The timing and societal synchronisation of energy demand

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challenges

Balancing supply and demand

Decarbonisation/renewables

Smart metering

Future demand

Relation between mobility and energy in buildings

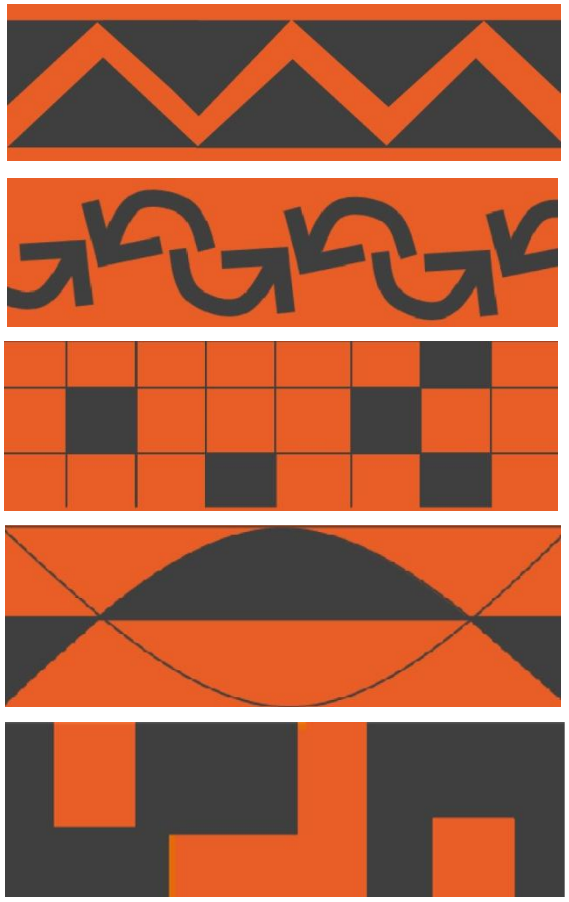
questions

1. What are peaks made of?
2. Societal synchronisation
3. Sequences and flexibilities
4. Change over time: decades, epochs
5. Where does policy influence lie?

DEMAND approach

These propositions underpin 5 research themes.

1. How and why do end use practices vary?
2. How and why do end use practices change over time?
3. How do infrastructures of supply and demand shape end use practices?
4. What are the implications for normality, need and entitlement?
5. How is energy demand constituted, transformed and steered?



1. Energy is used in the course of accomplishing social practices.
2. Social practices and energy demand are shaped by infrastructures and institutions.
3. These systems reproduce interpretations of need and entitlement, and of normal and acceptable ways of life.

Research within these themes allows us to:

Identify and explore new opportunities for **demand** management at different scales.

Achieve a step change in how energy **demand** is understood and managed.

Confront fundamental issues of **demand:** what is energy for?

Moving between energy, mobility and time use data

Different traditions and units

	Time	Energy/buildings	Mobility
Purpose	Coded categories	Don't care	Coded categories: much debate
Units/scale	**10 minute slots**	**Metered/seconds**	**'travel events' across a day/week**
Duration	Itself the topic	Estimates (appliance use)	Journey time
Timing	Recorded, could be analysed, often not	Largely ignored	Detailed information start and end times.
Frequency	**Not much insight**	**Don't care (averages)**	**Hard to handle infrequent (long distance) journeys**
Individual/household/ collective	Individual – some data on co-presence	Don't care	Individual plus – escorting/accompanying
Multiple purposes/multi-tasking	Primary and secondary activity	Don't care	Primary and secondary purposes
Spatial reference	Home and away	Only within the home	Only away from the home

Using existing data to address questions of timing and synchronisation – in practice: *for example*

Which practices constitute morning and evening peaks?

What is the timing and duration of activities during the morning (7.00 - 10.00 am) and afternoon (4.30 – 7.30 pm) peak periods, from Monday to Friday respectively?

Are there differences between peak practices/activity and peak energy demand?

Are many people doing the same things at the same time, or is the peak (electricity) made of many people doing different things?

How are practices synchronised and sequenced?

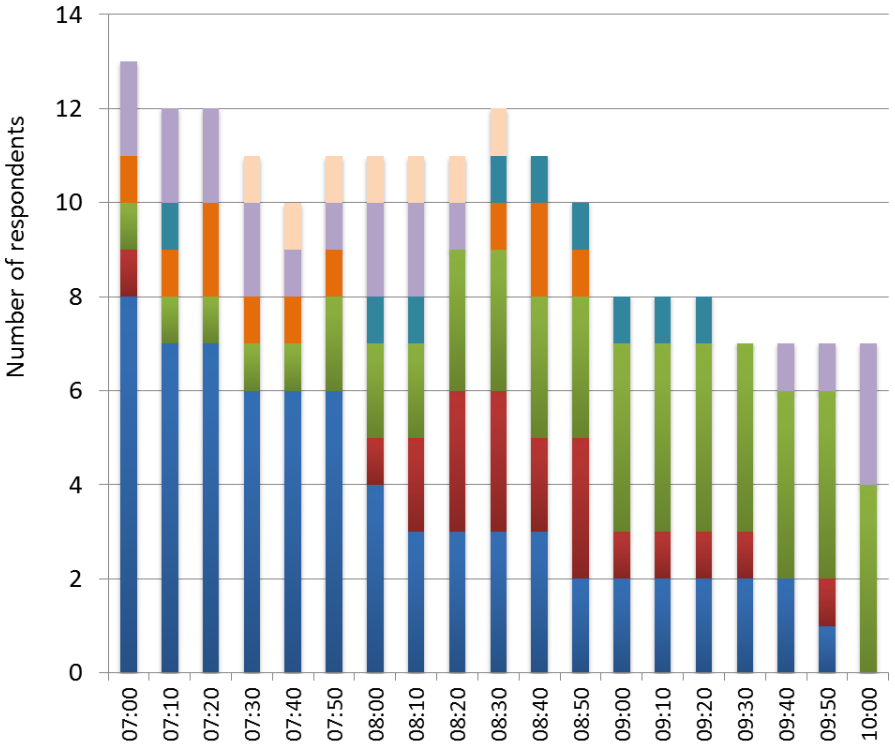
Is it possible to develop an index of societal synchronicity?
Can we identify close-coupled sequences of practice?

Notice:

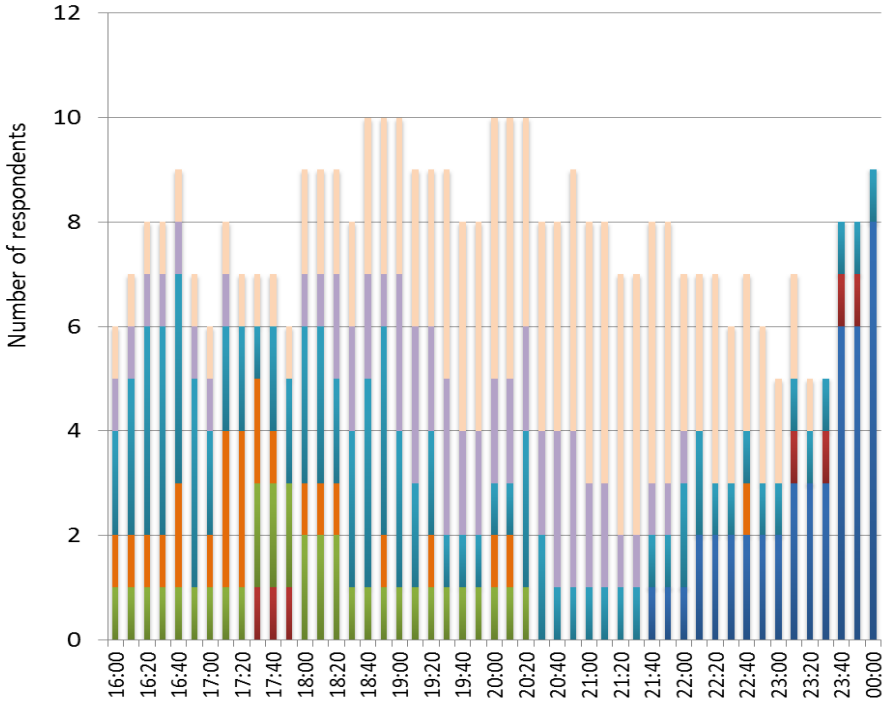
Some peaks in practice e.g. in transport are 'good' for energy: they permit better use of lower carbon modes.
Peaks in practice and energy occur during the day; over the week, over the year, over decades and epochs

