



Audiological Bulletin No. 3

Positioning of the Senso Diva SD-X in the ear

The functionality of directional microphones is based on the principle of physical separation between the microphone inlets. By utilising the timing differences between the sound's arrival to the front and rear sound inlets it is possible to obtain a wide variety of directional patterns and thus increase the signal-to-noise ratio in noisy environments.

The choice of distance between microphones (or microphone inlets) is a compromise between several considerations. Cosmetic preferences have to be weighed against the functional advantages and disadvantages associated with various distances. In *Senso Diva* the implementation of an adaptive microphone matching system (OptiMic) has made it possible to reduce the distance between the two microphones to less than 6 mm, thus allowing of cosmetically appealing ITE/ITC solutions while maintaining the substantial directional benefit offered by the Diva Locator.

Positioning directional ITE models in the ear

In a free field, the effect of a directional microphone system is optimum when the line connecting the two sound inlets is pointing straight at the desired sound source. This will result in the greatest sensitivity in the desired direction and less sensitivity to sounds from all other directions. When placed on/in the ear, reflections and shadow effects may influence the timing differences, which are used by the directional system to identify the direction of a sound. Especially in ITE/ITC models it is important to consider how the two sound inlets are placed relative to the landmarks of the outer ear and ear canal opening in order to obtain optimum directivity.

In ITE/ITC hearing aids, the directional characteristic will be influenced both by the head and by the outer ear. The head will shadow sounds coming from the opposite side but will also change the focus of the directional pattern, i.e. maximum sensitivity will not be precisely in the frontal direction but slightly to the side. The shape of the outer ear provides a natural directional effect especially in the range 1.5-4 kHz. Even though this in itself is a positive effect, it may contribute negatively to the combined directional effect. It is therefore of great importance that directional hearing aids are positioned in the ear in a way that allows the combined directional characteristic of the hearing aid and ear to be utilised to a maximum degree.

Positioning Senso Diva SD-X

During the development of the Diva Locator, the functionality of this adaptive dual-microphone system was thoroughly evaluated with special focus on the benefit obtained with ITE/ITC models. By systematically varying the position of the hearing aid in the ear, it was possible to measure the directional effect obtained for both ideal and extreme positions. Based on experience gained from this study, the Diva Locator was optimised to provide a directional advantage for a relatively wide range of ITE/ITC positions - see descriptions below. Also, tools and guidelines for shell production were developed in order to ensure that the position of *Senso Diva SD-X* in the individual ear allows optimum performance of the Diva Locator.

Below, the range of acceptable positions of *Senso Diva SD-X* is described using two views of the ear: a) seen from the side and b) a cross-section of the ear canal seen from above (see illustrations 1a and 1b below). Note the position of the tragus and antihelix, as these will be used as landmarks in the descriptions.

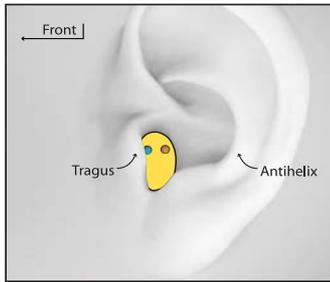


Fig. 1a

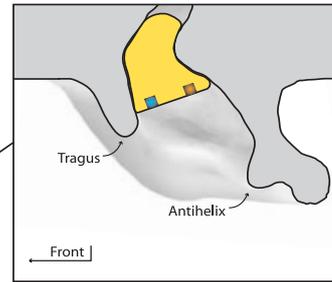
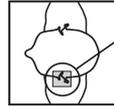
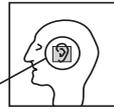
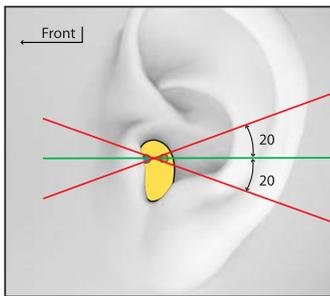
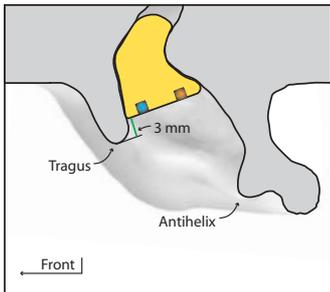


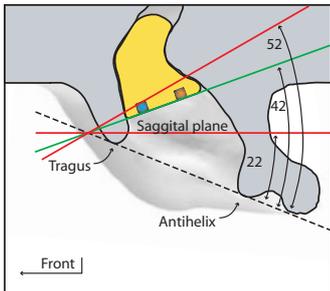
Fig. 1b



1. Looking at the hearing aid from the side, the best utilisation of the timing difference between sound reaching the two sound inlets is obtained when the line connecting the sound inlets is close to horizontal. The Diva Locator is optimised to provide a directional advantage for positions ranging from -20° to $+20^\circ$ from the horizontal plane.



