APPENDIX A - SUMMARY STATISTICS AND BALANCE TEST

We present here the summary statistics and our covariate balance test, as specified in our pre-analysis plan.

TABLE A.1—SUMMARY STATISTICS

Variable	N	Mean	Std. Dev.	Median
WHOfive	727	14	5.8	15
Change in WHOfive	727	0.31	3.9	0
Change in ACI	727	50	29	50
Change in BIO	727	-2.6	4.4	-1.5
Change in H	727	-0.006	0.009	-0.006
NS	727	17	6.8	18
education	727			
... Completed Secondary School	235	32%		
... Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS)	87	12%		
... Some Secondary	21	3%		
... Some University but no degree	57	8%		
... University Bachelors Degree	184	25%		
... Vocational or Similar	143	20%		
age	727			
... 18-24 years old	31	4%		
... 25-34 years old	79	11%		
... 35-44 years old	135	19%		
... 45-54 years old	164	23%		
... 55-64 years old	156	21%		
... 65+ years old	162	22%		
income	727			
... 20,000-39,999 pounds	268	37%		
... 40,000-59,999 pounds	160	22%		
... 60,000-99,999 pounds	106	15%		
... Less than 20,000 pounds	162	22%		
... More than 100,000 pounds	31	4%		
garden	727			
... No	80	11%		
... Yes (private)	591	81%		
... Yes (shared)	56	8%		
vehicle	727			
... No	176	24%		
... Yes	551	76%		
urban_rural	727			
... A suburban area	235	32%		
... A town	252	35%		
... A village	117	16%		
... An inner city area	92	13%		
... Rural or countryside	31	4%		
Country	727			
... England	621	85%		
... Scotland	72	10%		
... Wales	34	5%		

Notes: ACI = Acoustic Complexity Index. Bio = Bioacoustic Index.
H = Entropy, NS = Noise Sensitivity. See section III
Any variable with "change in" in the title is the difference in levels for that variable between wave 1 in winter and wave 2 in spring.

A1. Balance Test

We carry out a covariate balance test, as specified in our pre-analysis plan. This is a check on whether the sample has differential attrition between waves 1 and 2. We carry out this test using the (**?**) Bonferroni corrected joint covariate balance test. We find, as shown in table A.2, that there has been differential attrition. This is mainly due to young people dropping out of the sample in wave 2. We can see that all 3 of the z scores that are at least statistically significant at the 10% level, after Bonferroni correction, are age group indicators. The leads to the overall χ^2 test to have a large value and therefore a very low p-value.

This does not affect the internal validity of our estimates, as we estimate the WAOSS, which is analogous to the average effect of treatment on the treated, the ATT. Therefore, we still get a causal estimate for our sample. However, it can mean that, if the treatment effect for young people is very different, then our estimates cannot be extrapolated to groups of younger people.

