test

DISCUSSION
• Players still need to produce more power with lower pressure
• Longer test duration needed
• Different surfaces and tyres

Figure 1: Placement IMUs, wheel (Left), Frame (Right)

Figure 2: 10m Sprint (Left), Butterfly-Sprint (Right)

Figure 3: Mean rolling resistance for all participants with the various tyre pressures, P = Participant, m = Total weight of wheelchair-user combination

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Scan the QR code to connect with me on LinkedIn
Abstract MGP Thomas le Rütte
May 2019

Is a newly designed push-pull lever propulsion system a feasible wheelchair alternative? A pilot study.

Relevance
Hand-rim wheelchair (HRW) propulsion is a straining and mechanically inefficient mode of transportation, leading to high prevalence of upper limb injury. However, no better replacement has been developed for manual wheelchair users. Alternatives like handcycles and lever-propelled wheelchairs have been tested and showed to perform better or equal in physiological strain and mechanical efficiency.

Aim
To evaluate a newly designed push-pull lever propulsion system with a conventional handrim wheelchair on propulsion outcomes at low-intensity steady state exercise on a motor driven treadmill. Outcomes studied were propulsion pattern for the production of forward momentum, mechanical efficiency and peak force application.

Methods
Spread over five training sessions, twenty able-bodied participants performed 60 minutes of training in either a lever wheelchair (n=10) or a HRW (n=10). They were tested on gross mechanical efficiency, heart rate and peak forces applied to the hand-rim or the lever before and after the training protocol. Repeated measures ANOVA were performed, testing group effects, time effects and interaction effects. A paired t-test was used to compared pushing and pulling forces of lever propulsion.

Results
GME and HR were not found to be different between the lever wheelchair and the HRW. Peak propulsion force during HRW propulsion was found to be higher than both the peak pushing and pulling force in lever propulsion. Forces were found to be equally distributed between the pushing and pulling phase of lever propulsion.

Discussion
Combined with a more beneficial orientation of the upper limbs in lever propulsion compared to HRW propulsion, lower peak forces in lever propulsion seem to be promising in reducing prevalence of upper limb injuries. Studying joint loads and muscle activity could provide more insight in this matter.
Is a newly designed push-pull lever propulsion system a feasible wheelchair alternative? A pilot study.

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Introduction

Hand-rim wheelchair (HRW) propulsion is a straining and mechanically inefficient mode of transportation[1], leading to injuries. Handcycles and lever-propelled wheelchairs have been tested and showed to perform better or equal in physiological strain and mechanical efficiency[2]. Aim: To evaluate a newly developed lever propulsion wheelchair on mechanical efficiency and force application.

Methods

Spread over five training sessions, twenty able-bodied participants performed 60 minutes of training in either a lever wheelchair (figure 2) or a HRW. They were tested on gross mechanical efficiency (GME), heart rate (HR) and peak forces applied to the hand-rim or the lever before and after the training protocol (figure 1).

Results

- No difference between groups for HR and GME
- Lower peak force during lever propulsion than during HRW propulsion
- Equal pushing force to pulling force

Conclusion

Combined with a more beneficial orientation of the upper limbs compared to HRW propulsion, lower peak forces in lever propulsion seem to be promising in reducing prevalence of upper limb injuries.

References

Abstract
Cautious gait is a proactive locomotor control strategy, utilized to enhance dynamic balance against potential gait disturbances. Little is known about the development and utilization of proactive control in anticipation of, and with experience of slip perturbations. The purpose of the present study was threefold, (i) to assess proactive control in anticipation of a gait perturbation without prior slip experience, (ii) to assess the development and utilization of proactive control prior to slip perturbations, that vary in predictability and (iii) to assess proactive control during a wash-out period, when the perturbation is removed without the participant’s knowledge. Spatiotemporal step parameters and margins of stability (AP, ML) of twenty-seven healthy young adults (21.5 ± 2.7 years old) were measured. The results show that anticipation of a potential gait perturbation resulted in a generic proactive locomotor strategy. This strategy extinguished in the continuing absence of a gait perturbation. During repeated slip exposure, the development of proactive control was characterized by a dynamic process of adjustments, in which experience with unilaterally induced slips shaped the proactive control strategy. To effectively mitigate postural instability imposed by this specific task context, some proactive strategies became more dominant (e.g. asymmetric gait), whereas others were abandoned (e.g. increased m-l MOS). This was not different between experimental groups, indicating that the development of proactive control is not sensitive to the implicit structure in the perturbation sequence. During unannounced removal of the perturbations, proactive strategies were initially retained, but eventually extinguished. Overall this study shows that, anticipatory locomotor behaviour can be adopted without prior experience, but that perturbation experience is needed to shape the proactive strategy and gradually tune it to its properties.
Cautious gait is a proactive locomotor control strategy, employed to enhance balance against potential gait disturbances. This proactive strategy acts as an essential first line of defence against balance threats\(^1\). The exposure to slip perturbations in a experimental setting has been shown to improve dynamic stability and is therefore commonly used as a fall prevention training\(^2,3\). Since cautious gait, might serve as a potential first line of defence against possible perturbations, the development and utilization of this proactive control strategy warrants further study. The present study examined proactive control of stability in the following settings: (i) during perturbation anticipation, without prior slip experience, (ii) prior to slip-like perturbations, that either vary consistent, pseudo-or fully random in its intensity and (iii) during unannounced removal of the perturbations.

(2) Cautious gait strategies are tuned to perturbation type and side
Exposure to the perturbations resulted in cautious gait strategy specific for perturbation side and direction. Spatiotemporal step parameters of the non-perturbed leg were proactively increased, causing spatial and temporal asymmetric gait. Furthermore, (a-p) MOS of the perturbed leg decreased, to enhance stability against backward loss of balance. The development of cautious gait was not affected by the predictability of the slip duration.

(3) Cautious gait is initially retained during perturbation absence
The cautious gait strategy adopted during the perturbation phase, was initially retained during early wash-out, but extinguished in continuing absence of a perturbation. The necessity of walking cautiously might decrease as the fear of falling, due to prolonged perturbation absence, attenuates. No significant group differences were observed during early and late-wash-out.

Overall this study shows that, cautious gait can be adopted during perturbation awareness without prior experience. But this experience is needed to shape the cautious gait strategy and gradually tune it to the perturbation characteristics. Furthermore, the cautious gait strategy extinguishes in the prolonged absence of a perturbation, as the fear to fall attenuates.

References
Abstract

Purpose: The aim of this study was to compare physiological and biomechanical aspects of manual wheelchair propulsion in a group of able-bodied persons while propelling on a wheelchair ergometer, wheelchair treadmill and overground at matched power output.

Methods: A group of 19 able-bodied participants were included in the study. Participants underwent two training sessions before taking part in a measurement session that included propelling a wheelchair for 3x4 minutes on each of the different modalities. Physiological data and propulsion kinetics were recorded with a spirometer and OptiPush measurement wheel, respectively.

Results: A repeated measures multivariate analysis of variance showed no differences in power output or velocity between modalities (p=0.189). Two-way mixed, single measures, absolute agreement intra-class correlation (ICC) coefficients were calculated to compare the different modalities to one another. Good comparability (ICC > 0.85) was only found for comparisons of heart rate, the overground vs. ergometer and treadmill vs. ergometer comparisons for contact angle, and the overground vs. treadmill comparison for fraction of effective force.

Conclusion: Comparability was poor to moderate for most physiological and kinetic characteristics, with the exception of a few comparisons of heart rate, contact angle and fraction of effective force. Possible differences in physiological cost and propulsion kinetics exist in able-bodied persons when propelling overground, on a treadmill, or on an ergometer.

Keywords: Propulsion biomechanics, intra-class correlation, physiological cost, gross mechanical efficiency.
Physiological and kinetic comparison of overground, treadmill, and ergometer steady-state wheelchair propulsion

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INTRODUCTION
Treadmills and ergometers are widely used for rehabilitation, adapted sports, and research purposes, because of their various advantages over overground propulsion.¹ No clear consensus on the concurrent validity between these modalities and overground propulsion has yet been reached.²

The aim of this study was to compare physiological and kinetic characteristics between overground, treadmill, and ergometer propulsion. It is hypothesized that these characteristics are similar for all modalities provided that people deliver the same power output.

Participants: A group of nineteen able-bodied participants.

