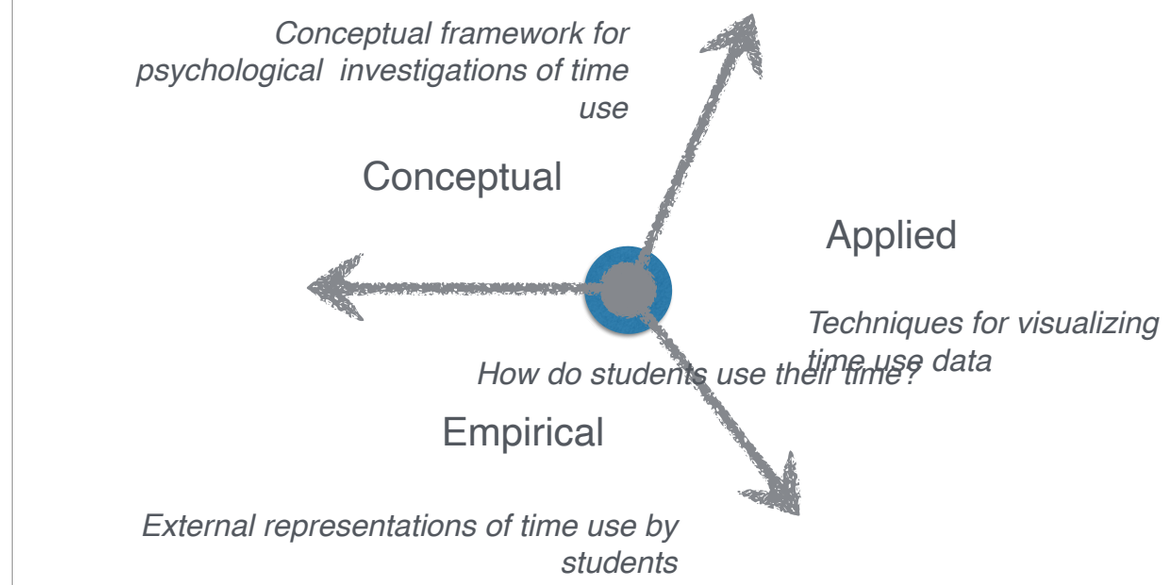
VISUALIZING TIME USE

AMY RAE FOX

Good afternoon everyone, and thank you for coming.

Today I am going to share with you the outcome of my semester project, titled: visualizing time use.



The genesis of this project was a manuscript prepared by my committee members. Their paper addressed the topic of time use, and in particular, how university students allocate their time to academic and extracurricular activities.
They used survey data gathered on students in the Rhone-Alps region of France, they compared a number of models from social science disciplines to see which could best explain variability in the data.
This paper was recently accepted for publication, the team decided the next step in this research is collecting time use data specifically targeted at addressing factors that might explain variation within and between different fields of study.

I was invited to take on this topic and explore the methods involved in time use research and applications for visualization.

I have organize my resulting work into three sections.
The first is **conceptual**: **I explored** the the methods of time use research, and tried to determine how they might be applied for psychological investigations of time use.
The second is **applied**: **I surveyed** a number of visualization techniques that might be used to analyze and communicate time use data.
The third is **empirical**: an exploration of what graphic representations students use to communicate their use of time.

This afternoon I will briefly review the conceptual and applied work, and we will use most of our time discussing the exploratory study.
(bonus points to anyone who can keep track of the number of times I use the word time in this presentation ;-)

Conceptual Framework

History of Time Use Research
Data Collection
Data Analysis
Time Geography
Applications

I set out this semester to learn everything I could about *time*, and so of course started with philosophy. From this literature I learned there are a number of perspectives on the ontology and epistemology of time. I also learned that I am not a metaphycicist, and am happy to leave philosophy to the philosophers :-)

I moved on to the psychology literature, hoping to find a more concrete discussion of our experience of time, and the nature of our relationship to time. I found the topic of time has had a long history in psychology research, going all the way back to William James. However, much of the research has focused on issues of perception. The question of time use has received relatively less attention, primarily in applied areas.

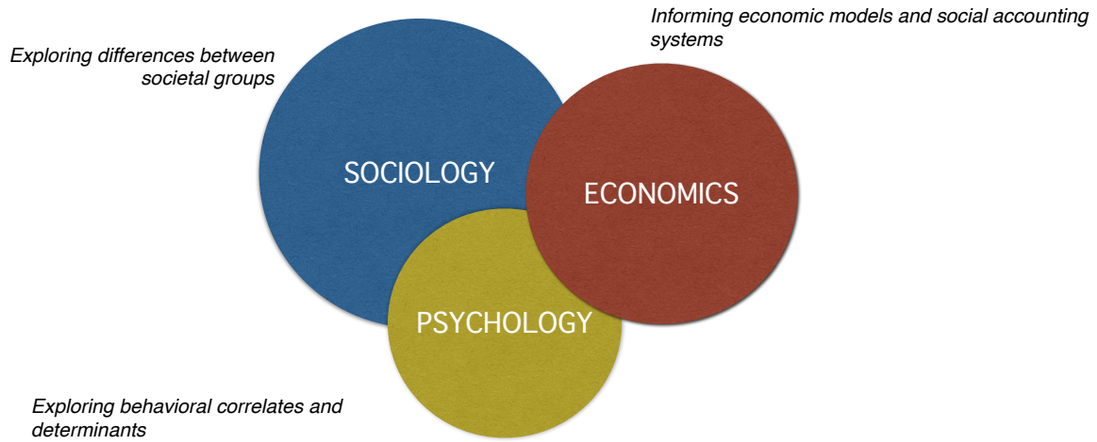
Meanwhile, throughout the 20th century researchers in sociology and economics developed sophisticated methods for studying time use in order to compare populations and inform policy decisions.

Since the UPMF team wishes to use these methods for their future data collection, I chose to explore conceptual frameworks for time use research, and find a suitable approach for psychological investigations in the sociological tradition.

Time can be viewed as the ultimate constraint on human activity. Unlike other resources, it is shared equally by everyone. Each of us 24 hours per day.

(United Nations, 2013)

Time Use Research



CONCEPTUAL FRAMEWORK

Time use research refers the study of how humans use their time in the performance of activities.

The earliest academic study of time use was published in 1924, examining the daily life of workers in Russia (Szalai, 1966).
In the first half of the 20th century, researchers investigating household budgets and living conditions conducted similar studies across Europe and North America.
In the 1960s, the value of time use data to compare populations became apparent, and many countries began collecting large nationally representative samples in conjunction with regular census efforts.
This information is very informative if it can be compared between countries, and so a number of efforts, notably by the EuroStat (the statistics office of the european union) have recommended guidelines for how to collect time use data so it can be more easily compared. The result is a large base of literature, a number of existing datasets and a well-defined methodology (Juster & Stafford, 1991).

In Europe and developing countries, the focus of research has been in **sociology**, where researchers have explored differences between societal groups.
How much time is spent doing household chores by men vs. women?
The resulting data can be compared to results from other countries OR compared to past data sets, to detect differences based on policy changes.
A main finding is that there are very substantial differences among industrialized countries in time use patterns-differences that are often larger than those between particular industrialized and preindustrial economies

In North America, most time-use research has been conducted by economists, interested in informing economic models and social accounting systems.
They seek to answer questions such as: how much time is spent on market vs. non-market work? These results can be compared to other measurements of economic output in order to analyze efficiency and produce models of economic activity.

In general, time-use research involves collection of huge data samples, so that conclusions can be drawn about large populations of individuals.
A smaller body of work is underway in psychology which seeks to evaluate time use at an individual level, investigating how the use of time relates to our subjective wellbeing.

