What factors are associated with noise sensitivity in the UK population?

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ABSTRACT

This paper explores whether certain sub-groups of the UK population are more or less noise sensitive, using the 2012 National Noise Attitude Survey (NNAS 2012) dataset. NNAS 2012 was a community questionnaire survey of 2747 respondents in the UK, which measured attitudes to environmental noise. Data relating to a range of sociodemographic, dwelling, and geographic factors was also collected. Respondents rated how sensitive they were to noise on a seven-point scale ranging from 'not at all sensitive' to 'very sensitive'. Linear effect coding regression analyses were used to develop multivariable models of associations with noise sensitivity. A range of noise sensitivities were reported by the respondents (median = 4). Overall, noise sensitivity was more strongly associated with sociodemographic factors than with dwelling or geographic factors. Age; gender, homeownership, children, employment status, social class, and interviewer rating of hearing problems were associated with noise sensitivity after adjustment for dwelling and geographic factors. The analyses suggest that certain sub-groups of the population may be more or less noise sensitive compared with the UK population as a whole. The policy implications of these findings will be discussed.

Keywords: 63 Psychological effects; 66 Sociological effects: community reaction to noise.

1. INTRODUCTION

At any given level of environmental noise there will be variation in the degree of annoyance expressed by different people to that environmental noise(1). This has led researchers to examine whether certain individuals are more vulnerable or more resilient to the effects of noise, with noise sensitivity identified as a potential explanatory factor(1).

Noise sensitivity has various definitions but is generally defined as "the internal states (be they physiological, psychological [including attitudinal], or related to life style or activities conducted) of any individual which increase their degree of reactivity to noise in general"(2). In community surveys noise sensitivity is measured by self-report questions(2), with assessments making use of either one question (e.g. How sensitive would you say you were to noise?), to more robust multi-item scales, such as the Weinstein Noise Sensitivity Scale(3). Noise sensitivity is thought to moderate an individual's response to noise: the Caerphilly & Speedwell study found that noise sensitive men were more likely to be highly annoyed by road traffic noise exposure than less noise-sensitive men(1).

Little is known about whether a negative response to noise and, in particular, noise sensitivity, is more common in certain groups of the population. Quantifying the effect of noise sensitivity on responses to noise would also further feed into policy decision-making. This paper explores whether certain sub-groups of the UK population are more or less noise sensitive to noise using the 2012 National Noise Attitude Survey (NNAS 2012) dataset.

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2. METHOD

2.1 Setting and Participants

This paper uses data from the 2012 National Noise Attitude Survey (NNAS 2012) dataset. The NNAS 2012 was a community questionnaire survey of 2747 respondents in the United Kingdom, which measured attitudes to environmental noise. Data relating to a range of sociodemographic, dwelling, and geographic factors was also collected. A stratified random sampling approach with clusters at the lowest level was used. The sample was designed to be representative of all people 16+ in the UK living in individual dwellings (i.e. excluding barracks, halls of residence, hospitals, care homes, prisons, etc.). Anyone who was profoundly deaf was not interviewed, but partially deaf people were included.

2.2 Measures

Noise sensitivity was assessed by a single question asking respondents how sensitive they were to noise with responses on a seven-point scale ranging from ‘not at all sensitive’ to ‘very sensitive’. Noise sensitivity was analysed as a continuous variable.