Tests: Two training sessions (10 min/modality) were followed by a measurement session (3x4 min/modality). Propulsion velocity was 1.11 m/s.

Power output: Conventional standardization methods (coast-down test, dragtest, pulley) were used to match power output on the treadmill and ergometer to overground propulsion.

Instrumentation: A spirometer was used to measure physiological characteristics; an OptiPush measurement wheel was used to collect propulsion kinetics.

Data analysis: The last minute of each four-minute block was used for analysis and was averaged for each modality. Intra-class correlation coefficients were calculated for comparisons between all modalities.

Table 1: Intra-class correlation (ICC) coefficients for all comparisons of the physiological and kinetic characteristics of manual wheelchair propulsion. ICC values lower than 0.7 were considered as poor, between 0.7 and 0.85 as moderate, and higher than 0.85 as good.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OG vs. TM</th>
<th>OG vs. WE</th>
<th>TM vs. WE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (bpm)</td>
<td>.883</td>
<td>.912</td>
<td>.875</td>
</tr>
<tr>
<td>Energy expenditure (W)</td>
<td>.658</td>
<td>.668</td>
<td>.755</td>
</tr>
<tr>
<td>Gross mechanical efficiency (%)</td>
<td>.754</td>
<td>.570</td>
<td>.547</td>
</tr>
<tr>
<td>Push time (s)</td>
<td>.812</td>
<td>.831</td>
<td>.811</td>
</tr>
<tr>
<td>Cycle time (s)</td>
<td>.847</td>
<td>.798</td>
<td>.706</td>
</tr>
<tr>
<td>Contact angle (rad)</td>
<td>.823</td>
<td>.868</td>
<td>.852</td>
</tr>
<tr>
<td>Peak force (N)</td>
<td>.782</td>
<td>.765</td>
<td>.710</td>
</tr>
<tr>
<td>Mean force (N)</td>
<td>.735</td>
<td>.780</td>
<td>.696</td>
</tr>
<tr>
<td>Fraction effective force (%)</td>
<td>.904</td>
<td>.709</td>
<td>.640</td>
</tr>
<tr>
<td>Power output (W)</td>
<td>.316</td>
<td>.614</td>
<td>.492</td>
</tr>
</tbody>
</table>

¹ n = 16 subjects
Bold values indicate good comparability between modalities.

CONCLUSION
Possible differences exist in physiological cost and propulsion technique when able-bodied persons propel a wheelchair overground, on a treadmill, or on an ergometer at similar power output and velocity. Future studies should match power output in a group of manual wheelchair users and look at physiological, kinetic, and kinematic differences between modalities.

References
¹ van der Woude et al. (2001), ² Chénier et al. (2018)
Abstract

**Background:** Dementia often goes together with mood related symptoms including symptoms of depression and anxiety. These symptoms affect patients' quality of life, heightens the caregiver burden and may lead to institutionalization. Physical exercise seems to be promising to improve mood since combined aerobic-strength exercise appeared beneficial for the mood of older people without dementia. This study investigated the effect of an aerobic and strength exercise program on mood in patients with dementia. Also, the mediating effect of global cognition in the exercise-mood relationship were examined.

**Methods:** 48 people with dementia (age 81 ± 7 years) visiting day care centers participated in a 24-week single blind RCT. The experimental group (N = 27) conducted walking and lower body strength exercises, three 30-minute sessions per week, 12 weeks with low intensity followed by 12 weeks with high intensity. The control group (N = 21) received an attentional program with the same frequency and duration. Assessment took place at pretest and after 12 and 24 weeks. Mood was assessed with the Rand-36 mental health subscale and global cognition with Mini-Mental State Examination (MMSE).

**Results:** Analysis of covariance did not show significant between group effects for mood for the total exercise period, low intensity period, and high intensity period. No significant correlations were found between changes in mood and changes in cognition.

**Conclusion:** We could not prove that a 24-weeks combined physical exercise program of aerobic and strength exercise has an effect on mood in patients with dementia. Finally, we did not find a relation between changes in global cognition and changes in mood after physical exercise. We recommend more research toward the effect of moderate to high strength exercise compared to treatment as usual control group in patients with dementia with the presence of a mood disorder.
**The effect of physical exercise on mood in patients with dementia and mediating effect of cognition**

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**INTRODUCTION**

- 11% to 90% patients with dementia experience neuropsychological symptoms (NPS).
- Mood related symptoms affects patients’ quality of life, heightens caregiver burden and may lead to institutionalization.
- Pharmacological and non-pharmacological didn’t succeed to improve mood related symptoms in patients with dementia.
- Physical exercise improves mood of older people without dementia.
- Physical exercise appears moderately effective to improve cognition in patients with dementia.
- Different studies observed an association between depression and decreased mood in older adults with and without dementia.

**RESEARCH QUESTIONS**

**RQ1**

What is the effect of an aerobic and strength exercise program on mood in patients with dementia? We expect a positive effect of physical exercise on mood.

**RQ2**

Is there a mediating effect of global cognition for the exercise-mood relationship? We expect a mediating effect of global cognition.

---

**METHODS**

**ALLOCATION**

<table>
<thead>
<tr>
<th>EXPERIMENTAL GROUP</th>
<th>CONTROL GROUP</th>
</tr>
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<tbody>
<tr>
<td>Aerobic exercise</td>
<td>Attentional individuial supervised program</td>
</tr>
<tr>
<td>Strength exercise</td>
<td></td>
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</table>

**INTERVENTION PERIOD**

**Experimental group (N = 27)**

- Low intensity exercise period: 12 weeks, 3 times per week, 30 min. sessions
- High intensity exercise period: 12 weeks, 3 times per week, 30 min. sessions

**Results**

- **RQ1**
  - **MEAN SCORE MOOD**
    - Baseline: 44.15
    - 12 weeks: 43.96
    - 24 weeks: 44.89

- **RQ2**
  - **CORRELATION LOW INTENSITY PERIOD**
    - Changes in mood and changes in global cognition showed no significant (p>0.05) correlation for both group during total intervention, low intensity period and high intensity period.

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**CONCLUSION**

- This study could not prove that 24-weeks combined physical exercise program has an effect on mood in patients with dementia.
- This study could not prove a mediating effect of global cognition in the mood-exercise relationship.
- It is recommended for future research to investigate the effect of a strength exercise program compared to a treatment as usual program in patients with dementia with the presence of a mood disorder.

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Synergies adapt flexibly to deal with a target switch
Maureen B.G. Wissing

The current study aims to understand coordination processes underlying adaptive behaviour by asking whether, and if so how, a target switch changes the synergy in which abundant degrees of freedom (DOF) are coordinated. We assumed that DOF are coordinated in a two-step process (Kay, 1988) whereby constraints: 1) act upon DOF resulting in the formation of a synergy, and 2) confine the synergy resulting in the end-effector movements. A target perturbation affects task constraints, therefore we studied whether changed constraints only confined the initial formed synergy differently (i.e., step 2) or formed a new synergy (i.e., step 1). Participants (N=12) performed discrete manual reaching movements toward a target (stationary target trials), after movement initiation the target could unexpectedly switch to a new location (switch trials). End-effector kinematics and joint angles were measured. The Uncontrolled Manifold analysis was used to assess co-variation in joint angles. To examine changes in the synergy, clusters of joint angle configurations at the beginning and end of switch trials were compared to those used in stationary target trials. Lastly, the timing of initial adjustments in the end-effector and the synergy following a target switch were compared. Results showed end-effector kinematic adjustments in switch trials. Joint angles showed primarily co-variation, indicating that DOF were synergistically organized. Clusters of joint angle configurations differed between stationary target and switch trials at movement termination, implying that the target switch evoked a change in the synergy. Finally, we found that in switch trials all participants, exhibited some trials where initial end-effector adjustments occurred before the initial change in synergy, whereas in other trials this was the other way around. The key finding was that a target switch, hence changed constraints, acted in the end always upon DOF resulting in the emerge of a new synergy. In about 70% of the trials end-effector adjustments followed from this new synergy. However, in about 30% of the trials changed constraints confined the initial formed synergy differently resulting in adjusted end-effector movements and after that a new synergy emerged. Together this implies that a synergy is flexible, and that this flexibility allows different routes for adaptive behaviour.
Synergies adapt flexibly to deal with a target switch

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Introduction

Aim: To examine coordinative processes underlying adaptive behaviour.