Data Collection

Time	**What were you doing?** *Record your main activity for each 10-minute period from 04.00 to 07.00!* Only one main activity on each line! Distinguish between travel and the activity that is the reason for travelling.	**What else were you doing?** *Record the most important parallel activity.* *Indicate if you used, in the main or parallel activity, a computer or internet. You do not need to record the use of a computer or internet during working time.*	*Where were you? Record the location or the mode of transport* e.g. at home, at friends' home, at school, at workplace, in restaurant, in shop, on foot, on bicycle, in car, on motorbike, on bus, ...	*Were you alone or together with somebody you know?* *Mark "yes" by crossing* Alone	With other household members: Partner	Parent	Household member up to 9 years	Other household member	Other persons that you know
04.00-04.10				☐	☐	☐	☐	☐	☐
04.10-04.20				☐	☐	☐	☐	☐	☐
04.20-04.30				☐	☐	☐	☐	☐	☐
04.30-04.40				☐	☐	☐	☐	☐	☐
04.40-04.50				☐	☐	☐	☐	☐	☐
04.50-**05.00**				☐	☐	☐	☐	☐	☐
05.00-05.10				☐	☐	☐	☐	☐	☐
05.10-05.20				☐	☐	☐	☐	☐	☐
05.20-05.30				☐	☐	☐	☐	☐	☐
05.30-05.40				☐	☐	☐	☐	☐	☐
05.40-05.50				☐	☐	☐	☐	☐	☐
05.50-**06.00**				☐	☐	☐	☐	☐	☐
06.00-06.10				☐	☐	☐	☐	☐	☐
06.10-06.20				☐	☐	☐	☐	☐	☐
06.20-06.30				☐	☐	☐	☐	☐	☐
06.30-06.40				☐	☐	☐	☐	☐	☐
06.40-06.50				☐	☐	☐	☐	☐	☐
06.50-**07.00**				☐	☐	☐	☐	☐	☐

(Eurostat, 2008)

CONCEPTUAL FRAMEWORK

There are five methods commonly used to collect time use data: direct observation, experience sampling, surveys, time-stamped electronic databases and time use diaries.

The preferred method for studying an individual's time allocation is through a time- use diary.

The time diary method records the detailed account of the activities undertaken by an individual, usually over a period of 24 hours.

The respondent reports successively all activities either in predetermined fixed time intervals or by indicating the beginning and ending time of each activity.

An advantage of the time diary method is to allow respondents to report activities that they have performed simultaneously,

This offers a wealth of analytical opportunities, and are capable of gathering data on the **contexts** surrounding the activities undertaken, for example, **whom people are with**, **where they are**

Data Analysis

duration	timing	sequence	frequency
quantity of time	*time of day*	*order of activities*	*number of occurrences*
How much time do I spend studying ?	What time of day do I study?	What do I do before and after studying?	How many times a day do I study?

CONCEPTUAL FRAMEWORK

Hopefully I've given you an impression of the potential size and complexity of diary data.

Diaries are immensely powerful instruments, and because of the time and cost associated with delivering them, it is important to have a solid conceptual grounding for an investigation.

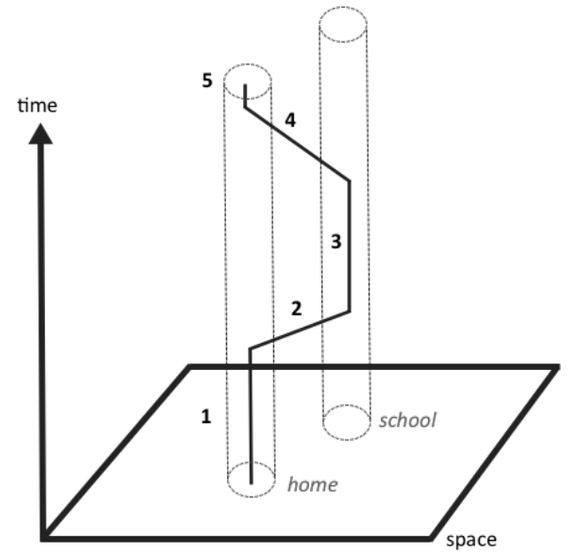
As soon as we have come into being we cannot take time off from our bodily existence. We have to leave a space-time trace in the world. And we share this condition with all other living and nonliving entities. As long as something exists it must be somewhere.

(Hägerstrand, 1989, p. 4)

In developing the principles of time-geography, Swedish researcher Torsten Hägerstrand proposed a framework for integrating **the time and spatial perspectives of multiple disciplines**

Fundamental to this perspective is the relationship of an individual to their surroundings.
It is by the very nature of existence that human activity exists equally in time and space.
While it is possible for the researcher to examine duration, sequence, timing and frequency in isolation,
and similarly to consider human movement through space without regard to time,
in doing so, we risk overlooking important relationships between the use of time and space.
By accounting for these dimensions, time-geography provides an effective approach for examining constraints on human activities.

Time Geography



resources
goals
activities
constraints
path
stations
prisms

(Thrift, 1977)

CONCEPTUAL FRAMEWORK

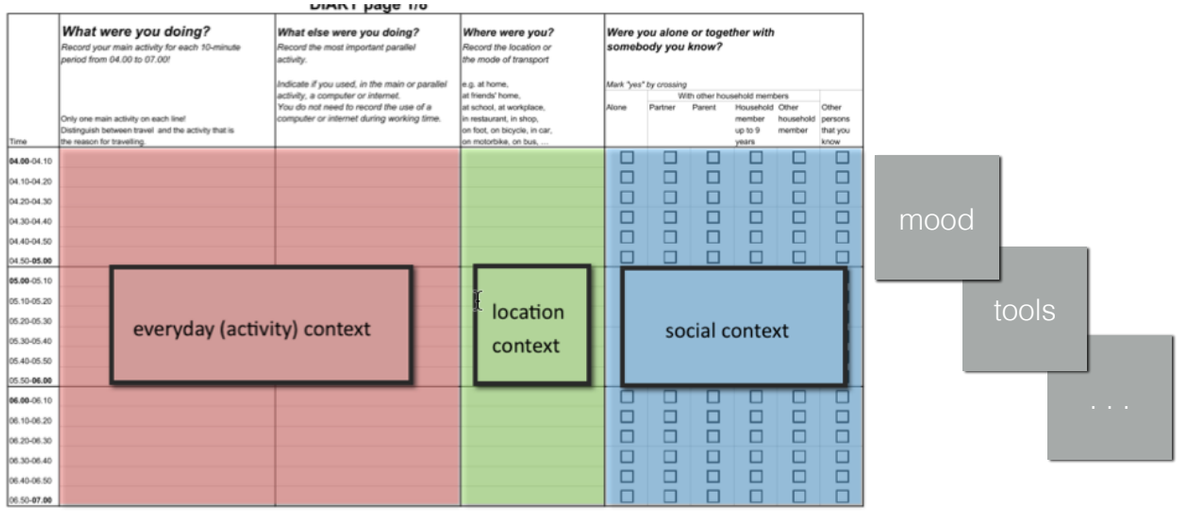
The roots of time-geography lie in the early 1960's, in the study of migration patterns of a small population in Sweden.
Hagerstrand was a human geographer, who used ethnographic methods to collect the life histories of tens of thousands of individuals. Hägerstrand struggled to analyze his data using existing instruments in geography,
He wanted to account for an individual's location in space and time
From this experience he constructed the building blocks for a the notational system, and its associated constructs.

Time and space are **resources** used by humans in daily life.
We use resources to perform **activities**, in pursuit of **goals**.
Everything we do is considered an activity, and all activities take place in space and time.
Constraints serve as obstacles to progress toward goals, and are the primary determinants of human experience in the environment.
Our movement through time and space forms a **path** which flow through locations in space-time called **stations**.
The potential volume of space and time within reach of the individual constitutes their **prism**, which graphically expresses their movement limitations in each dimension.
Hägerstrand planted the seeds of an elegant visualization scheme that depicts the path of an individual as a continuous line through time and space.

This figure depicts an individual's path through time-space over the course of one day. (1) At home, (2) drive to school, (3) at school, (4) drive home, (5) dinner and bedtime. While the individual is stationary the path is perpendicular to the space axis. In this 2D representation, an arbitrary distance differentiates the locations home (1, 5) and school (3). The slope of segments (2) and (4) indicate the individual's speed as they travel. The length of segment (4) over (2) suggests the individual may have encountered traffic on their drive home.

Hagerstrand's legacy in time geography is a notational system, its associated constructs, and also a worldview. There is unnecessary fracturing in social science disciplines. As we often study the same phenomena from different perspectives, it is advantageous to seek ways to integrate our perspectives to promote ecological validity in our investigations.

Contexts



mood

tools

. . .

