

# Impacts of different types of wheelchair backrests on the propulsion performance on a manual wheelchair: an exploratory study

## The 32nd International Seating Symposium

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# Study Context

- The majority of manual wheelchair users with a spinal cord injury present:
  - Trunk and lower limbs sensory motor deficiencies
  - Trunk control deficiencies
  - Manual wheelchair propulsion difficulties

Those deficiencies and difficulties result in



A lower manual wheelchair propulsion performance

- A profiled and rigid manual wheelchair backrest, with or without lateral thoracic supports, or a soft backrest also with or without thoracic support, are often recommended in our clinical practice.
- The decision making process for those types of backrests for our manual wheelchair users, remain an iterative process based on our clinical experiences, intuitions, trials and errors, and adjustments following interactions between therapists and users.

# Current evidence based practice

- There is minimal scientific data available to inform therapists about the decision making process for the proper choice of backrests, for manual wheelchair users.
  
- No biomechanical studies have quantified the effects of different backrests, for experimented users, on the manual wheelchair propulsion.

# Research objective

Compare the effects on propulsion of four different types of frequently used backrests, with quantitative and qualitative measures, among experienced spinal cord injury users of manual wheelchairs.

The hypothesis was that a rigid manual wheelchair backrest, with lateral thoracic supports, would optimize the propulsion performance.

# Backrests used

**Tension Adjustable  
Backrest Upholstery**



**JAY 3 without thoracic  
supports**



**Harmoni**



**JAY 3 with thoracic supports**

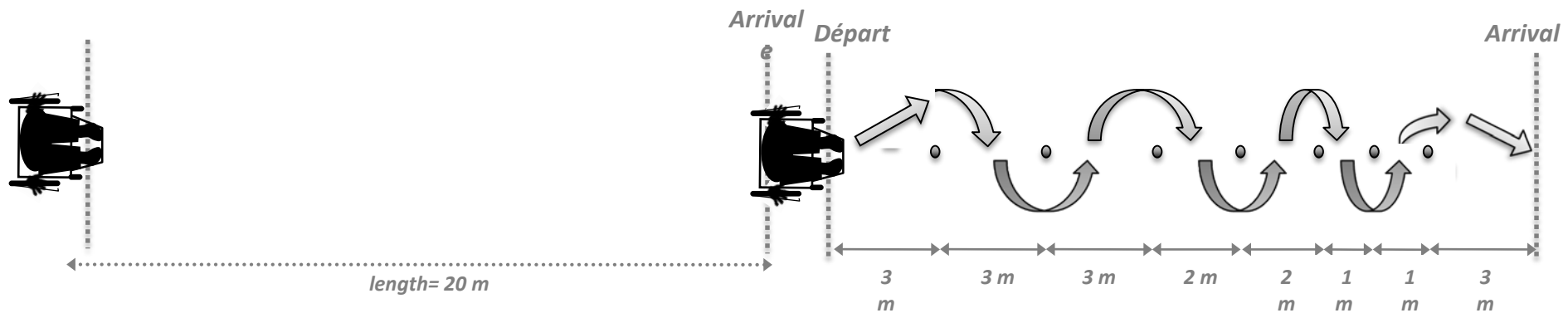


# Methodology

## 1. Manuel wheelchair propulsion test:

*20 meters straight line propulsion test:*      *20 meters slalom propulsion test*

*Start line*

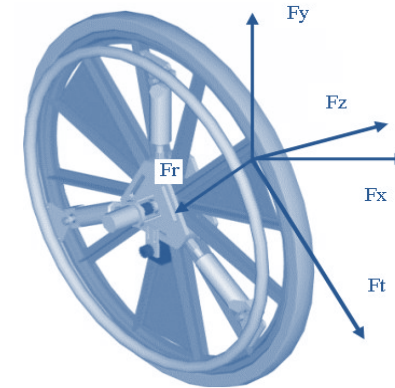


- Each test is chronometered twice with each backrest

# Methodology

## 2. Registration of spacial - temporal and biomechanical data

- Two rear wheels with instrumented handrims where installed (SMARTWHEEL™ ) on the personal wheelchair of each participant.
- The registered data where analysed with a homemade program developed by our pathokinesiological reasearch laboratory team.



