Is the motion of a child perceivably different from the motion of an adult?

Eakta Jain†, Lisa Anthony†, Aishat Aloba†, Amanda Castonguay‡, Isabella Cuba§, Alex Shaw†, Julia Woodward†
†University of Florida
‡University of Southern Maine, §Vassar College

Presented at the Symposium on Applied Perception July 22, 2016
Motivation

Children and adults seem to move differently, is it perceivable?

“Run as Fast as You Can”

p921 – adult – run fast

p290 – child – run fast
Motivation

Understanding child motion can improve animation, interaction applications

Disney Pixar’s Inside Out with 11 year old Riley

Exercise games for children, e.g., http://init.cise.ufl.edu/?q=Kinect
Motivation

Motion data for Jumping Jacks for an adult and a child

not scaled, pelvis locked
Related Work

• Studies of child motion (motion capture)
  • Quantifying and detecting sensorimotor impairments in children and teens
    [Delp et al, 2007; Rosengren et al, 2009; Sandlund et al, 2009; Sakuma et al, 2012; Chia et al, 2013]
  • Comparing kinesthetic characteristics of child and adult motion
    [Davis, 2001; Ivanenko et al, 2013]
Related Work

• Studies of child motion (motion capture)
  • Quantifying and detecting sensorimotor impairments in children and teens
    [Delp et al, 2007; Rosengren et al, 2009; Sandlund et al, 2009; Sakuma et al, 2012; Chia et al, 2013]
  • Comparing kinesthetic characteristics of child and adult motion
    [Davis, 2001; Ivanenko et al, 2013]

• Perception of human motion (point light displays) [Johansson, 1973]
  • Identification of gender [Cutting, 1978; Barclay et al, 1978; Pollick et al, 2002; Brooks et al, 2008]
  • Identification of emotion [Dittrich et al, 1996; Atkinson et al, 2004]
Related Work

• Studies of child motion (motion capture)
  • Quantifying and detecting **sensorimotor impairments** in children and teens [Delp et al, 2007; Rosengren et al, 2009; Sandlund et al, 2009; Sakuma et al, 2012; Chia et al, 2013]
  • Comparing **kinesthetic characteristics** of child and adult motion [Davis, 2001; Ivanenko et al, 2013]

• Perception of human motion (point light displays) [Johansson, 1973]
  • Identification of **gender** [Cutting, 1978; Barclay et al, 1978; Pollick et al, 2002; Brooks et al, 2008]
  • Identification of **emotion** [Dittrich et al, 1996; Atkinson et al, 2004]
  • Identification of **self, friends, strangers** [Cutting & Kozlowski, 1977; Beardsworth & Buckner, 1981; Loula et al, 2005; Wellerdiek et al, 2013]

What’s missing? Perception of child motion.
Research Question

• Is the motion of a child perceivably different from the motion of an adult?

<table>
<thead>
<tr>
<th>Jumping Jacks</th>
<th>Fly Like a Bird</th>
<th>Jump High</th>
<th>Run Fast</th>
<th>Walk</th>
<th>Wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>Adult</td>
<td>Adult</td>
<td>Adult</td>
<td>Adult</td>
<td>Adult</td>
</tr>
<tr>
<td>Child</td>
<td>Child</td>
<td>Child</td>
<td>Child</td>
<td>Child</td>
<td>Child</td>
</tr>
</tbody>
</table>

*frames from our point light display videos for each action type*
Stimuli Preparation

Motion data from 4 adults (ages 22-32, male) and 4 children (ages 5-9, 2 female)

<table>
<thead>
<tr>
<th>Hip CenterX</th>
<th>Hip CenterY</th>
<th>Hip CenterZ</th>
<th>...</th>
<th>Foot RightZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.17374</td>
<td>-0.30287</td>
<td>3.197146</td>
<td>...</td>
<td>3.195797</td>
</tr>
<tr>
<td>-0.16883</td>
<td>-0.30114</td>
<td>3.200149</td>
<td>...</td>
<td>3.198999</td>
</tr>
<tr>
<td>-0.16739</td>
<td>-0.30105</td>
<td>3.201977</td>
<td>...</td>
<td>3.200875</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>-0.21039</td>
<td>-0.27464</td>
<td>2.879612</td>
<td>...</td>
<td>2.823143</td>
</tr>
</tbody>
</table>

sample of joint data from Kinect
Stimuli Preparation

Motion data from 4 adults (ages 22-32, male) and 4 children (ages 5-9, 2 female)

<table>
<thead>
<tr>
<th>Hip CenterX</th>
<th>Hip CenterY</th>
<th>Hip CenterZ</th>
<th>Foot RightZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.17374</td>
<td>-0.30287</td>
<td>3.197146</td>
<td>3.195797</td>
</tr>
<tr>
<td>-0.16883</td>
<td>-0.30114</td>
<td>3.200149</td>
<td>3.198999</td>
</tr>
<tr>
<td>-0.16739</td>
<td>-0.30105</td>
<td>3.201977</td>
<td>3.200875</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>-0.21039</td>
<td>-0.27464</td>
<td>2.879612</td>
<td>2.823143</td>
</tr>
</tbody>
</table>