Research Question: Whether, and if so how, a target switch changes a synergy in which abundant degrees of freedom (DOF) are coordinated.

Hypotheses: A target switch, hence changed constraints could:
- confine the initial formed synergy differently,
- could act upon DOF resulting in the formation of a new synergy, which is further confined to produce the actual movements (Fig 1).

Methods

Participant: Twelve adults.

Task: Discrete manual reaching movements toward a target (stationary target trials) which after movement initiation could switch to a new location (switch trials) (Fig 2).

Data analysis:
1) End-effector kinematics.
2) Uncontrolled manifold method [2,3] to determine whether DOF were synergistically organized.
4) Timing of end-effector adjustments compared to adjustments in clustering of joint angle configurations, i.e. synergy adjustments.

Results

1) End-effector kinematics

2) Synergistic organization

3) Changes in the synergy

4) Timing of initial end-effector and synergy adjustments

Conclusion

To produce adaptive behaviour:
1) End-effector kinematics were adjusted,
2) DOF were organized in synergies,
3) In the end always a new synergy emerged,
4) End-effector adjustments were variably instantiated by the initial formed synergy or by a new synergy.

Altogether, this shows that the flexibility of a synergy allows different routes for adaptive behaviour.

References

Abstracts and posters
master's programme

Sport Sciences
Abstract
In order to correctly perceive the catchability of a ball, you must not only know if you are at the right path to the interception point but you also have to know something about your abilities to get there in time. Affordance-based control incorporates action boundaries to inform the actor about the catchability of a ball. The aim of the current research is to find an optical variable that describes lateral manual ball interception, that takes into account the action boundaries of the agent. In the experiment, 50 participants had to perform in an interception condition and a judgement condition. Virtual balls moving under an angle had to be intercepted with a physical slider. The results show that the order of performed conditions may have an influence on the ability to correctly perceive the catchability of lateral interception. Nulling the angular change is a proven interception strategy in previous studies. However, discrepancies in the set-up of the current experiment may cause the moment the angle becomes constant and the angular change to become 0 cm/s to differ in time. In conclusion, the lateral interception set-up offers an experiment with the optical angle as the informational variable. However, more research is needed to use this set-up, to find the affordance of catchability.

Keywords: affordance-based control, catchability, lateral interception,
Catchability of lateral manual interception

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Introduction
In our daily life, we show goal-directed behavior. We somehow know to get to the correct position at the correct moment in time. Affordance-based control includes the action boundaries of an actor to explain both catchable and uncatchable balls. The aim of this study is, first, to examine if actors are capable of judging catchability correctly. Second, to find an informational variable that can explain the perceived catchability of balls in lateral manual interception in a design with both catchable and uncatchable balls.

Method
- Task: to intercept and judge virtual balls with a paddle connected to a physical slider (figure 1 & 2).
- Condition: interception condition and judgement condition.
- Two groups: group I-J performed in the interception condition first and in the judgement condition later. Group J-I performed in the judgement condition first and in the interception condition later.

Results
- Group J-I got a lower success rate for the interceptions in the judgement condition than in the interception condition T(23) = 9.01, p = 0.00, figure 3 top).
- Group I-J overestimated their catching capabilities in the judgement condition (T(23) = 3.92, p = 0.01, figure 3 bottom).
- Figure 4 (left) shows an successful interception with the angular change becoming 0.
- Figure 4 (right) shows a participant who judged the ball as uncatchable. Angular change never reaches 0 and the angle becomes 90.

Discussion
The results of the judgment versus the interception condition contradicted each other. The boundary (figure 3) revealed an overestimation of the judging capabilities in group I-J, while group J-I was better in intercepting the balls than judging them. The boundary (figure 3) is more sensitive to outliers. This experiment had many outliers, because most participants missed some easier trials and also intercepted balls that were supposed to be harder to intercept. The result of figure 4 (left) was promising, however not all intercepted balls could be explained with nulling the angular change. Again, the set-up of this experiment may be of influence. Smaller movements in the paddle lead to small angle changes but can lead to greater angular change values.

Conclusion
In conclusion, the lateral interception set-up offers an experiment with the angle as a single informational variable. However, more research is needed to use this set-up to find the affordance for catchability in lateral manual interception.

References
The development of an in-field Space Reading measure for youth association football players.

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² Research Center of Sports Sciences, Health Sciences and Human Development (CIDESD), Universidade de Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal

Abstract
The mechanism of perceiving environmental information and identifying possible individual and collective solutions to the game problems seem to be a determinant of success. The current study aimed to develop an in-field measure of the concept of Space Reading (SR), defined as the ability to select the most appropriate opportunity for action from the dynamic and interacting environment (i.e. the players, the ball and the available space) and identify how this relates to player characteristics and environmental manipulations. Thirty male outdoor association football players (age: 15.4±1.06 years) played three small-sided (5 vs. 5 SSG), three large-sided (8 vs. 8 LSG) and three regular games (10 vs. 10 RG). The Overall Pass Risk (OV PassRisk), Disruption of the Defence (PassDisr) and Movement Leadership (ML) were calculated as determinants of SR. Space Reading is affected by player experience, player positions and playing formats.
The development of an in-field Space Reading measure for youth association football players.

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2Research Center of Sports Sciences, Health Sciences and Human Development (CIDESD), Universidade de Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal

Introduction

The mechanism of perceiving environmental information and identifying possible individual and collective solutions to game problems seem to be a determinant of success in association football. These opportunities for actions are linked to Space Reading.

Space Reading is defined as the ability to select the most appropriate opportunity for action from the dynamic and interacting environment (i.e. the players, the ball and the available space).

Study aim: Develop an in-field measure of Space Reading for youth association football players and identify how this relates to player experiences, player positions and playing formats.

Methods

• Participants: 30 male outfield association football players (mean±SD age:15.4±1.06 years, weight: 61.97±9.54 kg, height: 171.46 ± 8.12 cm, player experience: 5.11±2.72 years)

• Player tracking data: X and Y coordinates of the players were collected with a portable local positioning measurement system (WIMU PRO™, Real Track Systems SL) during 3 small-sided games (5 vs. 5, SSG), 3 large-sided games (8 vs. 8, LSG) and 3 regular games (10 vs. 10, RG).

• Ball coordinates: X and Y coordinates of the ball were calculated using the method of Folgado et al. (2019)

• Space Reading consist of
  - Overall Pass Risk (OV PassRisk) = probability the pass can be intercepted within the risk area
  - Pass Disruption (PassDisr) = disruption of the defensive organisation during a 3-second window
  - Movement leadership (ML) = number of frames where player initiates speed synchronization within in-phase synchronization mode

Results

Space Reading and Player Experiences

High experienced players scored higher on PassDisr than low experienced players during SSG (2.36 ± 1.00 vs. 2.08 ± 0.93, P < .05, d = 0.29) and LSG (2.51 ± 0.90 vs. 2.09 ± 0.96, P < .01, d = 0.45)

Space Reading and Player Positions

Midfielders scored higher on ML than in attackers during RG (446.69 ± 95.30 frames vs. 370.54 ± 85.47 frames, P< .01, d = 0.83).

Space Reading and Playing Formats

OV PassRisk was lower during SSG compared to LSG (1.80 ± 1.83 vs. 2.63 ± 2.70, P < .01, d = 0.36)

PassDisr was higher in RG compared to SSG (2.71 ± 1.16 vs. 2.26 ± .99, P< .01, d = .42) and LSG (2.71 ± 1.16 vs. 2.35 ± .94, P< .01, d = .34).

ML was lower during SSG compared to LSG (366.70 ± 89.78 frames vs. 428.89 ± 111.05 frames, P< .01, d = 0.62) and RG (306.73 ± 89.78 vs. 410.98 ± 98.09, P < .01, d = 0.53)

Conclusion

This experimental study tried to describe the Space Readings skills of youth association football players in relation to player experience, player positions and playing positions. Space Reading is defined as three separate entities: OV PassRisk, PassDisr and ML. Space Reading is affected by player experience (i.e. PassDisr is higher in more experienced players), player position (i.e. midfielders showed to have higher ML) and playing formats (OV PassRisk and ML were lower during SSG compared to LSG and in case of ML also during RG. PassDisr was higher during RG than SSG and LSG).

