Goldsmiths
UNIVERSITY OF LONDON

INVOLUNTARY MUSICAL IMAGERY

-INVESTIGATING MUSICAL FEATURES THAT PREDICT 'EARWORMS'-

Sebastian Finkel, Sagar Jilka, Victoria Williamson, Lauren Stewart, Daniel Müllensiefen

Correspondence to: finkel.sebastian@googlemail.com

“Roadmap”

- Introduction
  - Terminology
  - Previous findings
  - The idea behind this study
- Methods
- Results
- Conclusion and Discussion

“Roadmap”

- Introduction
- Methods
  - How to find genuine earworms
  - How to analyze InMI tunes
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“Roadmap”

- Introduction
- Methods
- Results
  - The earworm formula!?
- Conclusion and Discussion

“Roadmap”

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- Conclusion and Discussion
  - How to interpret the found features
  - How to shape future research

Terminology

- Involuntary musical imagery (InMI)
  - Liikkanen (2008)
  - Song in Your Head Phenomenon
  - Spontaneously, Repeatedly, Involuntarily
- Earworm
  - Derived from ‘Ohrwurm’ (German)
  - Levitin (2006), Sacks (2007), BBC 6 Radio

Previous findings

- Liikkanen (2008)
  - 90% experience earworms daily
  - Only 15% describe them disturbing
- Beaman & Williams (in press)
  - Earworm episode less than 24 hours
  - Earworm itself longer than short term memory capacity would suggest
- Hemming (2008)
  - Importance of genre and lyrics

The idea behind this study

- No study has dealt with musical features of earworms yet.
  - Are earworms different?
- De la Motte (1993)
  - Analyzed his personal earworms:
  - repetitive motif, harmonically appealing, only 3-5 tones
- Müllensiefen & Kopiez (in press)
  - Musical features can predict success of cover songs

How to find genuine earworms

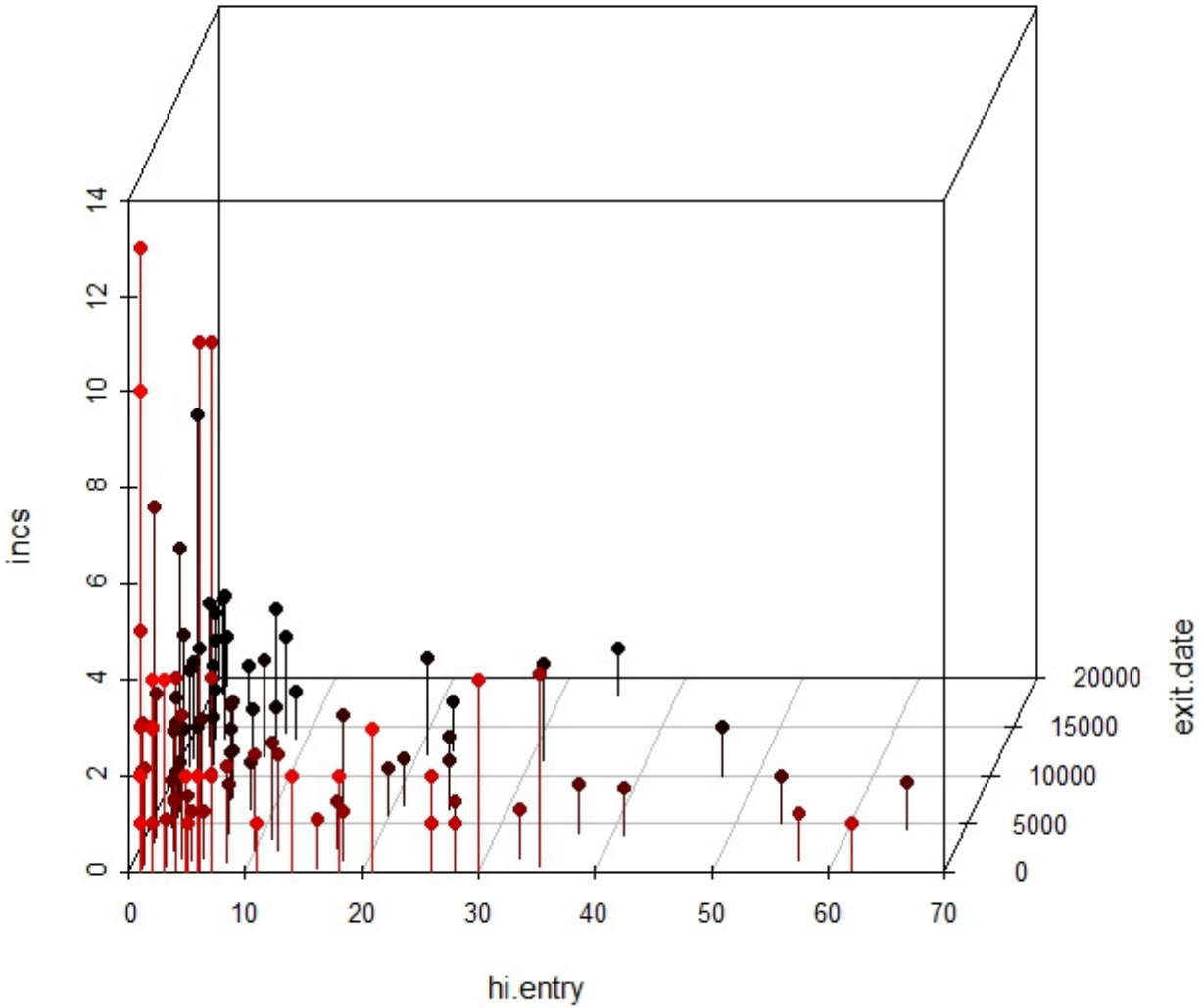
- Online Survey
- 1014 participants
  - 35.6 years (SD= 13.4 years; range 13–76 years)
  - 572 females and 441 males
- Recent earworm <-> Frequent earworms
  - Artist, song title, exact part
- 1449 usable earworm tracks
- Top earworm list -> 75 songs (6%)
  - Named more than once
  - In total: 227 (16%)
- 14.000 files MIDI Corpus