TABLE A.2—BALANCE TEST RESULTS

Variable	Treatment	Control	Adj. Diff	Std. Diff	Z-Score
WHOfive	14	14	-0.25	-0.04	-1.2
Noise Sensitivity	17	17	-0.14	-0.02	-0.56
Education (Some Secondary)	0.030	0.023	0.0071	0.04	1.2
Education (Vocational)	0.21	0.20	0.0085	0.02	0.56
Education (Some University)	0.073	0.084	-0.011	-0.04	-1.1
Education (Bachelor's Degree)	0.26	0.28	-0.015	-0.03	-0.89
Education (Graduate)	0.13	0.12	0.0026	0.01	0.21
Age 25-34	0.13	0.20	-0.068	-0.18	-4.7***
Age 35-44	0.19	0.16	0.03	0.08	2.1
Age 45-54	0.23	0.17	0.058	0.15	3.9***
Age 55-64	0.20	0.15	0.044	0.12	3.1*
Age 65+	0.20	0.19	0.013	0.03	0.90
Income (<£20k)	0.22	0.22	0.0001	0.00	0.01
Income (£40k-£60k)	0.23	0.22	0.01	0.02	0.63
Income (£60k-£100k)	0.15	0.14	0.0076	0.02	0.57
Income (>£100k)	0.045	0.041	0.0041	0.02	0.54
Local Greenspace (Daily)	0.036	0.037	-0.0006	0.00	-0.09
Local Greenspace (Never)	0.077	0.055	0.023	0.09	2.5
Local Greenspace (Once a Week)	0.19	0.19	0.0036	0.01	0.24
Vehicle (Yes)	0.77	0.78	-0.012	-0.03	-0.80
Urban (Town)	0.34	0.31	0.025	0.05	1.4
Urban (Village)	0.15	0.13	0.026	0.08	2.0
Urban (Inner City)	0.13	0.16	-0.032	-0.09	-2.3
Urban (Rural)	0.045	0.057	-0.012	-0.05	-1.4
Country (Scotland)	0.096	0.080	0.016	0.06	1.5
Country (Wales)	0.045	0.050	-0.0046	-0.02	-0.56
Overall Test: $\chi^2 = 126$, df = 41, $p = 1.6 \times 10^{-10}$					

*Bonferroni corrected joint covariate balance test of (**?**)*
WHOfive is the total score on the WHO mental well-being questionnaire and NS is the Noise Sensitivity score
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

APPENDIX B - ROBUSTNESS CHECKS

Here we add additional robustness checks as mentioned in Section V.

First we show simple regressions where we separate the winter and spring samples and regress, with and without covariates, on the winter or spring soundscape. The outcome and treatment variables here are in levels rather than changes.

TABLE B.1—WINTER AND SPRING CROSS-SECTIONAL REGRESSIONS

							WHOfive					
Treatment Variable	ACI Winter	ACI Spring	ACI Winter	ACI Spring	BIO Winter	BIO Spring	BIO Winter	Bio Spring	H Winter	H Spring	H Winter	H Spring
mean	-0.0019	-0.0135	-0.0011	-0.0109	-0.0397**	-0.0736	-0.0405**	-0.0499	20.79**	15.69	12.80	0.9989
	(0.0034)	(0.0088)	(0.0032)	(0.0083)	(0.0184)	(0.0726)	(0.0169)	(0.0682)	(9.773)	(34.71)	(8.765)	(33.17)
R^2	9.47×10^{-5}	0.00226	0.18655	0.20780	0.00141	0.00113	0.18794	0.20689	0.00140	0.00021	0.18704	0.20640
Observations	3,394	974	3,386	974	3,394	974	3,386	974	3,394	974	3,386	974
education fixed effects			✓	✓			✓	✓			✓	✓
age fixed effects			✓	✓			✓	✓			✓	✓
income fixed effects			✓	✓			✓	✓			✓	✓
local_greenspace fixed effects			✓	✓			✓	✓			✓	✓
garden fixed effects			✓	✓			✓	✓			✓	✓
outdoors fixed effects			✓	✓			✓	✓			✓	✓
vehicle fixed effects			✓	✓			✓	✓			✓	✓
Country fixed effects			✓	✓			✓	✓			✓	✓

Notes: ACI = Acoustic Complexity Index, Bio = Bioacoustic Index, H = Acoustic Entropy
Robust standard errors used.
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

As specified in our pre-analysis plan, we report results from the following two-way fixed effects regression as a benchmark:

$$Y_{it} = \alpha_i + \lambda_t + \theta D_{it} + \mathbf{x}_i\beta + \varepsilon_{it} \tag{B1}$$

Where Y_{it} is the WHO5 score, α_i is the time-invariant individual fixed effect, λ_t is the time-varying fixed-effect, which equals 1 in spring and 0 in winter, D_{it} is the soundscape metric (i.e. the treatment variable), and $\mathbf{x_i}$ our vector of covariates (see section III).

