High- and Low-Tech Approaches to Assessment and Intervention in Infants

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Disclosure

The authors declare that they have no conflicts of interest.
Objectives

1. Describe the developmental trajectory of commonly observed spontaneous movements in pediatrics.

2. Explain how different types of technology are used to measure spontaneous and purposeful movements in pediatrics.

3. Discuss examples of how low- and high-tech assessment can be used to guide treatment approach.

4. Discuss important issues and challenges associated with novel technologies for assessment and intervention.
The Key Challenge & Fun of Early Intervention

• Understanding how newborns evolve into walking, talking, problem-solving, social individuals
  – Critical for early identification of delays
  – Critical for designing effective interventions
Limitations of current infant assessments

• Standardized assessments for infants
  – Many utilize a Checklist mentality – If you can do something one way during one assessment, you receive credit. Do not assess variability and/or adaptation.
  – Are snapshots of performance, and infant performance is highly variable.
  – Do not reflect typical performance in everyday situations.
Best Practice Recommendations for Assessment

• Across:
  – Tasks
  – Contexts
  – Time
• Require a lot of resources – personnel, family, temporal, financial
• Technology may be able to make these recommendations more feasible without increased financial or temporal burden on families and professionals
Best Practice for Intervention

Infant-directed
Integrated into daily routine
High dosage/repetition
Aims of the Session

1) Describe the developmental trajectory of commonly observed spontaneous movements in pediatrics and review key early behaviors that are important for future motor and cognitive development
Aims of the Session

2) Provide examples of how low- and high-tech assessment can be used to guide treatment approach by characterizing key early behaviors
   – In the research realm
   – In the commercial realm
3) Explain how different types of technology are used to measure spontaneous and purposeful movements in pediatrics
Aims of the Session

4) Discuss important issues and challenges associated with novel technologies for assessment and intervention
Questions? Comments?
Aim 1 of the Session

• Describe the developmental trajectory of commonly observed spontaneous movements in pediatrics and review key early behaviors that are important for future motor and cognitive development
Bias to move

• *In Utero*
  – Isolated limb movements at 8-9 weeks gestational age
• Spontaneous
• Purposeful
• Infancy
  – Spontaneous
• Kicking, flapping, writhing, fidgety
  – Purposeful
• Reaching, walking, crawling, looking
A Theoretical Model for Early Exploration & Learning

• Learning about one’s body, the world, and the interactions among them is constructed, shaped, and maintained through everyday, frequent, variable exploration that is grounded in perceptual-motor experiences

  – Exploration of self
  – Exploration of objects
  – Exploration of others

  And exploration of their interactions
Amount & Variability May Be Key

• Across behaviors relative to infants with typical development, infants at risk generally show:
  – Differences (typically less) in terms of amount of behavioral performance than infants with typical development
  – Less variability in the behaviors they perform
What Might This Mean for Learning & Development?

• Less daily training for strength and motor control
• Building strong movement habits that are less variable and flexible to change
• Future behaviors draw from existing behaviors and the tool kit for selection is smaller
• Less information gathering about one’s body, surfaces, objects, others, and their interactions
• Poorer learning
Exploration of Self

• Head/trunk movement and lifting against gravity – COP in supine & sitting, head lifting in prone, head in midline
• Leg movement and kicking
• Arm movement, hand posturing, hand to mouth, looking at the hands
Center of Pressure in Supine & Sitting

• Typical development include a variety of movement strategies which provide a perceptual information

• Varied practice is needed
Early Kicking and Future Walking

Differences in infant kicking behavior:
= can be observed as early as 1 month (preterm)
= related to delayed onset of independent walking
(Down syndrome, preterm, myelomeningocele)

BUT: We have not shown cause and effect: that increasing or decreasing in infant kicking rates or characteristics has an effect on walking.
Perceptual-motor Exploration of the Head

• 2 weeks of training improved head control for young infants
Head Lifting & Midline Positioning

- From 0 through 9 months corrected age:
  - Less head lifting in prone for infants born PT and even less for those born PT with a significant brain injury
  - Less time holding the head in midline for infants born PT with brain injury in prone, and for all infants born PT in supine
Midline Positioning of the Hands

• From 0 through 24 months corrected age:
  – Less time with 1 or both hands in midline in prone and sitting for infants born PT
  – No differences in supine
Time Spent With Hand(s) Fisted