# Methodology

## Principal results :

- Quantitative measures
  - Spatial - temporal data
    - *Propulsion and recovery time phases*
    - *Total time and speed*
  - Biomechanical datas
    - *Total force and tangential force (resulting in direct propulsion force)*
    - *Rate of mechanical efficiency = ( Tangential force/Total force)\*100*
- Qualitative measures
  - Analogue Visual Scale (comfort, stability and performance)



# METHODOLOGY

## Statistics Analysis:

- **Descriptive Statistics**
  - Average and Standard deviation.
  - Number of observations and proportions.
- **Shapiro-Wilk test to verified the data distribution**
  - Average and standard deviation.
- **Friedman Test to confirme the differences between the backrests ( $p < 0.05$ )**
  - No significant difference.

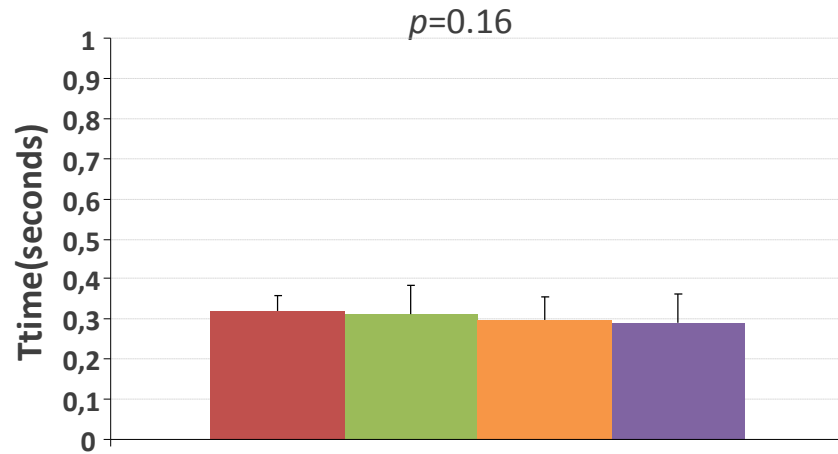
# Results

## Participant Characteristics (N=10)

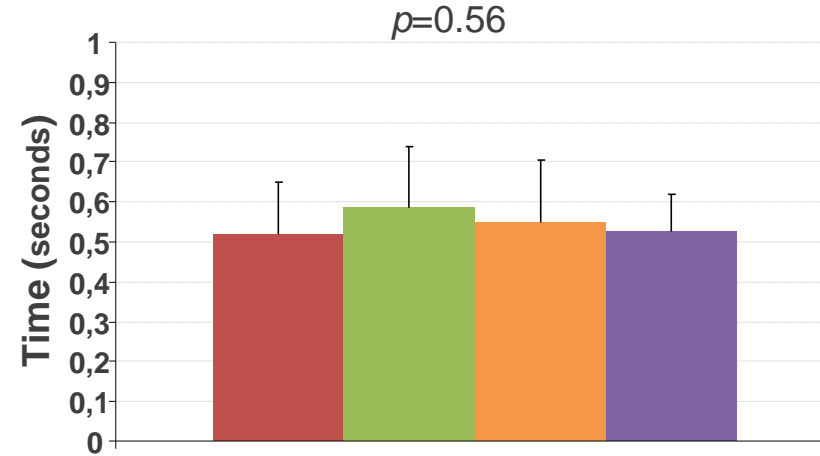
	Average (standard deviation)
Gender	8M/2F
Age (years)	44,4 (13,5)
Weight (kg)	75,4 (25,3)
Height (cm)	170,47 (7,85)
Spinal cord lesion level	Between C7 & T2
Severity of lesion	ASIA A or ASIA B
Time since spinal cord injury (years)	19,1 (11,1)