(Eurostat, 2008)

CONCEPTUAL FRAMEWORK

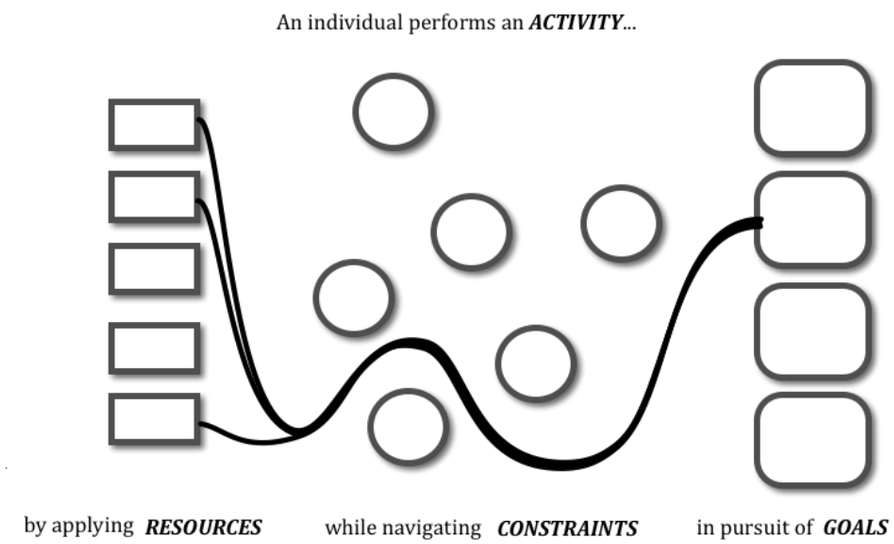
Kajsa Ellegard, a student of Hagerstrand, has proposed the application of time geographic principles to time use study.
An assumption is that the individual's habits may be revealed by the contexts in which activities are actually performed

She describes dividing time use data into a series of contexts, which structure the collection of data.

activity context
location context
social context
etc. etc.

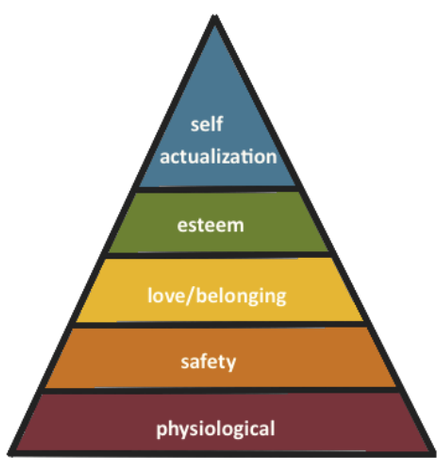
allows for the exploration of : timing, sequence, and frequency in addition to duration, which is the focus of most time use research.

Application

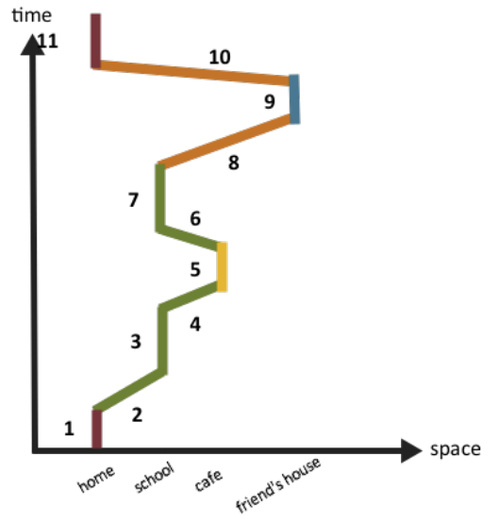


CONCEPTUAL FRAMEWORK

Application



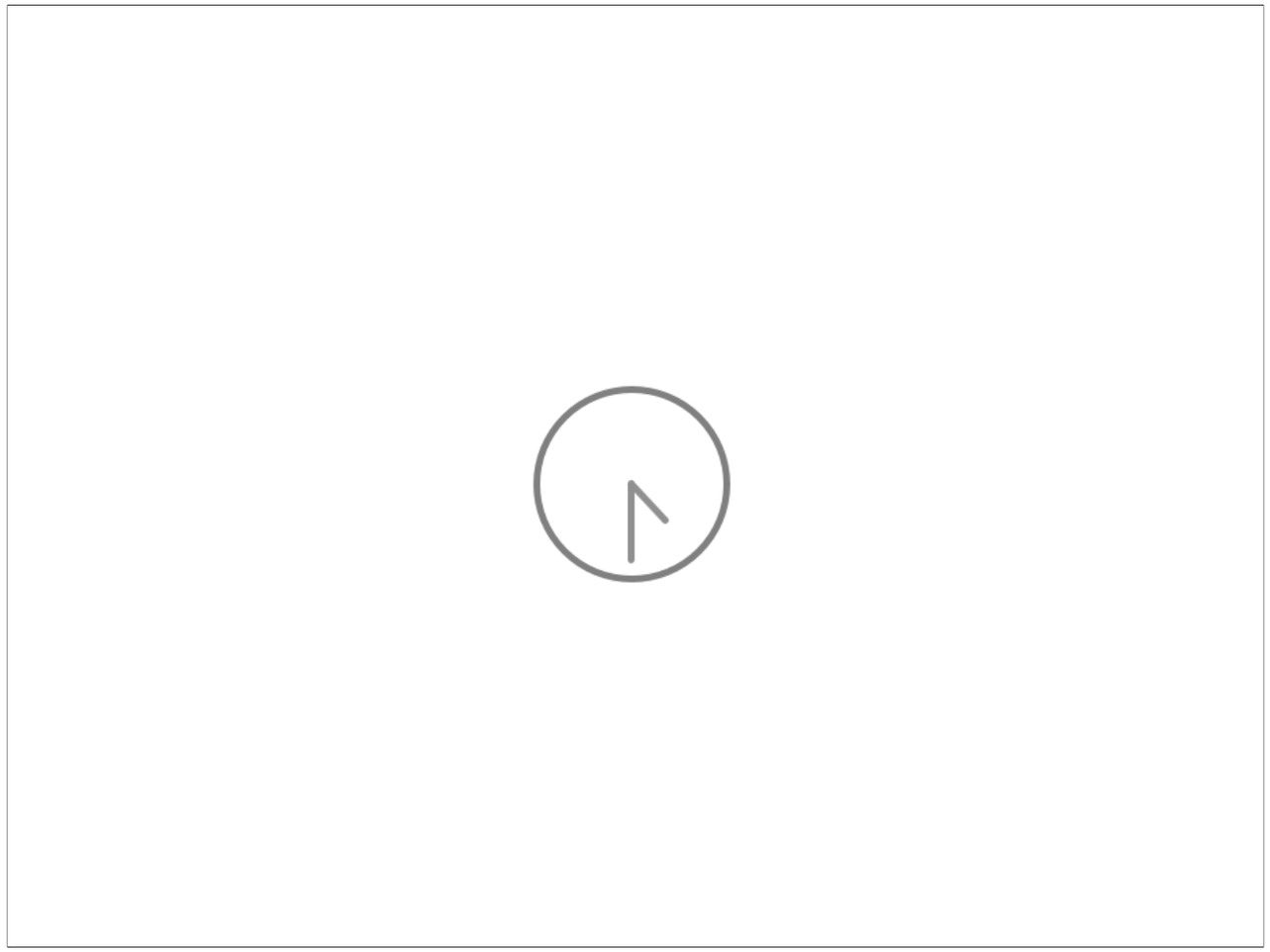
Maslow's Hierarchy of Needs (1943)



(Maslow, 1943)

Say I want to understand my distribution of time in regards to fulfilling my goals.
In this example, we adopt Maslow's "Hierarchy of Needs" (Maslow, 1943). as a typology for goals.

Figure 6 depicts a day in the life of the author, displayed in a time-geographic notation, with the author's goal for each activity color-coded in correspondence with Maslow's hierarchy (at left). In this day, the author: (1) wakes up, eats breakfast, (2) rides bike to school, (3) attends lecture, (4) rides bike to café, (5) meets classmate for lunch, (6) rides bike to school, (7) studies in library, (8) rides bike to friend's house, (9) designs game with classmate, (10) rides bike home, (11) eats dinner, sleeps.

