Hyperacusis & Misophonia in Children with Auditory Processing Disorder (APD)

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Background:

- Importance of Research Domain Criteria (RDoC) principle in differentiating between 'Hyperacusis' & 'Misophonia' has been raised[1].
- Hyperacusis' & 'Misophonia' linked to auditory processing, emotional regulation & learning[2].
- RDoC principles is in use to diagnose APD[3] .

Objectives:

- Prevalence of 'Hyperacusis' and 'Misophonia' in children and young people (CYP) with APD?
- How do 'Hyperacusis' and 'Misophonia' vary in CYP with APD?

Methods:

- Retrospective study of 279 CYP (m=160, f=119; NVIQ ≥80), normal hearing thresholds 0.5-12.5 kHz, aged 6 to 16 years (mean: 11.9; SD: 2.1) diagnosed with APD using RDoC priniple[3].
- Decreased sound tolerance (DST) "Most times" and "Always" in structured history considered in defining Hyperacusis and Misophonia
- Comorbidity screening : Children's Communication Checklist-2 (CCC-2) Strengths and Weaknesses of Attention-Deficit/Hyperactivity-symptoms and Normal-behaviours (SWAN) rating scale, Manual dexterity using Movement ABC (M-ABC2) and Anxiety Scale for Children-ASD (ASC-ASD).

Results:

***Group A*:** 136 (48.7%) **no DST**; m=82, f=54; 6-16 years (mean 11.7, SD 2.1), NVIQ 81-125 (mean 98.7)

***Group B* :** 107 (38.4%) DST to sounds other than eating/chewing (**Hyperacusis**); m=66, f=41; 7-16 years (mean 11.3, SD 2.1), NVIQ 80-127 (mean 99.5).

***Group C* :** 36 (12.9%) DST to eating/chewing sounds amongst other (**Misophonia**) [4,5]; m=12, f=24; 7-16 years (mean 12.6, SD 2.4), NVIQ 84-128 (mean 97.3)

Age: Group C significantly older than Groups A and B (Kruskal Wallis test, p< .01).
Gender: Significantly higher proportion of females in ***Group C*** compared to groups A [χ^2 (1, N=172) =8.35, p<.01] and group B [χ^2 (1, N=143)= 8.73, p<.01].

Different sound triggers

Common to Groups B and C
Any unexpected sounds, classroom noises, any crowed places, loud voices, school dining room, hand-dryers, firework, and balloon popping.

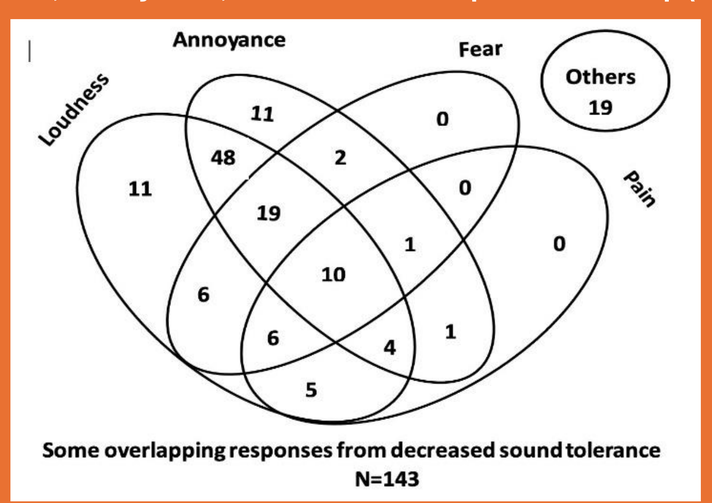
Triggers that are significantly greater in Group C

Trigger Sounds	Group B: Hyperacusis N (%) DST to trigger	Group C: Misophonia N (%) DST to trigger	χ^2 (DST Group B vs. C)
Eating	0	36 (100%)	
Tapping /clicking	**20 (18.6%)**	**23(63.8%)**	**χ^2 (1, N=143)= 26.168; p<.0001***
Breathing	**10 (9.3%)**	**20 (55.5%)**	**χ^2 (1, N=143)= 34.696; p<.0001***
Coughing	**9 (8.4%)**	**17 (47.2%)**	**χ^2 (1, N=143)= 27.275; p<.0001***
Playground	**20 (18.7%)**	**15 (41.6%)**	**χ^2 (1, N=143) =7.520; p< .01***
Sneezing/sniffing	**9 (8.4%)**	**14 (38.8%)**	**χ^2 (1, N=143) = 18.538 p<.0001***
Tap Running	**5 (4.6%)**	**9 (25%)**	**χ^2 (1, N=143) =12.602; p <.001***