Top 5 earworms

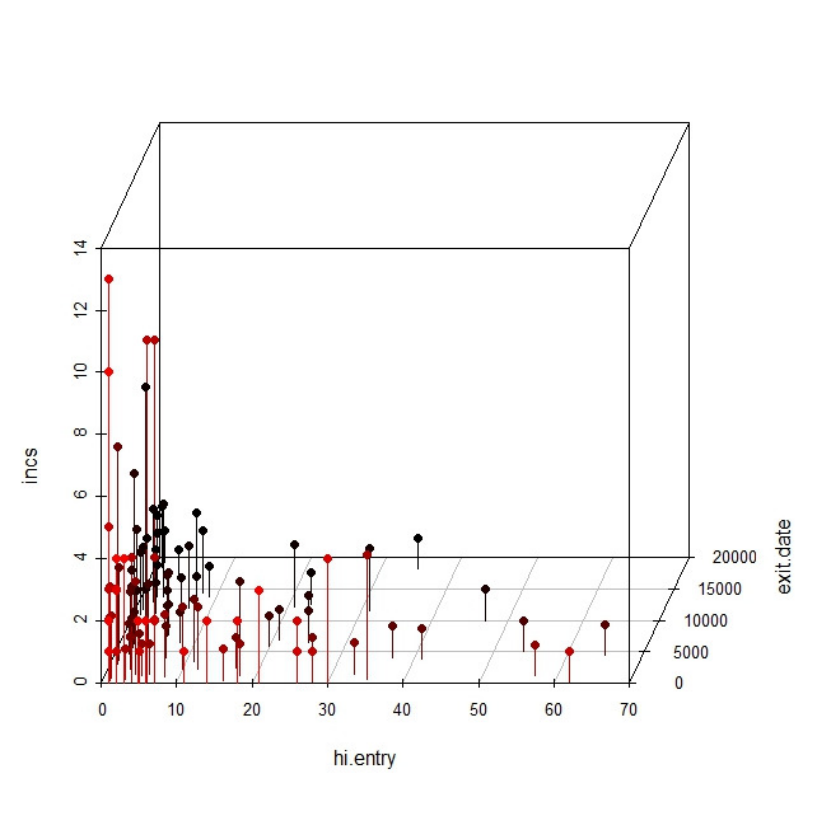
artist	song	incs
Lady Gaga	Bad romance	13
Journey	Don't stop believing	11
Lady Gaga	Alejandro	11
Katy Perry	California gurls	10
Kylie Minogue	Can't get you out of my head	7