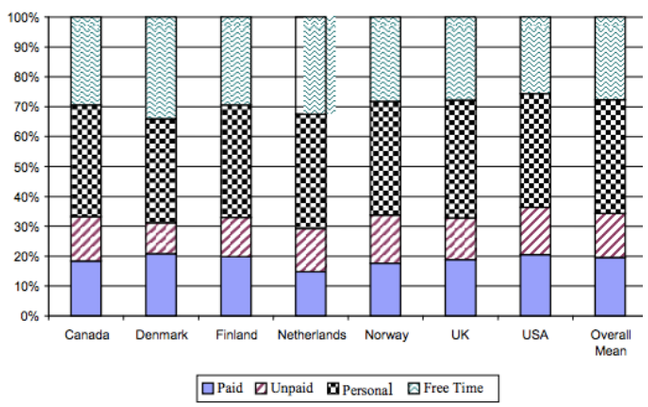


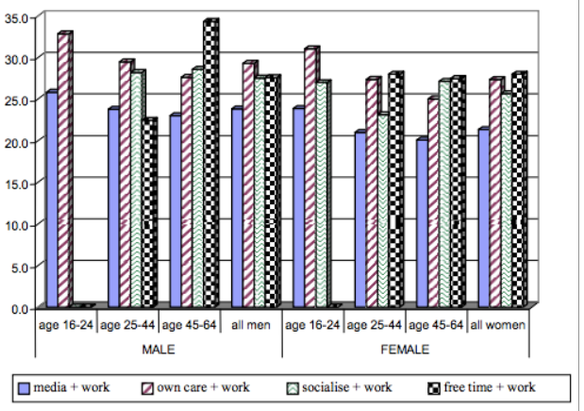
With the wealth of detail available in time use data, and the potential afforded by the proliferation of personal data tracking capabilities, there is a compelling opportunity for a flexible, comprehensive research model for investigating human behavior in time use data. In developing time-geography, Torsten Hägerstrand's goal was a deeper understanding of human action, rooted in an ecologically valid worldview. His resulting approach does not seek to explain the motivation of behavior, but rather, serve as a structure for thought. What is described is potential extensions to Hägerstrand's work that would allow psychologists to explore time use data using diary methods honed in the broader social sciences, in a way that is grounded in modern theories of cognitive psychology.

Visualization Techniques

Depicting Duration
Depicting Context
Activity Paths
Sequence Analysis

Duration



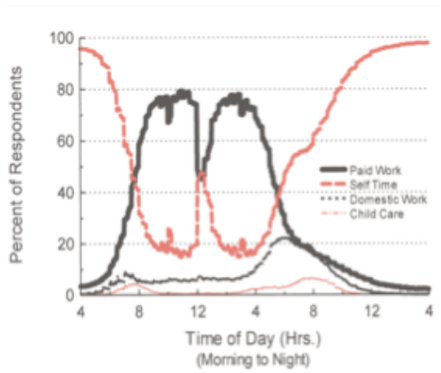


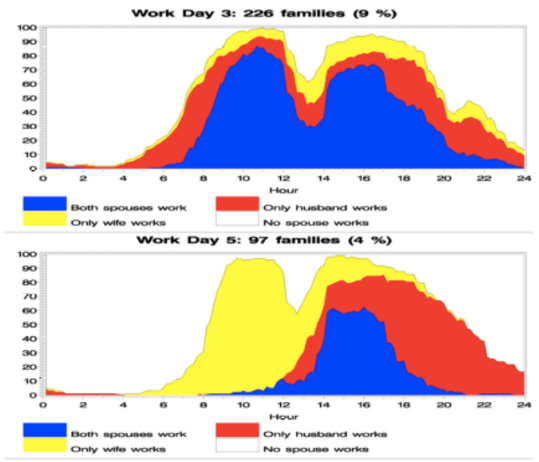
(Fisher & Layte,2004)

Figure 1: Average activity duration between countries.

Figure 2: Multitasking activity for different populations groups in England

Contexts





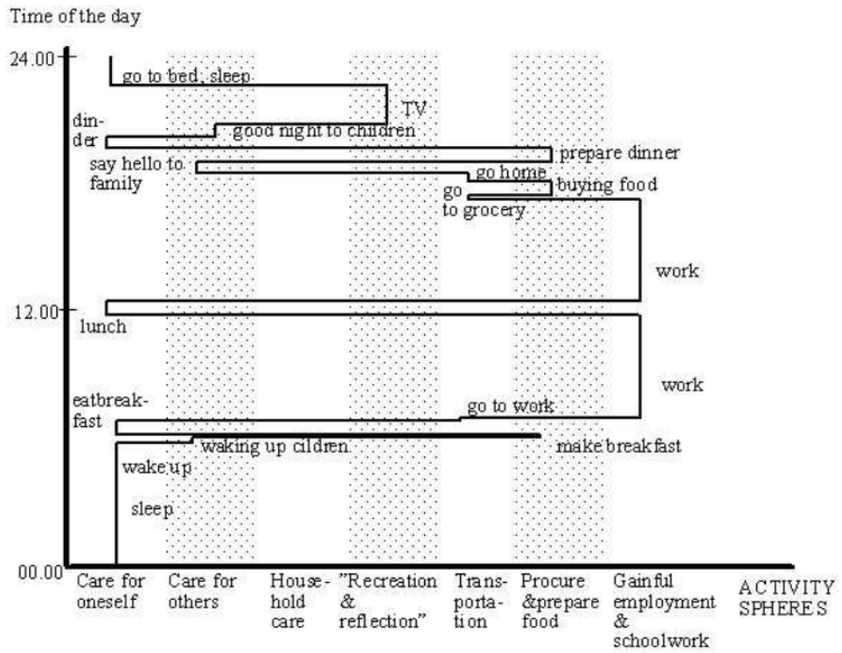
(Lesnard, L.,2004;Michelson, W., & Crouse, D.,2004)

VISUALIZATION TECHNIQUES

In Figure$7 we see an example from a time use publication which describes four types of activities represented by different color and weight of line for a sample of workers in Canada (Michelson & Crouse, 2004). The graph clearly displays the reciprocal relationship between paid work and selfDtime.

In Figure$8 we find two tempograms using an area variation that depicts two separate workdays for French families in 1985. Color is used to differentiate categories, and we can easily see the distinction between hours of the day when one or both of the spouses are working.

Activity Path

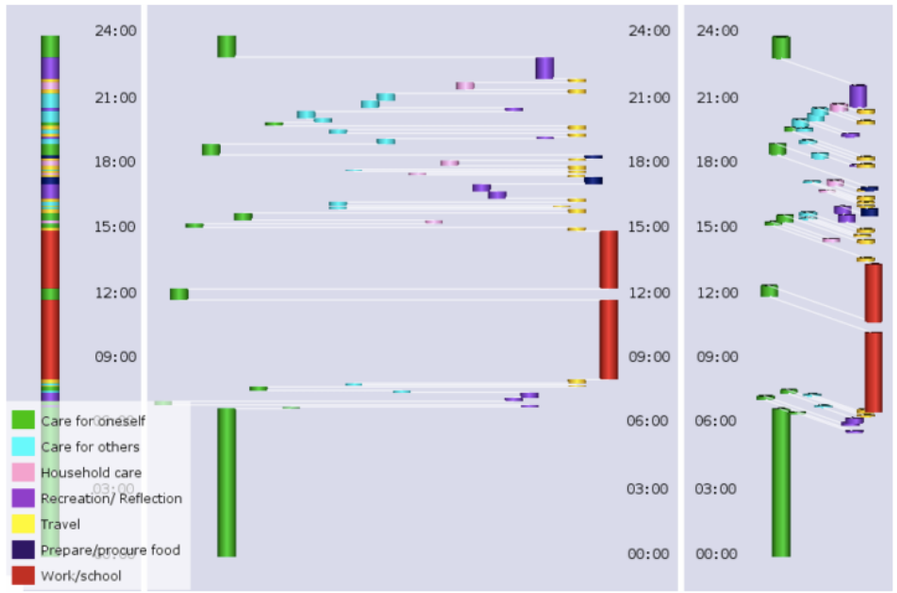


(Ellegård & Cooper, 2004)