References

Abstract

Introduction: Biomechanical load in handball is high due to many multidirectional changes. However, training monitoring in general is mostly focused on physiological load and not on the biomechanical load. That is why it was proposed to differentiate session Rating of Perceived Exertion (sRPE) in a respiratory (sRPEres) and muscular (sRPEmus) load. However, current practices with differentiated sRPE in team handball for all exercise modes and different weekdays are unknown. Therefore, the aim of this study is to describe and compare the distribution of sRPEres and sRPEmus of elite youth handball players with inclusion of all types of exercises during in-season microcycles. Methods: 13 female elite handball players (mean ± SD: age = 18.5 ± 1.2 years) were monitored during 12 weeks. After all training sessions sRPEres and sRPEmus were registered and multiplied by its duration into sRPEres-TL and sRPEmus-TL. Multilevel models were applied to account for within-players and between-players differences for either sRPEres-TL and sRPEmus-TL. Results: A total of 980 individual training sessions were collected. Results showed that sRPEmus-TL was significantly higher compared to sRPEres-TL in all exercise modes, with largest differences for the ball session (p < .05). Furthermore, sRPEmus-TL of Tuesday’s, Wednesday’s and Thursday’s ball session was relatively higher compared to sRPEres-TL, when compared to Monday’s ball session. Conclusion: It can be concluded that in handball differences exist between sRPEres-TL and sRPEmus-TL in all exercise modes and are most apparent in ball sessions. In practice, differentiated sRPE can be used to better understand the biomechanical loads, players sustained, rather than mainly the physiological loads.

Keywords
Perceived exertion, internal load, training load, team sport
The application of differential ratings of perceived exertion to training load monitoring in handball
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INTRODUCTION
Nowadays, training monitoring in team sports is mostly focused on physiological load and not on the biomechanical load (1). That is why it was proposed to differentiate session Rating of Perceived Exertion (sRPE) in a respiratory (sRPEres) and muscular (sRPEmus) load (2,3).

AIM
To describe and compare the distribution of sRPEres and sRPEmus during microcycles of elite youth handball players with inclusion of all types of exercises.

RESULTS
Figure 1. Team mean sRPEres-TL and sRPEmus-TL among all exercise modes. * sRPEmus-TL was significantly higher than sRPEres-TL. a ΔRPE-TL was higher for ball session compared to strength and conditioning sessions and matches (p<.05).

Figure 2. Periodization patterns of team mean sRPEres-TL and sRPEmus-TL of ball, strength and conditioning sessions and matches among all week days. Ball sessions performed at the HA only were analyzed. * sRPEmus-TL was significantly higher than sRPEres-TL. b ΔRPE-TL was lower for ball session on Monday compared to Tuesday, Wednesday and Thursday (p<.05).

CONCLUSION
sRPEmus-TL was higher compared to sRPEres-TL in all training sessions for handball players. Practitioners should therefore include differentiated sRPE, in order to understand both biomechanical and physiological loads players sustained.

Methods
• 13 female elite handball players (M ± SD = 18.5 ± 1.2 years) of the Dutch Handball Academy

sRPEres: How hard was your session on your chest?

sRPEmus: How hard was your session on your legs?

• After all training sessions sRPEres and sRPEmus was monitored and multiplied by the session’s duration into sRPEres-TL and sRPEmus-TL respectively.

• Data was collected during 12 weeks

• Statistical analyses: multilevel modelling with ΔRPE-TL (sRPEmus-TL minus sRPEres-TL)

References
(3) Los Arcos et al. (2014) Biol Sport, 34(2):149-55
The effects of personal protective clothing and equipment bulk and stiffness on maneuverability and internal load in confined spaces of military soldiers

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Poster abstract

Background  Personal protective clothing and equipment (PPCE) can diminish soldiers’ mobility, which can potentially lead to performance decreases and higher susceptibility to enemy fire (1–7). The effects of PPCE on mobility in confined spaces (maneuverability in confined spaces, MCS) are unknown. As confined spaces are increasingly occurring in warfare, knowledge about such effects is relevant for military forces (8,9).

Aim  To investigate the effects of PPCE bulk and stiffness on MCS and internal load in military soldiers.

Methods  Eleven male military soldiers in training (age 17.3 ± 0.9 years; height 183.5 ± 6.2 cm; bodyweight 74.1 ± 6.1 kg) performed MCS tests on a confined space obstacle while wearing five different PPCE configurations: a control condition with no added bulk or stiffness, moderate-bulk, high-bulk, moderate-stiffness and high-stiffness. MCS performance (measured as completion time and internal load (measured as heart rate and rate of perceived exertion) were compared between the different PPCE configurations.

Results  Completion time was significantly lower for only the high-bulk condition (32.2 ± 9.3 sec) compared to the control condition (20.8 ± 5.4 sec). Moderate bulk as only lower than the stiffness conditions. High-bulk showed a significantly lower internal load than the control condition, but only for rate of perceived exertion data.

Conclusions  The results of this study showed that added PPCE bulk decreases MCS but added stiffness does not. Neither bulk nor stiffness affected the internal load.
Soldiers in Combat: Protection or Maneuverability?
The effects of personal protective clothing and equipment bulk and stiffness on maneuverability and internal load in confined spaces of military soldiers
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INTRODUCTION
- Warfare is becoming more urban¹
- Urban environments contain confined spaces (tunnels, silos, ruins, etc.)²
- Personal protective clothing and equipment (PPCE) decrease soldiers’ overall mobility in the field³⁻⁷
- The effects of PPCE properties on maneuverability in confined spaces (MCS) is unclear

Aim: To explore the effects of PPCE bulk and stiffness on MCS and internal load

Hypothesis: Decreases in MCS and increases in internal load after adding bulk and stiffness are expected

Methods
- 11 male student soldiers
- Performing MCS tests (fig. 1)
- 5 conditions:
  - Control
  - Moderate-bulk
  - High-bulk (fig. 2)
  - Moderate-stiffness
  - High-stiffness
- Completion time and internal load (indicated by heart rate and rate of perceived exertion (RPE)) were measured for each condition
- Repeated measures design

Results
- Completion time (fig. 3):
  - High-bulk significantly higher than control \( (p < .05) \)
  - Moderate-bulk only higher than moderate and high stiffness \( (p < .05) \)
- Heart rate (fig. 4)
  - No differences between the conditions
- RPE (fig. 5)
  - Only high-bulk significantly lower than control \( (p < .05) \)

CONCLUSION
- Added PPCE bulk decreases MCS but added stiffness does not.
  Neither bulk nor stiffness affect the internal load.

Practical Implications
- Soldiers may benefit most from removing bulky pieces of equipment in dire situations.
- Stiff pieces of equipment have a lower priority of being removed.

References
¹Evans (2016); ²Moxley et al. (2004); ³Knapik et al. (2004); ⁴Holewijn & Lotens (1987); ⁵Birrell et al. (2007); ⁶Joseph et al. (2018); ⁷Lim et al. (2017); ⁸Laing Treolar & Billing (2011)
Differences in performance characteristics of top-level youth judokas between light and heavy weight categories
Ingrid M. Engwerda (S3035662)

Abstract
Considering the differences in the task between weight categories in judo, differences in the importance of performance characteristics are expected. Such information is potentially useful to optimize athletes’ development and performance. Therefore, it is important to understand the differences in performance characteristics between light and heavy weight categories. In the present study, 57 judokas (male=32; female=25) aged 16-21, all of whom were part of a talent development program of the National Judo Association (Judo Bond Nederland, JBN) were measured. Anthropometrics, physiological and psychological characteristics were examined. Multivariate analyses of covariance with age as covariate followed up by a discriminant analysis were executed for male and female judokas separately. Results showed that heavy weight males outscored their lighter peers on anthropometrics and physiological variables. In females, light weight judokas outscored their heavier peers on physiological variables, whereas heavy weights scored higher on anthropometrics and other physiological variables. The discriminant analysis revealed that 87.5% and 84.0% of the original grouped male and female judokas were correctly classified. No differences in psychological performance characteristics between light and heavy weight categories have been found. In conclusion, this study shows differences in anthropometrical and physiological profiles, the measures of psychological skills seem equally important, in light and heavy weight male and female judokas. Hereupon, talent development can be adapted, and performance optimized.

Keywords: judo, sport performance, adolescence, development, talent.
The differences in performance characteristics in top-level youth judokas between light and heavy weight categories

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INTRODUCTION
Considering the differences in the task between weight categories in judo, differences in the importance of performance characteristics are expected. Such information is essential to optimize athletes’ development and performance. The aim of this study was to understand the differences in performance characteristics in top-level youth judokas between light and heavy weight categories. The expectations are that light weight judokas score higher on explosive and velocity measures and heavy weights score higher on anthropometrics and maximal strength. No differences in psychological performance characteristics were expected.

