

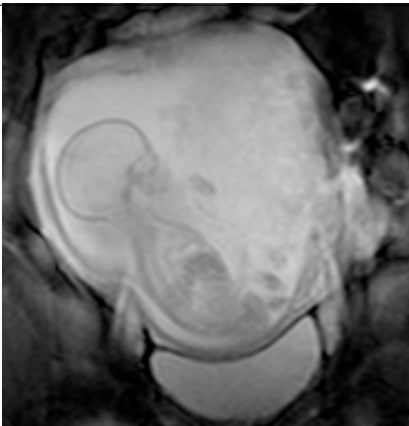
DEVELOPMENT OF THE MOTOR SYSTEM

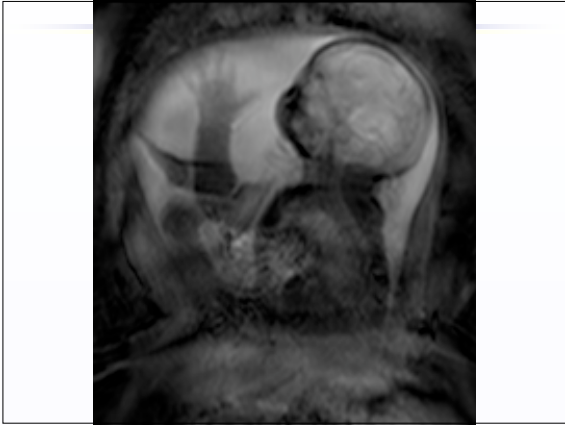
HDP1: Fall 2007

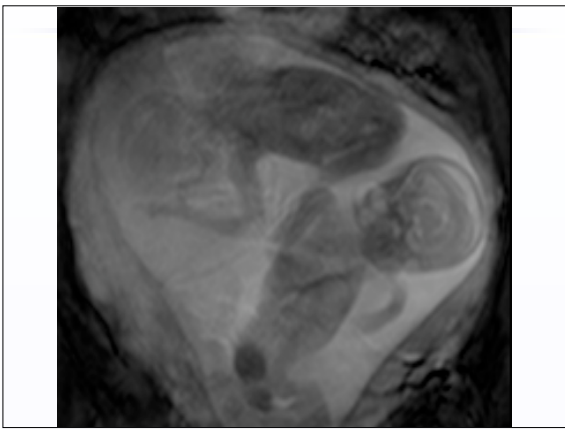
Joan Stiles
Department of Cognitive Science
University of California, San Diego

Motor system development begins during the Prenatal period

- Thalamocortical and Corticothalamic pathways are complete by the beginning of the third trimester (26 weeks)
- Provides the major sensory input and motor output pathway in the brain
- Babies are able to move even before then







POSTNATAL MOTOR DEVELOPMENT

Gesell & Thompson (1934; 1938)

- > Comprehensive study of motor development
- > Study of over 500 children, detailed assessment of developmental change in posture, balance, reach, locomotion.

General Trajectories

Cephalo-Caudal Development: "Head to tail"

- > Control of head and neck before lower torso and feet
- > lift head → sit → walk

Proximal-Distal Development: "Central to peripheral"

- > Control of shoulder before hands
- > Bat at object → directed reach → grasp

MOTOR DEVELOPMENT

REFLEX:

- > An involuntary muscular response to a sensory stimulus.
- > Cough, sneeze, blink, yawn, gag

PRIMITIVE REFLEXES:

- > Transient set of reflexes evident in the newborn
- > They are called primitive because they are controlled by the most primitive parts of the brain, the medulla and midbrain, both which are almost fully developed at birth

NEONATAL (PRIMITIVE) REFLEXES

Reflex	Description	Significance
Sucking	Baby sucks when lower lip is brushed	Fundamental to early feeding
Rooting	Baby turns head and opens mouth when cheek is touched	Facilitates early feeding
Grasp	When finger or other object touches baby's palm, fingers close around it	Maintain contact with parent.
Moro	If baby drops unexpectedly, or if there is a noise, baby throws arms out, arches back, and then brings arms together and grasps on	Possibly a facilitator of early bonding.
Stepping	When baby is held upright, toes lightly touching surface, makes rhythmic leg movement	Maybe a component of later walking
Babinski	When bottom of baby's foot is stroked, toes fan than curl.	Presence at birth is a sign of normal neurology. In adults is sign of pathology