VISUALIZATION TECHNIQUES

Activity
oriented path of one individual over one day Source:$

3D Activity Path

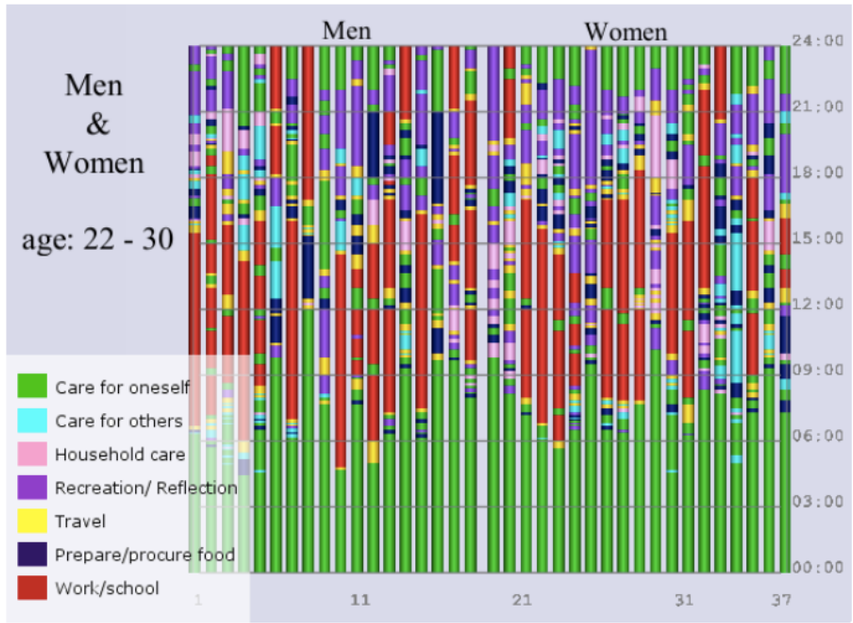


(Vrotsou, K., Ellegård, K., & Cooper, M, 2009)

VISUALIZATION TECHNIQUES

Visualization examples of the activity path of an individual in VISUAL-TimePAcTS
(a) front (b) side view (c) rotated view
Time is shown on the y-axis and colours represent the 7 activity categories. (a) shows the front view, where the general division of the activities can be detected at main category level. (b) shows the path in side view, reveal- ing the breakdown into more detailed activity descriptions. (c) shows a slightly rotated view of the activity path in 3D.
Source:

Sequence Analysis



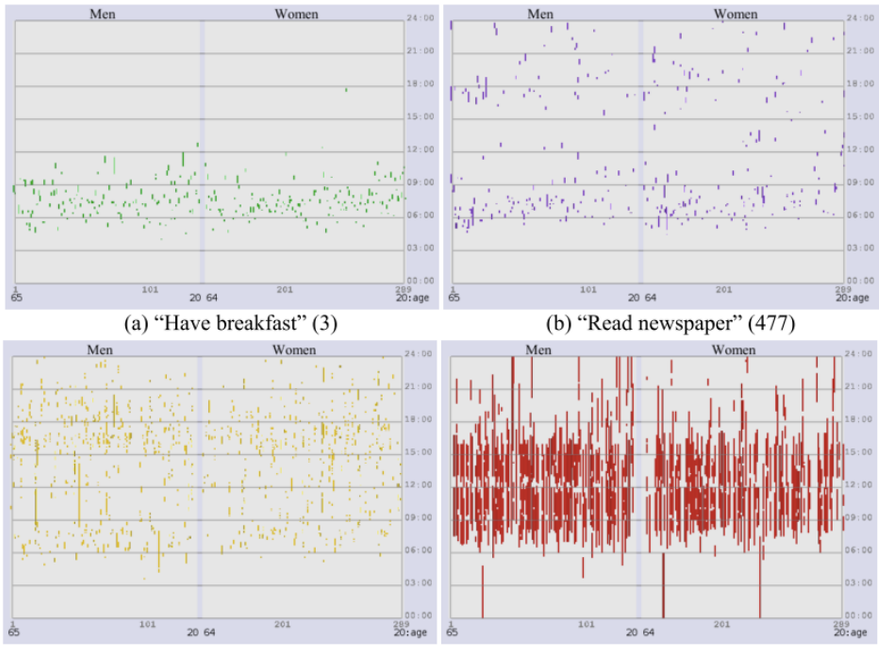
(Vrotsou, K., Ellegård, K., & Cooper, M, 2009)

Front view visualization of a weekday of a group of individuals aged 22-30 in VISUAL-TimePAcTS

Time is shown on the y-axis, individuals are ordered by sex and age from left to right on the x-axis. Colours represent the 7 activity categories.

Source: Produced using VISUAL-TimePAcTS

Sequence Analysis



(a) “Have breakfast” (3)

(b) “Read newspaper” (477)

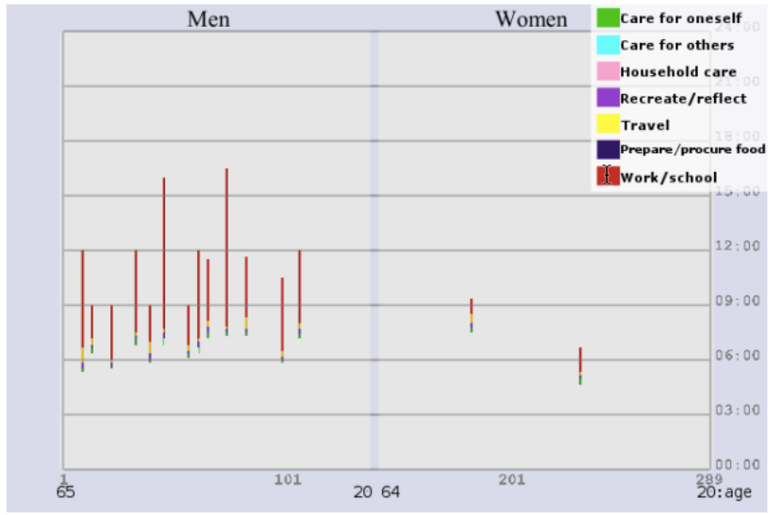
(c) “Travel by car” (556)

(d) “Work” (900)

(Vrotsou, K., Ellegård, K., & Cooper, M, 2009)

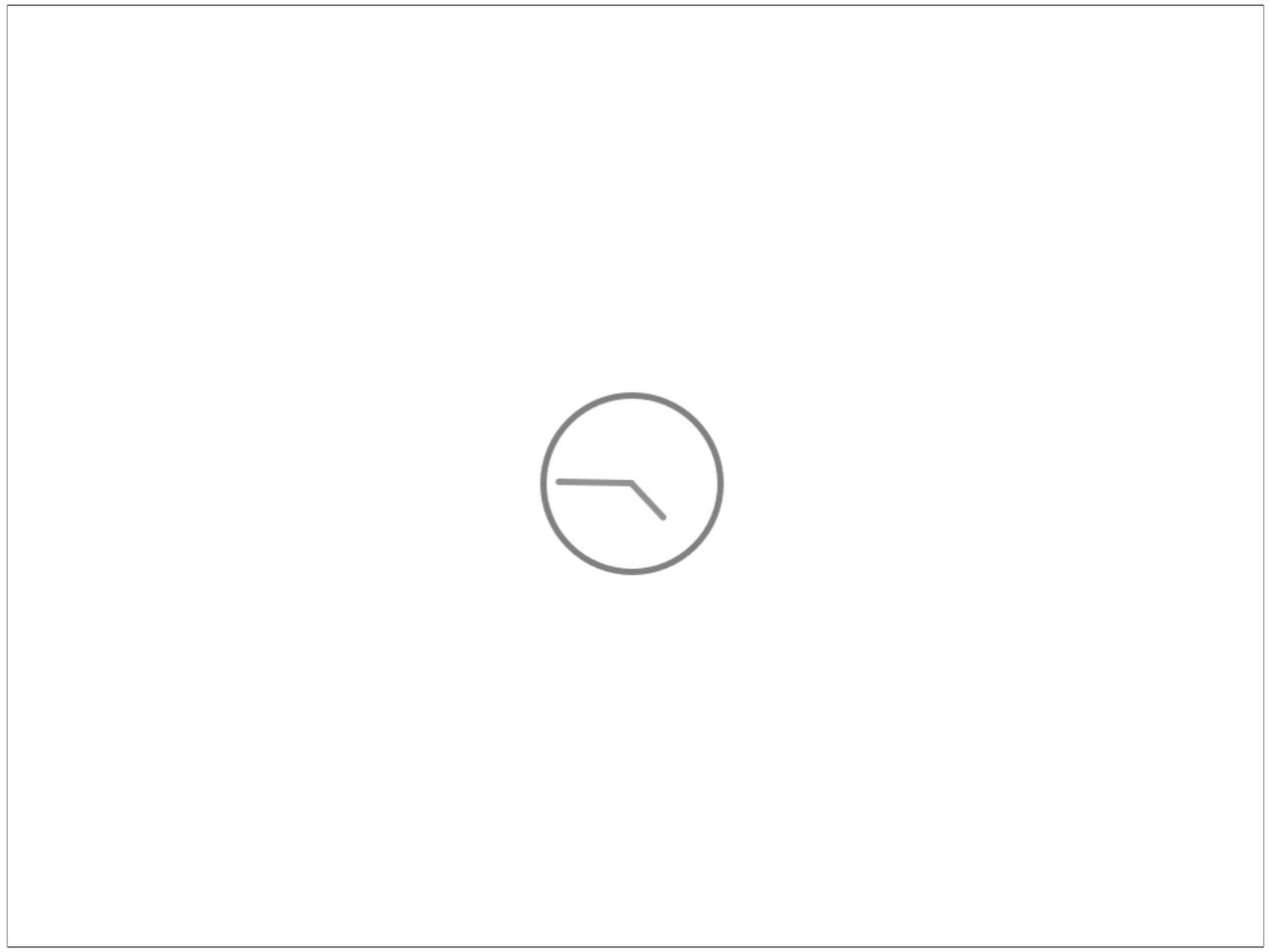
Visualization of the distinct single activities making up the collective activity pattern “getting ready for work”: “have breakfast→ read newspaper→ travel by car→ work” (3→477→556→900) in VISUAL-TimePAcTS.