Emotional & Behavioural Responses

Responses	Group B:Hyperacusis N (%) with responses	Group C:Misophonia N (%) with responses	Chi-Square statistics
Annoyed	68(64%)	29(80%)	χ^2 (1, N=143)=3.569; p>.05
Loudness complaint	82(77%)	27(75%)	χ^2 (1, N=143)=0.039; p>.05
Distressed	68(64%)	22(61%)	χ^2 (1, N=143)=0.068; p>.05
Anger	54(50%)	22(61%)	χ^2 (1, N=143)=1.225; p>.05
Anxious	65(61%)	17(47%)	χ^2 (1, N=143)=2.014; p>.05
Verbally abusive	**21(17%)**	**16(44%)**	**χ^2 (1, N=143)=8.650; p<.01***
Upset	**61(57%)**	**10(28%)**	**χ^2 (1, N=143)=9.207; p<.01***
Cries/screams	31(29%)	9(25%)	χ^2 (1, N=143)=0.210; p>.05
Disgusted	**6(6%)**	**8(22%)**	**χ^2 (1, N=143)=8.419; p<.01***
In pain	22(21%)	7(19%)	χ^2 (1, N=143)=0.020; p>.05
Hits own head	18(17%)	6(17%)	χ^2 (1, N=143)=0.001; p>.05
Hits others	11(10%)	3(8%)	χ^2 (1, N=143)=0.115; p>.05
Frightened	**44(41%)**	**3(8%)**	**χ^2 (1, N=143)=13.124; p<.001**

- **Getting frightened and upset significantly high in Group B.**
- **Verbal abuse and being disgusted significantly high in Group C.**
- **Loudness, Annoyance, Fear and Pain responses overlap (Fig 1).**



Some overlapping responses from decreased sound tolerance N=143

Co – morbidities

CCC-2 : Language impairment (LI) 70.5%, 90.6% and 88.8% in Groups A, B, C respectively. (Fig 2)
General communication composite significantly lower in groups B & C than group A (all p<.01).
SWAN scale: Significantly more children in groups B and C with ADHD than group A .
ASC-ASD: More than 70% in groups B and C had anxiety, significantly more than group A.
Impaired Manual Dexterity (IMD) not different between the three groups.

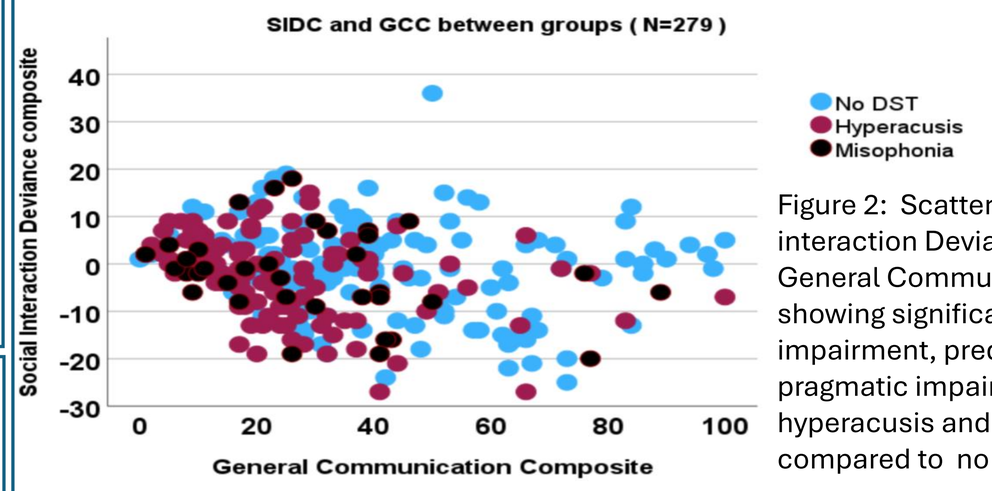
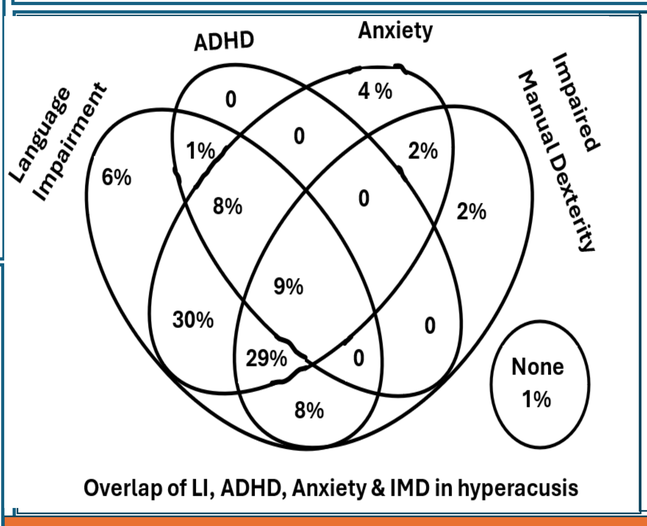
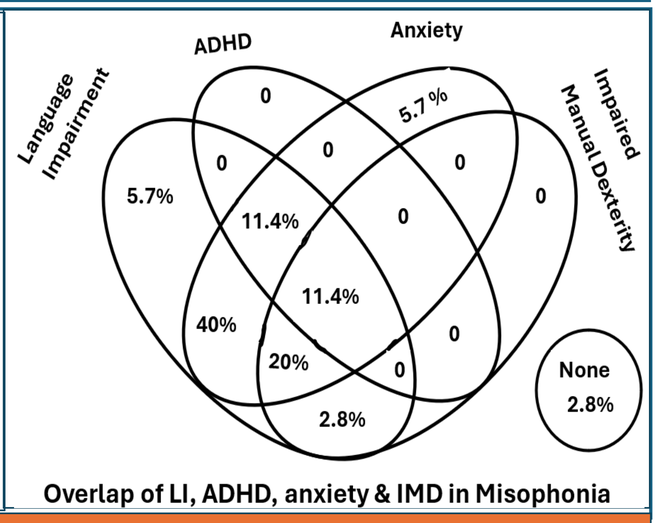