A number of self-report sociodemographic factors were assessed in the questionnaire including age, gender, home ownership, whether there were any children under the age of 17 in the household, employment status, whether the respondent worked at home, whether the respondent undertook shift work, the social class of head of household (assessed using Registrar General’s Social Classification (4)), and whether the interviewer rated the respondent as having a hearing problem (interviewers assessed hearing ability according to ability with any assistive devices, so as to evaluate hearing ability in the everyday situation). Dwelling factors assessed included whether the house had double glazing, the age of the house, how long the respondent had lived in the house, type of house (e.g. flat/maisonette, semi-detached, terraced, detached, bungalow), whether the respondent had access to a garden, balcony and/or terrace (any form of private outdoor space), and whether the interviewer noticed any noise from road traffic; neighbours or other people nearby; aircraft, airports or airfields; and trains or railway stations. Geographic factors available for the data included region (England, Wales, Northern Ireland or Scotland), location of dwelling (e.g. centre of a large city, suburbs/outskirts of large city, large town or small city, country village/small town, countryside) and local authority rating of Urbanicity (urban, semi-rural, rural– this data was only available for the England sub-sample).

2.3 Statistical Analysis

Effect coding regression models were run using SPSS (version 22) to assess the associations of the sociodemographic, dwelling or geographic factors with noise sensitivity. Three sets of analyses were run. At step one, univariable regression models were run for each of the sociodemographic, dwelling and geographic factors. At step two, individual models were developed for the sociodemographic, dwelling and geographic factors: these models contained the variables that had shown a statistically significant association with noise sensitivity ($p<0.05$) in step one. At step three, a multivariable model combining the sociodemographic, dwelling and geographic factors that had been statistically associated with noise sensitivity ($p<0.05$) in step two was run.

It was not possible to include the variables ‘working from home’ or ‘shift work’ in the multivariable analyses, as these data were only available for the working sub-sample of the population. Similarly, ‘urbanicity’ data were only available for the English sub-sample. To maximise the power of the multivariable analyses it was not possible to include these variables in the multivariable models.

Effect coding in regression analyses does not use dummy variables, as in conventional regression models, where there is a reference group to which all the other categories of the variable are compared in the regression. In effect coding, the regression coefficient for each category of the variable is compared to the unweighted grand mean of all the observations. The coefficients represent the difference between the mean for this group compared to the unweighted grand mean for the sample: unweighted simply reflects the fact that different sub-group sizes are present within the variable being examined. Statistical significance is indicated in the tables (*p=0.05, **p=0.01,

***p=<0.001).

3. RESULTS

3.1 Noise Sensitivity

2747 respondents participated in the NNAS 2012 survey. Table 1 shows the distribution of noise sensitivity scores in our sample. A wide-range of noise sensitivities were reported by the respondents. On the 7-point scale, the median noise sensitivity score was 4 and the mean score was 3.83 (standard deviation 1.87).

Table 1 – Distribution of noise sensitivity scores in the NNAS 2012 (n=2747)

How sensitive would you say you are to noise?	%	N
1 - not at all sensitive	12.8	352
2	14.7	405
3	18.0	495
4	19.2	527
5	13.9	382
6	9.4	258
7 - very sensitive	11.6	318
Don't know	0.4	11

3.2 Sociodemographic factors associated with noise sensitivity

In the univariable regression analyses, the following sociodemographic factors were statistically significantly associated with noise sensitivity scores: age; gender, homeownership, children, employment status, working at home, shift work, social class, and interviewer rating of hearing problems.

Table 2 shows the results of the multivariable linear regression model, which included all of the sociodemographic variables that showed a significant association with noise sensitivity in the univariable analyses. The following sociodemographic factors were statistically significantly associated with noise sensitivity scores in the multivariable model: age; gender, homeownership, children, employment status, social class, and interviewer rating of hearing problems. The R^2 for this multivariable model was 0.057.

Respondents aged 45-54 years, 55-64 years, and 65-74 years had higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.30, 95%CI 0.12, 0.48; β=0.33, 95%CI 0.15, 0.51; β=0.42, 95%CI 0.17, 0.67, respectively). Respondents aged 16-19 and 20-24 years had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.86, 95%CI -1.26, -0.46; β=-0.48, 95%CI -0.77,-0.19, respectively).

Males had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.14, 95%CI -0.21,-0.06). Females had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.14, 95%CI 0.06, 0.21).

