

# Infant Object Manipulation and Play

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EECS 598 : Action and Perception



# Introduction

- ❖ Learn a lot while manipulating objects.
- ❖ Generate unique ways to use objects beyond their intended design.
- ❖ Helps them to practice and refine manual skills and test the fit between body and environment.





# Object manipulation Vs Object Play

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| <ul style="list-style-type: none"><li>• Development of manual skill.</li><li>• Emphasis on perception-action feedback.</li><li>• Pays Less attention to pretended play.</li></ul> | <ul style="list-style-type: none"><li>• Development of Pretense.</li><li>• Initially undifferentiated actions.</li><li>• Later supplanted by complex behavior indicative of representational thought.</li></ul> |
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# Piaget's Theory

- Actions used for manipulation are less of an interest. ❌
- More emphasis on the heterogeneity and quality of infants' actions on objects and representational thinking. ✅

## 1. Stage-4 (8 months)

- Use similar routines to manipulate objects regardless of objects' features.
- Examples include shaking, rotating, and mouthing an object in hand.

## 2. Stage-5 and Stage-6 (2<sup>nd</sup> year)

- Can reason fully about the object and can understand they can exist independently of the self.

## 3. Final Sensorimotor Stage

- Infants' understanding of objects reflected their general capacity to represent the world symbolically.

# Piaget's Theory

## Sensorimotor Stage of Cognitive Development

Children gain knowledge through their senses and motor movements

### Primary Circular Reactions (1-4 months)

begin to repeat pleasurable actions



### Secondary Circular Reactions (4-8 months)

intentionally repeat actions to trigger a response



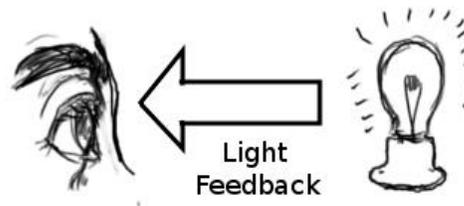
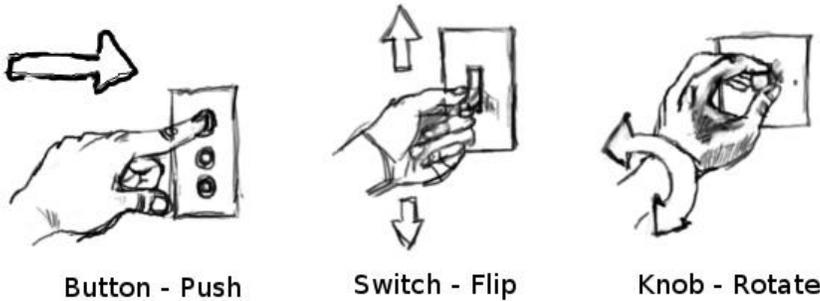
### Tertiary Circular Reactions (12-18 months)



trial and error experimentation

# Gibson Perception-Action Theory

- Contrastive approach to Piaget's theory.
- See to move and move to see.
- “Theory of affordances” – Humans perceive opportunities for action in the environment.
- The goal is to recruit and integrate existing action systems to get relevant affordance information.



