Dim, Bland and Muted World: Advantages of Immature Sensory Systems at Birth

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The world a newborn infant encounters at birth is one that is much different than the dark, warm, quiet womb it occupied for the last 9 months. As recent as thirty years ago, scientists could only assume what the infant saw, smelled or heard at birth. William James suggested that the infant is bombarded or "assailed by [the] eyes, ears, nose, skin, and entrails at once, feel[ing] it all as one great blooming, buzzing confusion" (James, 1890). This would be true if the infant's sensory systems are as mature as that of an adult's. Not knowing what infants really experience, others believed that some systems were so immature at birth, that in the case of vision, the infant could see nothing (Teller, 1990).

The infant motor system is obviously immature, but until recently little was known of the level of maturity of the sensory systems. Recent research has lain to rest some of these questions and we now know that the infant is born with relatively anatomically and functionally immature sensory systems (Kozma, 2001) with vision being the least developed of them all (Mendelson, 1976). The purpose of this paper is to review the literature regarding the development of the sensory systems of infants and whether the limitations of these immature systems (with an emphasis on the visual system) provide advantages for facilitating normal perceptual organization, categorical learning and embodied cognition.

Early development is characterized by reduced sensory input with gradual lowering of thresholds and increases in resolution over time. Intuitively, these levels of immaturity, have led to the to the assumption that the neonate has deficiencies to overcome in order for normal sensory (Turkewitz 1982, 1985) and cognitive development to occur. This view is understandable since it has been found that persistence of these immaturities,

especially in the visual system, can result in severe consequences, such as severe refractive errors, amblyopia (reduced visual acuity of one eye in the absence of ocular structural abnormalities and due to early abnormal visual experience), and deficits in visual information processing (Glass, 2002).

These can be thought of as examples where the limitations have become abnormal and have lead to deprivation, leaving the system with an obvious disadvantage. Yet, most sensory limitations may be considered a normal part of development and may not be equivalent to sensory deprivation, such as that mentioned above. It should be noted, that normal development does include the reduction of refractive error in the first years of life, along with the refinement of the focusing mechanisms, accommodation and ocular vergence.

On the other hand, the immature visual system is thought to help reduce the available sources of stimulation from the environment, leading to a competent and organized world for the infant rather than "blooming, buzzing" chaos. Overall these limitations succeed as a sort of passive filter for the infant by reducing the available sources of stimulation from the environment. This limits the amount of information that the infant must sort and generates a competent and organized world for the infant to contend rather than being distracted with "noise" allowing him retrieve what is important, such as his mother's face or her voice.

It is believed that this helps facilitate the development of these systems in a specific sequential over-lapping order leading to proper development via competition. The different levels of limitations in the function of these systems affect the presence or absence of competition both inter and intra-modally and play a major role in shaping both development within the system and relationships between systems. The timing and extent of competition determines the nature of developmental competitive relationships. The fact that the visual system falls behind the auditory system early in development is thought to be what allows for learning of linguist labels (Robinson, 2004).

Categorical perceptual learning (CPL) may also benefit from different sensory systems at various levels of maturity at birth. CPL occurs whenever perceived within-category differences are compressed and/or between-category differences are separated, relative to some baseline of comparison. French et al, 2002 used computer simulation of retinal development to simulate the output of visual cortex (V1) complex cells to support this. They were able to show that by reducing perceptual acuity (by reducing the range of spatial frequencies from the retinal map to V1) decreases the variance distribution within a category, producing an advantage for differentiating basic-level categories.

Another possible advantage of immature sensory systems and their sequential development is that they may facilitate embodied cognition (Smith, 2005). Intelligence emerges from the interaction of an agent with an environment and as a result of sensorimotor activity. Babies' early experiences are strongly ordered by the development of sensory systems and movement systems. Even though the visual system is less mature than the auditory system, infants can be observed to look in the direction of sound shortly after birth (Mendelson, 1976). Over the next few months, subtler sounds in relation to visual events begin to take control of visual attention, so that the infant now looks at the visual event that matches what he hears. The coupling of hearing and looking organizes the infant's attention and therefore what he learns. Deaf children show altered and more disorganized visual attention (Smith, 1998). This would support that the relation of the sensory systems and in what order they develop is important for proper for development and that adult level visual system may hinder visual attention.

These sensory limitations, such as abnormal refractive error, that must be overcome early in development may actually be advantageous filtering devices. This leads to implications of under or over-stimulating the sensory systems during early life. Maybe intervening too early may disrupt what would normally go away on its own. But, if intervention does not occur soon enough, in cases that are not progressing properly, detrimental consequences may persist. Therefore, there is a fine line that separates what is normal and abnormal development and at what point normal becomes abnormal. Whether the infants

muted experience of the world is an advantage or a disadvantage to overcome requires more research and further collaboration across disciplines.