

Project Design Specifications

Tactile Auditory Sensory Substitution

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Function:

The goal is to design and develop an auditory substitution device that through the use of a digital hearing aid and vibro- or electro-tactile stimulation can substitute for regional frequency hearing loss.

Client Requirements:

- High frequency hearing loss is the most common form of hearing loss experienced, which is caused by damaged nerve ends on the hairs in the cochlea and cannot be fixed with amplification of these high frequency consonants. Instead of amplification, these missing consonants can be communicated by sensory substitution.
- The device will allow the user to distinguish one sound from another which they are not able to do with auditory information alone.
- The substitution prototype will use vibro- or electro-tactile stimulation.
- The device should be self contained.
- The device should be able to be adjusted for the needs of the individual user's hearing loss.
- The device should be able to work with existing digital hearing aids in order to avoid the user needing separate devices.

Design Requirements:

1. Physical and operational characteristics

a. Performance requirements:

- When in use, the device will need to be functioning continuously and accurately.
- It will increase the user's quality of communication by allowing the user to recognize high frequency consonants and incorporate them into word recognition through tactile simulation.
- It will also recognize and alert the user to high frequency alarms.
- This device should use programmable functions of a digital signal processing hearing aid to recognize certain high frequency sounds and communicate them to the tactile stimulator.

b. Safety:

- This device will be used in or near to the ear. Therefore current of more than 5 mA should not pass through the device and into the user.
- The device should not heat to over 110° F while in use.

c. Accuracy and Reliability: The device should be accurate enough to process and substitute for the consonants T, F, S, Th, Sh, and P when coming from a variety of different vocal tones encountered in daily usage.

Human Hearing Frequency Range: 20 – 20,000 Hz

Speech Frequency Range: 125 – 8,000 Hz

High Frequency Hearing Loss: above 1,000 Hz

Sound	Approx. Frequency in Hertz
T	3500
F	4000
S	4000
Th	4000
Sh	2000
P	1500

*Most of these sounds are around 4000 Hz. This is the frequency most commonly damaged by loud noise and toxins.

* “S” sound is the most common sound in the English language. It is also the softest and highest frequency.

d. *Life in Service:*

- The device should have a service life comparable to that of a digital hearing aid, approximately 5 – 7 years.
- On a single battery charge the device should last approximately 5 days, similar to that of a common hearing aid so they can be charged at the same time.
- Common hearing aid batteries have an output voltage of 1.4 V and have power ratings between 140 and 640 mAh. With daily use of the device being about 14 hours the device should draw from 2 - 10 mA of current from the battery.

f. *Operating Environment:*

- The device will be located around or in the ear.
- If inside the ear (ITE) the device should not be adversely affected by earwax.
- If it is behind the ear (BTE) elements such as wind, rain, sun and sweat should not cause the device to vibrate for non-spoken noises, output dangerous levels of current or distort outgoing signals.

g. *Ergonomics:*

- The device should fit snugly in or behind the ear.
- The device should not move during normal physical activity.

h. *Size:*

- A BTE unit should be less than 5 cm in length, 1.75 cm wide and 1.25 cm thick so the unit can be completely covered by the ear.
- An ITE unit should be approximately 1.2 cm x .9 cm x .9 cm (approx. the size of an ITE hearing aid) to allow for easy access to insert and remove it.

i. *Weight:*

- The weight for the ITE device should be no more than 1.5g and the BTE unit should be no more than 5 g (similar to that of common digital hearing aids).

j. *Materials:*

- Soft, durable plastic such as vinyl
- Adhesive to hold the BTE unit in place should not irritate skin, leave large amounts of residue, or be painful to remove.

k. *Aesthetics, Appearance, and Finish:*

- Unit should be flesh-colored and not overtly noticeable to others.
- Adhesive attachment used for BTE unit should not leave large amounts of residue and should not be painful to remove.

2. Production Characteristics

a. *Quantity:* If able to plug into the users existing hearing aid, the device should be able to be produced in mass quantities.

b. *Target Product Cost:* The device should cost between 5-10% of the total cost of the hearing aid.

3. Miscellaneous

a. Standards and Specifications: FDA approval

b. Customer: May have preference for devices that are ITE or BTE

c. Patient-related concerns: Device should not cause discomfort due to tactile or electro-tactile stimulation or adhesive and should not be overtly noticeable. It should also be easy to use i.e. just require the user to put it in place.

d. Competition: Tactaid 7 <http://www.tactaid.com/tactaid71.html>
Tickle Talker
Tacticon 1600