Implications for an Exercise Prescription Authoring Notation

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Introduction

- In 2006, there were nearly 400,000 fitness professionals employed in the U.S.\[1\]
- Home-based, individualized exercise programs are an effective way to reduce fall risk in elderly populations\[2, 3\]
- “Exercise is Medicine”\[4\]
Motivation

- Not typically experts
- Dynamic content, static medium
- Rich media

CHEST - 1
Push-Up: Incline (Medicine Ball)

With chest one inch above ball, push up until arms are straight.

Do ___ sets.
Complete ___ repetitions.
Approach

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Implications for an Exercise Prescription Authoring Notation
Outline

- Related Work
- Methods
  - Case Study
  - Paper and Pencil Study[5]
- Results
  - Formative Studies
  - Prototype
  - Think-aloud Study
- Discussion
Related Work

- Video games
  - *Wii Fit*[^6]
  - *Yourself! Fitness*[^7]
  - Sinclair, et al. 2007[^8]

- Choreography

[^6]: Video game
[^7]: Video game
[^8]: Sinclair, et al. 2007
[^9]: Calvert, et al. 1993

Image Credit: “Dance and music of court and theater” By Wendy Hilton
Study # 1: Case Study

Research Question

What are the information needs of clinicians and their clients during the exercise prescription process?

- Patient examination and interview (P, T1)
- Meeting between two trainers (T1, T2)
- Training session and interview (P, T2)

Used grounded theory approach
Study # 2: Pencil and Paper Study

Goal
Investigate the language, structure, and spatial organization used by clinicians

- Questions: exercise prescription and description
- 5 males and 5 females, with 78 years combined experience
- From sports medicine graduate students to physical therapists

Analyzed with open coding
Exercise Communication

3. Resistance Band Row

- Closed door

*or*

- Heavy legged object

1. Resistance band looped around door handle (tied) or table leg

2. Stretch!
Exercise Communication

3. Resistance Band Bow

- closed door

or

Heavy-Legged Object

1. resistance band looped around door handle (tied) or table leg

2. stretch!
Exercise Communication

3. Resistance Band Row

- close door
- or
- Heavy-Legged Object

- resistance band looped around door handle (tied) or table leg
- stretch!

- What
- How
Exercise Communication

3. Resistance Band Row

- closed door
- or
- Heavy Legged Object

1. resistance band looped around door handle (tied) or table leg

2. stretch!

Quote from Case Study

... our entire job is based on communication. If they don’t understand, there is no point.
Prescription Organization

1) Beginner

- Goals
  - Fall reduction / fracture risk
  - Balance
  - Visual deficiency
  - Possible vestibular deficiency
  - Uses cane for ambulation

Warmup
- 10-15 min walking on treadmill
  - Goal is to increase walking capacity w/o cane
- Light stretching
  - Major muscle groups

Exercise
- Squat
  - 2 sets of 15
  - Can use support, but eventual shift to no support
- Split squat
  - 2 sets of 15
- Step ups
  - 4 directional or 3 directional (2 sets of 15)
  - Depending on comfort with book step
- Hip abduction w/ band resistance (Walking)
  - 10 reps each side

2 x / week (minimun)
Progress in this order
Prescription Organization

Risk Factors and Goals

- Beginner
  - Goals
    - Fall reduction / Fracture risk
    - Balance
    - Visual deficiency
    - Possible Vestibular deficiency
    - Users cane for ambulation

Warmup

10-15 min. walking on treadmill
- Goal is to increase walking capacity w/o cane

Light stretching
- Major muscle groups

Exercise

Squat
- 2 sets of 15
- Can use support, but eventual shift to no support

Split squat
- 2 sets of 15

Step ups
- 4 directional or 3 directional (2 sets of 15)
- Depending on comfort with each step

Hip abduction w/ band resistance (Walking)
- 10 reps each side

2x/ Week ( min)
Progress in this order

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Prescription Organization

1) Beginner
   - Goals
     - Fall reduction / fracture risk
     - Balance
     - Visual deficit
     - Possible vestibular deficit
     - Uses cane for ambulation