METHODS
Participants
57 judokas (♂ 32, ♀ 25), all part of the national talent program of the Judo Bond Nederland (JBN), mean age 17.76 ± 1.22
Two groups, light and heavy weight judokas

Measurements
Anthropometrics (body height and arm span)
Physiological characteristics (explosive jumping power, maximal handgrip strength, handgrip strength endurance and power of the upper- and lower extremities)
Psychological characteristics (Coping skills and self-regulation of learning)

Statistics
4 MANCOVA’s
2 Discriminant Analyses
Z-scores

RESULTS
♂ Heavy weight outscore their lighter peers on body height, arm span and maximal handgrip strength, both left and right (p < .05).
87.5% were correctly classified

♀ Heavy weight outscore their lighter peers on body height, arm span and maximal handgrip strength, both left and right (p < .05).

♀ Light weight outscore their heavier peers on jumping ability and peak power bench press (p < .05).
84.0% correctly classified

CONCLUSION
Top-level youth judokas in light and heavy weight categories score different on anthropometric and physiological characteristics. There were no differences in psychological characteristics, however compared to other athletes, these skills can be improved. Hereupon, talent development can be adapted, and performance optimized.

REFERENCES
1 Kuvačić, Krstulovic & Caput, 2017, 2 Jonker, Elferink-Gemser, & Visscher, 2010
Assessing on-field test performance and training load before and after injury in male elite soccer players.
L. (Laurens) Frik

Background: In professional soccer, there is high risk for recurrent injuries at the lower extremity. A reason for this is a lack of on-field performance criteria that can support decision-making when players return to competition (RTC). Furthermore, the amount of training load that players are exposed to is unknown. Therefore, the first aim of current study is to compare on-field sprint, agility and endurance performance before a lower extremity injury and at the moment of RTC in male elite soccer players. The second aim of the study is to compare training load before a lower extremity and at return-to-training (RTT) and RTC.

Methods: During the season 2018 – 2019 60 players from a U23, U19 and U17 team that played at the highest level in the Netherlands were followed in an observational longitudinal study. Players with a lower extremity injury with a time-loss of 28 days or more were included. At the start of the season the 10-meter and 30-meter sprint test, Agility T-test, and Interval Shuttle Run Test (ISRT) were performed. Players were re-tested in the week before RTC. Both external training load and internal training load were captured during training weeks of RTT and RTC and were compared with the loads before injury.

Results: In total 112 injuries were registered during the season 2018-2019. Eight injuries lasted longer than 28 days and thereby met the inclusion criteria of the study (age: 17.29 ± 1.80 years; height: 180.63 ± 6.29cm; mass: 68.76 ± 7.84kg; time-loss: 46.50 ± 24.37 days). For the sprint test no significant difference was found. Even though completion time was similar before and after injury for the agility test, performance appeared to be less during turns compared to before injury (p<.05). For the ISRT test no significant difference was found. The results of the external load showed that high intensity runs were significantly higher during RTT compared to before injury (p<.05). For internal load no difference was found between baseline and RTC, furthermore no difference was found for training load between RTT and RTC.

Conclusion: This study showed that agility performance is less after injury compared to baseline in elite male soccer players. Furthermore, players covered more high intensity runs at RTT compared to before injury. In contrast, players performance for sprint, endurance and internal training load is not altered at RTC.

Keywords: Athletic injuries; Rehabilitation; Return to sport; Decision-making
Assessing on-field test performance and training load before and after injury in male elite soccer players

L. Frik

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INTRODUCTION

In professional soccer, there is a high risk for recurrent injuries at the lower extremity\(^1\). A reason for this is a lack of on-field performance criteria that can support decision-making when players return-to-competition (RTC)\(^2\). Furthermore, the amount of training load that players are exposed to is unknown\(^3\).

Aims: 1) Comparing on-field sprint, agility and endurance performance before a lower extremity injury and at RTC.
2) Comparing training load before a lower extremity injury and at return-to-training (RTT) and RTC.

METHODS

60 players from a U23, U19 and U17 team followed during the season 2018 – 2019. Players with a severe lower extremity injury (>28 days) were included.

RESULTS

- **Sprint:** pre-injury = post-injury
- **Agility:** Max velocity and acceleration turns, Total distance and distance turns
- **Endurance:** pre-injury = post-injury

Players agility performance is less after injury. Furthermore, the high-IR is higher at RTT compared to pre-injury. In contrast, players performance for sprint and endurance, and the internal training load is not altered after injury.

CONCLUSION

PRACTICAL IMPLICATIONS

- Results in line with build-up rehabilitation
- Sprint and endurance still important indicators
- Focus during RTC on complexity of agility
- Training load can give an indication of rehab

REFERENCES

Synchronized velocity of the nearest defenders to the ball during pressing situations enhances successful ball recovery in football

ABSTRACT

When a football team does not have ball possession and wants to make a ball recovery, they can decide to either defend their goal or approach the ball possessing opponent. When trying to gain ball possession, defenders coordinate their behaviour to increase the likelihood of regaining possession. Currently, spatiotemporal variables of pressing situations have not been addressed in the literature. Positional data (xy-coordinates of players and the ball) from eleven teams, containing a total of 453 situations in 48 German 1st Bundesliga matches from the 2014/15 season were annotated by 5 experts (kappa = 0.84). Spatiotemporal variables between defenders and the ball were calculated for each situation. Each situation was coded as successful, unsuccessful, or neutral ball recovery. Logistic regression analysis indicated that velocity synchronization of the nearest two defenders during the first second of a pressing situation are related to more successful ball recoveries ($\chi^2 (6) = 14.592$, $p<0.05$, $R^2 = 0.049$). Thus, spatiotemporal arrangement and pressing behaviour of the defenders with respect to the ball provides crucial information to inform decision making in defenders. These results provide insights to improve tactical awareness in players, with respect to their behaviour in initiating successful pressing actions. Results suggest that the initial velocity of the defender(s) could be a determinant for successful pressing. Coaches may use these results to improve tactical behaviour during pressing initiation when designing training exercises in representative task design.
We want the ball back!

How to use pressing in a football match

J.P.J. de Jong

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German Sports University Cologne, Institute of Exercise Training and Sport Informatics, Cologne, Germany

Why

Lack of research investigating defensive pressing using positional data.¹⁻³

Pressing: clear, intentional high-intensity movement to recover ball possession.¹⁻³

Defenders perceive and act to constraints in a situation.⁴⁻⁵

**Aim:** To investigate the spatiotemporal variables in pressing situations.

**Hypotheses:** At the start of a successful pressing situation, for the two defenders nearest to the ball:

- Distance is smaller
- Relative velocity is lower
- Running velocity is higher
- Angle defender - ball is higher
- Stronger teams press better

How

**Tracking-data (25 Hz) of 48 Bundesliga matches⁶**

453 pressing situations, observed by 5 experts (k = 0.84)

Combine files [Python] to measure spatiotemporal variables during 1st second

3 groups: successful, unsuccessful and neutral recovery.

**Statistics:** One-Way ANOVA and Logistic regression analysis

What

One-Way ANOVA

No significant findings.

**Binary logistic regression**

*Successful recovery = 0.143 * velocity*defender1 — 0.163 * velocity*defender2*

Correctly classified 58.3% of the cases (vs 50.1%) \( \chi^2 (6) = 14.592; \ p < 0.05, \ R^2 = 0.049\). Explained 4.9% (Nagelkerke \( R^2 \)) of the variance in pressing situations.

Practical application

Same running velocity of nearest two defenders to the ball might enhance chance of ball recoveries.

Initial distance to the ball at the start of the pressing not so important?

Stronger teams are not better in pressing?⁷

Take home message:

Defenders match their running velocities in order to press together. This likely increase the opportunities for ball recoveries.

More research is required to determine the best metrics for quantification of pressure.

