Motor Development

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Introduction

- Motor development can offer fresh insights into processes of learning and development.
- The study of motor development can address issues that have challenged developmental scientists.
- The strategy is to focus on 10 general developmental issues that are broadly relevant to developmental science.
- The issues are loosely organized into embodied movement, embedded action, and enculturated interaction.

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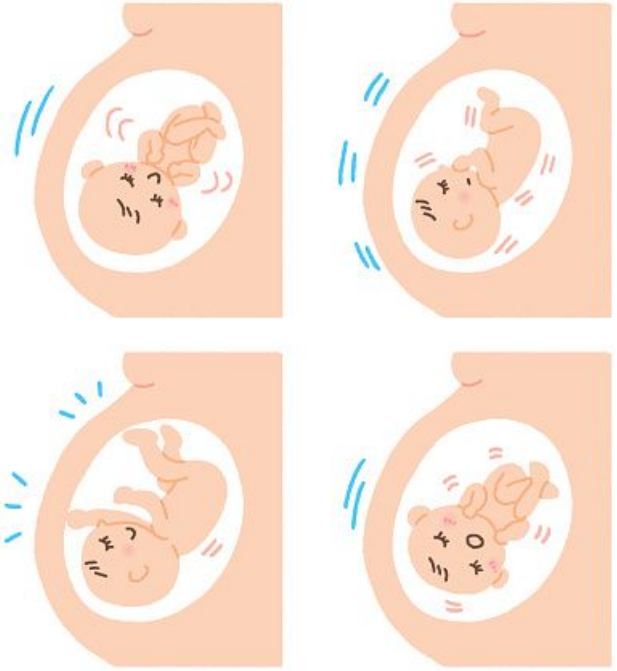
Incidental Activity and Consequential Function

Fetal Movements

- Fetal movements appear at 5-6 weeks after conception
- Various movements and postures during the first trimester
- Why do fetuses move?
    - Necessary for proper physical development
    - Helps shape neural development
- Not just random movements!



Infant Movements

- Infants display many different spontaneous movement patterns
  - Kickings, flailing, wiggling, etc
- Why do they do this?
  - Provide practice for eventually intentional movements
    - exg) reaching for something

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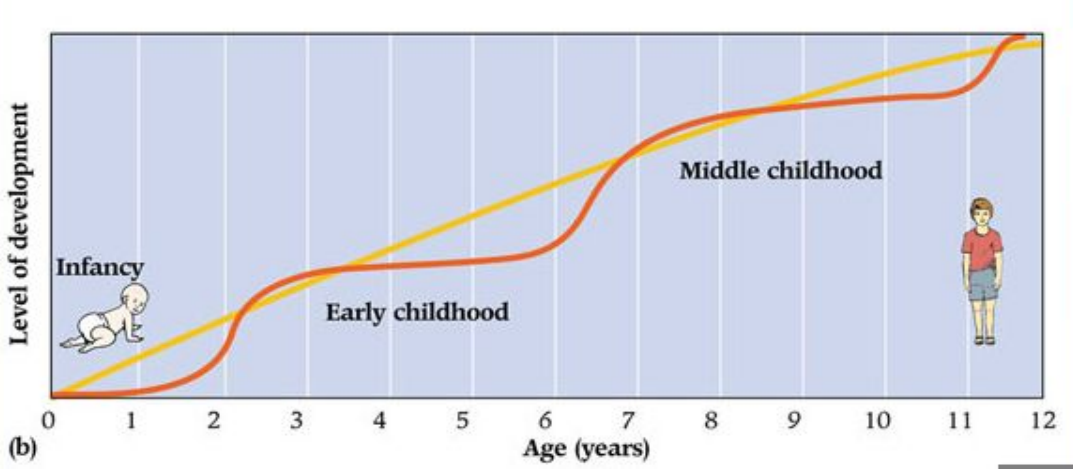
Developmental Continuity

Behavioral Similarities

- Some behavior that infants exhibit seem similar to adult behavior
- Examples of this include
  - Grasping, swimming, upright stepping
- Three possibilities
  - No relation between the behaviors
  - They are related historically, but are different
  - They are identical