# RESULTS 20 Meters Propulsion Test

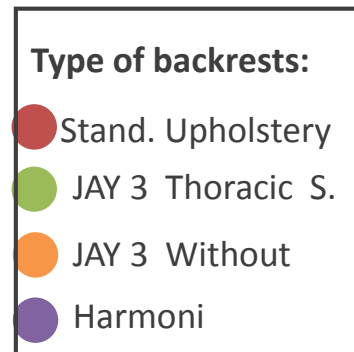
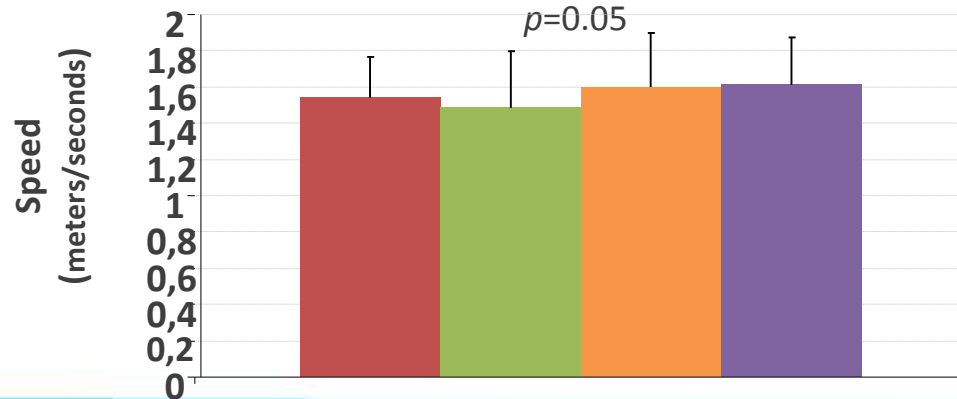
## Propulsion Phase