Figure 2: Scatterplot of Social interaction Deviance composite and General Communication Composite showing significant Language impairment, predominantly pragmatic impairment, in hyperacusis and misophonia compared to no DST



Overlap of LI, ADHD, Anxiety & IMD in hyperacusis



Overlap of LI, ADHD, anxiety & IMD in Misophonia

ADHD in misophonia and hyperacusis co-exist with Language impairment

Tinnitus

- Compared to Group A, significantly more tinnitus reported in groups B [χ^2 (1, N=237)=4.898; p<.05] and C [χ^2 (1, N=168)=15.272; p<.0001].
- Significantly higher report of tinnitus was also noted in group C compared to group B [χ^2 (1, N=141)=4.465; p<.05]

Other sensory sensitivities

Perceptions	Group B: Hyperacusis N (%) with sensitivity	Group C: Misophonia N (%) with sensitivity	Chi-Square statistics
Touch	48(45%)	21(58%)	χ^2 (1, N=143)=1.958; p>.05
Fussy eating	58(54%)	15(42%)	χ^2 (1, N=143)=1.694; p>.05
Smell	51(48%)	13(36%)	χ^2 (1, N=143)=1.454; p>.05
Taste	42(39%)	10(28%)	χ^2 (1, N=143)=1.532; p>.05
Pain	33(31%)	9(25%)	χ^2 (1, N=143)=0.443; p>.05
Light	24(22%)	8(22%)	χ^2 (1, N=143)=0.001; p>.05

Educational issues

- Reading concerns in 33.8%, 42%, & 27.7% in groups A, B, and C respectively
  Not significant [χ^2 (2, N=279)=3.027; p>.05].
- Spelling concerns in 50.7%, 53.2% & 52.7% in groups A, B, and C respectively,
  Not significant [χ^2 (2, N=279)=0.165; p>.05].
- Numeracy concerns in 42.6%, 45.2%, & 41.6% in groups A, B, and C respectively
  Not significant [χ^2 (2, N=278)=0.226; p>.05].
- *Education, Health & Care Plan (EHCP) in place for* 22.5%, 36.8%, & 16.6% in groups A, B, and C respectively; significant [χ^2(2,N=272)=8.351; p<.05].
- Significantly more EHCP in group B than groups A [χ^2 (1, N=236)=5.816; p<.05] and C [χ^2 (1, N=139)=5.044; p<.05].

Discussion

- First study to compare hyperacusis with misophonia in CYP with APD.
- Misophonia in older CYP and higher prevalence in females are consistent with literature.
- Sensitivity to body sounds and tapping/clicking sounds in misophonia is known, finding of increased sensitivity to playground noise is new.
- Verbal abuse & disgust responses in misophonia is known, fear is common in hyperacusis.
- Loudness, annoyance, fear and pain co-exists in both hyperacusis and misophonia.
- Language impairment and ADHD co-exists in both hyperacusis and misophonia.
- Tinnitus is more common in misophonia, also consistent with the literature.

Conclusion

- Hyperacusis and misophonia need evaluating within RDoC framework, including APD with prevalence of 38% hyperacusis and prevalence of 13% misophonia
- Most children with misophonia have hyperacusis but not all with hyperacusis have misophonia.
- The high prevalence of misophonia and certain emotional responses in females compared to hyperacusis support the view of misophonia as a separate mental health condition.
- Fewer EHCP in misophonia is a concern, which may be related to lack of awareness, internalization of problems in females, or unmet needs predisposing to misophonia.
- Future studies to explore other RDoC systems and constructs not included in this study.

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