These results can be seen in table B.2. For each acoustic metric we first regress without covariates and then with. In all cases, the estimate of the treatment effect is not statistically significant. For ACI and BIO, the point estimate is extremely small and the intervals are also small, indicating a precise null effect. For H, the point estimate is extremely large, given the maximum WHO5 score is 25. However, there is very little variation in our H metric, so we expect any results for this metric to be erratic but we report anyway as it was pre-specified.

Next we add northing and easting variables to our regressions, as spring happens at different times depending on the latitude, so a Northing variable may account for how far into spring each area is. The combination of northing and easting variables takes into account different location effects

Then we look only at rural households as they may be closer to birdsong and more able to hear it.

TABLE B.2—BENCHMARK RESULTS

	WHOfive Outcome variable					
Treatment Variable	ACI	ACI	BIO	BIO	H	H
Estimate	-0.0001	-0.0004	0.0457	0.0391	10.13	8.366
	(0.0047)	(0.0048)	(0.0302)	(0.0314)	(15.26)	(16.28)
R^2	0.88	0.88	0.88	0.88	0.88	0.88
N	1,454	1,454	1,454	1,454	1,454	1,454
Clusters	727	727	727	727	727	727
Individual Fixed Effect	✓	✓	✓	✓	✓	✓
Time	✓	✓	✓	✓	✓	✓
Education		✓		✓		✓
Age		✓		✓		✓
Income		✓		✓		✓
local Greenspace		✓		✓		✓
Garden		✓		✓		✓
Outdoors		✓		✓		✓
Vehicle		✓		✓		✓
Country		✓		✓		✓

Notes: ACI = Acoustic Complexity Index, Bio = Bioacoustic Index, H = Acoustic Entropy
SE = standard errors clustered at panel level.
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

We look only at households which reported different location data in wave 1 and 2. This could mean they were inattentive or deliverability providing inaccurate information, but many of these households may have moved. This gives us a sample of those people before and after moving to a different soundscape.

TABLE B.3—MOVERS ONLY SAMPLE

	WHOfive		
	ACI	BIO	H
mean	0.0137	0.0340	22.63
	(0.0152)	(0.0938)	(50.65)
R^2	0.67170	0.67056	0.67067
Observations	486	486	486
education fixed effects	✓	✓	✓
age fixed effects	✓	✓	✓
income fixed effects	✓	✓	✓
local_greenspace fixed effects	✓	✓	✓
garden fixed effects	✓	✓	✓
outdoors fixed effects	✓	✓	✓
vehicle fixed effects	✓	✓	✓
urban_rural fixed effects	✓	✓	✓
Country fixed effects	✓	✓	✓

Notes: ACI = Acoustic Complexity Index, Bio = Bioacoustic Index, H = Acoustic Entropy
Robust standard errors used.
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