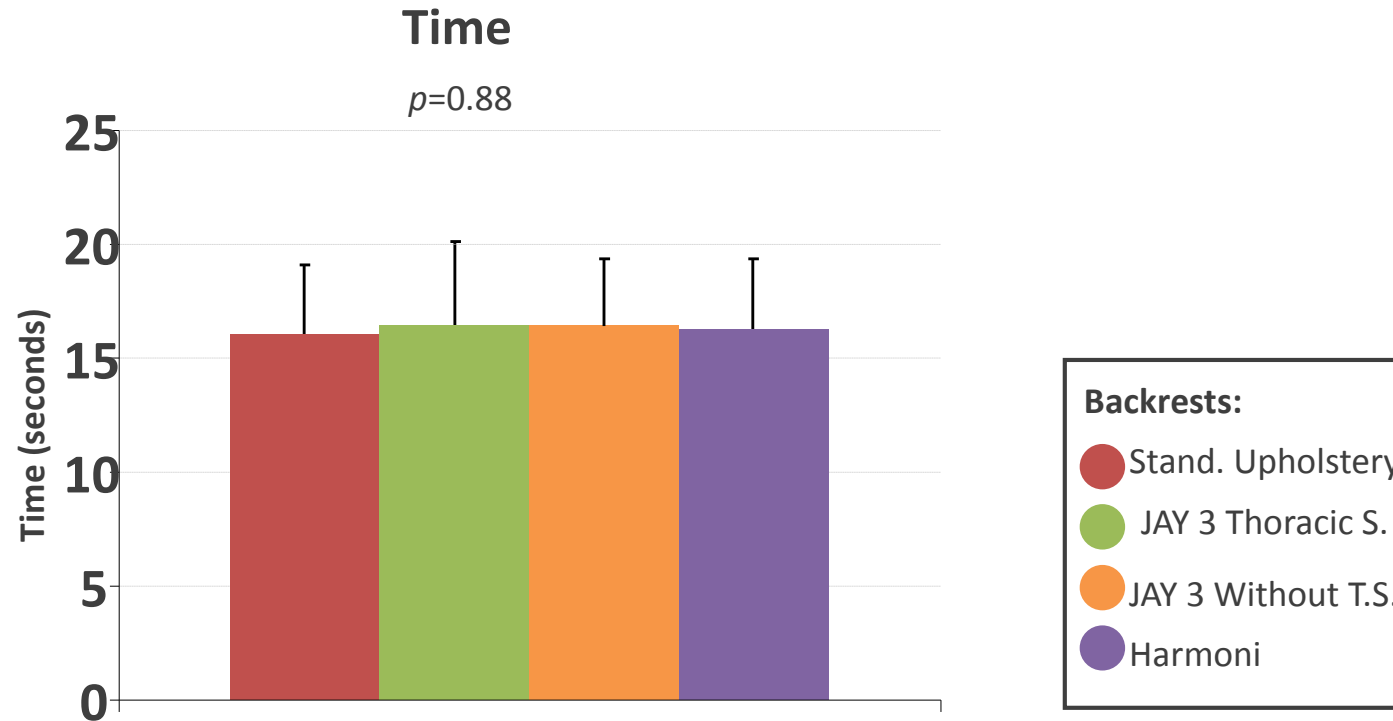
## Recovery Phase



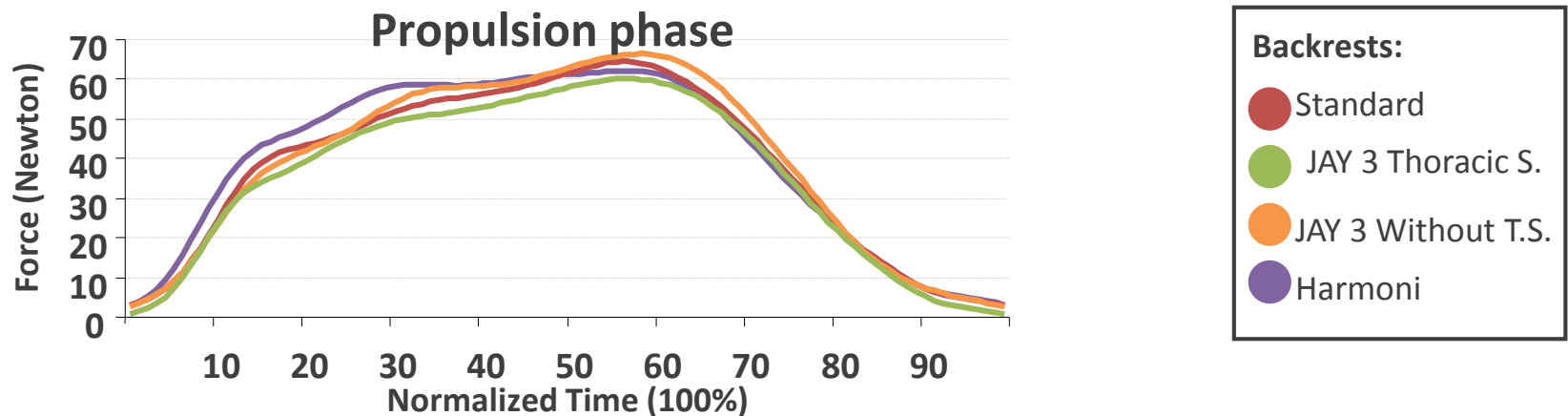
## Speed



# RESULTS – Propulsion slalom Test

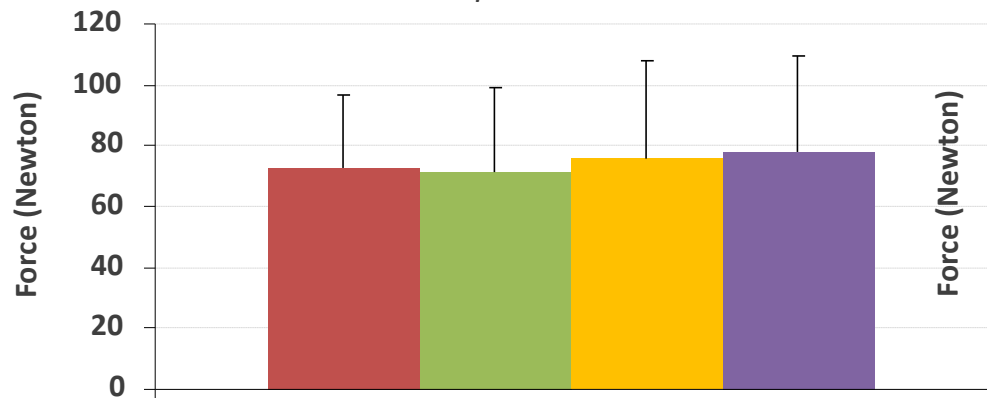