2x/week (2 minimum)
Progress in this order

Warmup
10-15 min walking on treadmill
- goal is to increase walking capacity w/o cane
- Light stretching
- Major muscle groups

Exercise
- Squat
  - 2 sets of 15
  - Can use support, but eventual shift to no support
- Split squat
  - 2 sets of 15
- Step ups
  - 4 directional or 3 directional (2 sets of 15)
  - Depending on comfort with back step
- Hip abduction w/ band resistance (Walking)
  - 10 reps each side

- Risk Factors and Goals
- Use of Lists
Prescription Organization

1) Beginner
   - Goals
     - Fall reduction/fracture risk
     - Balance
     - Visual difficulty
     - Possible vestibular difficulty
     - Uses cane for ambulation

   Warm-up
   - 10-15 min walking on treadmill
     - Goal is to increase walking capacity w/o cane
   - Light stretching
   - Major muscle groups

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   - Split squat
     - 2 sets of 15
   - Step ups
     - 4 directional or 3 directional (2 sets of 15)
     - depending on comfort with each step
   - Hip abduction w/ band resistance (walking)
     - 10 reps each side

   2x/week minimum
   Progress in this order

- Risk Factors and Goals
- Use of Lists
- Ordering
  - Created in order
  - Ordered as post-process
  - No specified order
Reversible Abstractions

Warm-up - (5 minutes)

Walking on flat surface (around the block, around his house)

Balance
Progression:
Using a chair back/table for support:
1. Shift weight from one foot to the other - unweighted foot off the ground for 1.2 sec. (Repeat 2x10)
2. Single leg balance 5 sec → 15 sec Repeat (2x10)
3. Chair lift-off (standing from seated position) 2x10
4. Single leg chair-lift-off 2x10

Agility
Using agility ladder (flat

Repeat each exercise twice

Strength
Upper body:
Wall presses 2x10
Resistance band low 2x10
Bicep curl 2x10
Tricep press 2x10 out of chair

Lower body:
Chair squats (seat touches lightly to chair) 2x10
Mini-drag lunges 2x10
Heel raises (supported) 2x10
## Reusable Abstractions

<table>
<thead>
<tr>
<th>Warm-up - (5 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking on flat surface (around the block, around his house)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Progression:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using a chair back/table for support:</td>
</tr>
<tr>
<td>1. Shift weight from one foot to the other - unweighted foot off the ground for 1-2 sec. (Repeat 2x10)</td>
</tr>
<tr>
<td>2. Single leg balance 5 sec to 15 sec Repeat (2x10)</td>
</tr>
<tr>
<td>3. Chair lift-off (standing from seated position) 2x10</td>
</tr>
<tr>
<td>4. Single leg chair lift-off 65 2x10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Using agility ladder (flatway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFF 2x</td>
</tr>
<tr>
<td>LFF 2x</td>
</tr>
<tr>
<td>RFB 2x</td>
</tr>
<tr>
<td>LFB 2x</td>
</tr>
<tr>
<td>Shuffle 2x</td>
</tr>
<tr>
<td>Slow ins/outs 2x</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Upper body:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall presses 2x10</td>
</tr>
<tr>
<td>Resistance band low 2x10</td>
</tr>
<tr>
<td>Bicep curl 2x10</td>
</tr>
<tr>
<td>Tricep press 2x10 out of chair</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lower body:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair squats (seat touches lightly to chair) 2x10</td>
</tr>
<tr>
<td>Mini-drag lunges 2x10</td>
</tr>
<tr>
<td>Heel raises (supported) 2x10</td>
</tr>
</tbody>
</table>

- **Grouping by**
  - **Goal**
Reusable Abstractions

Warm-up - (5 minutes)
- Walking on flat surface (around the block, around his house)

**Balance**
- Progression:
  - Using a chair back/table for support:
    1. Shift weight from one foot to the other - unweighted foot off the ground for 1.2 sec. (Repeat 2x10)
    2. Single leg balance 5 sec > 15 sec Repeat (2x10)
    3. Chair lift-off (standing from seated position) 2x10
    4. Single leg chair-lift-off 2x10
- Upper body:
  - Wall presses 2x10
  - Resistance band bow 2x10
  - Bicep curl 2x10
  - Tricep press 2x10 out of chair