Respondents who bought their house on a mortgage had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.18, 95%CI 0.02, 0.35).

Respondents who had children under 17 years in the household had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.16, 95%CI -0.28, -0.04). Respondents who did not have children under 17 years of age in the household had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.16, 95%CI 0.04, 0.28).

Respondents in full time work and who were retired had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.30, 95%CI -0.47, -0.14 and β=-0.37, 95%CI -0.61, -0.12, respectively). Working at home and shift work were not included in the multivariate model due to collinearity with employment and sample size reduction.

Respondents where the head of household was in social class A had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.45, 95%CI 0.21, 0.70). Respondents where the head of household was in social class C2 or D had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.24, 95%CI -0.40, -0.09; β=-0.21, 95%CI -0.40, -0.02).

Respondents without hearing problems had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.41, 95%CI 0.26, 0.57). Respondents with hearing problems had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.41, 95%CI -0.57, -0.26).

Table 2 – Multivariable linear regressions for sociodemographic factors with noise sensitivity (n=2727)

Sociodemographic factor		Mean noise sensitivity score	Coefficient	95% CI
Age	16-19	3.24	-0.86***	-1.26, -0.46
	20-24	3.34	-0.48***	-0.77, -0.19
	25-34	3.49	-0.18	-0.40, 0.05
	35-44	3.83	0.17	-0.04, 0.38
	45-54	4.07	0.30***	0.12, 0.48
	55-64	4.03	0.33***	0.15, 0.51
	65-74	3.95	0.42***	0.17, 0.67
	75+	3.66	0.29	-0.00, 0.59
Gender	Male	3.66	-0.14***	-0.21, -0.06
	Female	3.97	0.14***	0.06, 0.21
Home ownership	Mortgage	3.88	0.18*	0.02, 0.35
	Owned	3.90	0.10	-0.08, 0.27
	Rented - social	3.66	-0.02	-0.24, 0.20
	Rented -private	3.56	0.00	-0.21, 0.21
	Other	3.29	-0.26	-0.70, 0.18
Any children	No	3.85	0.16**	0.04, 0.28
	Yes	3.58	-0.16**	-0.28, -0.04
Employment status	Working FT	3.69	-0.30***	-0.47, -0.14
	Working PT	4.09	0.01	-0.19, 0.21
	Unemployed	3.88	0.06	-0.28, 0.41
	Retired	3.82	-0.37**	-0.61, -0.12
	FT Education	3.54	0.35	-0.02, 0.71
	Home maker	4.03	0.04	-0.24, 0.31
	Other	4.23	0.21	-0.17, 0.59
Social class of head of household	A	4.35	0.45***	0.21, 0.70

	B	3.99	0.11	-0.04, 0.25
	C1	3.77	-0.08	-0.22, 0.05
	C2	3.56	-0.24**	-0.40, -0.09
	D	3.61	-0.21*	-0.40, -0.02
	E	3.85	-0.02	-0.26, 0.21
Hearing problem	No	3.86	0.41***	0.26, 0.57
	Yes	3.07	-0.41***	-0.57, -0.26
				R^2=0.057

3.3 Dwelling factors associated with noise sensitivity

The following dwelling factors were statistically significantly associated with noise sensitivity scores in the univariable analyses: age of house; length of time living in home; and type of house. Table 3 shows the results of the multivariable linear regression model, which included all of the dwelling variables that showed a significant association with noise sensitivity in the univariable analyses. The following dwelling factors were statistically significantly associated with noise sensitivity scores in the multivariable model: age of house; length of time living in home; and type of house. The R^2 for this multivariable model was 0.016.

Respondents living in homes built between 1919-1940 had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.20, 95%CI -0.39, -0.01). Respondents living in homes built before 1919 had higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.20, 95%CI 0.02, 0.38).

Respondents who had been living in their home for less than 6 months had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.33, 95%CI -0.61, -0.05).