# RESULTS – Total Force



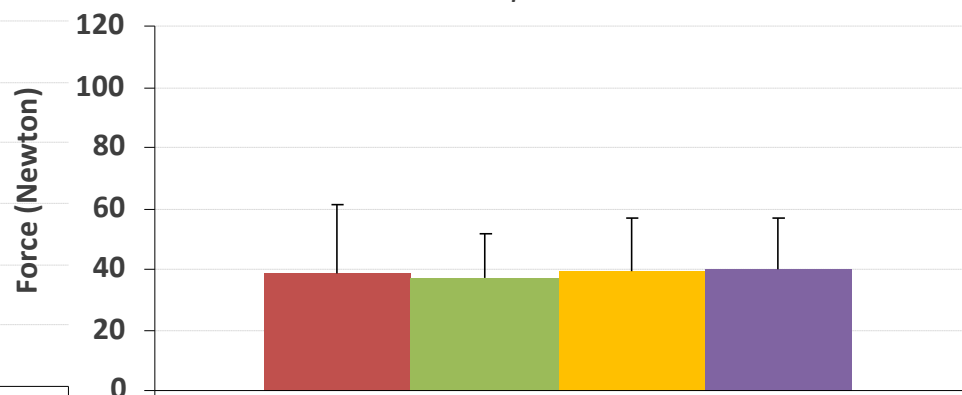
### Maximal Values

$p=0.70$



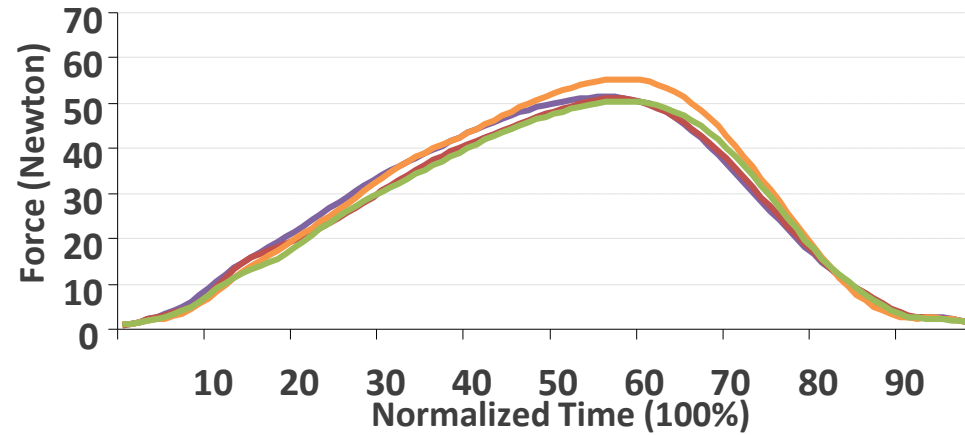