# Development of Object Manipulation

Object  
manipulation



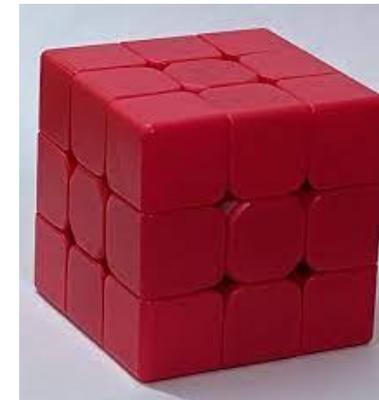
Gibsonian  
theory



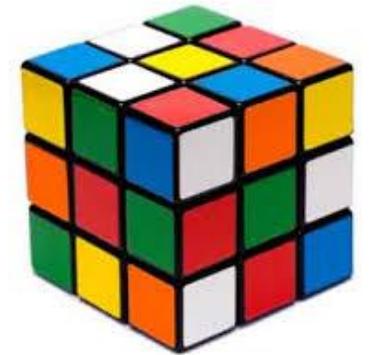
**More scratching of rough**



**More squeezing of soft  
object**



**More rotation with more color**



# Development of Object Manipulation

## Notable Inferences

- ❖ Infants in the first few months may tailor their manual behaviors to an object's features.
- ❖ A second year has more and more control of finger, hand, and arm movements leading to more exploratory and tailored behavior.
- ❖ Progress in motor development enables infants to engage in new haptic exploratory procedures to register information about objects.

# Object Manipulation – Prospective Adjustments



- Infants generally only begin to show prospective adjustments of the hand to other spatial features of objects (e.g., orientation, size, shape) during the second half year.
- When multiple spatial features (e.g., size and orientation) of an object change across trials infants experience difficulty in prospectively adjusting their grips.
- The role of cognitive load or complexity in constraining early forms of skilled action becomes apparent, an issue we return to when considering the early development of the play.

# Object Manipulation – A gateway

- Object manipulation in the first year paves the way for the emergence of tool use in the second year.
- Infants learn how objects cause different effects on surfaces – a key requirement of tool use.



Object banging



Controlled hammering in 2 years

# Development of Object Play

## Notable Points

- ❖ Object Play focuses on infants' interactions with toys as opposed to object manipulation.
- ❖ A key aim of play research is to document how infants progress from actions based on the functions of specific toys.
- ❖ Researchers describe the ways that object play changes in form and content across development as infants acquire new skills.

# Non symbolic Play

## Notable Points

- ❖ Toward the end of the first year, infants shift from primarily exploring objects visually, orally, and manually to engaging in nonsymbolic or functional play.
- ❖ With experience and motor skill, infants gradually combine objects in the ways that objects were intentionally designed.
- ❖ They acquire critical knowledge about spatial relations, including concepts around object support.



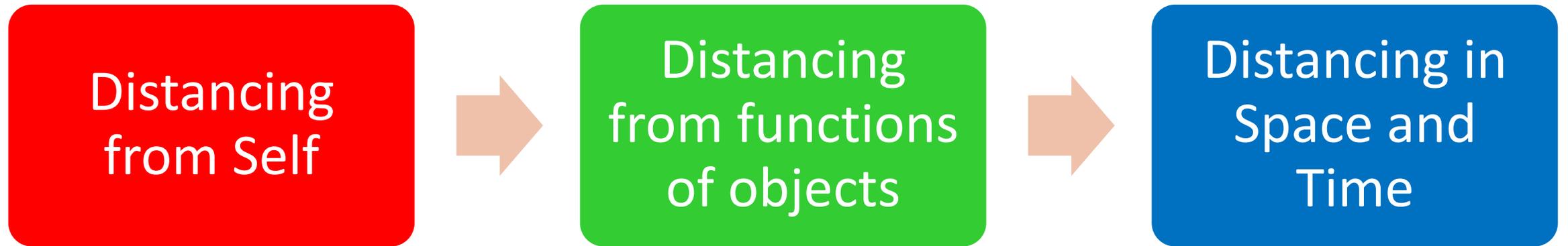
# Symbolic Play

## Notable Points

- ❖ Infants shift from seemingly asking, “What can this object do?” to “projecting an imagined situation onto an actual one”.
- ❖ As toddlers imbue objects with imagined characteristics and functions, play grows in complexity and symbolic demand
- ❖ Symbolic play grows in complexity across development.