Respondents living in a detached house had higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.26, 95%CI 0.07, 0.46).

Table 3 – Multivariable linear regressions for dwelling factors with noise sensitivity (n=2735)

Dwelling factor		Mean noise sensitivity score	Coefficient	95% CI
Age of house	Before 1919	3.84	0.20*	0.02, 0.38
	1919-1940	3.94	-0.20*	-0.39, -0.01
	1941-1960	3.52	0.09	-0.07, 0.25
	1961-1990	3.88	0.08	-0.11, 0.27
	1991-2000	3.86	-0.03	-0.28, 0.23
	2001-2012	3.74	-0.09	-0.36, 0.18
	Don’t know	3.58	-0.05	-0.63, 0.52
Time in home?	Less than 6 months	3.43	-0.33*	-0.61, -0.05
	6 months but less than 1 year	3.78	0.10	-0.16, 0.36
	1 year but less than 2 years	3.59	-0.13	-0.38, 0.11
	2 years but less than 5 years	3.92	0.18	-0.00, 0.37
	5 years but less than 10 years	3.92	0.14	-0.03, 0.31

	10 years or more	3.82	0.04	-0.09, 0.17
Type of house	Purpose built flat/maisonette	3.78	0.01	-0.28, 0.29
	Converted flat/maisonette	3.81	0.06	-0.39, 0.52
	Semi-detached/end of terrace house	3.72	-0.09	-0.28, 0.09
	Mid terrace house	3.70	-0.10	-0.32, 0.12
	Detached house	4.06	0.26**	0.07, 0.46
	Bungalow	3.69	-0.10	-0.36, 0.16
	Other	3.69	-0.04	-0.79, 0.71
				R^2=0.016

3.4 Geographic factors associated with noise sensitivity

There was no significant association between noise sensitivity scores and the location of the dwelling or for urbanicity. There was an association for region: respondents from England had higher noise sensitivity scores compared to the unweighted mean score for the sample (β=0.19, 95%CI 0.04, 0.35). As region was the only geographic factor to show a significant association with noise sensitivity scores, no multivariable model was run containing just the geographic factors (step two).

3.5 Multivariable model of sociodemographic, dwelling and geographic factors associated with noise sensitivity

Table 4 shows the results of the multivariable linear regression models, which included all the statistically significant variables from the multivariable sociodemographic (Table 2) and dwelling (Table 3) analyses, as well as the only significant geographic variable – region. The following factors were associated with noise sensitivity in the model: age; gender; home ownership; children; employment status; social class; hearing problems; and region. None of the dwelling factors remained significantly associated with noise sensitivity after adjustment for the sociodemographic and geographic factors. The R^2 for this multivariable model was 0.070.

Respondents aged 45-54 years, 55-64 years, 65-74 years, and 75 years or older had higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.28, 95%CI 0.10, 0.47; β=0.34, 95%CI 0.16, 0.52; β=0.44, 95%CI 0.18, 0.69; β=0.34, 95%CI 0.04, 0.65 respectively). Respondents aged 16-19 and 20-24 years had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.89, 95%CI -1.28, -0.49; β=-0.48, 95%CI -0.77,-0.19, respectively).

Males had lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.15, 95%CI -0.22,-0.07). Females had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.15, 95%CI 0.07, 0.22).

Respondents who are buying their house on a mortgage had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.18, 95%CI 0.01, 0.36).

Respondents who had children under 17 years of age in the household had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.16, 95%CI -0.28, -0.04). Respondents who did not have children under 17 years of age in the household had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.16, 95%CI 0.04, 0.28).

Respondents who were working full-time or who were retired had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.30, 95%CI -0.47,

-0.14; β=-0.37, 95%CI -0.61, -0.12, respectively). Respondents who were in full-time education had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.37, 95%CI 0.00, 0.74).

Respondents where the head of household was in social class A had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.37, 95%CI 0.12, 0.62). Respondents where the head of household was in social class C2 had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.20, 95%CI -0.36, -0.40).