How to find genuine earworms

- Using UK chart data to control for:
  - Popularity (exposure)
  - Recency effects
  - 52 songs left
- Predictors
  - hi.entry: Highest chart position
  - exit.date: Days from end of study to last chart appearance
  - weeks: Number of weeks in the charts
  - entry.date: Days from end of study to first chart appearance
- Response
  - incs: Number of namings


incs
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
hi.entry
exit.date
0
5000
10000
15000
20000

How to find genuine earworms



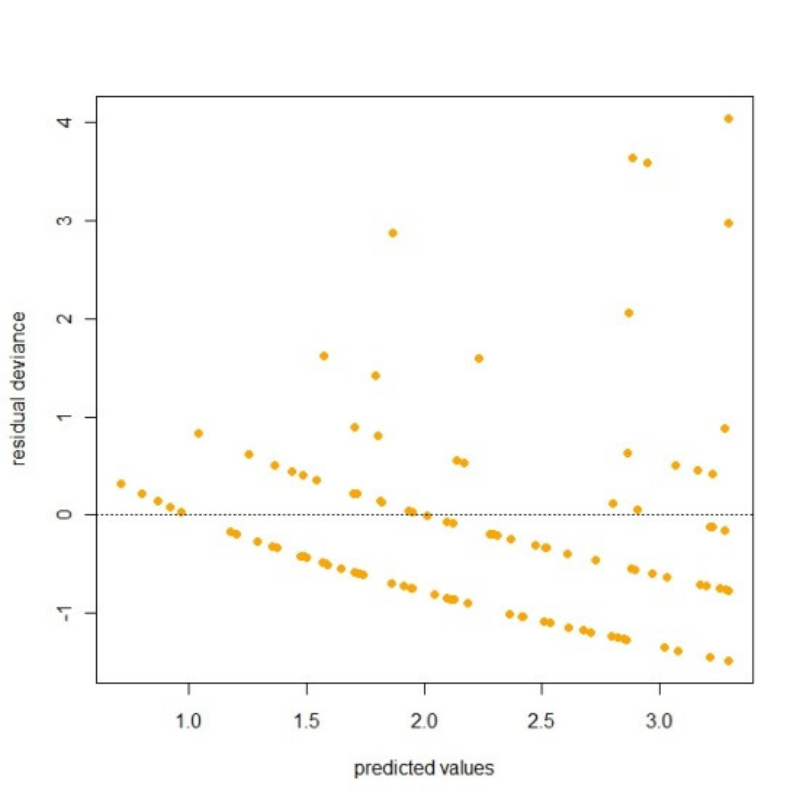
Poisson Model

	Estimate	Std. Error	z value	Pr (>|z|)
(Intercept)	1.2076e+00	9.4763e-02	12.7431	0.0000 ***
hi.entry	- 2.0764e-02	5.9391e-03	- 3.4961	0.0005 ***
exit.date	-4.3372e-05	1.2294e-05	- 3.5278	0.0004 ***

Wald's Chi-square test:

χ^2 (2, N = 110) = 19.218, $p < 0.001$ ***

How to find genuine earworms



- Positive residual deviance
  - More often named than expected from the model
- Named more than once
  - More likely to be genuine
- 29 earworms

How to analyze InMI tunes

- Findings matching non-earworms
- Random draw from MIDI corpus
  - 150 (UK chart data available)
  - Not named as earworms
- Gower's Dissimilarity coefficient

Gower's Dissimilarity

- Measuring similarity between two objects, using numeric and character variables
- We are using:
  - hi.entry
  - entry.date
  - exit.date
  - weeks
  - genre
  - artist
- Matrix -> lowest value for each earworm

You never gonna get this song….

