

HD FS 631
Learning & Cognitive
Development in Children

Biological Bases of
Cognitive Development

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Kloos, H. & Somerville, S. C.
(2001)

Providing impetus for conceptual
change:
The effect of organizing the input

Cognitive Development, 16, 737-759.

Hypotheses

Goal: to test whether calling to mind an initial belief and presenting information that challenges that belief affects the extent to which preschoolers will modify it.

- Providing a structure that serves to organize new information and link it with existing beliefs facilitates more refinement of beliefs.
- A demonstration that immediately follows the calling to mind of the belief facilitates more refinement of beliefs

Background

- Changes in people's knowledge has been studied in several areas
 - Knowledge: a whole system of beliefs or a specific belief
 - Beliefs may be implicit or explicit (verbalized)
- What provides impetus for conceptual change?
 - Calling up an existing belief may help ignore irrelevant information
- Usefulness of belief may depend on
 - connection between new information and child's expectations
 - Amount of consolidation between separate outcomes and implications
- Refining belief may be more likely than complete abandonment
 - Beliefs are interrelated in networks

Participants

- 48 preschoolers (30 boys & 18 girls)
- Age range from 46 mos. to 75 mos.
(median = 60 mos.)

Materials

- Colored pictures of objects (toy submarines)
- Tall glass fish tank filled with water divided into "racing lanes"
- Baby food jars with weights were dropped into the water

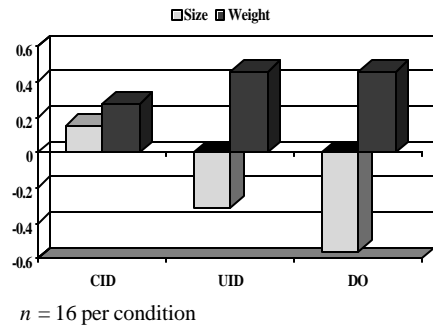
Procedures

- Familiarization
- Three conditions:
 - CID : Coordinated Interview & Demonstration
 - UID: Uncoordinated Interview & Demonstration
 - DO: Demonstration only
- Interview
 - "If we could sink all five submarines, do you think they would all sink at the same speed...Which would go fastest?"
- Demonstration
 - "Let's see how the submarines sink in our tank. ...can we find out the rules telling us what makes these submarines sink fast?"
- Final test
 - Child acts as submarine designer—a loser submarine, the fastest possible submarine, etc.

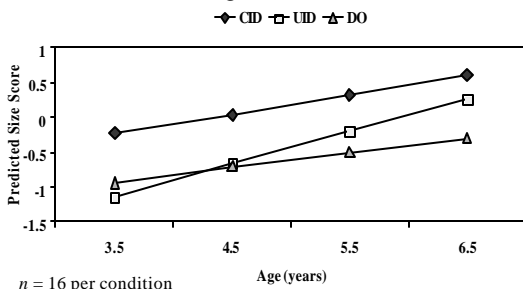
Results

- No statistically significant effect of type of trial for size or weight; no interaction
- No statistically significant effect of order; no interaction
- Two one-way ANOVA's for effects of size and weight, contrasting:
 - CID & UID vs DO:
 - CID vs UID
- Weight: Neither contrast significant
- Size: CID/UID > DO. $F(1, 45) = 5.26$, $Mse = .48$, $P < .03$
- Age and performance significantly related;
- Tendency to profit from demonstration with age highest when interview and demonstration NOT coordinated!
- Majority of children were consistent responders in final test
 - CID: 62.5% for size and weight
 - UID: 75% size; 87% weight

Mean size and weight scores for each condition:



Regression line predicting children's size scores from their age for each condition



Discussion

- Tailored demonstrations to two beliefs:
 - Heavier would sink faster if size held constant
 - Larger would sink faster if weight held constant
- Demonstrations supported weight belief; contradicted size belief
 - Changes in beliefs about size were function of condition
 - Changes in beliefs about weight were function of changes in belief about size.
- Simply encountering new information NOT sufficient to effect change in belief
 - Elicit belief PLUS demonstrate new information
 - Younger children need coordinated interview and demonstration