Sequence Analysis



(Vrotsou, K., Ellegård, K., & Cooper, M, 2009)

Visualization of the 4–tuple "have breakfast→read newspaper→travel by car→work" (3→477→556→900) in VISUAL-TimePAcTS. The constraints applied to the algorithm are: minimum of 15 people performing the tuple, maximum gap of zero between adjacent tuple activities and maximum duration 10 hours.
Source: Produced using VISUAL-TimePAcTS.



Empirical Study

Research Question
Methods
Results
Discussion

Research Question

What external representations do university students use to communicate their **use** of time?

If we cannot { see, hear, touch, smell, taste } time, how do we communicate it?

(Tversky, 1991,2011)

EMPIRICAL STUDY

Time is mysterious. If we cannot experience it through sensory perception, how do we communicate about it?

In language, we use a number of spatial metaphors.
The deadline coming up.
I'm ahead of schedule.
I need to be on time.
I'm looking forward to the weekend.
The best days are behind us.

It seems these spatial metaphors are transferred to the space of the page when we communicate visually.

My empirical study was inspired by the work of Barbara Tversky, who in the early 1990's studied children of various ages across three cultures. Her team sought to determine what how the children used space and form on the page to communicate their thoughts, including preference, quantity. Her results she found several indications for how the children used space to communicate about time.

Having been given access to a sample of university students, I decided to take the opportunity to do a short exercise, applying Tversky's observations to the topic of time use.

I asked the question…. what external representations do university students use to communicate their use of time?

Method

Qualitative content analysis of visual media

1. How do students use space to represent time use?
2. How do students use form to represent time use?
3. Is there any consistency in which mechanisms are used to represent each component of time use?

(Marsh & White, 2006)

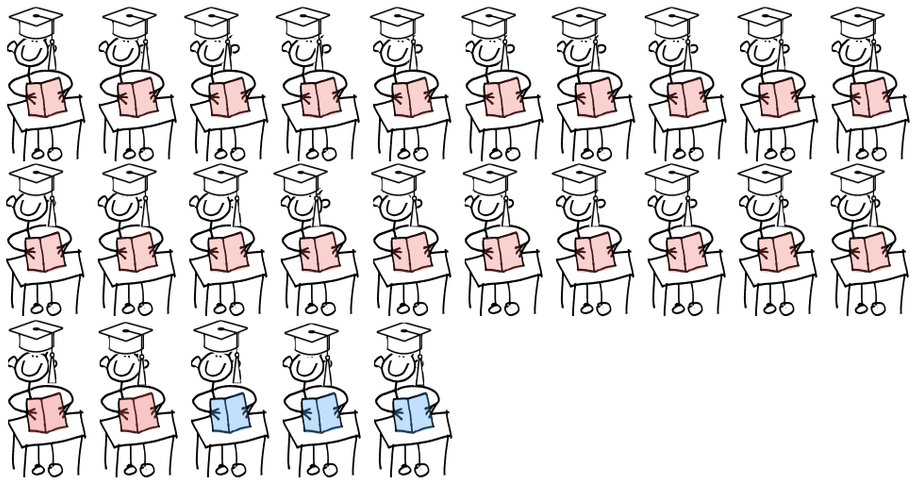
EMPIRICAL STUDY

We decided to conduct an exploratory exercise in conjunction with a pedagogical activity on time management.
We expected our participants, third year undergraduates, would be capable of reasoning about, and attempting to represent, their daily activities along the four components of time use.
Working with a limited sample of students, we decided on a **qualitative** approach that would enable us to pilot our materials,and refine our hypotheses.

We elected to conduct a **qualitative content analysis**, as it afforded an iterative deductive/inductive coding process, accommodating novel and unexpected forms of representation (Marsh & White, 2006).

Our analysis would be guided by three questions:
(1) How do students use space to represent time use?
(2) How do students use form to represent time use?
(3) Is there any consistency in which mechanisms are used to represent each component of time use?

Sample

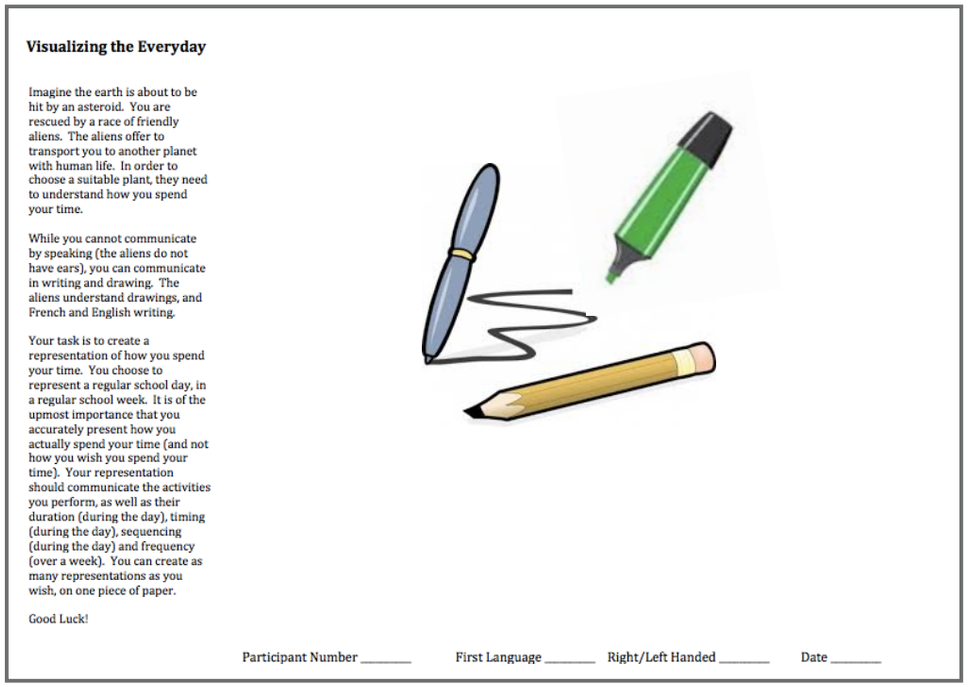


n = 25 (22 f, 3 m) Median = 23

Twenty five undergraduates enrolled in a graduate studies preparation course participated as a course requirement.
22 were female, 3 male, and the median age was 23. All were registered Education majors.

First, the students listened to a presentation on time use research where they were introduced to the components of time use data.
The presentation contained no graphics in order to avoid priming the students with spatial metaphors for temporal characteristics.
The students then completed a short demographic survey and were given a sheet of paper containing the visualization scenario.
Students were directed to read the scenario and create an appropriate representation.

Materials



Visualizing the Everyday

Imagine the earth is about to be hit by an asteroid. You are rescued by a race of friendly aliens. The aliens offer to transport you to another planet with human life. In order to choose a suitable plant, they need to understand how you spend your time.

While you cannot communicate by speaking (the aliens do not have ears), you can communicate in writing and drawing. The aliens understand drawings, and French and English writing.