### Average Values

$p=0.47$



# RESULTS – Tangential Force

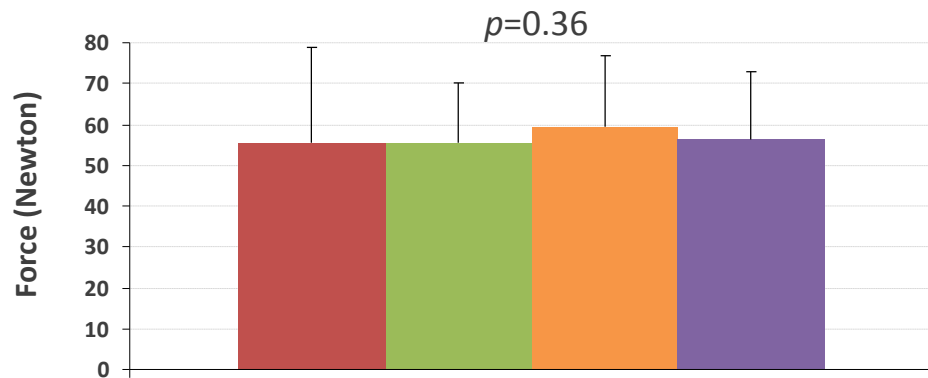
## Propulsion Phase



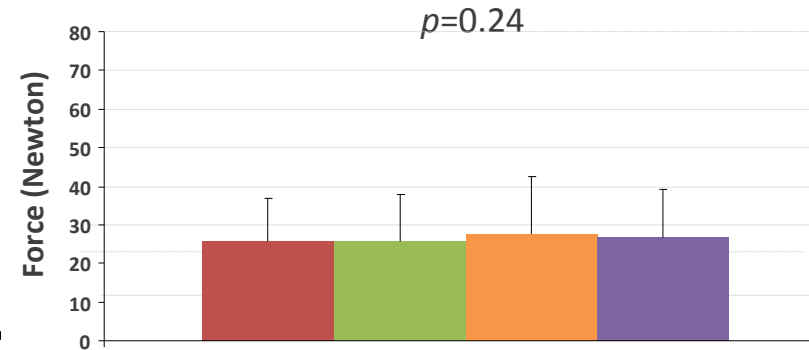
Backrests:

- Stand. Upholstery
- JAY 3 Thoracic S.
- JAY 3 Without T. S.
- Harmoni

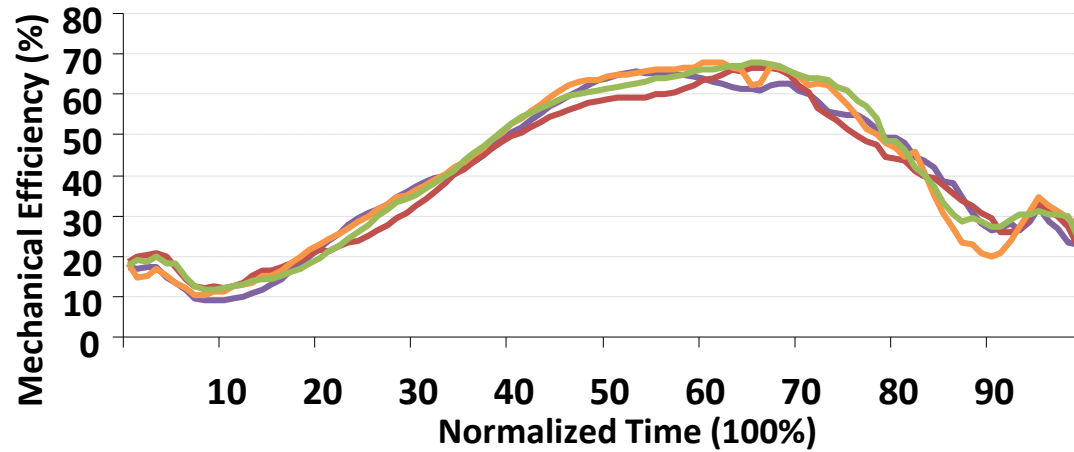
## Maximal Values



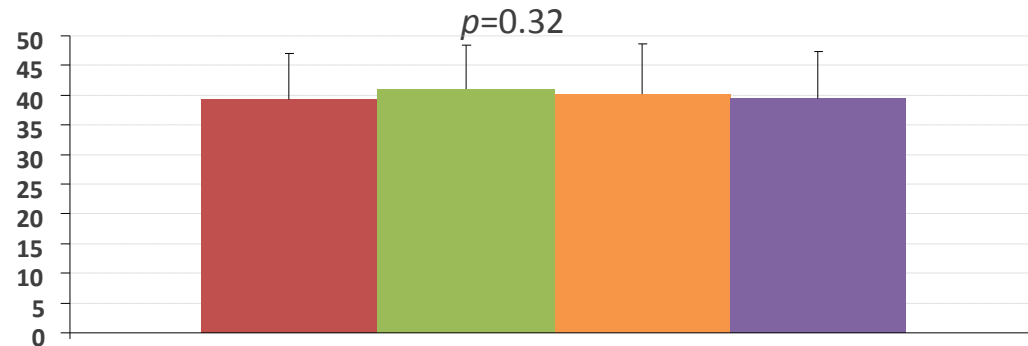
## Average Values



# RESULTS – Mechanical Efficiency



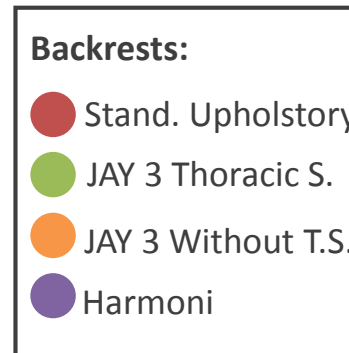
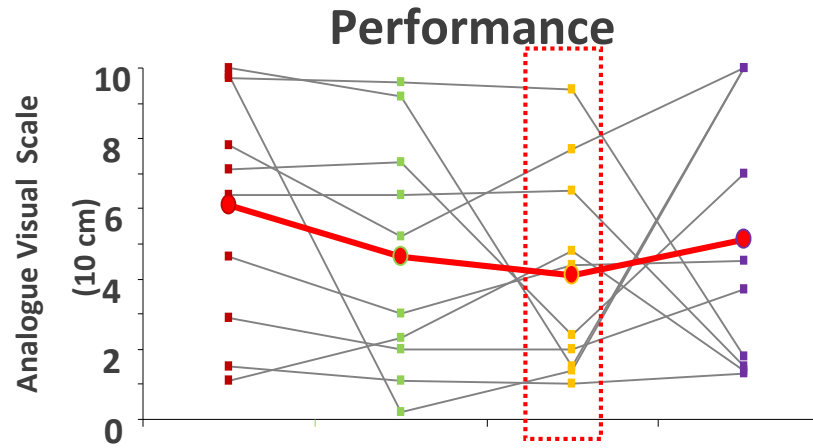
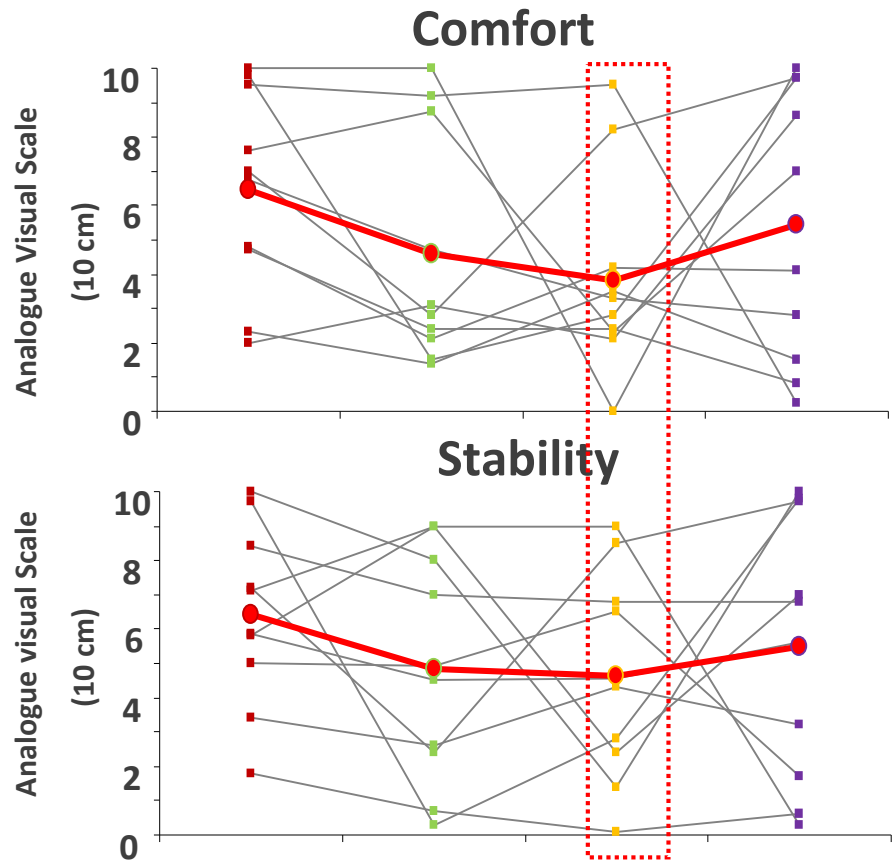
## Average Values



