

► **Noise** is not the only hazard to hearing in the workplace. **Chemicals**, such as aromatic solvents, are **ototoxic** following a chronic exposure.

► When inhaled, **solvents** easily enter the brain and cause acute **depressive** effects, even at low concentrations.

► Animal data suggest they also decrease the **acoustic reflex (AR) threshold**, which may alter one of the defense mechanisms of the ear against noise. **This has never been shown in humans yet.**

## Methods

► Data were collected from 2011 to 2021 from **215 employees** monitored in **45 different companies**.

Type of company → Job	Country	# of companies	# of workers	Mean exposure (ranges)*	
				Noise L <sub>Aeq</sub> db(A)	Solvents IAE**%
<b>Automotive repair</b> → Car body builders, painters	France	21	47	78 (65 to 90)	8 (0 to 66)
<b>Hospitals</b> → Histopathologists	Austria	2	9	68 (62 to 77)	32 (15 to 60)
<b>Composite materials</b> → Production workers	Austria France	3	20	77 (72 to 88)	14 (1 to 50)
<b>Entertainment</b> → Sound engineers, light / stage technicians, security agents, barmen	France	6	38	88 (79 to 96)	n.a.
<b>Industry and construction</b> → Production workers	France	5	26	85 (79 to 91)	n.a.
<b>Unexposed personnel</b> → Phone operators, backoffice	France	13	75	65 (54 to 73)	n.a.

\* Takes into account personal protection when worn.

\*\* IAE: Index of additional exposures. Sum of the ratios between the measured concentration and the 8-hour OEL of each solvent with the toxic effect.

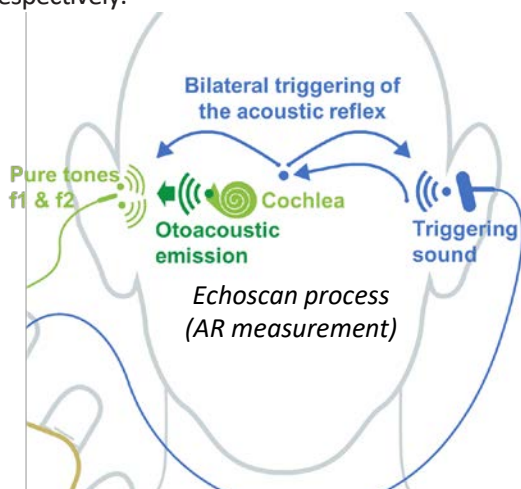
• Auditory measurements were made at the **beginning and end of the work shift**. The **difference** between these two measures was used to assess **auditory fatigue** and its putative **modulation by solvents**.

► INRS has conducted a series of studies in collaboration with AUVA (Austrian occupational health institute), Thalie Santé and CMTI (Inter-company medical centers) in order to:

(1) confirm, in humans, the **acute effect of the solvents on AR** observed in animals

(2) to evaluate the relevance of the measurement of the AR as a **biomarker of the solvent's action on the worker's brain**, and as a useful tool for prevention.

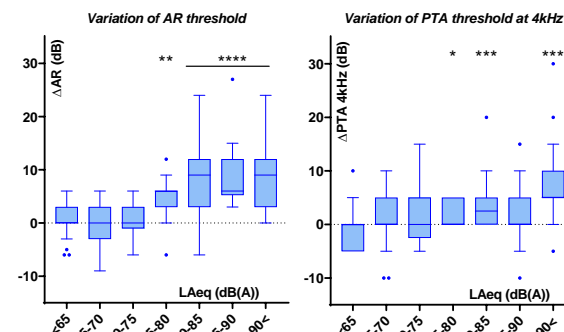
• Two types of tests were performed: **pure tone audiometry (PTA)** and **AR threshold** measurement by Echoscanner®, with performance changes during the day noted as  $\Delta$ PTA and  $\Delta$ AR, respectively.



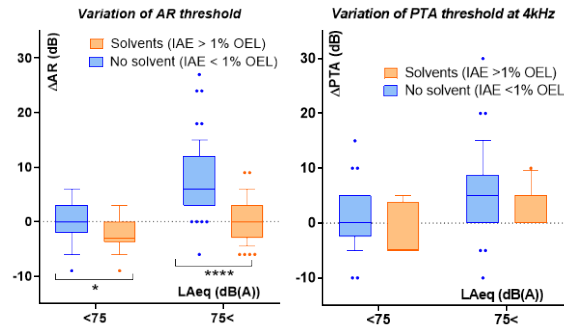
• Noise and solvent exposures were monitored with a **sound exposimeter** and a **passive charcoal sampling badge**, respectively.

## Results

### EXPOSURE TO NOISE ONLY



### EXPOSURE TO AROMATIC SOLVENTS AND/OR NOISE



► Noise exposure causes auditory fatigue.  **$\Delta$ AR becomes significant at 75dB(A)**. The effect of noise on PTA is less marked than for AR.

► **Brain plasticity** involved in the PTA measurements may explain in part the **lower sensitivity and specificity of PTA compared to AR**.

► The median  **$\Delta$ AR is 6dB** in workers exposed to **>75dB(A) without solvent**. In co-exposed workers,  **$\Delta$ AR is zero**. Exposure to **solvents alone** results in a **decrease in  $\Delta$ AR (-3 dB)**.

► **Solvent exposure has a significant impact on AR**, but **none on ATL**, whatever the level of the noise.

### FACTORS INFLUENCING THE THRESHOLD OF THE AUDITORY REFLEX

► Multifactorial modelling confirms these results. The "**noise exposure**" factor is both highly **significant and positive** (increasing AR and PTA thresholds with increasing exposure), whereas the "**solvent exposure**" factor is significant only in **explaining  $\Delta$ AR**. In addition, the value of the "solvent exposure" factor is negative, which means a **decrease in AR when solvent exposure increases**.

The factors "age", "gender", "duration of exposure" over the day are not significant.

## Conclusions

► The **acute effect of organic solvents on the brain**, even at very low concentrations, is demonstrated in workers at the end of a working day by measurements of the **variation of the threshold of AR** recorded by Echoscanner (but not by PTA). This is the **first proof** of the action of solvents on **the AR** in humans.

► Solvents cause a **decrease of the AR threshold**. Workers co-exposed to noise and solvents display a variation of the AR threshold close to zero (as unexposed workers): the AR threshold increase caused by noise is suppressed by the effect of the solvent.

► The AR threshold measured by Echoscanner is a **relevant functional biomarker** that could be applied to work environments where **noise and/or solvents** are present.