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Intraindividual variability

Intraindividual Variability in Motor Development

- Developmental research often focuses on differences in average performance, but intraindividual variability is a meaningful measure of motor development.
- Example
    - motor skills becoming increasingly smooth and precise with age and experience.
- Understanding intraindividual variability in motor development can provide insights into the developmental process

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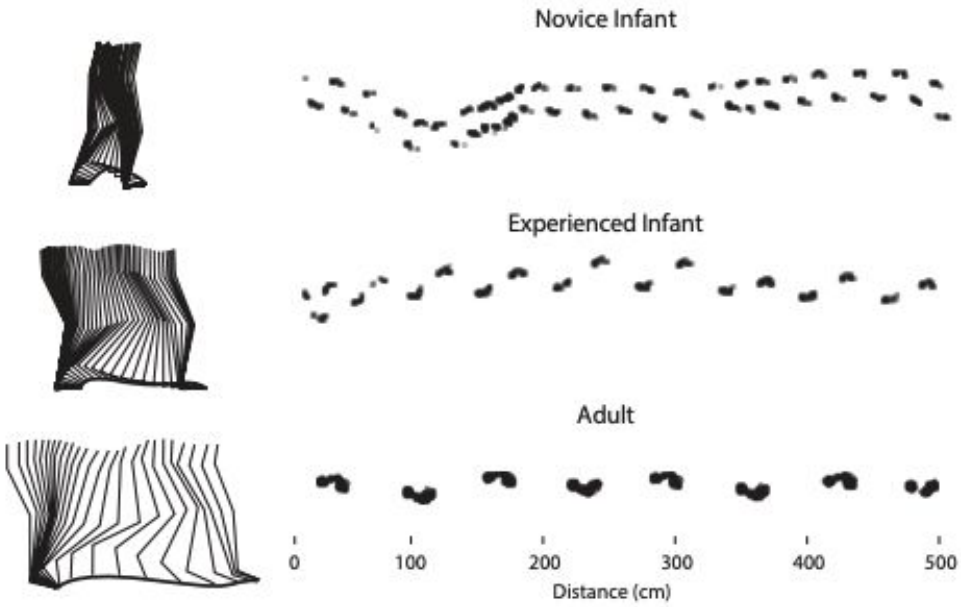
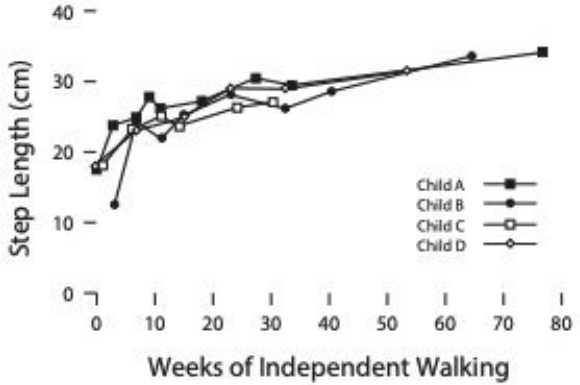
Elapsed time and developmental change

Important of Sampling





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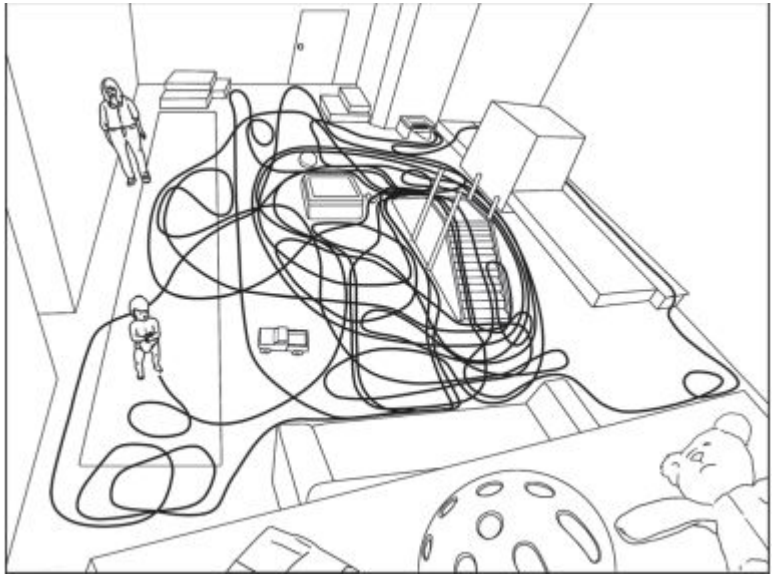
Learning By Doing and Exploring