Bjorklund

Chapter 1 & 2

1. Define cognitive development

- Development: change in structure or function over time
 - Result of experience & maturation
 - Hierarchical organization (intentional control)
- Cognitive: change in mental structures and functions governing acquiring, understanding, modifying information

Structure ↔ Function

Context in which development occurs is as important as genes individual inherits

- **Structure**
 - a substrate of the organism that develops, such as muscle, nervous tissue, or mental knowledge
- **Function**
 - action related to a structure, such as movement of a muscle, firing a nerve, or activation of a mental representation

2. Functions of cognitive immaturity

- Turkewitz & Kenny (1982) poor perception may limit cognitive system from overload
- Preschooler's tendencies to overestimate physical/cognitive skills (e.g., Flavell, Stipek) may protect self-esteem
- Slow information processing may prevent intellectual habits that will be hard to change (Bjorklund & Green)

3. Nature vs. Nurture

- Nativism hard-wired modules, or structures, that constrain development
 - Representational constraints
 - architectural constraints,
 - chronotopic constraints
 - Particularly popular for perceptual and language development
- Empiricism
 - Cultural context

4. Does cognitive development follow stages?

Flavell: requirements of stages:

- Qualitative, not quantitative differences
 - Both
 - Representation
 - Speed of information processing
- Change from one stage to another relatively abrupt; development is discontinuous
 - No evidence
- Children's thinking within a stage is homogeneous: similarities across domains
 - Level of representation

1. Developmental Systems vs. Genotype → phenotype theory

- Organism-context relationships important
- Genes interact with their environment at all levels—no development is “genetic”

Models of Gene-Environment Interactions :

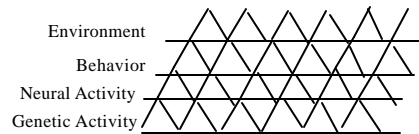
All self-respecting developmentalists believe that

- $d = F(\text{interaction b/w genetic/biological factors and environmental/experiential factors})$
- Child is an active agent in his/her own development
- development proceeds by bidirectional effect of structure and function

Developmental systems approach (Gottlieb)

- sees development occurring within a system of interacting levels
- centered on concept of **epigenesis**
- “emergence of new structures and functions during the course of development reflects bidirectional relationship between all levels of **biological & experiential** variables”

Hierarchy of four interacting systems



Gottlieb

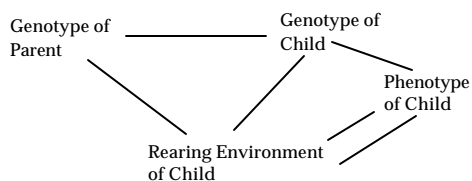
Genetic activity

- influences **and**
- is influenced by
- structural maturation,
 - which is bidirectionally related to function and activity.
- functioning at any level influences
- functioning at adjacent levels

Genes direct production of proteins

- proteins determine the formation of structures
- activity can turn on or off genes
- experience (self-produced activity) can alter development of cells
- therefore, no simple genetic or environmental effects

Genotype-environment Interaction



Scarr & McCartney (1983)

Genotype → phenotype theory (Scarr; McCartney)

Dawkins:

- no general reason for expecting genetic influences
- to be more irreversible than environmental ones!

Three kinds of genotype->environment effects

- passive
- evocative
- active

Scarr

passive

- occur when genetically related parents provide the rearing environment of the child
- influence of passive effects assumed to decline with age

evocative

- child elicits responses from others that are influenced by his/her genotype
- e.g., irritable child elicits different responses from more easy-going child
- remains constant throughout development

active

- one's genotype affects the type of environments one chooses to experience
- increase with age, as child becomes increasingly independent of parents
- able to select own environments

Implications for child development

- Suggests that parents' environmental influence on children greatest during early childhood and decreases with age as active takes over
- Scarr & Weinberg
 - average correlations of IQs of samples of adopted siblings in ec: .25 - .39
 - correlation in adolescence: 0
- Matheny et al:
 - dizygotic twins have higher r in IQ during preschool (.60) than during adolescence (.55)