Sample of joint data from Kinect

Height scaling formula (moves camera)

$$\mu_y = \frac{\sum_{i=1}^{N} \sum_{j=1}^{20} y_{ij}}{20 \times N}$$
Stimuli Preparation

Motion data from 4 adults (ages 22-32, male) and 4 children (ages 5-9, 2 female)

<table>
<thead>
<tr>
<th>Hip CenterX</th>
<th>Hip CenterY</th>
<th>Hip CenterZ</th>
<th>...</th>
<th>Foot RightZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.17374</td>
<td>-0.30287</td>
<td>3.197146</td>
<td>...</td>
<td>3.195797</td>
</tr>
<tr>
<td>-0.16883</td>
<td>-0.30114</td>
<td>3.200149</td>
<td>...</td>
<td>3.198999</td>
</tr>
<tr>
<td>-0.16739</td>
<td>-0.30105</td>
<td>3.201977</td>
<td>...</td>
<td>3.200875</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>-0.21039</td>
<td>-0.27464</td>
<td>2.879612</td>
<td>...</td>
<td>2.823143</td>
</tr>
</tbody>
</table>

Sample of joint data from Kinect

Height scaling formula (moves camera)

\[ \mu_y = \frac{\sum_{i=1}^{N} \sum_{j=1}^{20} y_{ij}}{20 \times N} \]

p337 – child – jumping jacks
Stimuli Dataset

• 48 point light display videos
  • 8 actors (4 adults, 4 children) x 6 actions
  • Available for download at http://jainlab.cise.ufl.edu/pose-perception.html
Studying “natural motion”

Number of repetitions were similar but children’s actions were shorter in duration: children were more rapid in their motions

“Run as Fast as You Can”

p921 – adult – run fast

p290 – child – run fast
Studying “natural motion”

Number of repetitions were similar but children’s actions were shorter in duration: children were more rapid in their motions

<table>
<thead>
<tr>
<th>Actions</th>
<th>Mean Time (seconds)</th>
<th>Mean No. Repetitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Like a Bird</td>
<td>4.7 [1.2]</td>
<td>5.6 [1.3]</td>
</tr>
<tr>
<td>Jump High</td>
<td>2.8 [0.8]</td>
<td>2.4 [0.4]</td>
</tr>
<tr>
<td>5 Jumping Jacks</td>
<td>5.0 [0.3]</td>
<td>5.8 [0.6]</td>
</tr>
<tr>
<td>Run Fast</td>
<td>3.5 [1.0]</td>
<td>4.1 [0.9]</td>
</tr>
<tr>
<td>Walk in Place</td>
<td>6.6 [1.1]</td>
<td>7.4 [1.0]</td>
</tr>
<tr>
<td>Wave</td>
<td>4.1 [0.9]</td>
<td>5.0 [1.0]</td>
</tr>
</tbody>
</table>

“Jump high” motion only one with different numbers of repetitions for children / adults
Prelim Study: Person-Not-a-Person

Q: is our dataset sufficient to conduct a perception study?

• “random” stimuli videos

p921 – adult – jumping jacks
Prelim Study: Person-Not-a-Person

Q: is our dataset sufficient to conduct a perception study?

- 5 participants (ages 19-26, 2 male)

accuracy above 90% for all survey participants
Main Study: Child vs Adult

Q: are child and adult motion perceived different, w/o appearance, absolute scale?

• 24 participants (ages 20-37, 3 female)
Findings

People can accurately identify motion as belonging to a child or adult

- Accuracy above 50% chance for all survey participants
- Adult and child both significantly above chance ($p < .05$)
Findings: Video

People can accurately identify motion as belonging to a child or adult

“Jumping Jacks”

p921 – adult – jumping jacks

p644 – child – jumping jacks
Findings

Dynamic actions involving the whole body are more readily distinguished

accuracy above 90% for all survey participants
Findings: Video

Dynamic actions involving the whole body are more readily distinguished

“Fly Like a Bird”

p921 – adult – fly like a bird

p290 – child – fly like a bird
Findings: Video

Dynamic actions involving the whole body are more readily distinguished

“Run as Fast as You Can”

p921 – adult – run fast

p290 – child – run fast
Findings

Younger and older children show perceivable trends as well

younger and older both significantly above chance ($p < .05$)
Findings: Video

Younger and older children show perceivable trends as well

“Jumping Jacks”

p644 – older child – jumping jacks

p290 – younger child – jumping jacks
Summary

• First study of the perception of child motion compared to analogous adult motion:
  • application of the point light display paradigm towards studying the movement of young children and adults performing the same actions
  • finding that naive viewers can identify a motion as belonging to a child actor or an adult actor in a two-alternative forced choice task at better-than-chance levels
Future Work

• **Expansion of study** to more actions, other actors, older or younger children actors, participants more familiar with child motion

• Investigation of **quantitative differences** that characterize the perceivable child-like motion characteristics
Thank you!

For more information:

• **Eakta Jain:**
  ejain@cise.ufl.edu

• **Lisa Anthony:**
  lanthony@cise.ufl.edu

• **Website:**
  http://jainlab.cise.ufl.edu/pose-perception.html

• **The authors wish to thank University of Florida students Nathan de Krey and Zsolt Szabo, who both worked on early versions of the Microsoft Kinect skeleton tracking and data collection software.**