Exploration of the Environment

- Infants are naturally motivated to explore the environment.
- Motor development initially limits and then expands the effective environment.
- Information from a distance can prompt exploration by direct contact.
    - Friction / rigidity can only be determined from direct contact



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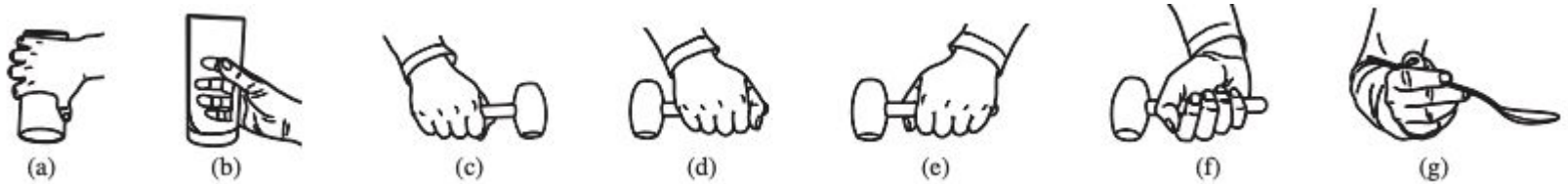
Prospective control

Planning and Innovating

- Prospective control is an adaptive way to adopt motor control strategies
- Split up into 3 steps
  - Formulate a Plan
  - Modify the Plan
  - Make a New Plan
- Infants exhibit this multi step action planning
  - Able to graph spoons in various orientations by 9-14 months



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Affordances for action

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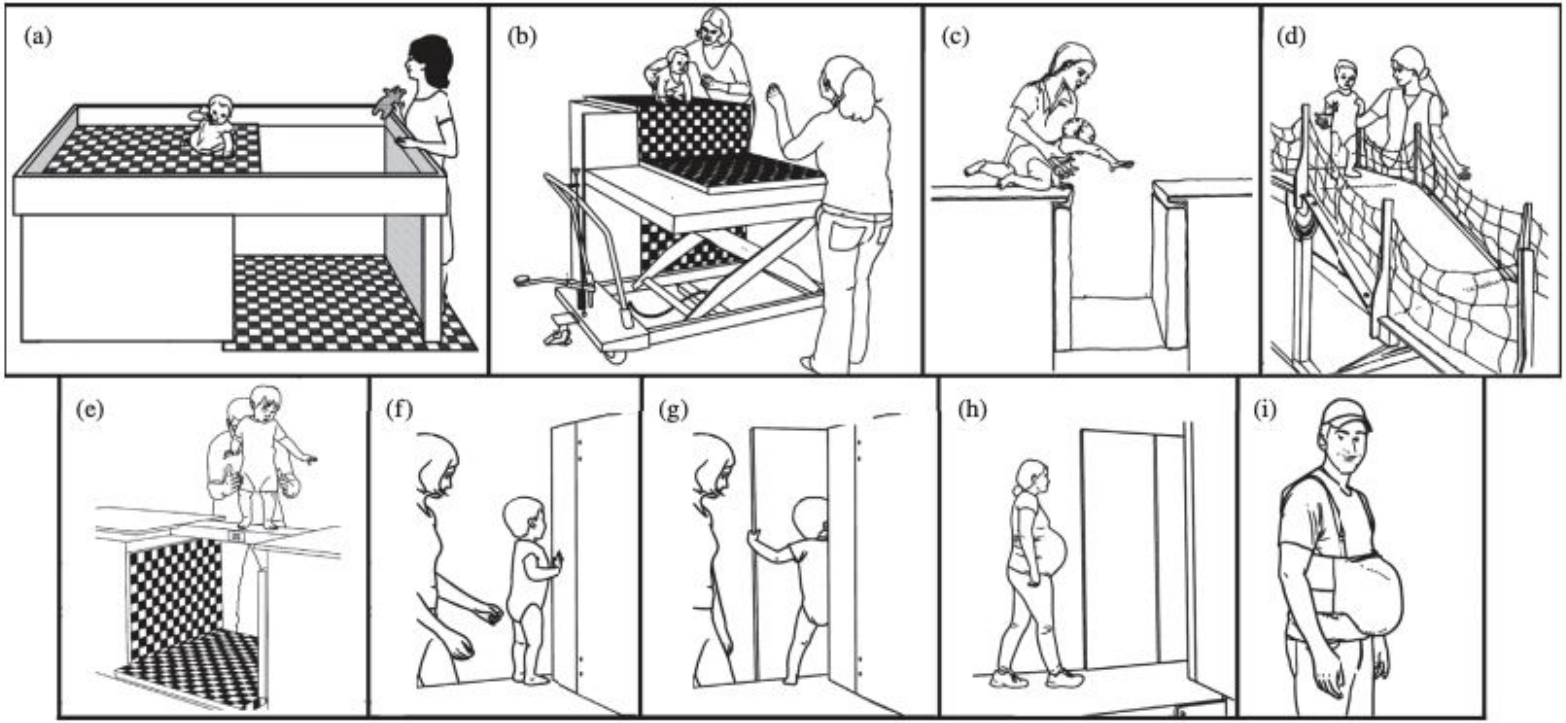
Perceiving Affordances