1. What are peaks made of?

Morning and evening peaks compared: Mondays



Monday morning

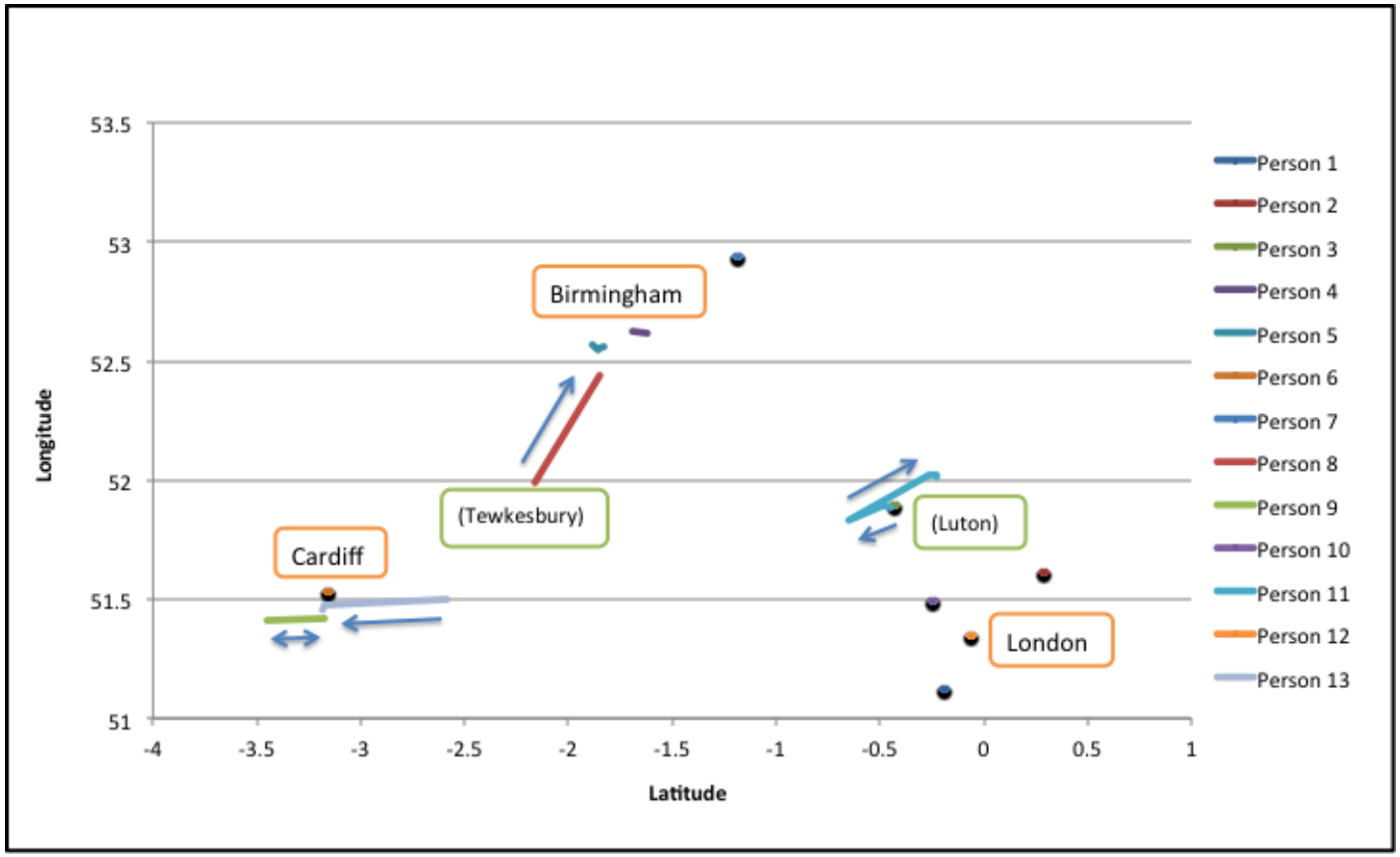


Monday evening

Sleeping
Washing, dressing/undressing etc.
Work for your job (includes paid and unpaid overtime, work brought home)
Travelling: car
Preparing food and drinks, cooking, washing up
Eating or drinking/having a meal (at home/away from home)
Watching TV and videos/DVDs, listening to radio or music

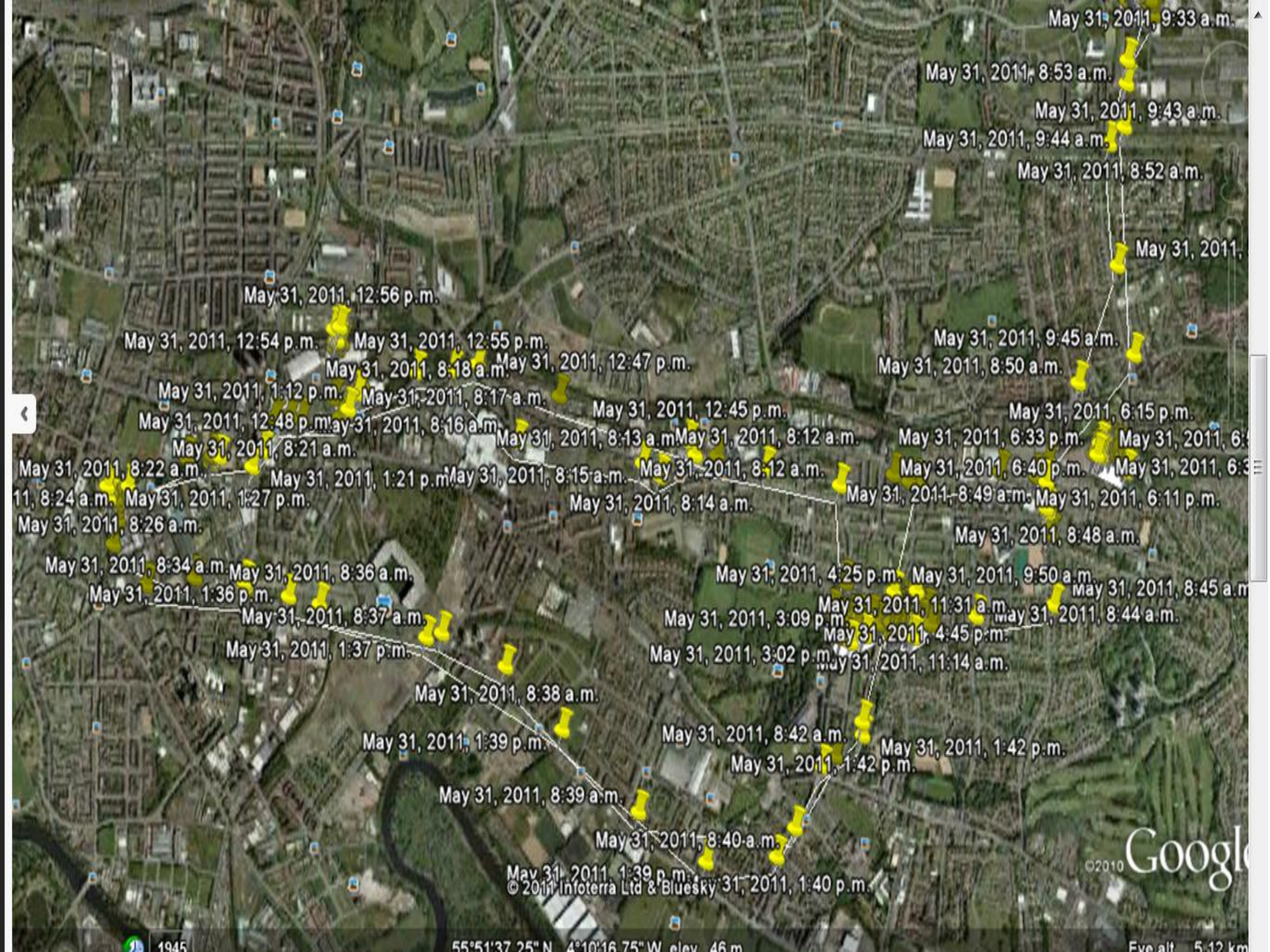
Illustrative examples, based on a small sub-set
Source: Trajectory Global Foresight
Base: Subsample (50)

Monday evening peak (4pm to 10pm): Use of GPS data to assess travel patterns



Person 8 – church > driving > cleaning, tidying house
Person 11 – resting > driving > shopping > driving > work for job
Person 13 – driving > resting > preparing food & drink

Illustrative examples, based on a small sub-set
Source: Trajectory Global Foresight
Base: Subsample (50)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May 31, 2011, 1:40 p.m.
©2010 Google
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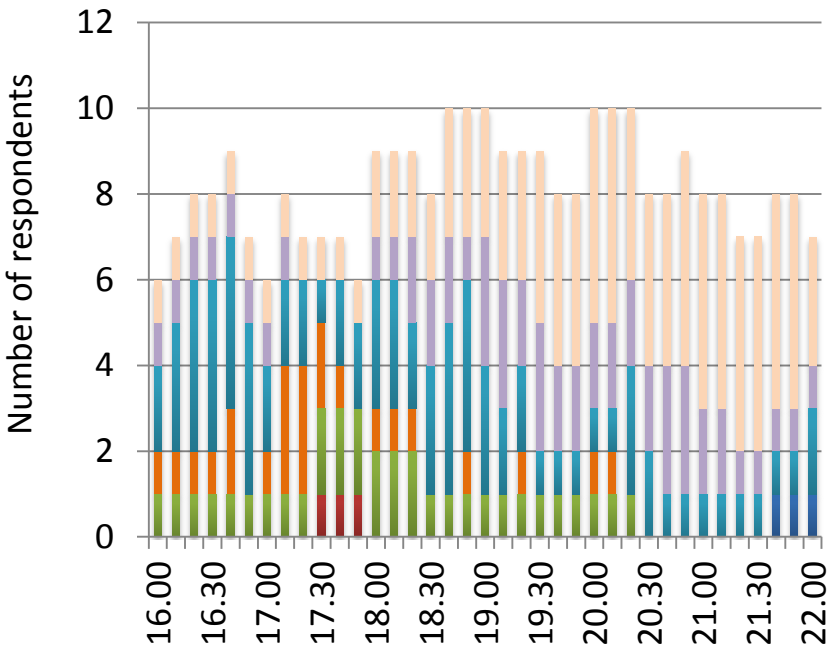
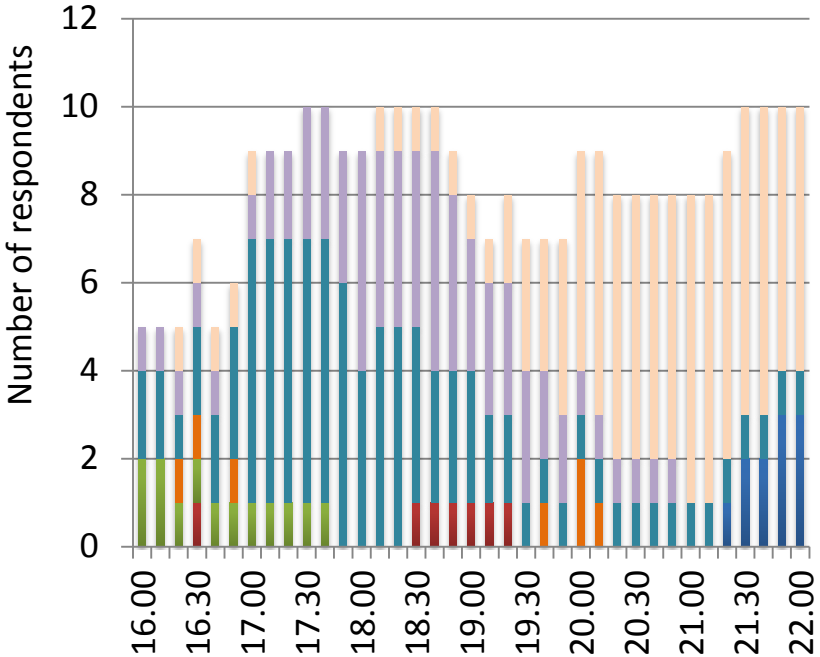
1945
55°51'37.25" N 4°10'16.75" W elev 46 m
Eye alt 5.12 km

Monday and Friday evening peaks compared



Monday



Friday

Sleeping

Washing, dressing/undressing etc.

