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## High Amplitude Sucking

The high-amplitude sucking technique (HAS), also called non-nutritive sucking, is an experimental method appropriate for testing infants from birth to age 4 months. The HAS technique capitalizes on infants' sucking reflex: infants hear a sound stimulus every time they produce a strong or "high-amplitude" suck. The number of high amplitude sucks produced is used as an index of interest. Variants of the procedure can be used to test infants' discrimination of and preference for a variety of language stimuli. The use of HAS in the field of language acquisition was pioneered by Peter D. Eimas and his colleagues in their 1971 study of categorical discrimination, where they showed that 1-4 month-old infants are more sensitive to an acoustic difference that crosses an adult consonant boundary than to one that does not. In the more than 40 years since this initial study, the HAS technique has been foundational in understanding speech perception in very young infants. Recently, the popularity of HAS has declined in favor of newer brain-based techniques that do not require an overt behavioral response.

HAS studies with neonates are conducted in the hospital within a few days after birth, while studies with older infants are conducted in the laboratory. In a quiet room, infants are seated either in an infant-appropriate chair or on an experimenter's lap. Infants are offered a sterilized pacifier, which is connected to a pressure transducer. The pacifier is held in place either by the experimenter or by a mechanical arm. The pressure transducer relays information to an adjacent computer about the frequency and intensity of the infants' sucking.

A silent baseline period lasting 1-2 minutes is used to measure the infants' average frequency and intensity of sucking when no stimulus is played. Subsequently, experimental stimuli are played when infants deliver a "high amplitude suck", for example those falling in the upper 1/3 of their sucking range. There are two basic variants of the HAS procedure: discrimination and preference.

**Discrimination:** To test infants' discrimination of different classes of stimuli (e.g. different syllables or different languages), infants are habituated to one type of stimulus. During the habituation phase, each time the infants produce a high amplitude suck, a sound is played over loudspeakers. This continues until infants' sucking has declined to a predetermined level, for example a 20% reduction in the number of high amplitude sucks produced per minute. Habituation typically lasts between 5 and 15 minutes. Once the habituation criterion has been met, infants proceed to the test phase, which typically lasts for 2-5 minutes. Infants in the control condition continue to hear more stimuli of the same type as heard during habituation. Infants in the experimental condition hear stimuli of a new type. If infants can discriminate between the two stimulus types, sucking is expected to increase for infants in the experimental condition, but not for infants in the control condition.

**Preference:** To test infants' preference for different stimuli (e.g. preference for the native language over a foreign language, or for a familiar voice over an unfamiliar voice), two different stimuli are available on alternating minutes. For example, during minute 1, infants hear stimulus A each time a high amplitude suck is produced (e.g. French sentences), and during minute 2, infants hear stimulus B each time a high amplitude suck is produced (e.g. English sentences). The two types of stimuli are presented alternately, typically for a total of 10 minutes. The number of high amplitude sucks produced during each minute type is compared. Infants demonstrate a preference for one stimulus over the other if they suck reliably more during one minute type than during the other.

The basic mechanism underlying the HAS procedure is thought to be operant conditioning. Infants suck more to interesting stimuli because they learn that a high amplitude suck will produce a rewarding sound. It has also been suggested that high amplitude sucking is a simple index of infant arousal. Some variants of the HAS procedure thus do not involve a contingency between sucking and

sound presentation. However, both proposed mechanisms yield the same prediction, that infants will suck more in response to interesting than to disinteresting stimuli.

The HAS procedure presents several methodological challenges. First, infants must be awake and willing to suck to begin the study, yet neonates spend much of their time sleeping and can be difficult to wake. Further, amongst infants that do begin the procedure, attrition rates are often high. Common reasons for attrition include loss of interest in sucking partway through the study, falling asleep during the study, the pacifier slipping out of the infant's mouth, and crying. Finally, there are no commercially available HAS systems, thus this procedure requires custom hardware and software. Due to these methodological challenges, there has been a decline in the use of the HAS procedure in favor of non-invasive neuroimaging techniques. These include near-infrared spectroscopy and event-related potentials, which are appropriate for very young infants but do not require an overt behavioral response.

Despite its limitations, the HAS procedure has been important to the field of language acquisition, and has been instrumental in advancing knowledge of speech and language perception in very young infants. For example, HAS studies have shown that very young infants can discriminate numerous languages and speech sounds from each other, and can discriminate different voices, syllables, stress patterns, and pitch contours. Further, neonates show a preference for their native language, for their mother's voice, for passages familiarized during pregnancy, for speech over non-speech, and for content words (e.g. nouns, verbs) over function words (e.g. prepositions, articles).

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**See also:** Neonatal Preference for Speech, Neonatal Speech Perception

#### **Further readings**

DeCasper, Anthony J., & Fifer, William P. "Of Human Bonding: Newborns Prefer Their Mothers' Voices." *Science*, v. 208 (1980).

Eimas, Peter D., Siqueland, Einar R., Jusczyk, P., & Vigorito, J. "Speech Perception in Infants." *Science*, v. 171 (1971).

Jusczyk, Peter W. "The High-Amplitude Sucking Technique as a Methodological Tool in Speech Perception Research". In Krasnegor, Norman A., & Gottlieb, Gilbert [Eds.] *Measurement of Audition and Vision in the First Year of Postnatal Life: A Methodological Overview*. Westport: Ablex Publishing, 1985.