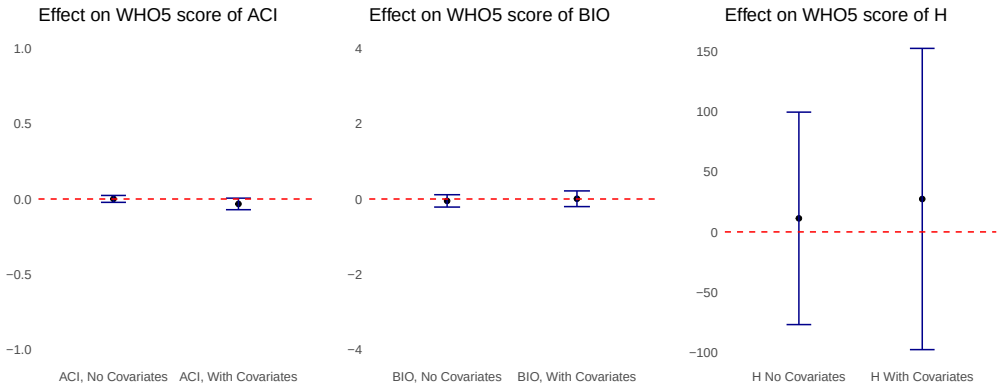

FIGURE B.1. EFFECT OF ACOUSTIC CHANGES ON WHO5 SCORE, WHEN NORTHING VARIABLE ADDED

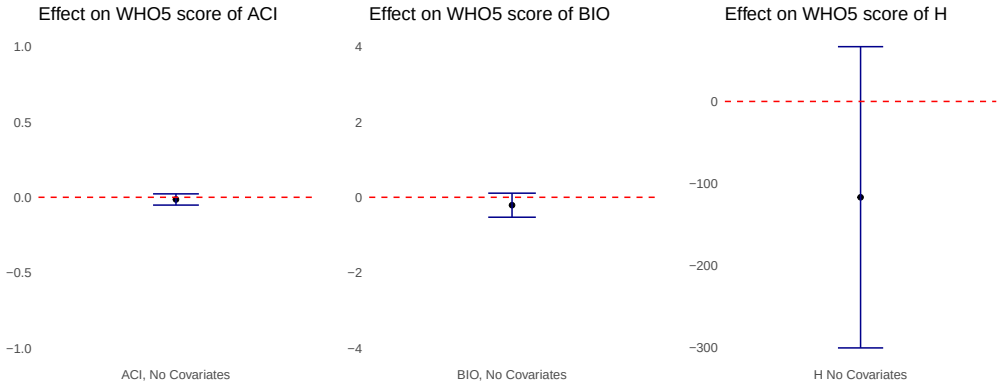

FIGURE B.2. EFFECT OF ACOUSTIC CHANGES ON WHO5 SCORE, RURAL HOUSEHOLDS ONLY

Finally, we use alternative soundscape data at a much more granular level.