Work for your job (includes paid and unpaid overtime, work brought home)

Travelling: car

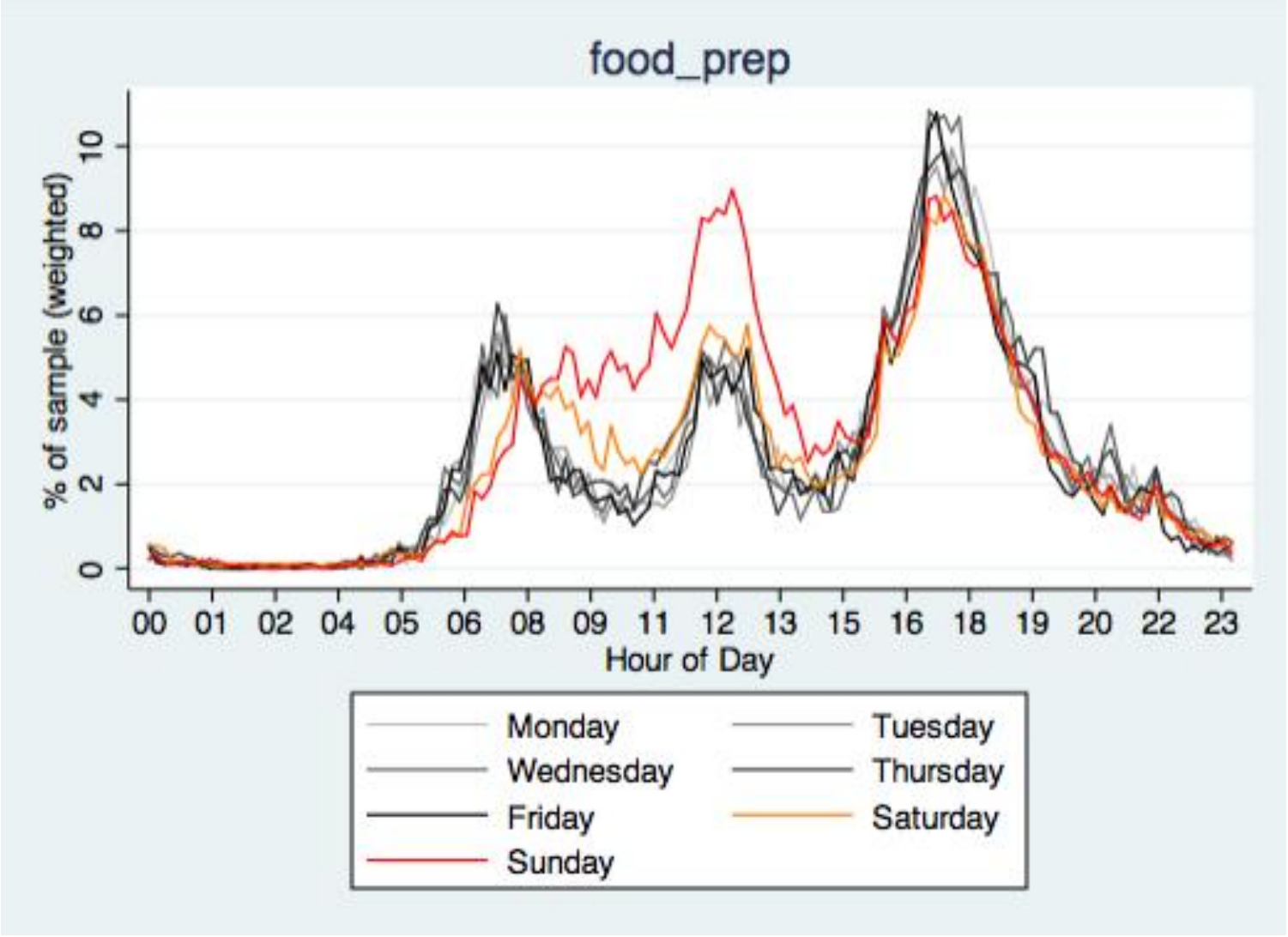
Preparing food and drinks, cooking, washing up

Eating or drinking/having a meal (at home/away from home)

Watching TV and videos/DVDs, listening to radio or music

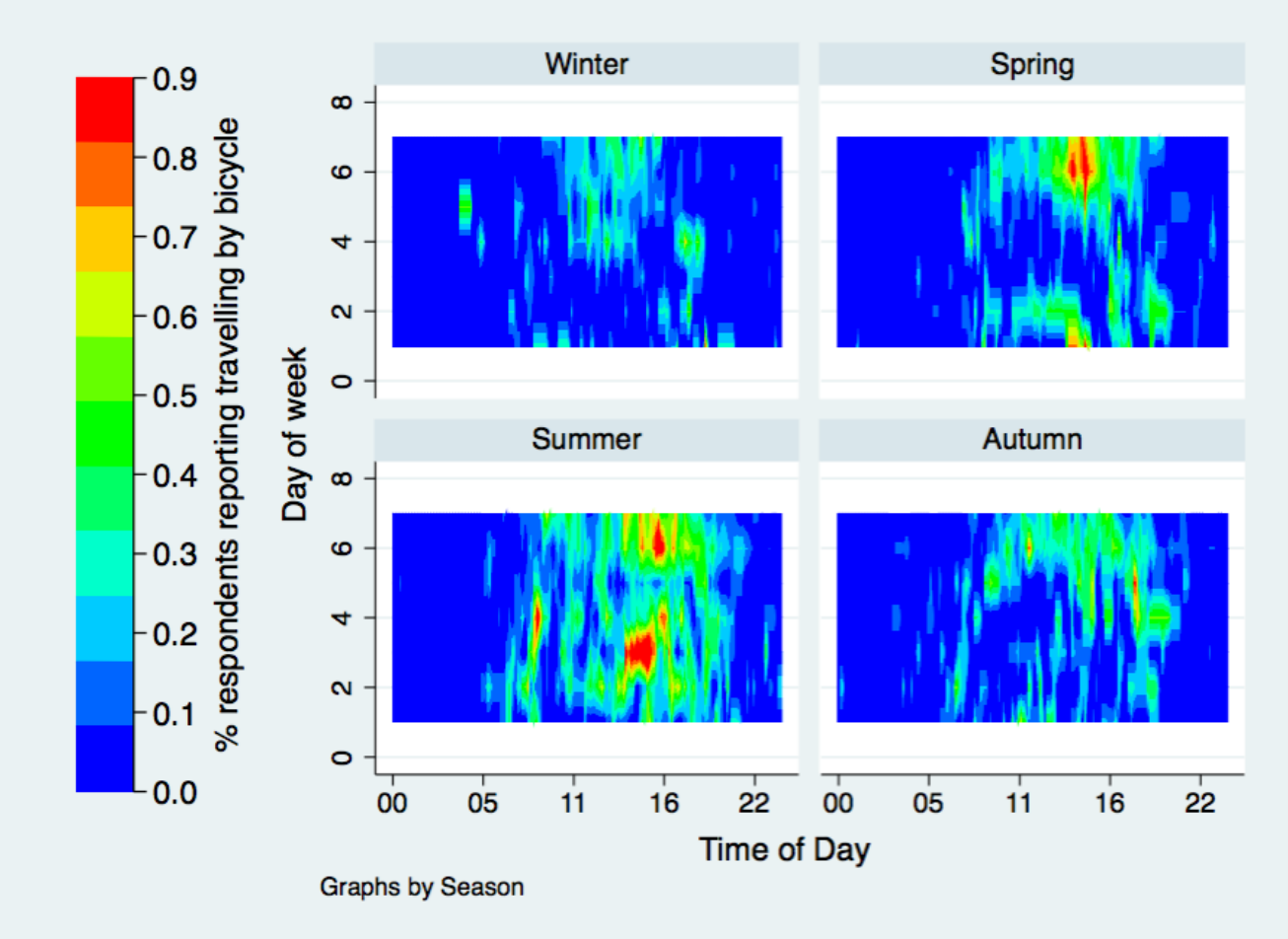
Finish work earlier on Friday

Daily/weekly portrait of a practice: food preparation



Original dataset: ONS 2000 UK Time-Use Survey (Ipsos-RSL and Office for National Statistics, United Kingdom Time Use Survey, 2000 [computer file]. 3rd Edition. Colchester, Essex: UK Data Archive [distributor], September 2003. SN: 4504, http://dx.doi.org/10.5255/UKDA-SN-4504-1)