Children are primary directors of their development

- bring innate abilities
- actively work to shape environments
- evoke certain behaviors from parents and other caregivers
- select types of activities and experiences in which they want to participate
- experiences help foster development

Children create experiences from environments

- driving force that shapes child's thinking is child
- Parents don't need to try to be "super parents"
 - Parents need only to be "good enough"
 - to provide an adequate environment in which the child can develop

"Good enough" excludes:

- Abusive parenting
- Neglectful parenting
- Conditions that are not "average expectable"

Intervention

- to improve children's development is difficult
- **Unless...** their environments are outside the range of what is normal and adequate for human beings

Examples: chick embryos

- chick embryos display spontaneous movement before muscle and skeletal development is complete
- movement comes from maturation of underlying structures (bones, muscle, nervous tissue)
- when drugged to temporarily paralyze them for one to two days,
 - deformation of joints develop, which affects subsequent movement

To understand development, look at organism-context relationship

- Considerable plasticity occurs in development;
- However, there are species specific environments
- Changes in species-specific environment --> Changes in species-specific behaviors
 - e.g., ducklings who can't hear or produce their own sounds
 - don't move towards others producing their sounds

How does brain development involve loss of physical structures and functions?

- Initially, proliferation of neurons leads to more synapses & neurons than needed
- Selective cell death & synaptic pruning occurs in different parts of brains
 - Dendrites increase in diversity
- Greenough: specific sensory and motor experiences determine which excess synapses survive
 - Experience expectant processes
 - Experience dependent processes
- Chugani : brain metabolism increases after first year of life; peaks at 4 to 5 years of age

Experience expectant processes

- Given species typical environment, functions develop for all members
- Hardwiring provides susceptibility to certain environmental experiences
 - E.g., Riesen: cats lacking early visual experience
 - At First Sight

Greenough

Experience dependent processes

- Connections made that reflect unique experiences of individual
- Overproduction of neurons enable connections that reflect unique experiences
- Neurons/synapses/dendritic branches depend on experience
- Greenough

What is plasticity as related to the brain?

- Neuronal plasticity
- Recovery from brain damage
- Slow growth & plasticity: adoption studies

Neuronal Plasticity:

- Hebb: brain (and problem solving) differences in rats from enriched environments

Recovering function from brain damage

- Following brain damage, younger children recover more language functioning than do older children (Annett)
- General cognitive functioning: young children show more **permanent** deficits than older children (Kolb, Riva)

Slow growth and plasticity

- Skodak & Skeels: Iowa orphans raised in school for retarded
- Winick, Clark: adopted children showed normal IQ's & social by early childhood

Theory: development of left hemisphere superiority for language

- hemispheres similar but not identical
 - each hemisphere controls the opposite side of the body
- one hemisphere typically predominates, resulting in left- or right-side preference

Are developmental neuroscience & developmental biology important for cognitive development?

- Brain research shows
 - Impact of early experience (or lack thereof)
 - Impact of developmental disorders
 - Autism
 - ADHD
 - Dyslexia
 - AIDS
- Limits of brain research?

Critical Periods

- Developmental timing
- the time in development (usually early in life) when it is most easily (or only?) acquired
- Lickliter research with bobwhite quail chicks on timing of perceptual experience
- following mother's call due both to
 - presence of auditory and
 - absence of visual stimuli before birth.

Limited visual functioning at birth may protect the child from sensory overload!

- poor functioning in vision may permit earlier developing sense (hearing) to develop
 - without undue competition for neural resources
- Removed part of shell and provided visual experience to bobwhite quails two to three days before hatching
 - controls: shell off; no stimulation
 - controls: preferred bobwhite call after birth

Visual stimulation: no auditory preference for chicken or quail

- same results with rats and olfactory
- Therefore, timing is critical
- Earlier may not better
- See similar research by Harlow and Papousek
- Als, Bjorklund, Elman suggest that early overstimulation may have detrimental effects
- What implications for human cognitive development?