### Backrests:

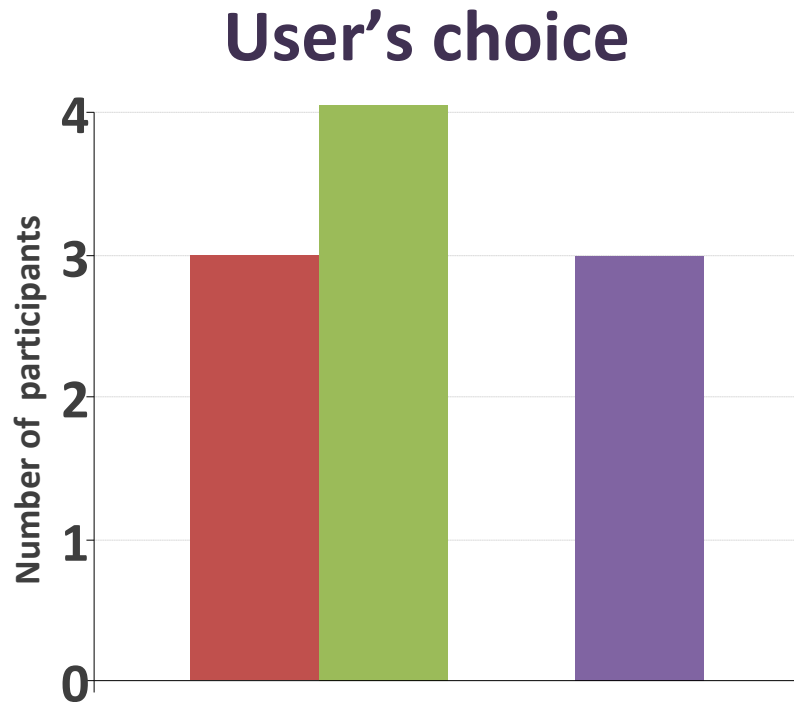
- Stand. Upholstry
- JAY 3 Thoracic S.
- JAY 3 Without
- Harmoni

# RESULTS – Qualitative Measures





# RESULTS – User's choices



90% Agreement  
between O.T. and  
User's Choices.

**Backrests:**

- Stand. Upholstory
- JAY 3 Thoracic S.
- JAY 3 Without T.S.
- Harmoni

# DISCUSSION

## **Spatial- temporal and biomechanical data remain similar**

- Globally the spatial-temporal data, the applied forces on the handrims, the mechanical efficacy, are comparable between the different types of backrests during the straight and slalom propulsion.

## **VARIABILITY of comfort, the stability and the perceived performance:**

- The comfort, the trunk stability and the performance remains also comparable between the different backrests.
- The final choice of backrests is moderately influenced by the perception of comfort, stability and performance, and this could explain the great variability of responses.

## **Principal limits of this study:**

- Small group of participants
- Experimental effort's
- Trial period of time

# CONCLUSION

- The results confirms the *importance of personalizing the therapeutic actions leading to the recommendations of different types of backrests, according to the effects on comfort, stability and performance, on the propulsion of a manual wheelchair.*
- *Further research seems necessary on this subject, with a larger group of experimented manual wheelchair users.*

# Our Thanks



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