Seasonal portrait of a practice: cycling: more in spring and summer



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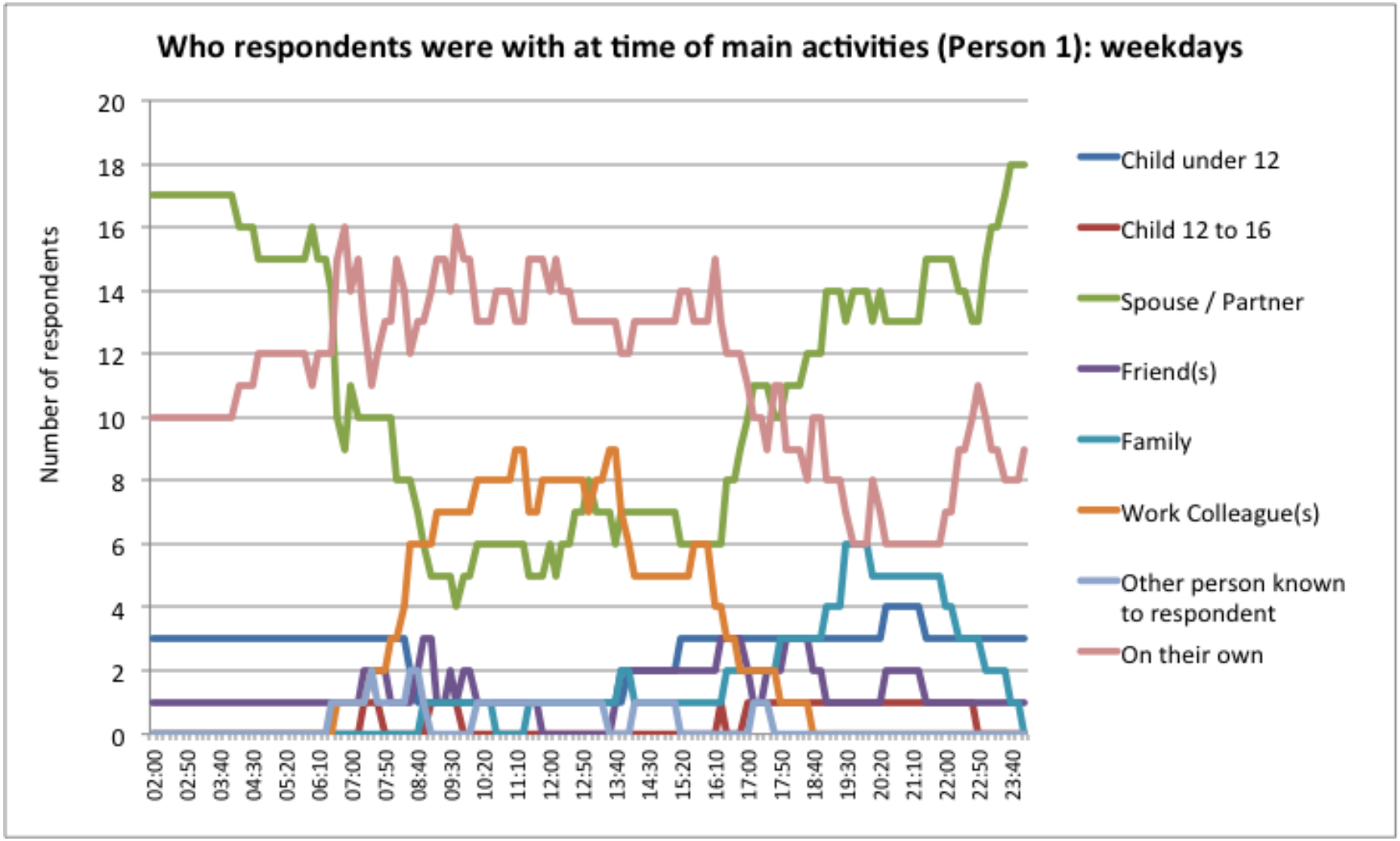
Portrait of a moment: Saturday morning at 11am.

Could be represented in terms of energy use, and time use/practice, over the year. ONS 200 (for 2000-2001), showing activities that vary most by season.

http://www.brigs.com/brigs-announces-extended-weekday-specials-hours/

Peaks and co-presence : implications for schedules and flexibility

Who respondents were with at time of main activities (weekdays)



Source: Trajectory Global Foresight

Base: Subsample (50)

2. Societal synchronisation

Examples

Lots of people doing the same thing creates synchronised demand: e.g. TV watching

Lots of people doing different things creates non-synchronised demand: e.g. ‘Saturday midday peak travel’

Lots of people doing the same ‘low’ energy things creates non-demand: e.g. Sleep

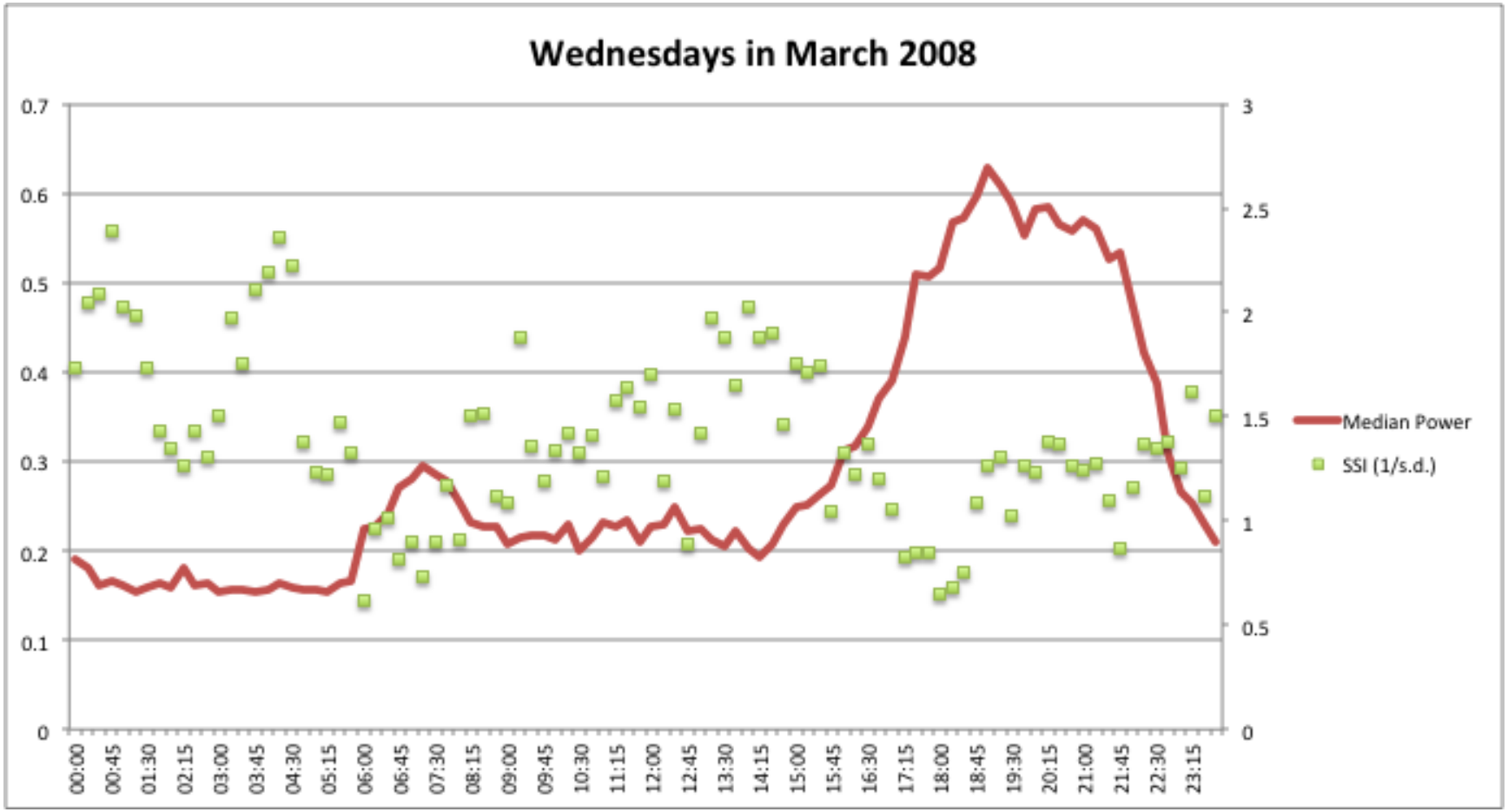
How to measure synchronisation?

It is the inverse of variation so:

- Measured data:
  1/standard deviation
- Category data:
  100 –
  (standardised) entropy index

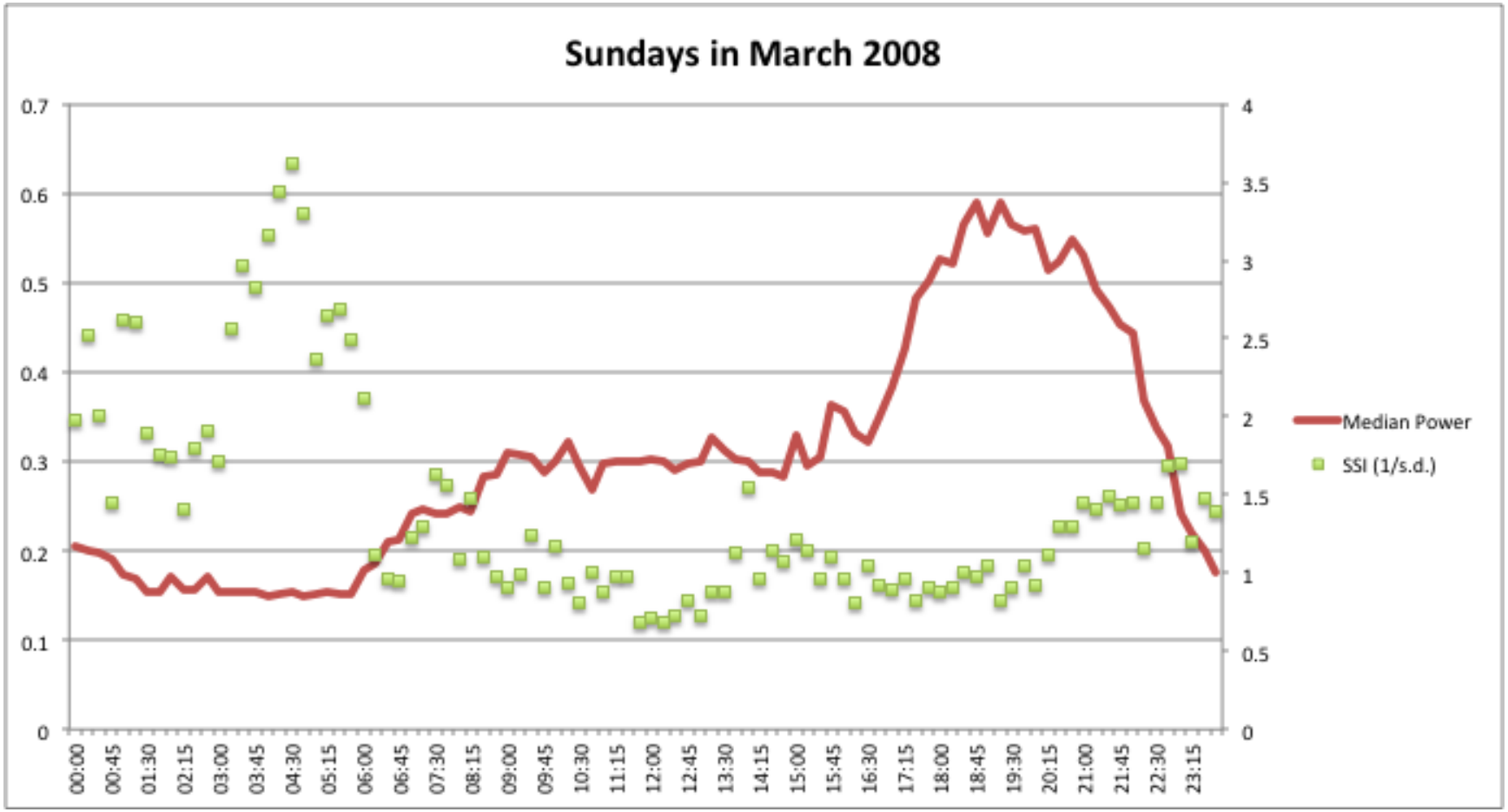
Synchronisation high	Synchronisation low	
Many people doing the same energy-intensive activity at the same time	Many people doing different energy-intensive activities at the same time	Energy demand higher
Many people doing the same lower energy activity at the same time	Many people doing different lower energy activities at the same time	Energy demand lower

