

Prenatal Sensory Development

A sequential order of development and maturation is present in typically developing infants. This chart gives an overview of each sensory system, listed in the order in which the system matures to functionality and a brief description of the system's purpose and function. The last column in the table provides clinical observations and implications related to the sensory development of preterm infants, whose final weeks of development usually take place in the unnatural environment of an intensive care nursery.

Sensory System	Description	Maturation	Clinical Observations/Implications
TACTILE	<ul style="list-style-type: none"> ❖ System of touch and reflexes ❖ Functions as a protection and discriminatory system ❖ Communicates sensory input from periphery to cortex ❖ Purpose is to establish identity and security within the environment ❖ Communicates both pleasant and painful stimuli 	<ul style="list-style-type: none"> ☐ Early fetal movement detected by ultrasound as early as 7 weeks ☐ Perioral area sensitive to stimulation by 7.5 weeks ☐ Sensory nerve endings in place and functioning by 11 weeks ☐ By 26 weeks primitive tactile reflexes can be elicited; rooting is present ☐ Back and legs modulate input by 32 weeks 	<ul style="list-style-type: none"> ➔ At any viable gestational age, infant perceives pressure, pain, temperature ➔ Entire system is extremely sensitive and easily over-stimulated ➔ Behaviors resulting from over-stimulation include pulling away from stimulus, squirming, crying, inability to settle/get comfortable, feeding aversions ➔ Perioral area is very sophisticated by 24 weeks ➔ Tactile defensiveness can be an over active protective response
VESTIBULAR	<ul style="list-style-type: none"> ❖ System of balance and motion ❖ Function is to provide input from inner ear to vestibular center in brainstem ❖ Maintenance of equilibrium 	<ul style="list-style-type: none"> ☐ Day 44: Primitive semicircular canal ☐ Week 14: Sensory innervation completed ☐ Week 16: Myelinization completed ☐ System is functional by Week 21 	<ul style="list-style-type: none"> ➔ Impacts infant's state, ability to rest, ability to self-regulate ➔ Motion and position changes can be very over-stimulating ➔ Behaviors from over-stimulation include increased motor activity, color changes, crying, poor feeding
GUSTATORY	<ul style="list-style-type: none"> ❖ System of taste ❖ Function is to transmit impulses to taste center in cerebral cortex ❖ Encourages exploration ❖ Facilitates developmental skills (hand-to-mouth, readiness for oral feeding, midline play) 	<ul style="list-style-type: none"> ☐ Week 4: Mouth begins to form tongue bud ☐ Week 8: Mouth and tongue development completed ☐ Week 20: Taste buds emerging ☐ Weeks 26-28: Withdrawal response to bitter taste ☐ Week 35: Differentiation between glucose and water with calming ☐ Newborn (Day 3 to 6): Differentiate between sweet, sour, bitter; between breast milk and formula 	<ul style="list-style-type: none"> ➔ Fetus sucks/swallows average of 1 liter amniotic fluid daily in utero; provides practice for feeding and self-regulation ➔ Preterm babies miss this practice or practice is confused because conditions outside the womb add new variables ➔ Infants have a high level of discriminatory taste; very easy to overstimulate this system ➔ Impacts infant ability in areas such as coordination of suck/swallow/breathe patterns and later feeding

<p>OLFACTORY</p>	<ul style="list-style-type: none"> ❖ System of smell ❖ Purpose is recognition & discovery ❖ One of most well-developed senses in newborn ❖ Assists in gastro-intestinal functions ❖ Elicits adaptive behaviors (breast feeding, rooting) ❖ Warns of potential dangers 	<ul style="list-style-type: none"> ☐ Week 5: Nasal pits present ☐ Nasal structure and components in place by Week 8 	<ul style="list-style-type: none"> ➔ Sense of smell and taste are closely linked ➔ Approach/withdrawal reactions present to olfactory stimuli ➔ Recognition of mother through smell ➔ Over-stimulation of system can lead to disinterest in feeding ➔ Hypoxia can affect smell, which affects feeding interest
<p>AUDITORY</p>	<ul style="list-style-type: none"> ❖ System of hearing ❖ Consists of external, middle, inner ear and auditory center in cortex ❖ Important for attention and learning ❖ Is motivating for alerting and orientation behaviors ❖ Basic to development of spoken language 	<ul style="list-style-type: none"> ☐ Week 4 – First anatomical division of inner ear ☐ Week 24 - System is structurally complete and functional 	<ul style="list-style-type: none"> ➔ Preterm inability to habituate makes the auditory system very sensitive ➔ Observed behaviors in response to increased auditory levels in NICU include: <ul style="list-style-type: none"> • Changes in color, heart rate and respiration rate • Desaturation in oxygen levels • Inability to sleep • Increased motor activity ➔ Wait to introduce musical toys/tape recorders until after discharge (or greater than 39-40 weeks gestational age)
<p>VISUAL</p>	<ul style="list-style-type: none"> ❖ System of sight ❖ Provides input for processing information to the brain ❖ Most complex system—one of earliest to begin development, but takes longest to complete ❖ Complements the vestibular system by correlating visual reference with equilibrium ❖ Strong connection between visual and tactile system ❖ Development continues from 40 weeks gestation to 3-4 months postnatally to increase differentiation skills 	<ul style="list-style-type: none"> ☐ Day 22 – Eye formation begins ☐ 2nd month – Retinal differentiation ☐ Weeks 6-8 – Optic nerve ☐ 3rd month – Precursors of rods and cones ☐ 22 weeks – All retinal layers present ☐ 23 weeks – Immature rods and cones ☐ 24 weeks – Myelination of optic nerve begins ☐ 25-26 weeks – All neurons of visual cortex present ☐ 7th month – Eyes open ☐ 28-40 weeks – General rapid ocular growth ☐ 8th month – Iris sphincter develops ☐ 9th month – retinal vessels reach the periphery ☐ By 36 weeks – Awake visual alertness 	<ul style="list-style-type: none"> ➔ Babies born earlier than 27-28 weeks gestation may still have their eyes sealed shut or cornea is hazy ➔ No awake visual attention earlier than 30-32 weeks ➔ Prior to 8th month, there is no way for preterm infant to control the amount of light into the retinal field ➔ Behaviors observed in response to increased visual stimulation in NICU include squinting, shading face with hands, turning away ➔ The visual cortex is one of the last to be myelinated, so higher levels of perception occur later (visual spatial relationship, visual motor coordination, visual memory, figure ground) ➔ Long term developmental outcomes indicate visual perceptual deficits

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