- From 0 through 24 months corrected age:
  - More time with 1 hand asymmetrically fisted in prone, supine, and sitting for infants born PT – even though only 1 child in sample ended with a diagnosis of hemiplegic CP
  - No systematic differences in time with both hands fisted
Exploring the Hand Via Mouthing or Looking

• From 0 through 9 months corrected age:
  – Less time mouthing the hand(s) for infants born PT; No differences in prone or sitting
Exploration of Objects

• From 0 through 6 months corrected age:
  – Less time exploring objects for infants born PT
Bimanual Exploration & Manipulation of Objects

• From 0-24 months corrected age:
  – Less bimanual exploration and manipulation of objects for infants born PT
Potential Early Identifiers of Atypical Development

• Less:
  – Variability in center of pressure and leg kicking patterns
  – Head lifting in prone
  – Midline positioning of the head and hands
  – Hand to mouth behavior
  – Looking at hands
  – Time exploring the body and objects, time exploring objects with both hands
  – Multimodal exploration of objects (looking while handling)
  – Matching of exploratory behavior to take advantage of the properties of objects
  – Variability of types of exploratory behaviors used to explore the body and objects
  – Bouts of exploratory behaviors
Questions & Discussion
Aims 2 & 3 of the Session

• Provide examples of how low- and high-tech assessment can be used to guide treatment approach by characterizing key early behaviors
  – In the research realm
  – In the commercial realm
• Explain how different types of technology are used to measure spontaneous and purposeful movements in pediatrics
Potential of technology (but also challenges!)

• Observing these behaviors across contexts (with different body positions, tasks, objects, etc.)
• Quantifying these behaviors in a meaningful and accurate manner across large samples of time
Potential of Technology

• To improve early identification of delayed performance
• To assess the effects of interventions on daily perceptual-motor performance
• To provide feedback for caregivers and therapists to maximize performance of desired activities
Response to the environment

• Kicking in rat pups (Robinson, 2008)
• Tensile properties of uterus
  – Affords alternating kicking in utero
  – Alternating leg movements in rat infancy
• Yoked kicking in utero
  – More bilateral kicking

• Evidence of early motor learning (i.e. before birth), importance of the environment
Mobile Paradigm

Infant’s leg tethered to a Mobile
Conjugate Reinforcement

2-6 month old infants

Tool in Developmental Psychology
(Rovee, CK & Rovee, DT 1969)
To study Memory
Mobile Paradigm
Low and High Technology Approaches
Mobile Paradigm

• Very specific types of movement causes mobile movement
• Coordination
  – Touch a platform (Chen 2002)
  – Discovery learning (Fetters and Sargent, 2014)
» Including at-risk (for movement disability) populations
Feet reaching, learning, LE coordination
Learning using touch screen technology
Kidology

• Touchscreen technology rapidly changing and improving
  – Double touch, 5 point touch, 11 point touch
  – Flexibility and placement of touchscreen materials – limitless application for pediatrics
• Rehab-Engineering team
• Specifics
  – Ages 18 months – 3 years
  – Before hand preference
  – Take advantage of developmental plasticity
Problem

• Upper extremity dysfunction
• Early neglect
  – Because a less affected arm can be used to complete the task
• Window for early plastic changes
  – Three important things to know
  1. Use it or lose it
  2. Earlier intervene the better
  3. Motivation to use the affected limb difficult (early childhood)
  – Sensory and motor impairment
Hand function and Learning

video
Kidology and Telemedicine
Current Solution

• Infant
  – Assessment of early milestones
  – Passive screen-based games (screen time)
• Active exploration (like the mobile paradigm) is more predictive (Lobo and Galloway, 2014)
• Evaluation of learning outside the research lab
  – Compliance and tracking
  – Telemedicine
  – Emerging all day monitoring
CCHD example

• Infants with complex congenital heart disease (CCHD)
Early Kicking and Future Walking

Infants with typical development, 1-12 months of age (n=12) full-day of wearable sensors on legs (8-12 hours) 3 recordings, 2 month intervals Walking onset (3 independent steps per parent report)

-Infants who moved more had a later onset of walking! Note: all leg movements measured, not only kicking movements
Early Kicking and Future Walking

Smith et al, Sensors, 2015
Full-day arm movement bouts

figure showing full day arm movement bout quantity, adjusted for hours of awake time

Smith et al, under review
Full-day arm movement bouts

Smith et al, under review

figure showing full day arm movement bouts: percent right arm only, left arm only, or both arms moving.
Interaction With Objects Allows for Causal Learning