Your task is to create a representation of how you spend your time. You choose to represent a regular school day, in a regular school week. It is of the upmost importance that you accurately present how you actually spend your time (and not how you wish you spend your time). Your representation should communicate the activities you perform, as well as their duration (during the day), timing (during the day), sequencing (during the day) and frequency (over a week). You can create as many representations as you wish, on one piece of paper.

Good Luck!

Participant Number _____ First Language _____ Right/Left Handed _____ Date _____

Although their participation was a requirement of their academic course, we wanted to motivate students to expend cognitive and creative effort on the activity.

We developed a humorous scenario. *Imagine the earth is about to be destroyed by an asteroid. You are rescued by aliens, who will relocate you to a suitable planet. In order to decide which planet, you must communicate to the aliens how you usually spend your time on typical school day in a typical week.*

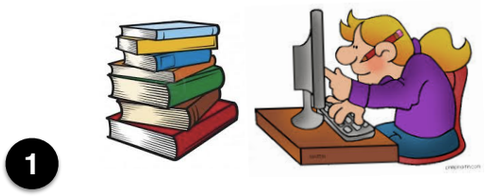
While there are many purposes for external representation (i.e. persuasion, problem solving, exposition, planning) the scenario was constructed to prompt graphic productions in the most general case: informative communication.

The scenario explicitly called for representation of five components: activity (what), duration (quantity), timing (chronological point in time), sequence (order) and frequency (number of times).

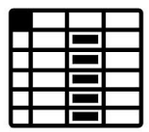
They were instructed to create **as many representations as necessary, using any graphic conventions desired**. The text was carefully worded to use only the term "representation" when referring to the graphic output, avoiding a bias in visual forms with words such as: chart, graph, picture, sketch, icon, or text.

The students were given one sheet of A4 paper, and had access to their own pens, pencils and colored highlighters.

Analysis



1

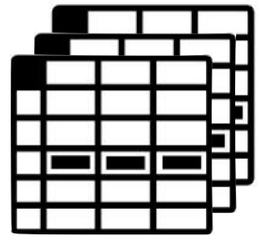


v1

2

v2

3



v3

EMPIRICAL STUDY

The coding scheme was developed by the author using a directed approach (Hsieh & Shannon, 2005).

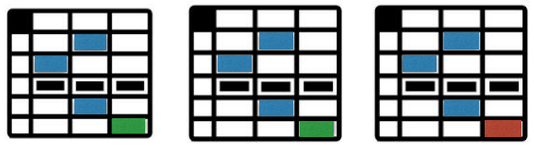
(1) First, categories were defined in response to the foreshadowing questions, in alignment with the discussion of form and space in Tversky (2011).

(2) The author then reviewed a subset of diagrams (n=5), and applied the coding scheme. Multiple modifications were made during this inductive process, including the addition of two categories the researcher noted as present and variant in the sample, and removal of one category that proved too subjective to evaluate2. The researcher then developed operational definitions for each variable and set variable values that were exhaustive and mutually exclusive (Theo & Jewitt, 2004).

(3) The resulting scheme was then applied to the diagrams by two additional raters, who coded the entire sample. Three graduate students in Cognitive Visualization (including the author) coded the resulting diagrams following the procedure for directed qualitative content analysis (see Hsieh & Shannon, 2005; Krippendorff, 1989; Patton, 2002, for a thorough description). The raters agreed on the operational definitions for each component in the coding scheme before analyzing two diagrams from the sample as a training exercise. After every five diagrams, the raters paused to discuss their evaluations, following the constant comparison method (Glasner & Strauss, 1967 as cited in Marsh & White, 2006). In the case of discrepancies, each rater explained their interpretation of the code, after which raters could revise or maintain their original assessment. In one case, a revision to an operational definition was proposed, and the corresponding components of the previously reviewed diagrams were re-evaluated. The final coding scheme reflects a response to the both the research questions and the evidence present in the sample. As the sample size (n=25) was small, each rater proceeded to code the entirety of the sample.

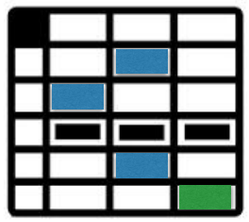
Analysis

4



(space) $\alpha = 0.876$
(form) $\alpha = 1.000$
(mechanisms) $\alpha = 0.972$

5



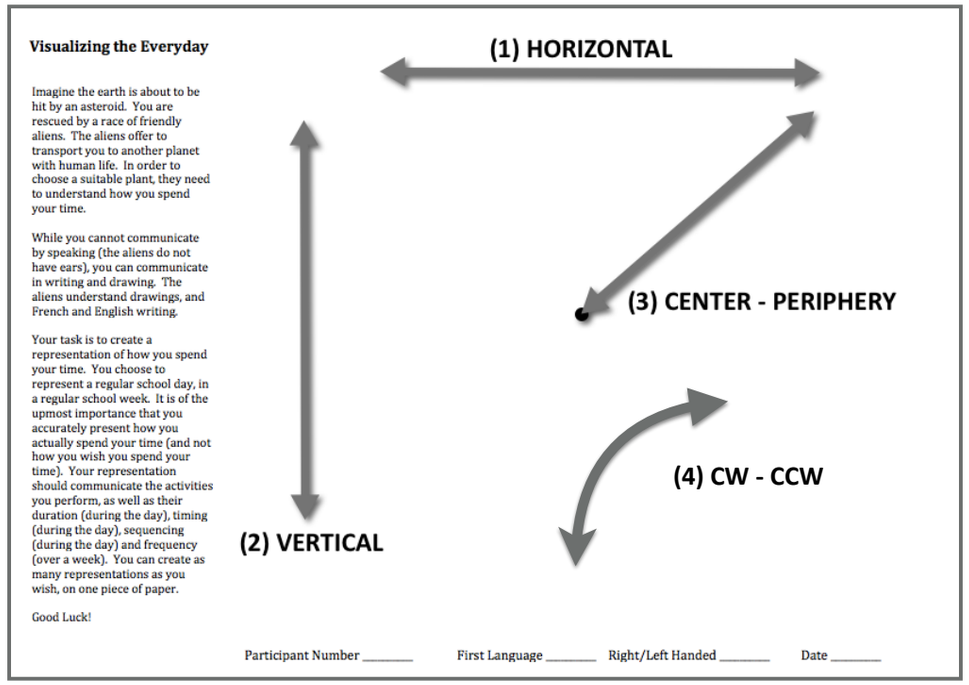
(Hayes & Krippendorff, 2007)

EMPIRICAL STUDY

(4) Coding results for the whole sample were then evaluated for interXrater reliability, with positive outcomes. Krippendorff 's alpha was selected as the most appropriate measure of reliability for nominal variables assessed by more than two coders (Hayes & Krippendorff, 2007). For use of space (S1XS6) $\alpha = 0.876$, use of form (F1XF5) $\alpha = 1.000$ and primary mechanisms (M1XM5) $\alpha = 0.972$, all exceeding the recommended threshold of $\alpha \geq 0.800$ (Geertzen, 2012; Lombard, SnyderXDuch, & Bracken, 2004).

(5) Finally, a combined coding result was constructed from the individual results (based on the majority rating) for use in data analysis.

Analysis : Space



EMPIRICAL STUDY

We first analyzed the diagrams for their use of space.