2. *Senso Diva SD-X* can be positioned up to 3 mm into the ear canal as measured from the outer edge of the tragus.



3. The angle of the faceplate into the ear can be defined relative to the line that connects the outer edges of the tragus and antihelix. By doing this the variance in outer ear protrusion between individuals is taken into account. The performance of the Diva Locator is optimised for angles between 22 and 52 degrees into the ear canal with the optimum position at an angle of 42° .



Fitting Senso Diva SD-X

When fitting *Senso Diva* SD-X for a client, it is important to observe the following guidelines in order to ensure the best possible outcome.

- **Make a good impression of the ear/ear canal**
In order for the earmould technician to position the faceplate (and thus the two sound inlets) of the ITE/ITC hearing aid appropriately in the shell of the hearing aid, it is necessary to have a good impression which reveals all the important landmarks of the ear.
 - Use a silicone-based material. The choice of material is important for the quality and stability of the impression.
 - Make sure to fill out the entire concha so that the tragus and anti-helix are identifiable.
 - Ensure that the impression is long enough. It should reach 3 mm past the second bend of the ear canal.
 - Ensure that no air pockets or other irregularities are present in the impression.
- **Make sure that the right and left hearing aids are connected correctly to SP3/HI-PRO during programming**

In order for the two microphones in a SD-X hearing aid to point in the right direction when this is placed in the ear, the Diva Locator will be preprogrammed to either right or left ear when the hearing aid is mounted in the shell during production. This right/left configuration must be preserved when the hearing aid is fitted for the user and therefore it is important to connect the hearing aids to the correct sockets of SP3/HI-PRO (i.e., the hearing aid that fits the right ear/has a red marking to the right socket and the hearing aid that fits the left ear/has a blue marking to the left socket). As long as a correct connection is ensured, you are free to proceed with the fitting. If Compass/SP3 registers that a hearing aid configured as “left” is connected to the right socket (or vice versa) a warning will appear. When this happens, check whether the hearing aids are connected correctly and if not perform the following steps:

- For SP3 fittings reconnect the hearing aids to the correct sockets and press *No*. Proceed with the fitting.
- For Compass fittings click *No* (twice if two hearing aids are connected). In the Client Information screen, click *Cancel*. Go back to *Selection* in the vertical navigation bar. Reconnect the hearing aids to the correct sockets. Click on the *Detect* icon in the toolbar and proceed with the fitting.

If you are absolutely certain that the hearing aids are connected to the correct sockets, press *Yes* on SP3/Compass. This will change the configuration of the directional system. Be aware that if you press “Yes” in situations where the prompt is actually caused by an incorrect connection the directionality will be reversed – that is, when the hearing aid is placed in the ear of the client, sounds coming from behind will be enhanced.

- **Counsel the client on individual variability in directional effect**
Because no two ears are the same, individual variations in the performance of the Diva Locator will occur. All users should expect a directional effect, i.e., in noisy surroundings sounds coming from the back and sides should be dampened while sounds originating from the front should be perceived as unattenuated. However the degree of directional benefit will to some extent depend on the anatomical characteristics of the individual ear, and thus may vary. As with all directional hearing aids it is important to point out to the user that it is a prerequisite for obtaining a directional advantage that the user faces the sound source/speaker he or she wants to hear while turning the back to unwanted sounds.



Follow-up

If a client comes back after a period of hearing aid use with complaints about his or her ability to hear in noise it may be difficult to determine whether the problems are related to the client's hearing, use of the hearing aid or malfunctions of the hearing aid. In order to eliminate the Diva Locator from your troubleshooting process go through the following steps:

- **Perform a Diva Self-test to evaluate the integrity of the microphones**
If one of the microphones is defect the client may experience reduced loudness and reduced directional effect. This can be checked by activating the Diva Self-test from either Compass or SP3. See Audiological Bulletin no. 2 for further instructions.
- **Check that the microphone configuration (right/left) is correct**
If the configuration of the Diva Locator is wrong, the directional characteristic of the hearing aid will be reversed (sounds coming from the back will be enhanced). To investigate this, connect the hearing aid(s) to SP3/HI-PRO and check that no warning about right/left connections appear.
- **Visually inspect the position of the two microphones in the ear.**
If the two sound inlets are placed in a way that does not allow the Diva Locator to distinguish between sounds coming from the front and from behind, the client may experience reduced or even reversed directional effect. Place the hearing aid in the ear and check whether the position of the SD-X is roughly in accordance with the guidelines listed in the previous section.

If all three points are OK, it is highly likely that the reason for the client's complaints should be found in the way the hearing aid is used or in the characteristics of the client's hearing.