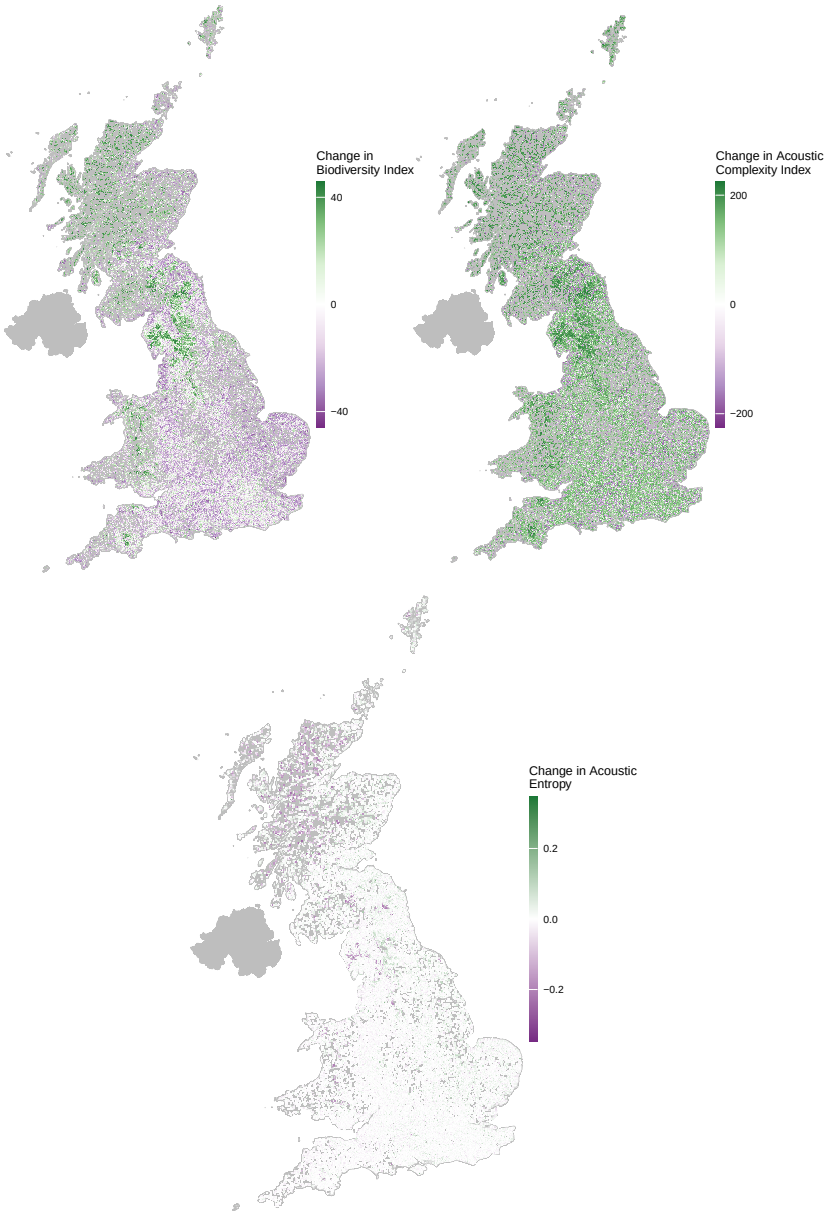

FIGURE B.3. CHANGE BETWEEN WINTER AND SPRING IN ACOUSTIC INDICES, TETRADS *Note: Areas with no data are grey. Variables are pseudo-log transformed before plotting.*

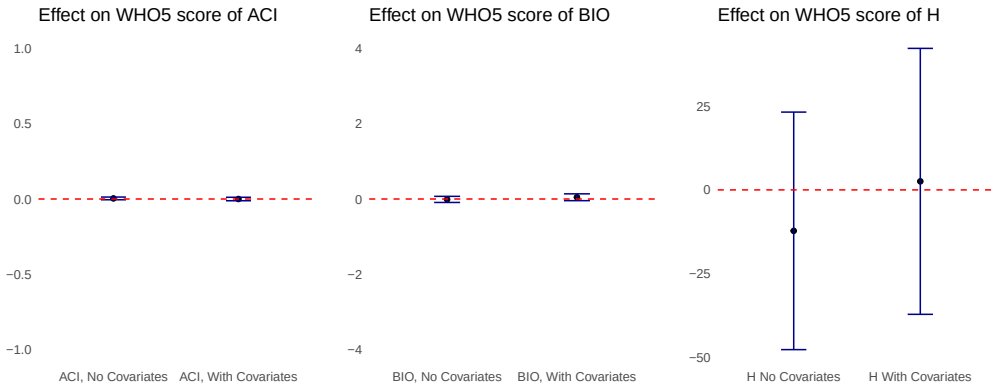

FIGURE B.4. EFFECT OF ACOUSTIC CHANGES ON WHO5 SCORE

TABLE B.4—EFFECT OF ACOUSTIC CHANGES ON WHO5 SCORE

Variable	$\hat{\theta}$	SE	Z-score	P-Value	MDE	N
ACI, No Covariates	0.00	(0.01)	0.85	0.20	0.03	681
ACI, With Covariates	0.00	(0.01)	0.01	0.50	0.04	681
BIO, No Covariates	-0.01	(0.04)	-0.25	0.60	0.10	681
BIO, With Covariates	0.05	(0.05)	1.01	0.16	0.12	681
H No Covariates	-12.23	(18.10)	-0.68	0.75	45.24	681
H With Covariates	2.55	(20.26)	0.13	0.45	50.66	681

Notes: ACI = Acoustic Complexity Index.
Bio = Bioacoustic Index.
H = Entropy. SE = standard error. $\hat{\theta}$ is the WAOSS estimate (see section IV).
MDE is minimal detectable effect, calculated as 2.5*SE.
P-value shows one-tailed p-values.
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

In all cases, results show no effect, similar to our main results.