

efficient, a child must be able to comply with simple requests given by the parent. All of these “prerequisites” signal that a child is likely to be effectively trained. Given the readiness criteria, it is not surprising that the later training is initiated, the faster dryness is accomplished. For example, children who begin toilet training at 26 months or later tend to be successfully trained twice as fast as those whose training begins before 24 months.

As the differences are great regarding the age of initiating toilet training, opinions about the method of toilet training are equally wide-ranging. Over the years, the prevalent thinking regarding toilet training in the United States has varied between gentle child-centered approaches and intense prescribed methods designed for rapid training in as little as 4 hours. Many diverse techniques and strategies are included in training methods such as the use of scheduled toilet sits, charts, rewards, books, and dolls to assist the child’s learning. Despite their differences, varying methods appear to have similar rates of success, given that approximately 90% of children are successfully trained by age 4.

Although toilet training is typically achieved by the age of 4, it is not uncommon for accidents to occasionally occur in children of 3 to 6 years of age. Typical accidents occur when children are intently involved in play activities. Professional guidance is rarely needed in these cases. However, up to 25% of boys and 15% of girls have persistent problems with wetting the bed or their pants. Additionally, from 1.5 to 5% of children have difficulty with soiling or defecating in their pants. These persistent concerns can be effectively treated, but may warrant professional assistance from a physician and/or psychologist.

—Eve A. Herrera

See also Parent-Child Relationships, Parenting

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## TOUCH

Touch typically refers to sensations that occur when skin receptors are triggered by external stimuli. Touch has been described as one of the most fundamental means of contact with the world and the simplest and most straightforward of all sensory systems. It is the first sense to develop in utero and by 14 weeks after gestation, the surface of the fetus is almost entirely sensitive to tactile stimulation. By adulthood, the skin constitutes the largest organ of the body, covering 1.8 square meters of the average person.

The importance of touch has been implicated in several domains of life across the life span, particularly in early life. Touch helps us learn about the world around us and plays an integral role in biological, cognitive, and social development. Below, each of these domains is described along with the physiological underpinnings and physical dimensions of touch that help make it such a rich and important modality in life.

### THE PHYSIOLOGICAL UNDERPINNINGS AND PHYSICAL DIMENSIONS OF TOUCH

As mentioned, the skin is the largest organ of the human body and weighs between six and ten pounds. The skin is a multilayered structure containing several receptors, each of which sends unique signals to the brain via neurons via the spinal cord. Information from the spinal cord enters the thalamus—the “relay station” of the brain—and input from there is sent to a strip of the brain called the somatosensory cortex located on the parietal cortex. The more area on the somatosensory cortex that is dedicated to a given area of skin on the body, the more sensitive that area of skin is to tactile stimulation. Thus, areas of the body such as the fingers and lips—two of the most sensitive areas of the body to tactile stimulation—are well represented on the somatosensory cortex compared to less sensitive areas of the skin such as the back.

When considering the impact of touch, one must consider not only the physiological underpinnings of the modality but the physical dimensions of tactile stimulation on the skin. The dimensions of touch can be divided by the *qualities* of touch (the actual tactile stimulus that is administered) and the *parameters* of touch (where and how much touch is administered). The following constitute the qualities and parameters of touch:

### Qualities

- Action: the specific movements on the skin (e.g., stroking, squeezing)
- Intensity: the degree of pressure on the skin
- Velocity: the rate at which something is impressed upon or across the skin
- Abruptness: the acceleration or deceleration that the skin is touched
- Temperature: the temperature of the tactile stimulus on the skin

### Parameters

- Location: where the tactile stimulus is on the skin
- Frequency: the number of times that the skin is touched
- Duration: the elapsed time that the skin is touched
- Extent of surface area touched: the amount of surface area that is covered

Together, these dimensions of touch comprise the richness of the tactile modality.

## LEARNING ABOUT THE WORLD VIA TOUCH

Throughout life we actively explore the world with our hands to learn about objects in the world—a process known as haptic perception. Haptic perception, in conjunction with vision, is particularly important for infants to learn about the world. Research indicates that by 3 months of age infants can distinguish objects by size and shape (e.g., a cube from a hollow square), by 6 months of age they can distinguish objects by hardness and texture, by 9 months of age they can distinguish objects by weight, and by 15 months of age they can distinguish between shapes that are similar in features but differ in spatial arrangement.

## EFFECTS OF TOUCH ON BIOLOGY

Touch plays an instrumental role in brain development and growth, especially in early life. Without

adequate tactile stimulation early in life, the brain does not grow to a normal size and the synapses between neurons do not develop properly. In addition, adequate tactile stimulation early in life can buffer the effects of tactile deprivation later in life. Thus, exposure to adequate amounts of touch early in life seems to form a foundation for later nervous system development.