References:

¹ Gudmundsson & Horton, 2016; ² Andrienko et al., 2019; ³ Barreira et al., 2014; ⁴ Newell, 1986; ⁵ Pruna & Bahdur, 2016; ⁶ TRACAB, ChyronHego, Sweden; ⁷ Wunderlich & Memmert, 2018
To resistance train or not: The practices of trainers of Dutch adolescent basketball players
Mohammed Khudair
Supervisor: Dr. Marije T. Elferink-Gemser Center for Human Movement Sciences, University of Groningen, University Medical Center Groningen (UMCG) Master graduation project Word count
Abstract and keywords: 236

ABSTRACT
The aim of the current study was to investigate the programming practices and different types of resistance training in trainers of basketball players across adolescence. A questionnaire was distributed nation-wide to trainers of adolescent basketball players in the Netherlands, asking them whether they applied resistance training with their players and how they used different inter- and intra-session variables in program prescription. The responses were stratified by different age categories that likely correspond to different maturity status – early-, mid- and late adolescence, and adults. Forty-five trainers responded to the questionnaire. Twelve (26.7%) of the respondents did not apply any resistance training with their players. In the remaining 33 respondents, a significant difference was found between age categories in application (Chi²=43.87; df=3; p<0.001) and in intensity of resistance training (Chi²=14.57; df=6; p=0.024), where resistance training was prescribed more and at higher intensity to older players. Significant differences were found between the reported intra-session variables and recommended intra-session variables in the literature. Body mass-based and plyometric training were more popular than other types of resistance training. The results suggest an underuse of resistance training in Dutch adolescent basketball players. The respondents seem to practice caution when prescribing resistance training to adolescent players at the earlier stages of adolescence. It is suggested that basketball trainers consider applying organized resistance training as an important component in basketball training and to prescribe RT programs of low-moderate volume (2–4 sets/exercise, ≤6 repetitions/set) and high intensity (≥85% of max capacity) and long resting periods (2-4 minutes per set)

Keywords Youth; sport; maturation; strength training; performance
INTRODUCTION

The Netherlands has the second tallest population in the world. They have high aspirations in international sports and high quality talent academies around the country. But they are far from the top in basketball.

Basketball requires high levels of strength and power. Resistance training may be one of the training methods that could help increase performance in adolescent basketball players for current performance and for the future.

The extent to which resistance training is applied in adolescent athletes is unclear.

Aim: To investigate the programming practices and different types of resistance training in trainers of basketball players across adolescence.

METHODS

Basketball trainers (n=45) in the Netherlands completed a questionnaire on Resistance training program prescription for adolescent athletes – Inter- and intra-session variables.

Questions based on age categories that likely correspond to maturity status: 10-11, 12-14, 15-18, >18 years.

Analysis: Chi2 and one-way ANOVA for differences between age categories; Cohen’s d for effect sizes.

Results discussed in relation to recommendations and findings in the literature (Lloyd et al., 2014).

RESULTS

Resistance training is not widely applied with Dutch adolescent basketball players (figure 1a-b).

Significant differences were found between age categories in the extent to which resistance training is applied, and in inter-session variables (frequency, volume and intensity). Whereas, intra-session variable id not vary significantly.

Inter- and intra-session variables deviated from what is recommended in the literature: lower intensity, less sets per exercise, more repetitions per set and less rest between sets.

Body-mass based RT and Plyometric training were the most popular among respondents.

CONCLUSION

The results of the current study show that RT is not applied by a large portion of the Dutch basketball trainers. In order to enhance muscle strength, power and eventually sports performance, trainers are suggested to prescribe RT programs of low-moderate volume (2–4 sets/exercise, ≤6 repetitions/set) and high intensity (≥85% of max capacity) and long resting periods (2-4 minutes per set). For adolescent players who are young and inexperienced in RT, trainers are suggested to prescribe RT with low volume and low intensity with long resting periods during the sessions in order to attend to exercise execution.

REFERENCES


Can the mismatch between coach’ and players’ perception of exertion predict well-being and physical complaints in academy soccer teams?

M. (Mees) van der Linde

Introduction Coaches carefully plan training sessions in order to improve overall performance. However, a mismatch can exist between the intended and observed exertion of the coach and the perceived exertion of individual players. It is unknown if this mismatch influences well-being and physical complaints of the players. Therefore, the aim of this study is to examine if the mismatch predicts future well-being and physical complaints. Methods In total forty-one players (18.0 ± 1.2 y; 180.2 ± 6.3 cm; 70.7 ± 6.8 kg) of U23, U19 and U17 youth academy teams participated during the pre-season. Before each training session, the coach rated the intended exertion (RIE) for each player. After the training session, the coach rated the observed exertion (ROE) for each player and the players rated their perceived exertion (RPE). Finally, players filled in a weekly questionnaire regarding their general well-being and physical complaints (OSTRC). A multilevel model was performed to assess if the mismatch between coach’ and players’ perception of exertion could predict future well-being and physical complaints. Results In total 914 individual training sessions were included, which resulted in 220 training weeks with the RIE, ROE and RPE, well-being and OSTRC. The mean (± SD) mismatch pre-training was 1.1 (± 0.6), 1.3 (± 0.7) and 1.6 (± 1.1) for the U23, U19 and U17 team respectively. The mismatch post training was 0.9 (± 0.6), 1.2 (± 0.7) and 1.3 (± 0.9) for the U23, U19 and U17 team respectively. Average well-being (5-25) was 18.7 (± 2.0) indicating good well-being and average OSTRC score (0-100) was 8.5 (± 13.0) indicating minimal complaints. Multilevel analyses showed that the null model with the grand mean had the greatest predictive value compared to every model including the mismatch or team differences. Conclusion Despite the presence of a mismatch between coaches’ and players’ exertion, the mismatch does not predict future well-being or physical complaints during pre-season in soccer. However, combining the mismatch with team differences improves the prediction of physical complaints indicating the importance of assessing the mismatch for each team individually.

Keywords: periodization; training load; overuse; injuries; wellness; football
Can the mismatch between coach’ and players’ perception of exertion predict well-being and physical complaints in academy soccer teams?

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Department of Human Movement Sciences, University Medical Center Groningen, University of Groningen, The Netherlands

Introduction

• Training with right intensity & at right moment to improve performance\(^1,2\)
• Too little and too much training could hinder performance\(^3\)
• Coaches are challenged by players with different physical capacities \(\Rightarrow\) mismatch between the coach’ perception of exertion and the perceived exertion of individual players.

Aim: the aim of this study is to examine if the mismatch predicts future well-being and physical complaints in youth soccer.

Methods

• Forty-one players (U23, U19 & U17) during their pre-season
• Coach provided for each player:
  • Rating of intended exertion (RIE) pre-training
  • Rating of observed exertion (ROE) post training
• Players provided:
  • Rating of perceived exertion (RPE) post training
  • Weekly five questions concerning general well-being
  • Weekly four questions concerning physical complaints

Data analysis: A multilevel model (including week, mismatch and team) was performed to assess if the mismatch could predict future well-being and physical complaints.

Week 1

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Data

RIE/ROE/RPE + Questionnaire

Week 2

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</table>

RIE/ROE/RPE

No training

Table 2. Mean (± SD) for the mismatch pre-training (RIE-RPE) and post training (ROE-RPE) for the U23 (n=523 training sessions), the U19 (n=199 training sessions) and the U17 (n=192 training sessions) team.

<table>
<thead>
<tr>
<th>Mismatch pre-training</th>
<th>Mismatch post training</th>
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<tr>
<td>Under-23</td>
<td>1.1 ± 0.6</td>
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<tr>
<td>Under-19</td>
<td>1.3 ± 0.7</td>
</tr>
<tr>
<td>Under-17</td>
<td>1.6 ± 1.1</td>
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<tr>
<td>Total</td>
<td>1.2 ± 0.7</td>
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Multilevel analysis

Well-being
• The grand mean performed better predictions than any model with the independent variables (week, mismatch & team)

OSTRC
• Factor ‘team’ predicted sports-related pain;
• The interaction between mismatch and team predicted all subscales of OSTRC indicating inter-team difference.

Results

In total, scores of 914 individual training sessions were included, which resulted in 220 individual training weeks with the RIE, ROE and RPE, well-being and OSTRC.

CONCLUSION

Despite the presence of a mismatch between coaches’ and players’ exertion, it does not seem to predict future well-being or physical complaints during pre-season in academy soccer. The combination between the mismatch and the teams does predict physical complaints.