How to analyze InMI tunes

- 29 earworm tracks

artist	song	incs	hi.entry	weeks	entry.date	exit.date	genre
lady gaga	bad romance	13	1	38	281	15	pop
lady gaga	alejandro	11	7	10	253	183	pop
journey	don't stop believing	11	6	47	477	149	rock
katy perry	california gurls	10	1	6	43	1	pop
queen	bohemian rhapsody	7	1	17	12699	12580	rock

- 29 non-earworm tracks

artist	song	incs	hi.entry	weeks	entry.date	exit.date	genre
gorillaz	feel good inc.	0	2	39	1940	1667	pop
jessica simpson	these boots are made for walkin'	0	4	10	1800	1730	pop
stereophonics	handbags and gladrags	0	4	15	3164	3059	rock
nelly	my place	0	1	11	2164	2087	pop
elvis presley	way down	0	1	13	12054	11963	rock

Modelling

Logistic Regression

- Predictor variables:
  - 40 musical features
  - 12 clusters
- Response variable
  - Binary earworm status
  - (1 = yes, 0 = no)

Step AIC

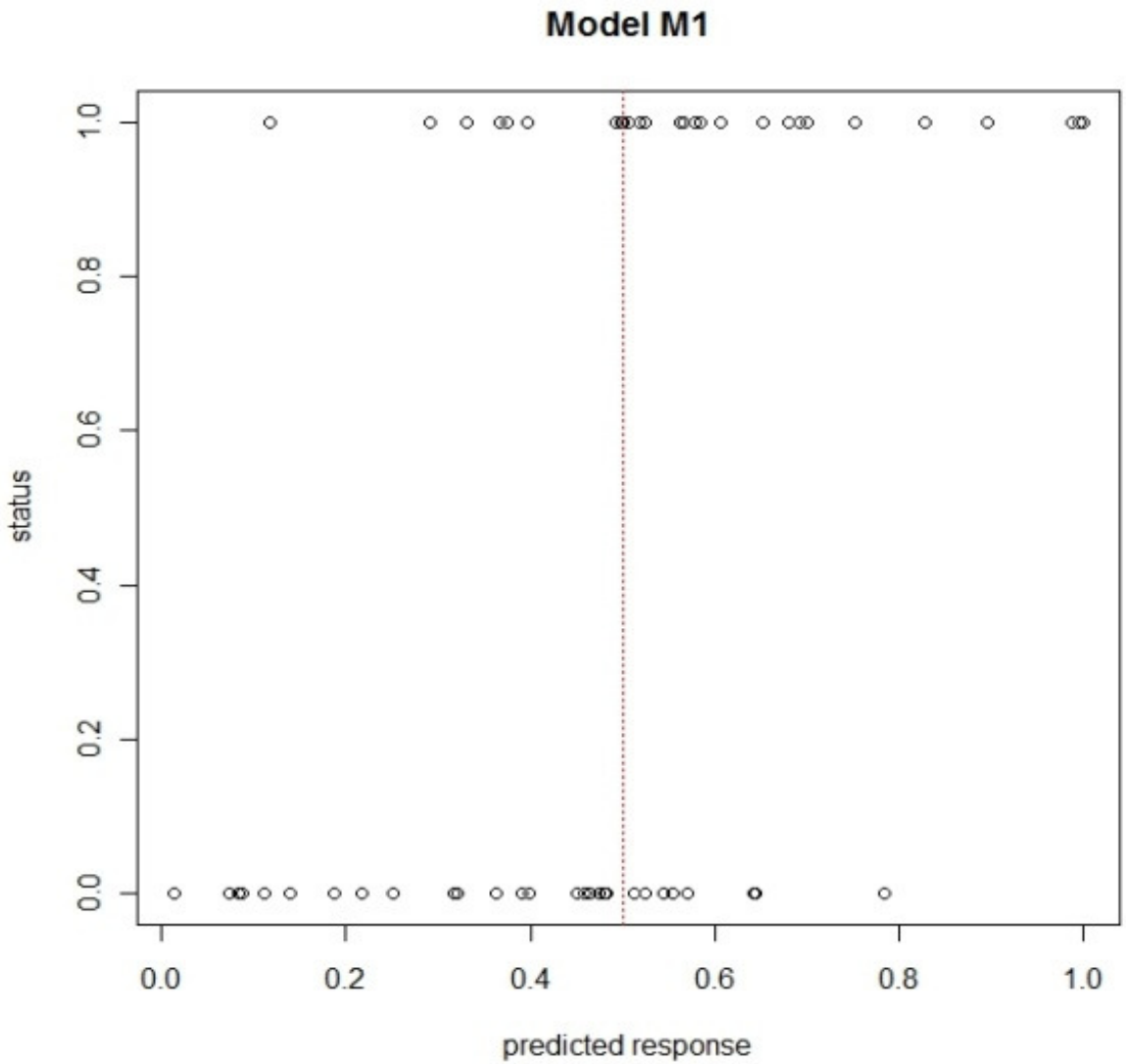
- Stepwise algorithm for model selection
- Using Akaike information creterion
- Simplifying the the logistic regression