Respondents without hearing problems had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.41, 95%CI 0.26, 0.57). Respondents with hearing problems had significantly lower noise sensitivity scores compared to the unweighted grand mean for the sample (β=-0.41, 95%CI -0.57, -0.26).

Respondents living in England had significantly higher noise sensitivity scores compared to the unweighted grand mean for the sample (β=0.18, 95%CI 0.02, 0.33).

Table 4 – Multivariable linear regressions for sociodemographic, dwelling and geographic factors with noise sensitivity (n=2728)

Factor		Coefficient	95% CI
Age	16-19	-0.89***	-1.28, -0.49
	20-24	-0.48***	-0.77, -0.19
	25-34	-0.19	-0.42, 0.04
	35-44	0.15	-0.07, 0.36
	45-54	0.28**	0.10, 0.47
	55-64	0.34***	0.16, 0.52
	65-74	0.44***	0.18, 0.69
	75+	0.34*	0.04, 0.65
Gender	Male	-0.15***	-0.22, -0.07
	Female	0.15***	0.07, 0.22
Home ownership	Mortgage	0.18*	0.01, 0.36
	Owned	0.13	-0.05, 0.32
	Rented - social	0.02	-0.21, 0.25
	Rented -private	-0.04	-0.27, 0.19
	Other	-0.29	-0.74, 0.15
Any children	No	0.16**	0.04, 0.28
	Yes	-0.16**	-0.28, -0.04
Employment status	Working FT	-0.30***	-0.47, -0.14
	Working PT	-0.01	-0.21, 0.20
	Unemployed	0.10	-0.25, 0.44
	Retired	-0.37**	-0.61, -0.12
	FT Education	0.37*	0.00, 0.74
	Home maker	0.01	-0.27, 0.28

	Other	0.20	-0.18, 0.58
Social class of head of household	A	0.37**	0.12, 0.62
	B	0.07	-0.08, 0.22
	C1	-0.08	-0.22, 0.06
	C2	-0.20*	-0.36, -0.40
	D	-0.16	-0.36, 0.03
	E	0.01	-0.24, 0.25
Hearing problem	No	0.41***	0.26, 0.57
	Yes	-0.41***	-0.57, -0.26
Age of house	Before 1919	0.15	-0.03, 0.33
	1919-1940	-0.16	-0.35, 0.03
	1941-1960	0.10	-0.07, 0.26
	1961-1990	0.01	-0.18, 0.20
	1991-2000	0.04	-0.21, 0.29
	2001-2012	-0.04	-0.31, 0.23
	Don’t know	-0.09	-0.66, 0.48
Time in home?	Less than 6 months	-0.25	-0.54, 0.04
	6 months but less than 1 year	0.20	-0.07, 0.46
	1 year but less than 2 years	-0.01	-0.26, 0.24
	2 years but less than 5 years	0.14	-0.04, 0.33
	5 years but less than 10 years	0.03	-0.16, 0.21
	10 years or more	-0.11	-0.27, 0.05
Type of house	Purpose built flat/maisonette	0.06	-0.24, 0.35
	Converted flat/maisonette	0.25	-0.20, 0.70
	Semi-detached/end of terrace house	-0.15	-0.33, 0.04
	Mid terrace house	-0.09	-0.31, 0.12
	Detached house	0.12	-0.08, 0.33
	Bungalow	-0.25	-0.52, 0.02

	Other		0.06	-0.69, 0.80
Region		England	0.18*	0.02, 0.33
		Wales	-0.06	-0.30, 0.18
		Scotland	-0.15	-0.41, 0.10
		Northern Ireland	0.03	-0.30, 0.37
				R^2=0.070

4. CONCLUSIONS

This paper has examined which groups of the UK population report being the most and least noise sensitive. The analyses suggest that certain sub-groups of the population may be more or less noise sensitive compared with the UK population as a whole. However, in considering the findings, it should be remembered that the data in NNAS 2012 are all cross-sectional and that causal relationships between individual characteristics and noise sensitivity cannot be inferred.