**Agility**
- Using agility ladder (flat way)
  - RFF 2x
  - LFF 2x
  - RFB 2x
  - LFB 2x
  - Shuffle 2x
  - Slow in/out 2x
  - Repeat each exercise twice

**Strength**
- Lower body:
  - Chair squats (seat touches lightly to chair) 2x10
  - Mini-drag lunges 2x10
  - Heel raises (supported) 2x10

- Grouping by
  - Goal
  - Targeted body part
Reusable Abstractions

- Grouping by
  - Goal
  - Targeted body part
  - Time of performance

- Warm-up - (5 minutes)
  - Walking on flat surface (around the block, around his house)

- Progression:
  - Using a chair back/table for support:
    1. Shift weight from one foot to the other - unweighted feet off the ground for 1.2 sec. (Repeat 2x10)
    2. Single leg balance 5 sec > 15 sec Repeat (2x10)
    3. Chair lift-off (standing from seated position) 2x10
    4. Single leg chair-lift (4x6) 2x10

- Agility:
  - Using agility ladder (flat run)
    - RFF 2x
    - LFF 2x
    - RFB 2x
    - LFB 2x
    - Shuffle 2x
    - Slow ins/outs 2x
    - Repeat each exercise twice

- Strength:
  - Upper body:
    - Wall presses 2x10
    - Resistance band low 2x10
    - Bicep curl 2x10
    - Tricep press 2x10 out of chair

  - Lower body:
    - Chair squats (seat touches lightly to chair) 2x10
    - Mini-drag, lunges 2x10
    - Heel raises (supported) 2x10
Reusable Abstractions, II

- Mon: Warm-up + Balance + Agility + Cool-Down
- Tues: Warm-up + Agility + Strength + Cool-Down
- Wed: OFF
- Thurs: Warm-up + Balance + Strength + Cool-Down
- Fri: Warm-up + Agility + Balance + Cool-Down
- Sat: OFF
- Sun: Warm-up + Strength + Walk + Cool-Down
Cues

**Set position - stand tall**
- chest up, shldr down
- abs strong
- st. toes knees slightly out @ 11:00 & 11:00
- knees soft
- eyes front

**Sit down as if sitting in chair**
- hips to back wall
- wt on heels
- not lower than 90° knees

- Correct form
- Evidence
Cues

Set position
- Stand tall
- Chest up, shrug down
- Abs strong
- Feet knees slightly out at 11:00 & 1:00
- Knees soft
- Eyes front

Sit down as if sitting in chair
- Hips to back wall
- Weight on heels
- Not lower than 90° knees

Posture
Cues

**Posture**
- Stand tall
  - Chest up, shoulders down
  - Abs strong
  - Sit toes, knees slightly out @ 11:00 & 11:00
  - Knees soft
  - Eyes front

**Clock face**
- Sit down as if sitting in a chair
  - Hips to back wall
  - Weight in heels
  - Not lower than 90° knees
Cues

- Set position - stand tall
  - chest up, should down
  - abs strong
  - feet knees slightly out at 11:00 & 1:00
  - knees soft
  - eyes front

- Sit down as if sitting in chair
  - hips to back wall
  - wt on heels

- not lower than 90° knees
Cues

Set position - stand tall
- chest up, shldr down
- abs strong
- st toes, knees slightly out @ 11:00 & 1:00
- knees soft
- eyes front

Sit down as if sitting in chair
- hips to back wall
- wt on heels
- not lower than 90° knees

Posture
- Clock face
- Angles
- Metaphor
Cues

Set position - stand tall
- chest up, should down
- abs strong
- toes knees slightly out @ 11:00 & 1:00
- knees soft
- eyes front

Sit down as if sitting in a chair
- hips to back wall
- wt in heels
- not lower than 90° knees