MILESTONES OF MOTOR DEVELOPMENT

- Newly acquired skills that are fundamental to skilled performance
- The acquisition of each skill is a landmark in the individual's motor development

POSTURAL CHANGES
REACH AND GRASP
LOCOMOTION

Age	Prone	Sitting	Standing	Eye-Hand
1mo	Flexion. Lifts head momentarily.	When pulled to sit, head lags.	Reflexive stepping.	Eyes follow to midline. Hands clenched.
2mo	Head middle. Lifts head.	Head starts righting.		Eyes follow past midline. Regards hand of extended arm.
3mo	Head lifting sustained. Supports on forearms. Knees flexed.	Head bobs forward.	Small fraction of weight supported.	Eyes follow 180° Glances at objects. Hands close loosely.
4mo	Head and chest lifting sustained.	When pulled to sit, little head lag	Stands. Rises to toes.	Clutches fist near face over chest - fingers extend. Looks at object in hand.
6mo	Arms extended, rolls supine to prone. Head up, reaches for toy.	Sits propped on chair	Child supports most weight. Bounces	Manual pursuit and reach.
8mo	Goes from prone to sitting to hands and knees. Crawls.	Assists when pulled to sit	Takes full weight. Holds rail.	Reaches - hand open. Shakes, bangs, transfers.
10mo	Creeps. Rises to feet. Stands, free hands.	Sits erect: 1 minute	Stands, holding hand. Cruises on rail.	Points. Pincer grasp.
12mo	Creeps well		Walks held by hand.	Cooperates in dressing.

WHAT CHANGES WITH DEVELOPMENT?

Classic theories stressed prescribed maturation – biological change *enables* behavioral change.

More recent work stresses the *interaction* of biological development and experience.

Two examples from studies of the “Stepping Reflex”

The stepping reflex is a transient neonatal response that goes away at about 2-months of age.

Infants do not show such “walking” movements again until the end of the first year of life.

Two possibilities:

- The stepping reflex is a developmental anomaly, with little relationship to later walking
- The stepping reflex reflects an early phase in motor development, that gradually becomes elaborated.

Thelen: Developmental change in the “Stepping Reflex”
Early evidence for systematic change.

Used “kinematic” data analysis and Electromyography of the four major muscle groups of the leg to analyze:

- The stepping reflex
- Spontaneous kicking while lying in a supine position.

Results

The leg movements in the two conditions were identical in terms of both the kinematic sequence and engagement of muscle groups:

- Rapid simultaneous *flexion* of ankle, knee, and hip
- *Extension* characterized by a swing forward of lower leg and flexion of the ankle
- The timing parameters for the two conditions was very similar.

Results

These findings demonstrate that the “stepping reflex” is part of a more general pattern of motor activity.

But:

- why does the reflex go away
- while spontaneous kicking does not – indeed kicking *increases* in frequency as reflexive stepping wanes.

Thelen: Developmental change in the “Stepping Reflex”
Early evidence for systematic change.

There is a relationship between the mass of the infants legs and the disappearance of the reflex.

Thelen postulated that as infants legs became heavier their ability to lift them declined

Thus, there are physical constraints on the stepping response.

Thelen: Developmental change in the “Stepping Reflex”
Early evidence for systematic change.

Two tests:

- > When infant who no longer showed the stepping reflex were placed in a pool of water, the stepping reflex returned.
- > When weights were attached to the legs of infants who still showed the stepping reflex, the children no longer showed the reflexive response

DOES CHANGE IN MOTOR ABILITY AFFECT
OTHER ASPECTS OF DEVELOPMENT?

CAMPOS:

What is the effect of self-locomotor activity on social, cognitive, attentional development?