(Non)Synchronised power – measured data



Original dataset: Richardson, I. and Thomson, M., *One-Minute Resolution Domestic Electricity Use Data, 2008-2009* [computer file]. Colchester, Essex: UK Data Archive [distributor], October 2010. SN: 6583, http://dx.doi.org/10.5255/UKDA-SN-6583-1.

(Non)Synchronised power



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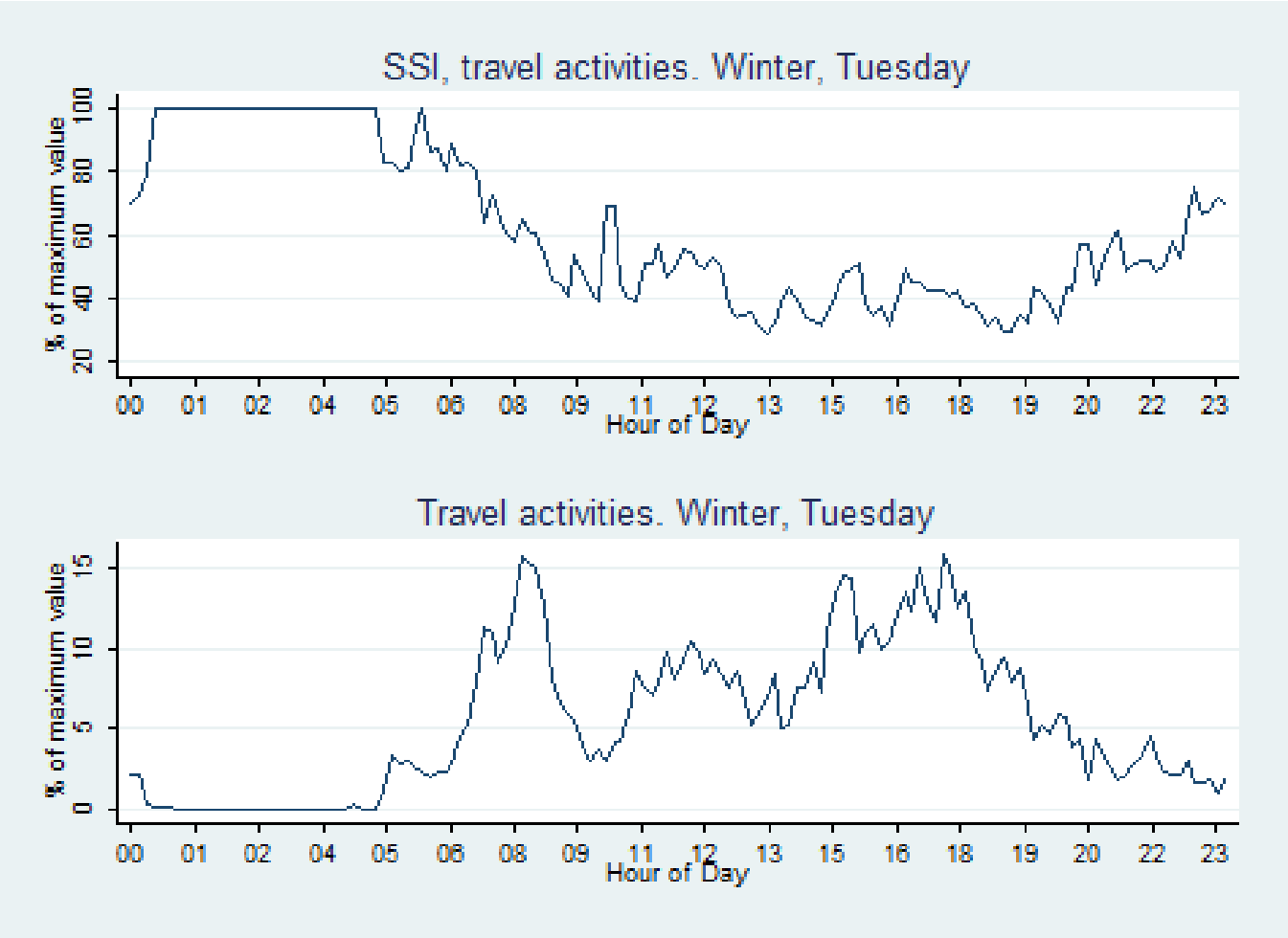
Category data – entropy



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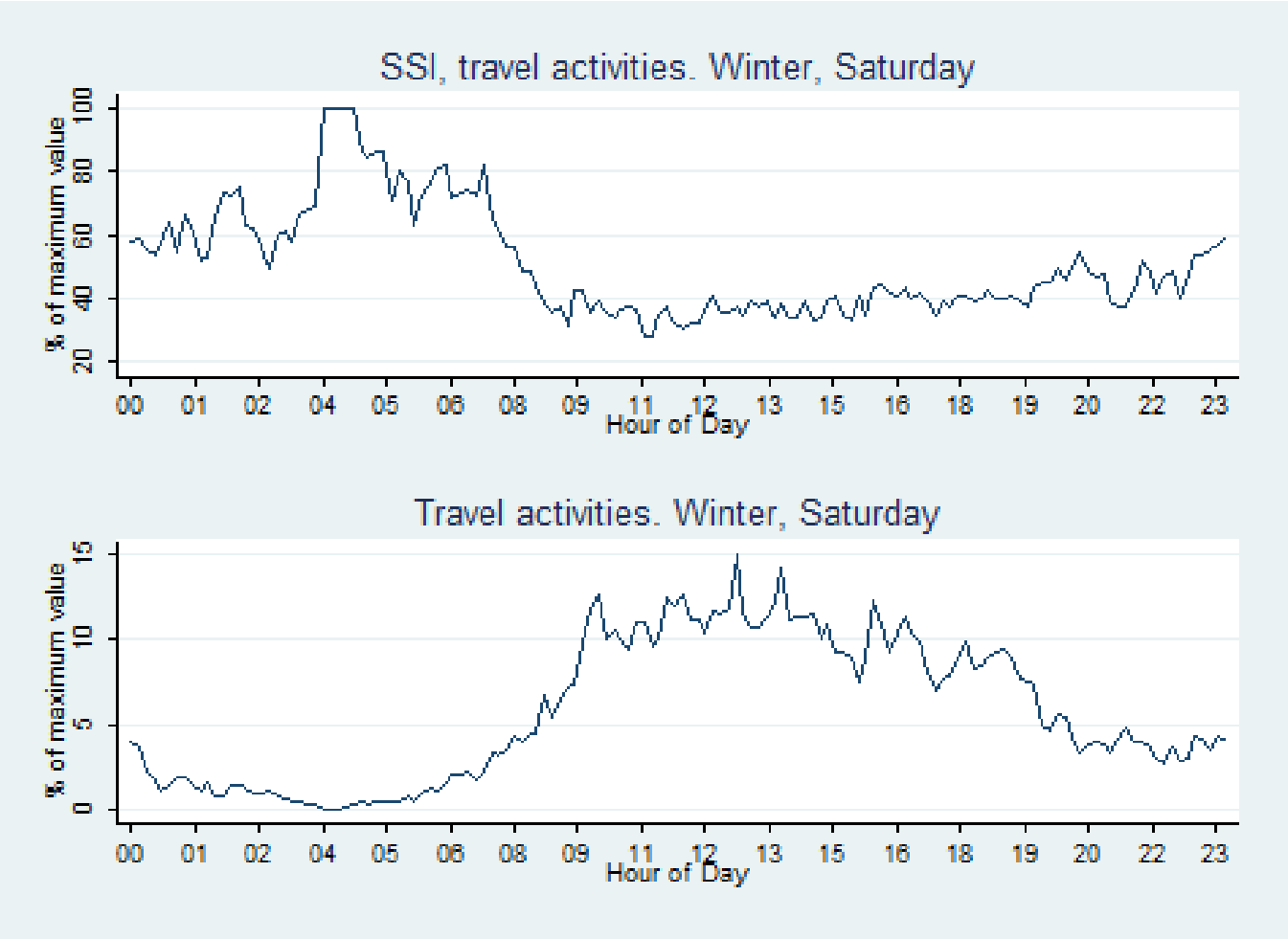

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3. Sequences and flexibilities

Practices are linked over time; some sequences are ***tightly locked*** together, others are more ***flexible,*** and can be done at different times.