- Posture
  - Clock face
  - Angles
  - Metaphor

- Sensation
Cues

Set position - stand tall
- chest up, shdr down
- abs strong
- toes knees slightly out @ 11:00 & 1:00
- knees soft
- eyes front

Sit down as if sitting in chair
- hips to back wall
- wt on heels
- not lower than 90° knees

- Posture
  - Clock face
  - Angles
  - Metaphor

- Sensation

- Do not...
Physical models are important when describing exercises.
- Anatomical models
- Pointing vs jargon
Parameterization of Exercises

- Repetitions and sets
Parameterization of Exercises

- Repetitions and sets
- Rhythm
Parameterization of Exercises

- Repetitions and sets
- Rhythm
- Kinematics
Prototype Designs

(a) Timeline View
(b) Grid View
(c) List View
(d) Prescription Viewer

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Study # 3: Think Aloud Study

Goal
Identify usability problems and understand the tradeoffs between the three interaction metaphors with our prototype.

- 10 tasks, questionnaire
- 5 males and 2 females, with 75 years combined experience
- 3 athletic trainers, 2 graduate students, 2 physical therapists

Analyzed using open coding
Think Aloud Study: Findings

- List view preferred
- Weekly workout view
- Adjusting the speed of the motion
- Audio cues are desirable
“When you are organizing a program, sometimes you just want to get the exercises in order, because you are already thinking about that kind of strategy, then you can go back and edit the parameters.”
Think Aloud Study: Quotes

- “When you are organizing a program, sometimes you just want to get the exercises in order, because you are already thinking about that kind of strategy, then you can go back and edit the parameters.”

- “Generally most programs need to be created in 4-6 minutes, with some original protocols taking planning time that is longer, maybe half an hour.”
Parallels to Programming

Creating an interactive exercise prescription and computer programming exhibit both similarities and differences.

- Both use abstraction and parameterization
- Exercise prescription is often *time constrained*
- Debugging facilities are necessary
- Cues loosely correlate to program comments
There exists a need for notations to allow clinicians to create interactive 3D exercise prescriptions.

An exercise prescription is a small program that requires organization, abstraction, cueing, and parameterization.

We have presented studies designed to understand the requirements for a notation to allow clinicians to create these programs.
Future Work

- Iterate on the prototype
- Requirements for the viewing environment
- Longitudinal clinical study
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- Study participants
- Dr. Margaret Burnett, Dr. Carlos Jensen, Christoph Neumann, and Amie Russel
- EUSES Consortium

Contact Info

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https://secure.engr.oregonstate.edu/wiki/infoviz/index.php/Main/ExercisePrescription
Study # 2: Pencil and Paper Study Tasks

Paper and Pencil Study Tasks (abbreviated)

1. Devise a prescription based on a patient history
2. Describe when the client should exercise
3. Describe a specific exercise in detail
4. Describe the materials that a client would get
5. Describe the motion in a video clip (2 questions)
7. Describe when modifications/progressions should be used and how they are described
8. Describe how sensation cues should be conveyed
9. Describe when the client should cease an exercise
10. Provide further comments
### Study # 3: Think Aloud Study Tasks

<table>
<thead>
<tr>
<th></th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>View the playback of an example regimen</td>
</tr>
<tr>
<td>2</td>
<td>Implement a short exercise regimen</td>
</tr>
<tr>
<td>3</td>
<td>Delete an exercise</td>
</tr>
<tr>
<td>4</td>
<td>Rearrange the exercise regimen in time</td>
</tr>
<tr>
<td>5</td>
<td>Edit the parameters of an exercise</td>
</tr>
<tr>
<td>6</td>
<td>Edit the description of an exercise</td>
</tr>
<tr>
<td>7</td>
<td>Edit the default parameters for an exercise</td>
</tr>
<tr>
<td>8</td>
<td>Add prompts to the regimen</td>
</tr>
<tr>
<td>9</td>
<td>Save and load a protocol</td>
</tr>
<tr>
<td>10</td>
<td>View the playback of the new regimen</td>
</tr>
</tbody>
</table>
References I

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