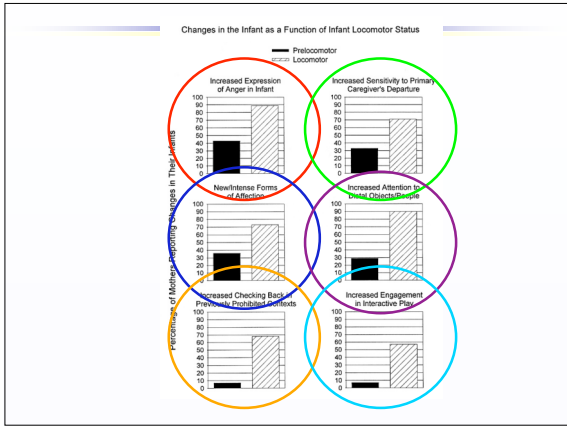
“Travel broadens the mind”

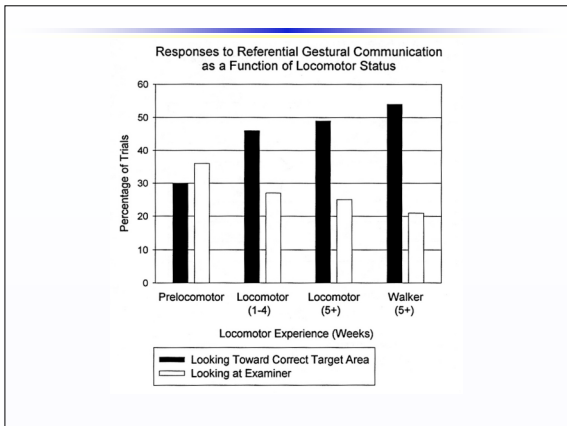
Studies of Children with Different Early Experiences

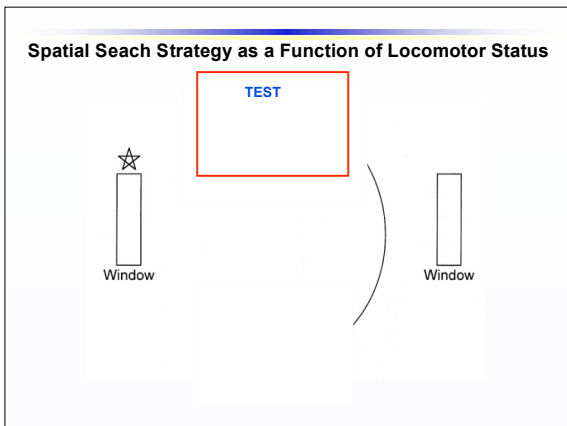
GROUPS:

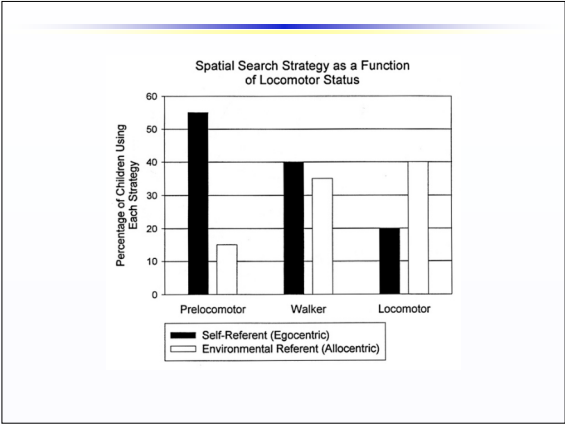
- Pre-locomotor
- Self-locomotor infants
- Walker experienced infants

- Controlled for age (all 8-months)
- Tested on a variety of cognitive, affective and attention tasks.









Cross-cultural Differences in Children's Early Experiences

Children growing up in urban China:

- Show a average 3.3 month delay in onset of locomotion
- Result of living in constrained contemporary urban apartments
- Infants are placed on a bed surrounded by thick pillows, the bed is soft and does not provide enough resistance to the child's efforts to push up resulting in delayed development of the upper musculature

Cross-cultural Differences in Children's Early Experiences

Results:

Locomotor experience – but not age – had a significant effect on spatial search performance.

Delays of several months in the development of spatial search performance were observed -- these corresponded with duration of delays in onset of locomotor activity.