Tightly coupled sequences make ‘blocks’ that structure the rhythm of the day

These arrangements have distinctive features both of timing and duration

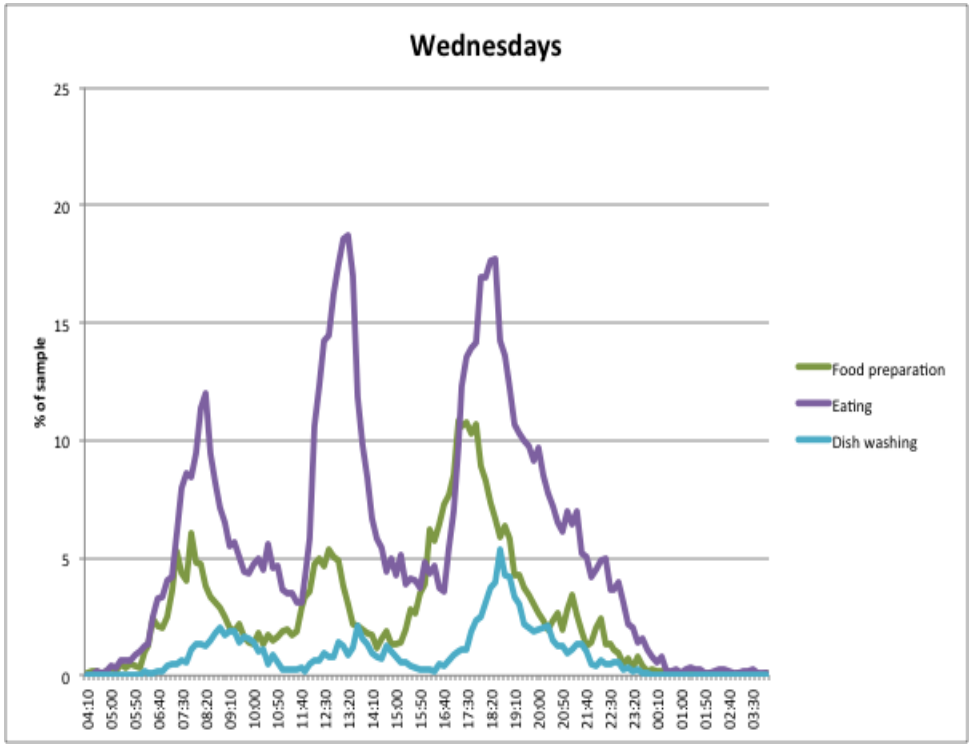
Some practices have to come before or after others
Some practices often come before or after others
Some practices rarely come before or after others

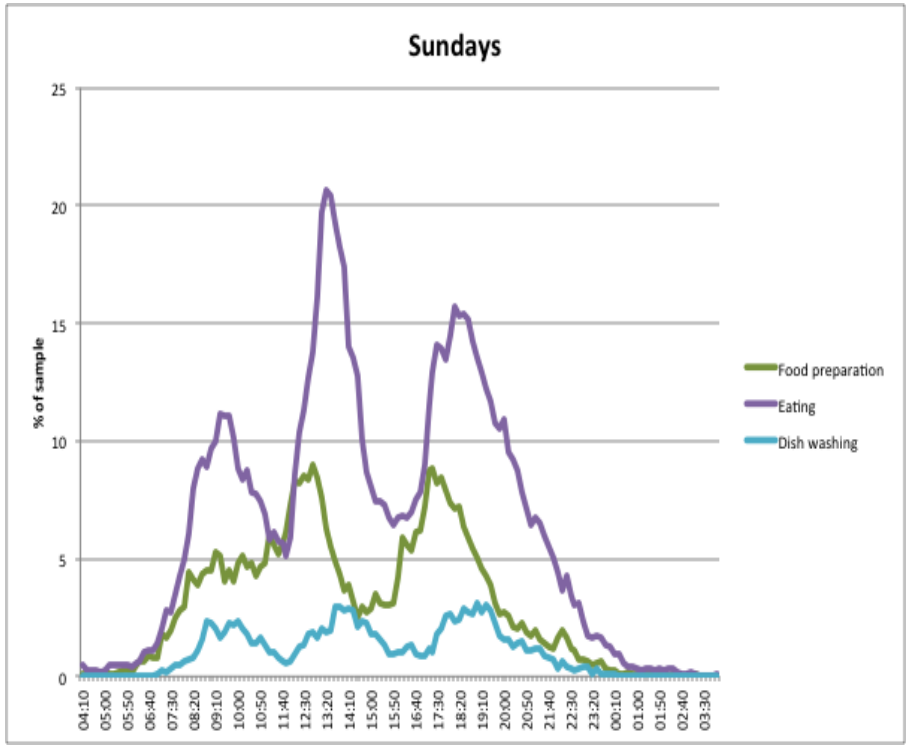
Practices of short duration can be slotted in between longer ‘blocks’

The ‘blocking’ and the coupling and de-coupling of practices changes historically e.g. the decreasing significance of seasonality; potential for multi-tasking.

How to identify and analyse sequential patterns?

Series and sequences : representing several practices at once

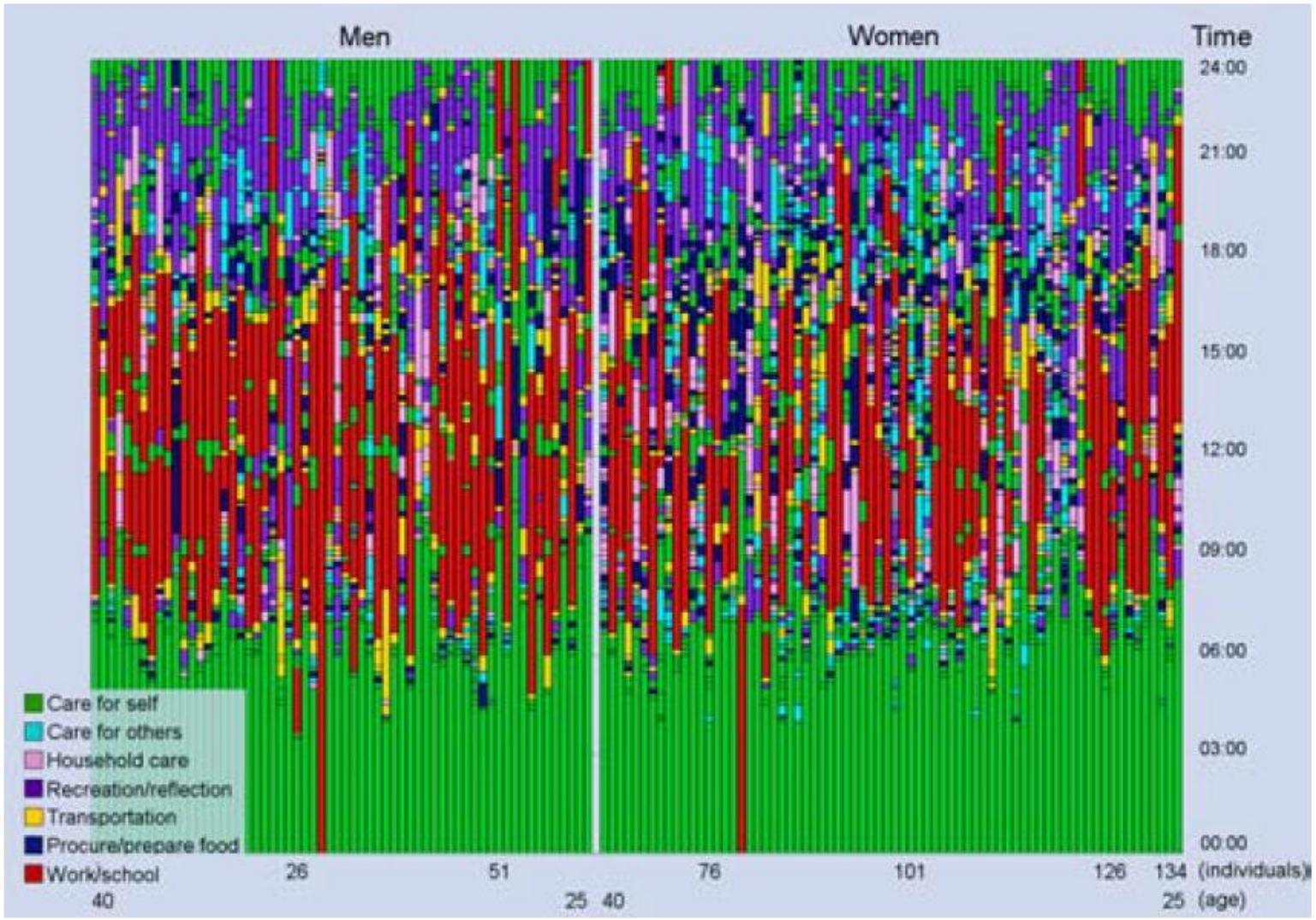




Assuming that food preparation, eating and washing are linked
Sequences can be configured differently, and occur at different times of day

Original dataset: ONS 2000 UK Time-Use Survey (Ipsos-RSL and Office for National Statistics, United Kingdom Time Use Survey, 2000 [computer file]. 3rd Edition. Colchester, Essex: UK Data Archive [distributor], September 2003. SN: 4504, http://dx.doi.org/10.5255/UKDA-SN-4504-1)