The importance of touch does not wane later in life. Research indicates that when nonhuman animals are provided extra tactile stimulation later in life, their brains increase in size and the synapses between neurons increase. Moreover, tactile stimulation can help stimulate neuronal growth due to brain lesions and infarcts in the brain later in life.

In addition to studying the effects of touch on the brain, researchers have investigated the effects of touch on premature infants' growth. In one study a group of premature infants received a 10-day protocol of massage therapy comprised of tactile/kinesthetic stimulation while a control group did not receive the massage therapy protocol. Compared to the control group, the treatment group gained 47% more weight, was more active and alert, and spent 6 fewer days in the hospital. If all of the premature infants in the country received massage therapy, an estimated total of \$4.7 million would be saved in medical costs annually.

Massage therapy improves a host of other biological and health related phenomena. Children and adults receiving massage therapy experience less anxiety, lower levels of stress hormones (cortisol, norepinephrine, and epinephrine), enhanced immune system functioning, and heightened alertness as indexed by EEG. Massage therapy can also play a role in the treatment of several medical conditions including juvenile rheumatoid arthritis, fibromyalgia, chronic lower back pain, migraine headaches, depression, autism, attention deficit hyperactivity disorder, post-traumatic stress disorder, and some eating disorders.

## EFFECTS OF TOUCH ON COGNITION

Touch has a significant impact on cognitive development. A wide body of literature suggests that cognitive development is intimately tied to brain development in the childhood years and, as mentioned, touch plays a pivotal role in neuronal development in the early years of life. Parental aversions to touch as well as harsh touch have been implicated as factors in the development of language and learning disorders. In addition, research suggests that parents who use touch to stimulate the central nervous system

regularly and appropriately have children that are more likely to develop an accurate and sophisticated body image. These parents provide a variety of forms of tactile stimulation to a number of areas on the body.

### EFFECTS OF TOUCH ON EMOTION AND SOCIAL INTERACTION

Touch plays an integral role in the caregiver-child relationship from the beginning of life. In one U.S. sample, infants were touched for 33% to 61% of the time during brief interactions with their mothers. The frequency of contact is much higher in some cultures such as the !Kung and the Efe tribe of Zaire where mothers spend approximately 75% of the time in contact with their infants.

In infancy, caregivers' touch is thought to serve a variety of communicative functions while they are in contact with their infants. Two of the most important are the communication of emotions, as well as the communication of security. A number of studies indicates that touch is capable of communicating and eliciting positive and negative emotions. One powerful demonstration of the power of touch to elicit positive emotions has been shown when researchers use the "still-face paradigm" to study infant emotionality. The still-face paradigm is comprised of a period of interaction when the caregiver assumes a still-face, thereby not responding to the infant's actions. During this period, infants typically react negatively because this is an unusual event in most infants' lives. Several studies indicate that if caregivers touch their infants during the still-face period, their infants' emotional displays are significantly less negative and more positive compared to infants who are not touched during the still-face period.

The quality of caregiver-infant touch is a central feature of the responsive and available caregiving environment that is necessary to foster an infant's sense of security. Several studies suggest that touch between the caregiver and infant is the "ultimate signal" of security of the infant. In one experimental study, researchers compared how infants were attached to their caregivers when they carried their infants ventrally in soft infant carriers versus those who were carried in harder infant seats. The researchers found that infants carried in the soft infant carriers were significantly more likely to be securely attached to their caregivers than infants who were carried in the infant seats. This study and others strongly suggest that touch plays a key role in the communication of security to children.

Touch continues to play an integral role in social communication in adulthood. For example, touch communicates power and emotions to others, as well as aids in persuading others to comply with our requests. In addition, touch increases verbal interaction among people, gains attention from others, and communicates our attraction toward others.

In sum, touch not only helps us learn about the world in which we live but plays an integral role in several other domains of life including biological, cognitive, and social development. Although touch may be one of the most powerful and most important sensory modalities across the life span, the study of touch has remained minimal. Future work on touch will continue to unravel the mysteries of touch.

—Matthew J. Hertenstein

*See also* Sensory Development

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## TOURETTE'S SYNDROME

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Tourette's syndrome (TS) is a neurobehavioral disorder named after the French neurologist Georges Gilles de la Tourette who in 1885 described nine patients with TS symptoms including verbal and motor childhood-onset tics and other behavioral problems including poor impulse control and obsessive-compulsive behaviors. The disease, once believed to be extremely rare, is now considered to be quite