References

Abstract poster
A soccer game asks for quick adaptations in a constantly changing environment, therefore motor inhibition is of great importance. Motor inhibition is the ability to inhibit a motor response when needed. A soccer-specific inhibition test is desirable to measure motor inhibition in youth soccer players. This study evaluated the validity of a newly developed soccer-specific inhibition test (SSIT). The study included eighteen elite youth soccer players (age = 15.9 ± 0.3) and fifteen sub-elite youth soccer players (age = 16.3 ± 0.6). All players executed the SSIT and a Stop-Signal Task (SST). The outcome variables of both tests were the reaction time (RT) and accuracy for go- and stop-trials. The stop-trials are the inhibition components of both tests. The concurrent validity was determined by comparing all four outcome variables of the SSIT and SST by means of Pearson correlations. The construct validity was determined by comparing the outcome variables of the SSIT for elite and sub-elite youth soccer players, by performing independent t-tests and ANCOVAs, with covariates age and training hours. The concurrent validity showed only one significant correlation between the SSIT and SST for the accuracy in go-trials (r = 0.422; p < .05). The construct validity was strong for the RT and accuracy at stop-trials, thus the inhibition components of the SSIT. The elite youth soccer players outperformed the sub-elite youth soccer players in the inhibition components. In conclusion, the newly developed soccer-specific inhibition test is sensitive enough to compare between performance levels for the inhibition components.
INTRODUCTION

A soccer game asks for quick adaptations in a constantly changing environment, therefore motor inhibition is of great importance. Motor inhibition is the ability to inhibit a motor response when needed. A soccer-specific inhibition test is desirable to measure motor inhibition in youth soccer players1-3.

Aim

To investigate the concurrent and construct validity of a newly developed soccer-specific inhibition test (SSIT).

Methods

Participants: Elite (n=18; age = 15.9 ± 0.3) and sub-elite (n=15; age = 16.3 ± 0.6) youth soccer players.

Procedure: All participants executed the SSIT and a Stop-Signal Task (SST). The outcome variables of both tests were the reaction time (RT) for go-trials and stop-trials and the accuracy for go- and stop-trials, the stop-trials were the inhibition components of the SSIT and SST.

Analyses: The concurrent validity was determined by comparing the SSIT with the SST, by performing Pearson correlations for all four outcome variables. The construct validity was determined by comparing elite and sub-elite youth soccer players with an independent t-test and ANCOVA, with covariates age and training hours4.

Results

Concurrent validity: Only one significant correlation between the SSIT and SST for the accuracy in go-trials (r = 0.422; p < .05)

Construct validity: Elite outperformed sub-elite for the RT and accuracy at stop-trials, see Figure 2a and 2b. When correcting for age and training hours the significant differences disappeared.

CONCLUSION

The newly developed SSIT is sensitive enough to compare within youth soccer players of different performance levels for the inhibition components.

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The newly developed SSIT is sensitive enough to compare within youth soccer players of different performance levels for the inhibition components.

References

1Wang et al., 2013; 2Diamond, 2014; 3Best & Miller, 2010; 4Field, 2014
Play equipment with a more open function: do children perform a wider variety of actions?

Poster abstract

The concept of ‘open function’ is introduced by Fuchs to refer to play equipment that does not suggest a specific type of play behavior. Such play equipment is often characterized by its neutral and abstract forms, supposed to foster children’s creativity.

The current study examined whether children perform a wider variety of actions on play elements that have an open function. Twenty-two children, between 6 to 12 years old, were to play for two minutes on each of the seven different play elements in a Parkour playground. These play elements were supposed to vary in their degree of open function. Participants were asked to mention what action children will mainly perform on each of the seven Parkour play elements. Based on the participants’ answers and reaction times, we found that the Parkour play elements indeed differ in the degree to which they have an open function. However, we found that children did not show more variation in their play behavior on play elements with a higher degree of open function. However, the test to determine the number of different actions appeared not to be valid. Hence, no solid conclusions can be drawn. The implications of the findings are explored.
Play equipment with a more open function: do children perform a wider variety of actions?

by Lynn van der Schaaf, supervised by Rob Withagen

Introduction

Open functions:
> The concept of open function refers to play equipment that does not suggest a specific type of behavior.
> Play elements with an open function allow children to discover all of the action possibilities a play element has to offer.

Aim:
> To determine whether children perform a wider variety of actions on play equipment with an open function.

Methods

Determination of open function:
> 26 participants (18-25 years old) mentioned what action, in their view, children will mainly perform on each of the seven Parkour play elements and three conventional elements (slide, swing, seesaw).
> Answers were noted and reaction times determined.
> Students made piles of answers that refer to the same action.
> The more piles, the higher the degree of open function.
> The longer the reaction times, the higher the degree of open function.

Examining children's play behavior:
> 22 children (6-12 years old) played for two minutes on each of the seven different Parkour play elements. Their behaviors were filmed.
> 20 participants (17-49 years old) watched short video clips (2 sec.) of individual playing children and were to describe the actions.
> The more action categories the participants made, the more actions the children had performed.

Hypothesis

It is expected that children perform more different actions on play equipment with a more open function.

Results

The seven Parkour play elements

Bench | Gibbonswing | Precision Ball | Precision Bars | Precision Beam | Spider Cage | Vault Rails

Discussion and conclusion

> Reaction time suffices as a method to determine degree of open function.
> Method to determine the number of different actions performed by the children was not valid.
> Hence, no conclusion can be drawn regarding the play behavior of the children.

References


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The development of a physical-technical tennis-specific field test (PTTF-test) for the monitoring of tennis performance
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Abstract:
Standardized test protocols are a valuable tool to capture an individual’s tennis performance, to monitor progress over a time frame or to compare an athlete’s performance to another athlete. The four components that comprise tennis performance are the technical, tactical, physical and psychological component (Kovacs, 2007). The technical component is often considered the most determining factor to win points. However the intermittent physical component is important for athletes to persevere the demands of matches in high-intensity points (Kovacs, 2007; Reid et al., 2014). The monitoring of physical performance in a tennis-specific setting is therefore indispensable. Several incremental physical test protocols, that include the tennis-specific ball hitting, have yet been developed (Brechbuhl., 2016). Tough implementations to further increase tennis-specificity are available. The implementation of oncoming ball direction randomization secures the need for tennis-specific footwork between the strokes. Furthermore, the quality of strokes should serve as outcome variables of a tennis-specific protocol as well. Consequently the present study has developed the PTTF-test for the monitoring of tennis performance. This test will serve specifically to monitor decreasing technical performance under increasing physical intensity. Assessment of discriminant validity was included.

15 male tennis athletes were included within this study and classified as either elite (n=5, age 13.8±1.0) or sub-elite (n=10, age=14.3±1.0) based on singles ranking per year of birth. Participants were fed by a ball machine with randomized oncoming ball direction and were instructed to direct their strokes towards targets. Intensity levels of 60 seconds were alternated with rest periods of 30 seconds, given the intermittent nature of tennis. The intensity of the PTTF-test protocol was incremented per intensity level. Outcome variables of the PTTF-test protocol were mean heart rate increase, mean stroke velocity decrease, mean stroke accuracy decrease, mean velocity-accuracy-index (VA-index) decrease and mean percentage errors (PE) decrease per intensity level and final reached intensity level (PTTF-level) The outcome variables were checked for differences between elite and sub-elite athletes by a multivariate analysis of variance.

Analysis revealed that elite athletes outscored sub-elite athletes on mean PE decrease per intensity level (p<.05) and PTTF-level (p<.05). These results indicate the discriminative value of mean PE decrease and PTTF-level for performance. The PTTF-test protocol hereby has proven its value for performance monitoring and talent discrimination in tennis for male athletes aged 13 to 16 years old.

References:
Brechbuhl C, Girard O, Millet GP, Schmitt L. On the Use of a Test to Exhaustion Specific to Tennis (TEST) with Ball Hitting by Elite Players. PLoS ONE 2016; 11(4).


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INTRODUCTION

Fixed test protocols are a valuable tool to monitor tennis performance. The physical component is important to persevere the demands of matches as fatigue develops and in points of high intensity. The technical component is the most determining factor to win points. Test batteries require the inclusion of the physical and technical component in a maximized tennis-specific protocol. Tennis-specific modifications to the TEST-protocol are available.


Methods

15 male tennis athletes, aged 13 to 16 years, were included in this study. These athletes were classified for performance levels as either elite (n=5; age 13.8±1.0) or sub-elite (n=10; age 14.3±1.0), based on singles ranking per year of birth (cut-off rank: 3).