Results

- Logistic regression model:
  - Using 4 features

	Estimate	Std. Error	z value	Pr (>|z|)
(Intercept)	- 7.7520	4.1703	0.9386	0.0630 .
d.median	0.0767	0.0373	2.0613	0.0393 *
tonal.clarity	5.9946	3.4817	1.7218	0.0851 .
int.cont.grad.std	- 0.3878	0.1989	- 1.9597	0.0512 .
i.leaps	41.8001	20.3481	2.0543	0.0399 *

  - Predicts 72% of the data set correctly
  - χ^2 (4, N = 58) = 8.7476, p = .0677


Model M1
status
predicted response
0.0
0.2
0.4
0.6
0.8
1.0

How to interpret the features

- d.median
  - the median of the average duration of all notes
- int.cont.grad.std
  - standard deviation of interpolation contour measure
- tonal.clarity
  - how clear is the tonality of the melody
  - Auhagen (1994)
- i.leaps
  - average number of leaps larger than a 5th
  - Rauhe (1987) “Activation structures”

Conclusions

- Songs that appear often as earworms can be distinguished from other pop songs
  - Model predicts 72% correctly
  - Using only musical features
  - Excluding contextual & subject-related variables

How to shape further research

- Better ways to control for exposure
  - Airplay charts, API queries (lastfm)
  - Hurdle and negative binomial models
- Increasing number of possible matches
- Different earworm types?
  - Decision tree models
  - Corpus features
- Including context and subject-related variables

Asking bigger questions

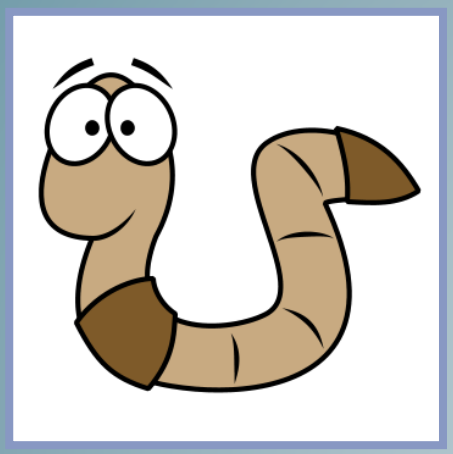
- Have we found the ultimate pop song formula?
- Are successful songs earworm OR earworms commercially bestselling?
- Can we learn something about musical memory?
  - Müllensiefen & Halpern (submitted)
    - Musical features predict implicit and explicit memory for melodies

How to shape further research

Project is ongoing!!!

Any ideas are welcome!

Thank you for your attention



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