In this general population sample, a wide-range of noise sensitivities were reported, as shown by the median score of 4 on the 7-point noise sensitivity scale. However, this study made use of a one-item measure of noise sensitivity ‘How sensitive would you say you were to noise’, scored on a 7-point scale. In considering the findings of this report, it is important to acknowledge that the question used for this study may influence the findings. A more robust multi-item noise sensitivity scale may provide a more accurate assessment of an individual’s noise sensitivity than the one-item measure selected for the NNAS 2012.

Overall, noise sensitivity was more strongly associated with sociodemographic factors than with dwelling or geographic factors. This might be expected, as noise sensitivity is defined as an individual-level factor making it perhaps less likely to be influenced by dwelling or geographical influences and more likely to be influenced by sociodemographic factors at the individual level such as age and gender.

Considered individually several sociodemographic factors were significantly associated with noise sensitivity: age; gender, homeownership, children, employment status, working at home, shift work, social class, and interviewer rating of hearing problems. These factors remained associated with noise sensitivity scores, after taking other statistically significant sociodemographic, dwelling, and geographic factors into account.

Older respondents (aged mid-forties and upwards) had higher noise sensitivity scores, whilst younger respondents (aged 16-24 years) had lower noise sensitivity scores. There was also a significant gender difference in noise sensitivity, with males having lower noise sensitivity scores and females having higher noise sensitivity scores. These findings suggest that within the population, younger respondents and male respondents may be less sensitive to environmental noise exposure than older respondents and female respondents.

Respondents who were buying their house with a mortgage had significantly higher noise sensitivity scores, even after controlling for other factors, such as age, which might explain the association as respondents in certain age groups are more likely to have a mortgage. This finding seems specific to respondents buying their home with a mortgage, rather than home ownership per se, as respondents who owned their home outright did not have significantly higher noise sensitivity scores. Attitudes that might explain the association between being a mortgagee and noise sensitivity should be explored in future studies.

Respondents who had children under 17 years of age living in the household had significantly lower noise sensitivity scores and respondents without children under 17 years of age in the household had significantly higher noise sensitivity scores. These findings might be explained by higher internal noise exposure within houses with children under 17 years of age, associated with activities within the home and more residents per se, making respondents less sensitive to noise. It might also be the case that people who are less sensitive to noise are more tolerant of having children.

Respondents who were working full-time or who were retired had significantly lower noise sensitivity scores. This may reflect the fact that respondents who work full-time probably spend less time at home compared to the general population. It is unclear why retired respondents might be less noise sensitive: it may be due to changes in the auditory system due to aging, but is more likely to be explained by other attitudes and behaviour, as the association between retirement and noise sensitivity remained after taking hearing problems into account.

There was a social gradient in noise sensitivity, with noise sensitivity being higher in respondents with a head of household with a high social class (A) and lower in respondents where the head of household had a lower social class (C2 or D). Future research could examine what other individual or situational factors might explain this social gradient.

The results also suggest that hearing ability might be related to noise sensitivity: respondents without hearing problems had significantly higher noise sensitivity and respondents with hearing problems had significantly lower noise sensitivity scores.

Several dwelling factors were significantly associated with noise sensitivity scores: age of house; length of time living in home; and type of house. However, none of the dwelling factors remained significantly associated with noise sensitivity after adjustment for sociodemographic and geographic factors. The univariable associations between dwelling factors and noise sensitivity appear to be explained by sociodemographic factors.

Noise sensitivity scores were significantly higher in England both before and after adjustment for the other sociodemographic and dwelling factors, compared with scores in Wales, Northern Ireland and Scotland. However, overall, geographic factors appear to have little relationship with noise sensitivity in the UK population.

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