# The concept of Distancing



# Social Influences

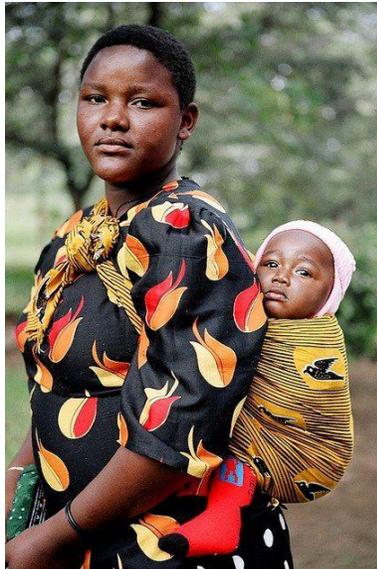
- In Western cultures, caregivers often demonstrate to infants how to handle and explore objects and they manipulate objects with their infants in targeted ways. In essence, caregivers act like a coach.
- Other investigators have likewise observed that caregivers often exaggerate their actions – such as through greater amplitude and more frequent repetitions of action. (motionese)



# Cultural Variation

## Notable Points

- The process by which skills are socially transmitted from more to less experienced individuals may vary from culture to culture and even within a culture.
- In some cultures, caregivers engage in overt pedagogy, whereas in others, caregivers expect infants and young children to learn through observation



## Key Takeaways:

- Cultural differences in the availability of objects for play affect the types of play infants display and even the complexity of play.
- Family socioeconomic status (SES), might also influence the materials available to infants, caregivers' time for play and views around play, and thus the frequency and quality of infant object manipulation and play.
- Cultural communities also differ in how parents play with their infants in the context of object play.
- These studies help to illuminate the processes that underlie the effects of poverty on early perception and cognition and suggest avenues for intervention

# Practice and Policy Directions



**Working with Parents**



**Working with Educators**



**Working with Practitioners**

**Thank You**

# Some discussion ideas

- Techniques like fMRI (functional magnetic resonance imaging), fNIRs, EEG (electroencephalography) are used to study the neural bases of object manipulation and play development. I wonder if these techniques could apply in studying robots, particularly humanoids. Or if this cognitive data can be used to better understand and translate the human brain thereby mapping it to the workings of robots.
- They described an experiment where infants manipulate different objects in different ways (e.g. rubbing an object when the texture changes, but banging an object when the hardness changes). I thought it was an interesting concept that the motor system may act as the rate-limiting factor in this process rather than cognition.

# Some discussion ideas

- **I wonder if such nuances go into the field of Object manipulation and play (like cultural background, the influence of caregivers, and stuff like that), which almost changes the way they develop in the future, how could a humanoid robot be trained with a policy which remotely replicates what is done with infants. It will be interesting to see how the field develops in the future (QUESTION)**
- Whatever the cultural/environmental differences, there are key patterns and structures driving the ability to develop according to that environment.
- The environment in which learning takes place is definitely critical, at least as much as the policy a robot is learning to use for exploration.
- From an RL perspective, I think all the cultural/environmental differences will be counted towards the reward that we receive during motor development. So it's definitely an important factor. Maybe one of the reasons that robot learning stagnates is that the reward in the real world is too sophisticated that we cannot replicate it.
- Sociocultural factors can change perspectives on predicting behavior or recognizing objects. Although those are important aspects of human society, we are not sure whether our technology can implement such factors. It's not just about simple learning; understanding situations and embracing change could be the key.

# Some discussion ideas

- **Cultural influence on infants some discussion takes**
  - I also found the cultural influence on infant learning very interesting. I know our cultures are a very prevalent part of who we are and what we become but I never knew that they could affect everything from such a deep level.
  - It is also worth noting that the authors emphasize the role of sociocultural context in shaping infants' object interactions. Caregivers' interactions with infants around objects, as well as the objects that are available to infants, can influence the development of their object manipulation and play skills
  - Ref Infant learning from the paper about iCub, where the authors talk about how the affordances an infant is able to learn are directly tied to the objects it comes into contact with. The objects that infants first learn to interact with will largely differ from all factors, including cultural background, income, and climate.
  - Interesting to see the impact of biological conditions in developing cognition skills.

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**Interesting take: According to the author, it is much easier for an infant to feed themselves with a spoon, for example, than try to feed someone else. I wonder if this same phenomenon is present in general robotics/machine learning. Is it innately harder to train a robot to "feed itself" or to feed others?**