• Importance of causal learning & intentional understanding
• Examples of early causal learning – pacifier sucking, mobile paradigm, means-end
• Advanced for children who reach and explore more earlier
• Delayed for infants at socioeconomic or biological risk
Wearable Technology
Using Sensor Technology:
Making It Soft & Comfortable
Textile Sensors for
Softer Smart Clothing
Applications for Rehabilitation

- Assessment – tracking activity, identifying atypical activity
- To motivate activity performance
- Feedback to change activity performance
- Enabling interaction & user control of environmental factors, communication devices, mobility devices, etc.
Applications for Health Promotion & Injury Prevention
Smart Garments That May Be Useful for Rehabilitation

Sensoria Sock:
Feedback on foot pressure, step count, speed, calories, altitude, distance
Smart Garments That May Be Useful for Rehabilitation

Athos Gym Clothing: Feedback on which muscles are active, heart rate, and breathing
Pediatric Wearable Tech

Mimo Baby Products:  
  Feedback on body temperature, position, activity, and sleep

Owlet Smart Sock:  
  Feedback on heart rate and oxygen saturation
Pediatric Wearable Technology: Early Detection

Embrace By Empatica:
Feedback on physiological state related to seizures
Pediatric Wearable Technology: Fitness

Miiya Watch: Feedback on physical activity in game form
Questions & Discussion
Aim 4 of the Session

4) Discuss important issues and challenges associated with novel technologies for assessment and intervention.
Potential of technology

• Observing these behaviors across contexts (with different body positions, tasks, objects, etc.)
• Quantifying these behaviors in a meaningful and accurate manner across large samples of time
Challenges of technology

- Determination of a normative gold standard for new measures
- What is it actually measuring? How accurate?
- Making technology comfortable and easy to use
- Gathering data
- Cleaning and processing data
- Determining thresholds
- Determining how to summarize and provide feedback to users, clinicians, family, others
- Medical device or not? FDA
What is a medical device?

A medical device is "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is:

- recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them,
- intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals,
- intended to affect the structure or any function of the body of man or other animals, and which does not achieve any of its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes."

Is Owlet FDA approved?

"Owlet is not yet FDA approved. Though that is something we are working toward."
What Is Owlet's Disclaimer?

Please use common sense and remember:

1) Do not use Owlet as a diagnostic tool.
2) Do not use Owlet if your doctor recommends the use of a hospital pulse oximeter.
3) Do not use Owlet if your doctor recommends the use of a hospital apnea monitor.
4) Do not use Owlet as an excuse for unsafe sleep habits.

We wanted to make sure the above points were clear, but here is our full disclaimer.

Disclaimer: Owlet is intended to provide peace of mind. It is not intended to diagnose, treat, mitigate, cure, or prevent any disease or condition. This is not a medical device and is not intended for use as a medical device or to replace a medical device. The Owlet Baby Monitor is only intended to assist you in tracking your baby’s wellbeing and is not intended to replace you as a caregiver. You are ultimately responsible for your baby. This device is not intended to cure, treat, or prevent any disease or health condition, including, but not limited to, Sudden Infant Death Syndrome (SIDS).

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Pediatric Wearable Tech

Sproutling has joined the Mattel family.
Together we’re building smart products for parents.

Thank you! Click the link in the email we just sent you to confirm your wait list sign up.

Baby wearable.
A wearable specially designed for babies that monitors heart rate, motion, and position to give you peace of mind.

Sleep well.
Get insights into your baby’s sleep patterns and environment to learn how to help them sleep better.

Smart.
Sproutling learns about your unique baby and gets better over time.

You’ve got this.
We make parenting less worrisome and more fun by taking away some of the guesswork.
Measurement and accuracy

- What about fitbit, actical, actigraph, etc.....
Intervention

Currently in development

Others are developing similar systems, this is just one example (Lobo, Smith, Kolobe, Sargent & Fetters, etc....)
Low and High Tech in Prone Play

AAP recommendations

Evidence of lack of meeting
Low tech approaches

The Ins and Outs of Tummy Time

What is tummy time?
Any activity that keeps a baby from lying flat on his or her back against a hard, supporting surface is considered “tummy time.” Tummy time should always be supervised and serves as a good opportunity to interact, play and bond with a baby. Tummy time is essential for babies of all ages and, with proper head support, can be started from day one. When your baby is awake, position them on their tummy and/or off their back as frequently as possible.
High tech approaches

Example of PPAC - 2 video clips

Non-reinforced

Reinforced
Pilot data

Increase prone head lift and duration
Parent and Daycare feedback
Questions & Discussion
References

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References


