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NEONATE COGNITION SYMPOSIUM

Chair: Richard Held, Department of Brain & Cognitive Sciences, MIT

Advances in experimental technique and technology reveal more and more hitherto unexpected cognitive capabilities in infants. Moreover, these achievements appear at earlier and earlier ages. We discern a trend in infant research as investigators increasingly attribute the appearance of cognitive capacity to the development of sensory and motor systems as opposed to that of higher centers in the brain. Pushed to an extreme this trend leads to the view that the neonatal mind-brain lacks only the sensory input and motor output required to potentiate its capability. In place of the doctrine of the neonate *tabula rasa*, organized by sense and movement, we would have the neonate *tabula cognitiva* awaiting the perfection of its sensory and motor apparatus in order to engage the world. Echoing this theme, Jane Gwiazda will discuss the development of vision in infants. She reports that visual resolution, limited initially by peripheral retinal processes, improves slowly over several years. In contrast, the hyperacuities, with presumedly more significant central cortical components, rise much more abruptly. Renee Baillargeon presents evidence that very young infants understand that objects possess at least some of the physical properties taken for granted by adults. Their perceptual worlds are structured in accord with this understanding. Quantitative physical reasoning is a bit slower to develop but it too is present by the end of the first half-year. Adele Diamond has discovered that infants understand concepts long before they have the capacity to plan and inhibit the motor activity required to perform responses during testing. Sequential actions requiring motor planning and reflex inhibition do not appear until half a year of age. Together these reports argue for the change in viewpoint discussed above.

Discussant: Jacques Mehler

DEVELOPMENT OF VISION

Jane Gwiazda, Department of Brain & Cognitive Sciences, MIT

Study of the development of vision provides an opportunity to relate changes in visual functions to changes in the nervous system. Over the past fifteen years we have studied basic measures of visual function, including grating acuity, stereoacuity, and vernier acuity, in human infants. An initial attempt has been made to relate the developmental changes in vision to changes in the underlying neuronal mechanisms.

All of our data were obtained using a two-alternative forced choice preferential looking procedure. Grating acuity develops more slowly than vernier and stereoacuity. It is very poor at birth and does not reach adult levels until 3 or 4 years of age. Changes occurring at the retinal level during the early months can account for the increases in grating acuity.

Vernier acuity is termed a hyperacuity because the smallest offset of a line that can be detected by an adult is almost an order of magnitude more sensitive than the minimal separation of foveal cones. It is thought by many to be cortically processed. In infants, vernier acuity is actually poorer than grating acuity in the first two months, but rises rapidly and exceeds grating acuity by the fourth month.

Stereopsis is not present in very young infants, but has an abrupt onset at 3 to 4 months. We have speculated that the onset is dependent upon the segregation of ocular dominance columns in layer 4 of the cortex. Stereoacuity rises very rapidly, approaching adult values within a few weeks from onset of coarse stereopsis. This implies fine tuning of the disparity-sensitive neuronal mechanism.

Females show superiority over males in months 4 through 7 on the hyperacuities, but not grating acuity, which suggests that sex differences are found at the cortical level.

YOUNG INFANTS' PHYSICAL WORLD

Renee Baillargeon, Department of Psychology, University of Illinois

Infants' understanding of the physical world has traditionally been characterized as severely limited. Infants are said to hold no beliefs or to hold incorrect beliefs about objects, and to possess at best primitive physical reasoning abilities. However, recent evidence collected by my collaborators and myself suggests that this characterization is inaccurate. My talk is divided into three sections. In the first section, I report experiments that indicate that young infants share many of adults' beliefs about the physical world. To illustrate, I argue that, by 3.5 months of age, infants understand that (a) objects continue to exist when out of sight; (b) objects cannot move through the space occupied by other objects; and (c) objects fall when their supports are removed. In the second section, I summarize experiments that suggest that young infants possess an impressive array of physical reasoning abilities. I distinguish between qualitative reasoning (e.g., determining that a rotating screen should stop when encountering an obstacle in its path) and quantitative reasoning (e.g., judging at what point a rotating screen should stop based on the location and height of the obstacle in its path), and argue that infants engage in the former type of reasoning several months before they do the latter. In the third section, I present experiments that reveal how infants' physical knowledge affects their perceptions and categorizations of objects. I conclude with a review of the many similarities and few differences brought to light by the present research between infants' and adults' physical worlds.

THE PLANNING, EXECUTION, AND INHIBITION OF MOVEMENT DURING INFANCY

Adele Diamond, Department of Psychology, University of Pennsylvania

Infants appear to understand the concept of contiguity, understand and remember that an object they can no longer see is still there, and remember which of two objects they have already seen, long before they can show these abilities on traditional measures. Why?

I would like to suggest that traditional measures require planning of motor actions and inhibition of motor actions, both of which require maturation in the supplementary motor area (SMA). Maturation in SMA may account for many of the advances we see in infants' behavior between 5-8 months of age. Note, the suggestion is that the cognitive abilities mentioned in paragraph 1 are present early, but they cannot be demonstrated in reaching behavior until much later.

SMA is required for putting two or more actions together into a sequence, as for example, in uncovering one object to retrieve another or in executing a circuitous reach with two-vector components. It is also required for the inhibition of the reflexes of the hand: the grasp and avoidance reflex. Traditional measures of object permanence (uncovering a hidden object), recognition memory (the delayed non-matching to sample task), and spatial contiguity (retrieving an object directly behind a screen) have all required skills dependent on SMA. Tasks using looking as the dependent measure have not required motor planning or inhibition and have shown these memory and conceptual abilities to be present much earlier; similar results have recently been obtained with reaching tasks that do not require SMA-dependent abilities.