Athletes were fed by a ball machine (Promatch SmartShot Xtra) and instructed to direct strokes crosscourt towards targets (figure 1). Intensity levels of 60 seconds were alternated with rest periods of 30 seconds. The intensity of the PTTF-test protocol was raised by increasing stroke frequency per intensity level. Randomisation of oncoming ball order was implemented to secure the need for tennis-specific footwork.

Playsight Smartcourt was used for registration of raw outcome values for stroke velocity, stroke accuracy, velocity-accuracy-index (VA-index) and percentage errors (PE).

Outcome variables of the protocol were mean heart rate increase, mean stroke velocity decrease, mean stroke accuracy decrease, mean VA-index decrease and mean PE decrease per intensity level and final reached intensity level (PTTF-level).

A multivariate analysis of variance was executed to check whether differences for the outcome variables between elite and sub-elite athletes exist.

Results

The outcome variables, specified per performance level, are presented in figure 2.

- Elite athletes outscored sub-elite athletes on mean percentage error decrease per level (p<.05).
- Elite athletes reached a higher intensity at the PTTF-test than their sub-elite counterparts (p<.05).

Figure 2. Elite/Sub-elite differences in outcome variables of the PTTF-test protocol

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- Discriminant validity of the PTTF-test protocol is determined by significant differences in PTTF-level and mean decrease in error percentage between elite and sub-elite athletes.
- The PTTF-test protocol is a valuable tool for performance monitoring and talent discrimination in tennis for male athletes aged 13 to 16 years old.
- Complete article on the additional assessment of PTTF-test construct validity and feasibility.

References

Unravelling offensive success in soccer: A dynamical analysis of passing by time-to-intercept modelling

Rick C.T. Stoop

Abstract

Large tracking and event datasets of official matches in soccer provide sport scientists, data analysts and researchers with data for advanced spatial-temporal tactical analysis. In soccer, passing can be seen as a fundamental performance indicator. However, the main focus of previous research in passing was primarily on notational or spatial parameters solely, whereas the combination was studied to a lesser extent. Therefore, the purpose of this study was to see if forward passing options, pass difficulty and pass quality related to team success in soccer. In total, this study included 21 official matches of one professional soccer team during an entire season of the Dutch Eredivisie. By using a time-to-intercept model forward pass options, pass difficulty and pass quality were calculated as independent variables, whereas score-box penetrations, goal scoring and winning were included as measures of success. The results showed that the proposed model was able to predict 71% of all received passes in the dataset with 47% of the passes being received in the dominant direction of play. Besides, mean forward options per pass was the only variable relating to success, i.e. score-box penetrations ($r = .267; p = .044$), and hinted towards a relation with goal scoring ($r = .253; p = .053$). An additional result was the negative relation between passing difficulty and passing quality for losing teams ($r = .686; p < .001$). Interestingly, this relation was not apparent in winning teams ($r = .228; p = .320$) resulting in a significant difference between winning and losing teams ($z = -1.82; p = .034$). So, it seemed that creating more forward passing options can influence success in a team sport like soccer and additionally there seemed to be a difference in the trade-off for pass difficulty and pass quality. Altogether, this new approach for passing analysis on macro level showed a promising trend and application for analyzing success in soccer. Additionally, the proposed model could be improved while also extending the analysis more on a meso or micro level. Furthermore, focusing on different pitch areas and pass sequences preceding (un)successful match events could substantially contribute to future research as well.

Keywords: Big data, Decision-making, Ecological approach, Football, Performance analysis, Physics based modelling
Unravelling offensive success in soccer by analyzing passing options

Rick C.T. Stoop

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Introduction

- Large datasets of official matches in soccer provide sport scientists, data analysts and researchers with data for advanced spatial-temporal tactical analysis1.
- Passing is a fundamental aspect in soccer, however the quantification of passing lacks consensus regarding match successfulness2.
- Combining event and tracking data might provide a solution for this problem3.
- The purpose of this study is to see if forward passing options, pass difficulty and pass quality relate to team success in official soccer matches.

Methods

For the purpose of this study 21 official matches of one professional soccer team during an entire season of the Dutch Eredivisie were included.

Based on player’s velocity, acceleration, pass speed, pass length and pass area a time-to-intercept model was used to calculate pass options.

Dependent variables

- Score-box penetrations
- Scoring
- Winning

Independent variables

- Forward pass options
- Pass difficulty
- Pass quality

The model predicted 71% of all received passes with 47% being in the dominant direction of play.

- 22% of all options were in the attacking third
- Forward pass options positively relate to score-box penetrations ($r = .267; p = .044$)
- Pass difficulty and pass quality were negatively related for losing teams ($r = .686; p < .001$) and differed from winning teams ($r = .228; p = .320$) ($z = -1.82; p = .034$).

CONCLUSION

The proposed model can be used as a building block towards future time-to-intercept models. Despite the strength, forward pass options might provide as useful parameter to analyze success in soccer. Lastly, future research could focus on analyzing meso/micro level of pass characteristics, locations on the pitch or pass sequences before (un)successful events.

References

Quantification of pressure on passers in football matches to predict pass successfulness

Kyrill A. Visser

Abstract

To study tactics in football with positional tracking data, the outcome of passes can be used to evaluate performance behaviour by the attacking and defending team. Previous research has shown that player density of the defending team and exerted pressure on passes is higher in the defending team’s half. This study aims to assess to what extent pass accuracy is influenced by the exerted pressure on the passer and the distance to the opponent's goal at pass reception/interception.

120984 passes in 120 matches in the highest Dutch professional football league were analysed. To quantify pressure exerted on the passer, an existing pressure model was adapted to better catch the influence of the pressing defenders. Using a machine learning technique, probabilities of pass successfulness were predicted with the exerted pressure on passers and the distance to the opponent's goal at pass reception. A binary logistic regression was used to create a model that classified passes as either successful or intercepted.

The pressure exerted on passers who passed successfully (6.6 ± 16) was lower compared to the pressure exerted on passers whose passes were intercepted (12.4 ± 22). When the distance between the opponent’s goal and the pass receiver was lower, the probability that the pass would be successful was lower. 67% of the passes were classified accurately with a Log Loss of 0.62. The distance between the opponent’s goal and the pass receiver was the strongest predictor of pass successfulness. Although the recall was 92%, a relatively high amount of passes were incorrectly classified as successful.

This study showed that the pressure model is able to quantify pressure in relation to the successfulness of attacking plays. Receiving a pass closer to the opponent’s goal and a higher exerted pressure on the passer decreases pass accuracy. Using a machine learning technique, classification of pass successfulness was reasonable accurate.

Keywords: football, tactical analysis, setting pressure, predicting pass successfulness
Quantification of pressure on passers in football matches to predict pass successfulness

Kyrill A. Visser
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Introduction
The successfulness of passes can be used to evaluate tactical performance behaviour by the attacking and defending team\(^1\). Player density of the defending team and exerted pressure on passes are higher in the defending team’s half\(^2,3\). Pressure on the passer and the distance between the pass receiver and opponent’s goal were expected to influence pass outcome. This study aims to test these variables as predictors of pass successfulness.

Methods
- 120,984 passes detected in 120 Eredivisie matches
- Existing pressure model with 2 adaptions\(^3\)
- Machine learning: a binary logistic regression

Predictors
- Pressure on passer
- Receiver–Goal distance

Figure 1. Pass accuracy for 10m ranges of Receiver–Goal distance.

Figure 2. Pressure on passers and pass receivers for 10 m ranges of Receiver–Goal distance.

\(\text{Pressure on passer} + 0.721 \left( \text{Receiver - Goal distance} \right)\)

• Pressure on unsuccessful passes (12.4 ± 22) was higher compared to successful passes (6.6 ± 16)
• Pressure on pass receivers was 5.3 ± 17
• The model classified 67% of all passes accurately (Log Loss = 0.62)
• Receiver–Goal distance was the strongest predictor

Regression equation

\[\text{probability of pass successfulness} = 0.740 - 0.115 \left[ \text{pressure on passer} \right] + 0.721 \left[ \text{Receiver – Goal distance} \right]\]

Results

Conclusion
- Receiver–Goal distance and pressure on a passer are reasonably accurate predictors of pass successfulness
- Future research should evaluate exerted pressure in relation to the effectiveness of passes

References
\(^1\) Memmert et al. (2017); \(^2\) Tenga et al. (2010); \(^3\) Andrienko et al. (2016)