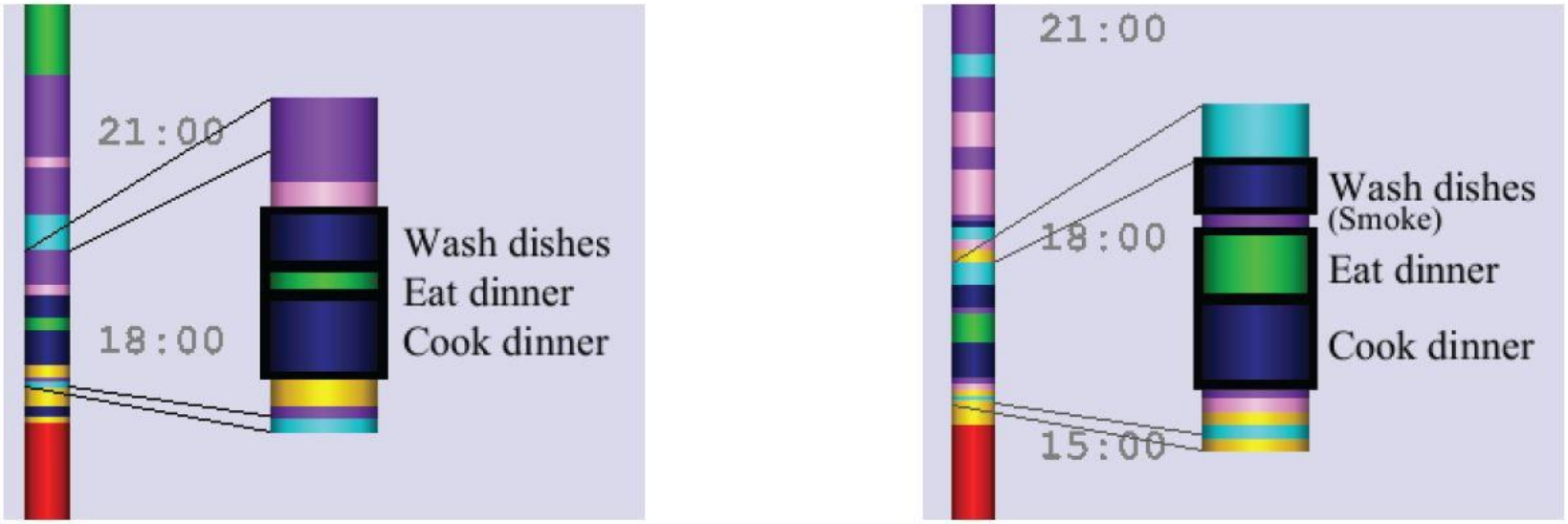
Visual-TimePAcTS – sequential patterns



Source: Vrotsou, K. (2010). Everyday Mining. Exploring sequences in event-based data. Linköping: Linköping University Electronic Press, , p.40.

Sequential mining pattern tool

Figure 5
Examples of the activity sequence (*tuple*) "cook dinner→ eat dinner→ wash dishes" integrated in different ways in two individuals' diaries



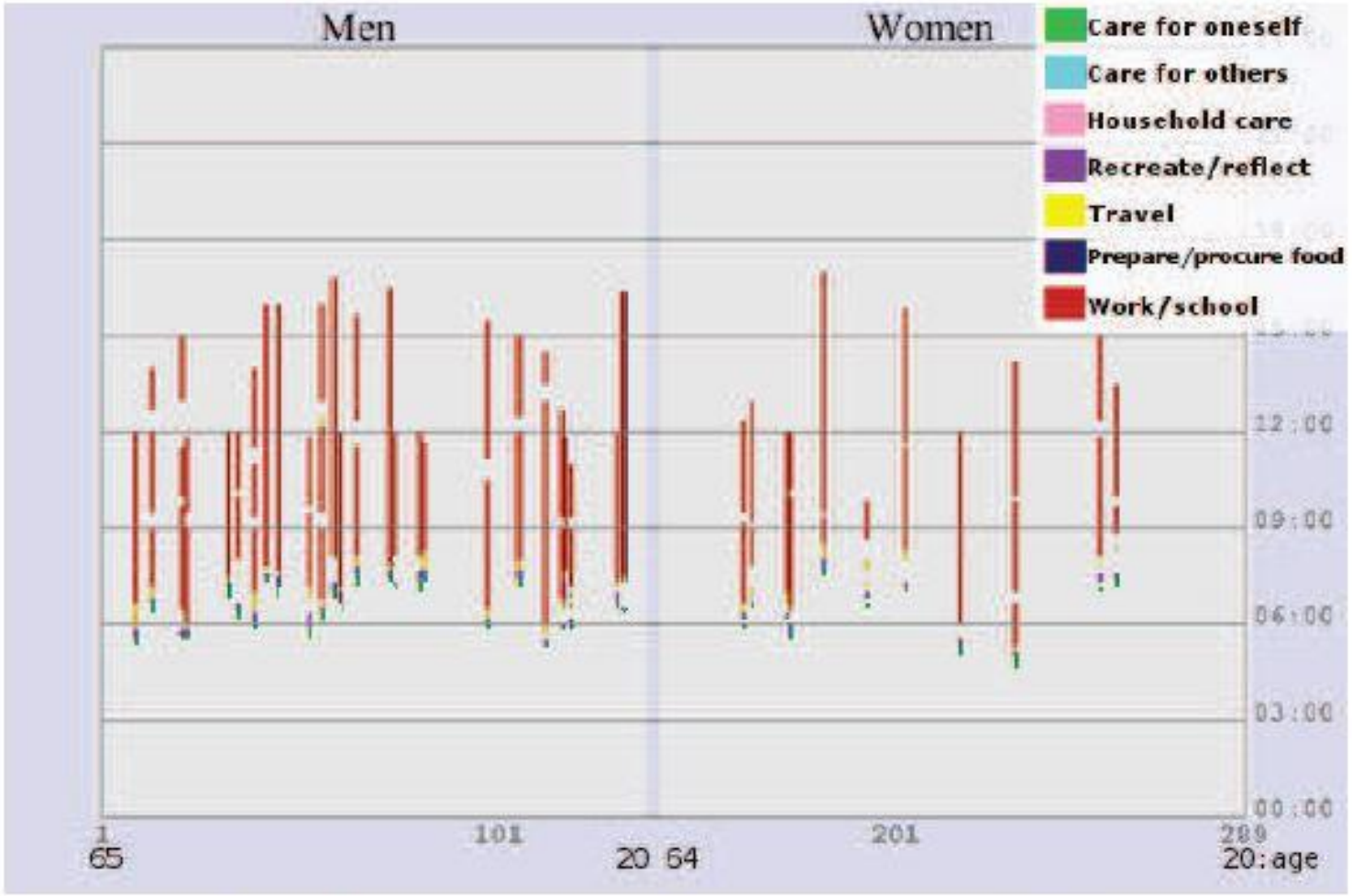
a) a zero gap match

b) a gap = 1 match

Source: Produced using VISUAL-TimePAcTS.

Source: Vrotsou, K., Ellegård, K., & Cooper, M. (2009). Exploring time diaries using semi-automated activity pattern extraction. electronic International Journal of Time Use Research , 6 (1), p.11.

Figure 12
Visualization of the *4–tuple* "breakfast→ read newspaper→ drive car→ work" (3→477→556→900)

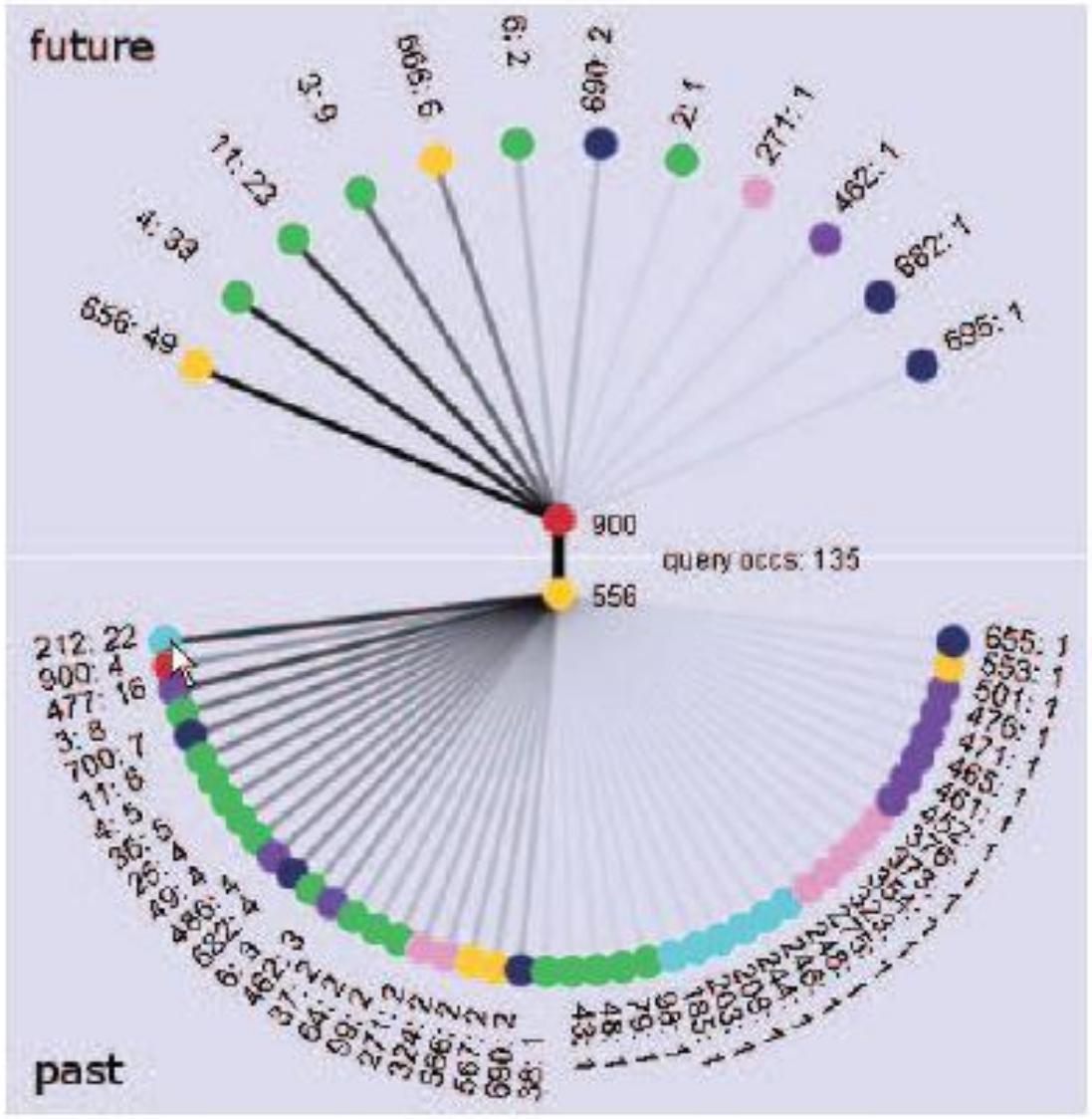


Source: Vrotsou, K., Ellegård, K., & Cooper, M. (2009). Exploring time diaries using semi-automated activity pattern extraction. electronic International Journal of Time Use Research , 6 (1), p.11.