- Infants are born with perceptual-motor skills, and they learn to generate and detect information for affordances at each moment.
- Infants are “Learning to learn to move”
- Learning to learn to move entails variable experiences over a long time, which is not a real limitation for motor development.
- Development puts limits on the flexibility of learning because new action systems create entirely new affordance relations.

Infants Perception of Affordances



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Social and cultural context

Culture and Motor Development

- The cultural and parental conditions can have a significant effect on motor development
  - exg) Turkish Crawlers

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Motor development as a developmental cascade

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Developmental Cascades

- Motor development can trigger a cascade of events that lead to learning and development in seemingly unrelated areas.
- Performing a manual action prior to viewing a display can enhance mental abilities, visual anticipation, attention to others' intentions, and perception of causal relations.
- Crawling experience is related to increased anger, sensitivity to optic flow, differentiation of object motion, and more flexible memory.
- Walking experience leads to more object carrying, object interactions, and engagement with distal objects.

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Discussion

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Priya Thanneermalai 12 hours ago

Out of the 10 salient points brought to light in this paper, I found the one about “how children recognize what they can and cannot do in a particular situation” interesting. Toddlers by the age of 1 learn not to touch sharp or hot objects! This is by imitation learning or touching it and experiencing pain which acts as a sharp reminder the next time they find hot or sharp objects in their environment. This is somewhat like negative rewards given to robots upon taking an action that must not be taken. However, I wonder how much of this memory that children seem to have (the last incident was painful) can be transferred to robots? Since the idea of giving negative rewards could depend on the quantity as well since a larger negative reward discourages robots more from taking that action again as compared to a smaller negative reward.

helpful! | 0

Maxwell Li (maxwelli) 8 hours ago

Actions

I also found this really interesting! I wonder if it could be tied into the curiosity that we have seen through some reinforcement learning algorithms. Like once the model knows that this is something that could harm them the curiosity would just drop to 0 and there would be no drive to interact with it.

helpful! | 0

Benjamin Steinig (bsteinig) 8 hours ago

I really like the idea that Maxwell had about this, using intrinsic negative rewards to influence curiosity based learning is an interesting way to push the agent to explore more fruitful areas of its environment. I wonder if there might be someone to apply this idea to the ICM reinforcement learning of the Super Mario game. The Mario agent ended up getting stuck due to a large hole, but received no negative penalty for repeatedly falling into the hole and having to restart. If the agent had negative rewards for harmful actions it may have been able to learn to navigate past that point. (if it also was able to plan enough moves in advance for that particular situation).

helpful! | 0

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Haoyuan Ma 1 hour ago

The paper suggests the social environment also matters in the development. Mother's facial expression and particular way of taking care of the baby might influence its development. How should we incorporate this into our model? It sounds like something similar to few shot learning. The same model (the baby) can have different potentials depend on the environment it learns.

helpful! | 0

Wenfan Jiang 1 hour ago

I agree with this idea. The behaviors of the caregivers will influence the development, but generally they will all grow to the same direction, which is exactly like few shot learning in downstream tasks.

Questions?