The constraints applied on the pattern extraction algorithm are: minimum of 15 people performing the *tuple*, maximum gap of 4 between adjacent *tuple* activities and maximum *tuple* duration of 10 hours. 39 individuals (12 women and 27 men) display this activity pattern at the population level.

Source: Produced using VISUAL-TimePAcTS.

Travel by car: what activities is it positioned between?

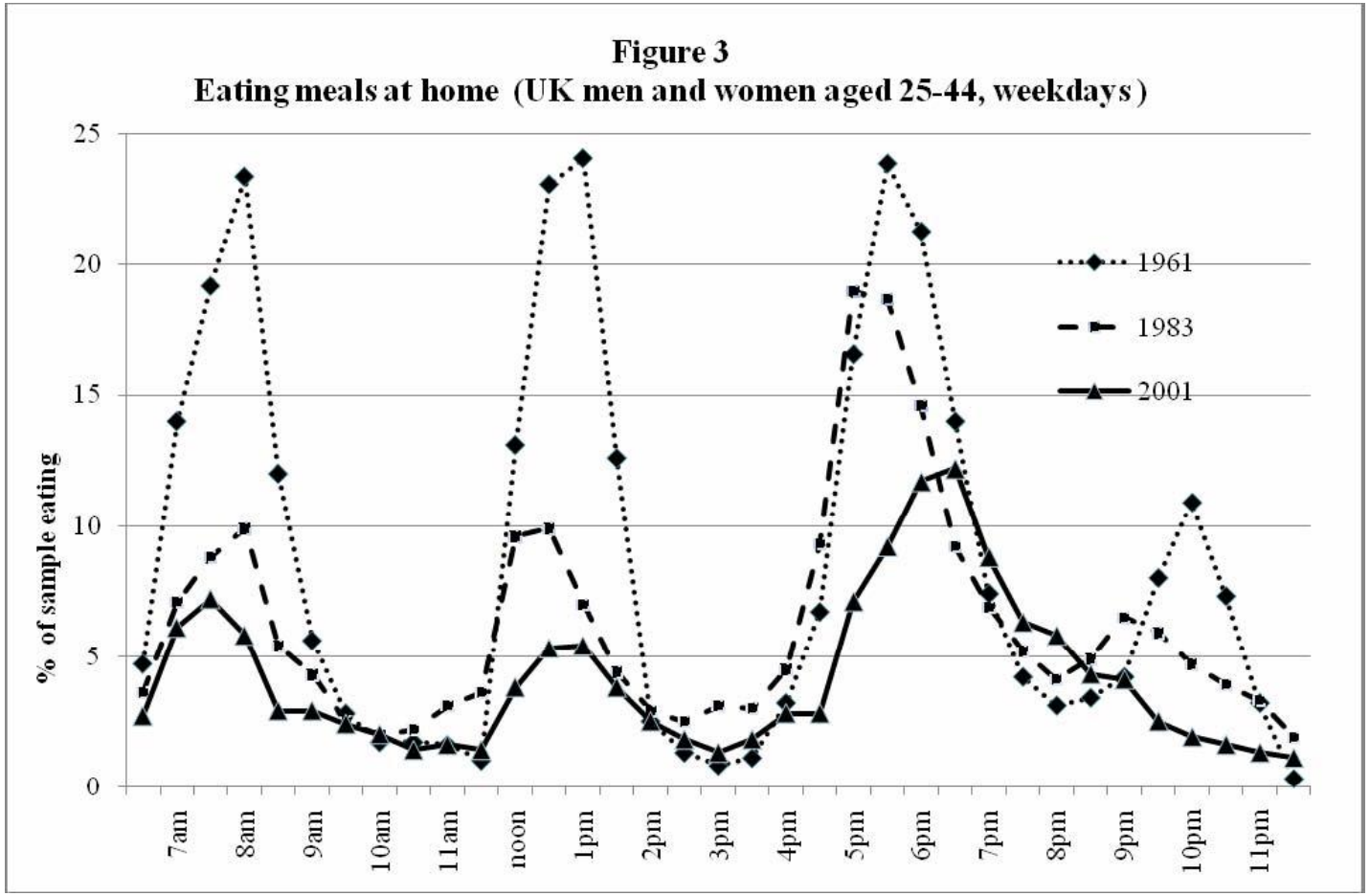


(a) The 'ActiviTree' visual interface.

Source: Vrotsou, K., Johansson, J., & Cooper, M. (2009). ActiviTree: Interactive Visual Exploration of Sequences in Event-Based Data Using Graph Similarity. IEEE Transactions on Visualization and Computer Graphics , 15 (6), p.946. .

4. How practices change over time

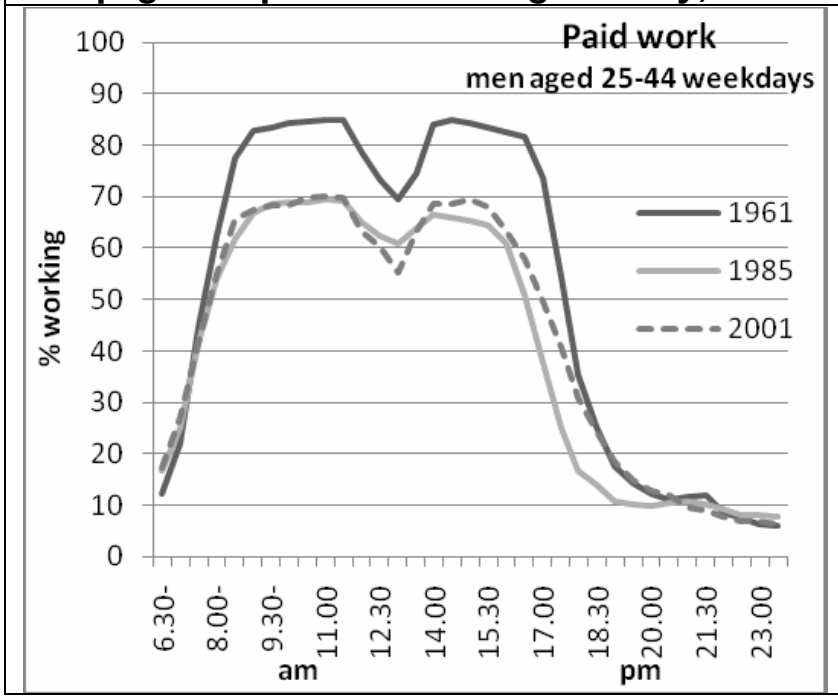
Over the long run, more and less energy demanding practices emerge, persist, change and disappear: to give just a few examples…

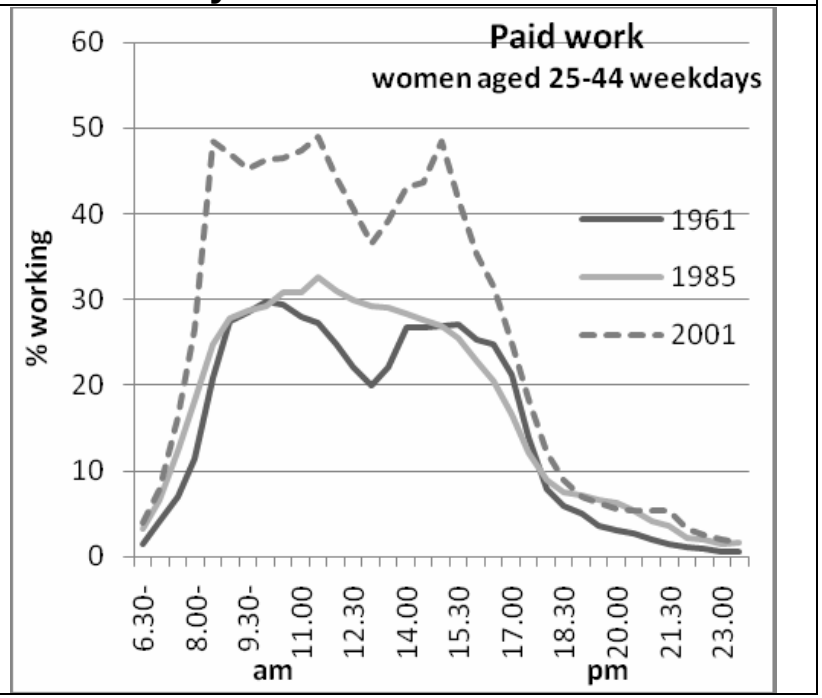


Source:Gershuny, J (2011*) Time-Use Surveys and the Measurement of National Well-Being*, Centre for Time-use Research Department of Sociology University of Oxford(12 September 2011)

Change over time: paid work through the day

Figure 2:
Tempograms: paid work through the day; UK national time diary studies 1961-2001





Source:Gershuny, J (2011*) Time-Use Surveys and the Measurement of National Well-Being*, Centre for Time-use Research Department of Sociology University of Oxford(12 September 2011)

Change over time: technologies, practices and temporal rhythms

Matching the rhythm of energy demand/services with the rhythm of social practices

Detaching the rhythm of energy demand/services with the rhythm of social practices

Technologies implicated in practices that call for more and for less energy demand…

And so we could go on…

5. Where does policy influence lie?

Non energy policy matters for timing, synchronisation and energy demand

School Choice
Daylight Saving Time
Opening hours: Sunday trading; GP services; pubs
Working Time Directive
Shift work
Urban planning

Business practices matter for timing, synchronisation and energy demand

Public Transport Fares – on/off peak
On-line delivery charges
Diamond Saver days (B&Q)
Economy 7 and other time-related tariffs
Parking fees (or max duration of stay)

Discussion:

Opportunities for intervening in the timing and synchronisation of energy demand
Implications for data collection, analysis and energy modelling
Focusing on practices: when demand occurs
Focusing on practices: extent of demand