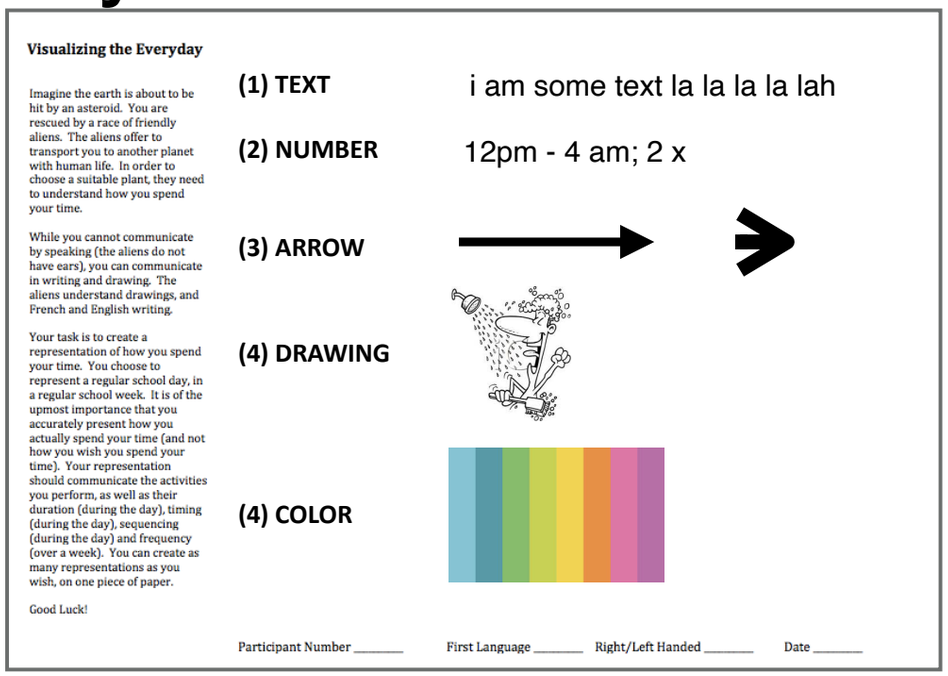
We determined if the **Gestalt use of space** was primarily ***linear*** or ***circular.***

Then we evaluated the direction of the flow of information.

For linear representations, we evaluated the direction in **horizontal** and **vertical**

For circular representations, we evaluated the direction along the **circumference**, and along the **radius**.

Analysis : Form



We then analyzed the diagrams for their use of form.

Each diagram was coded yes/no to see if they contained

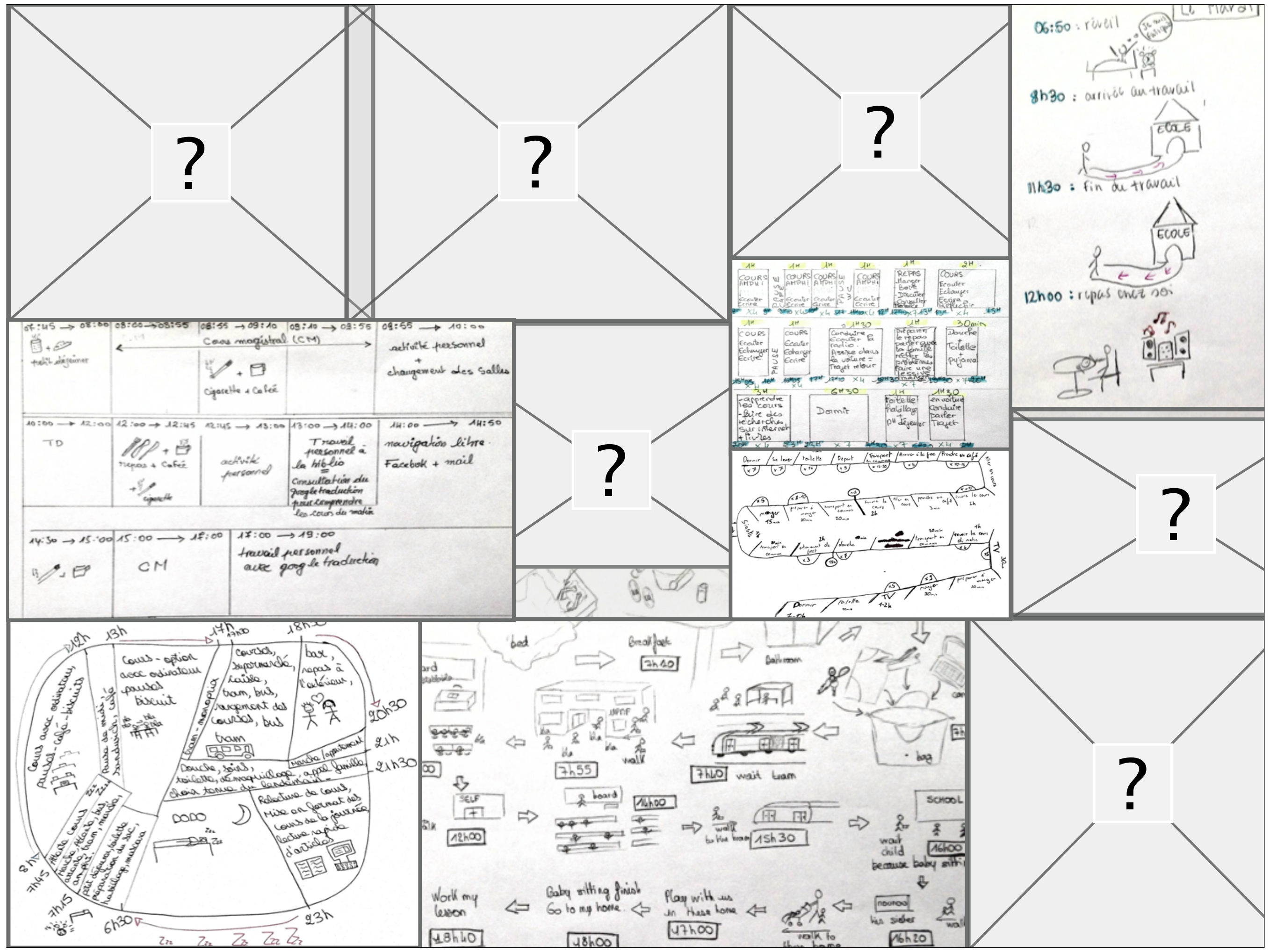
text

number

arrow

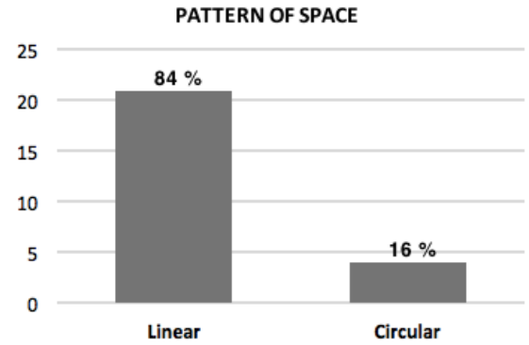
drawing

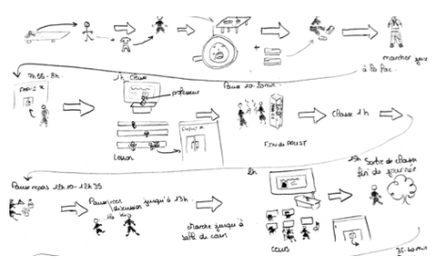
color

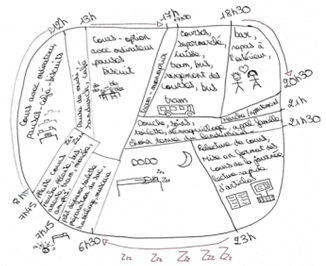


06:50 : réveil
8h30 : arrivée au travail
11h30 : fin du travail
12h00 : repas chez soi
ECOLE
Cours magistral (CM)
activité personnel + changement des salles
TD
navigation libre Facebook + mail
CM
Dormir
Breakfast
Bathroom
wait tram
SCHOOL

Use of Space



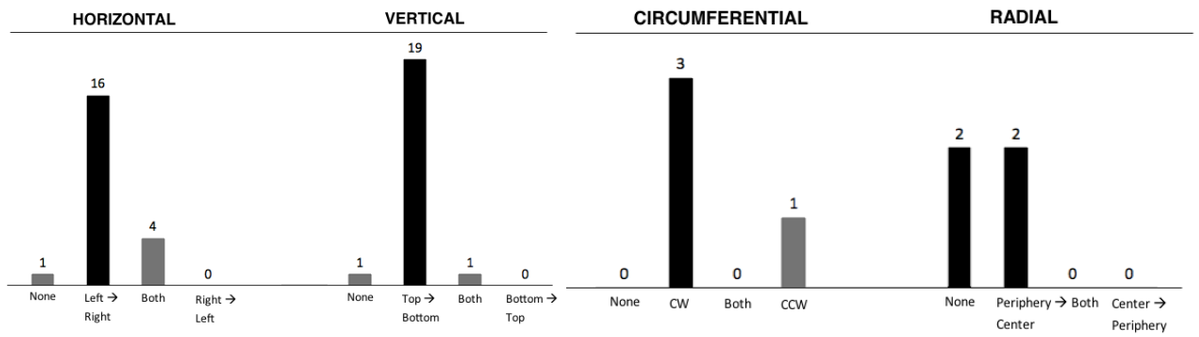




Results

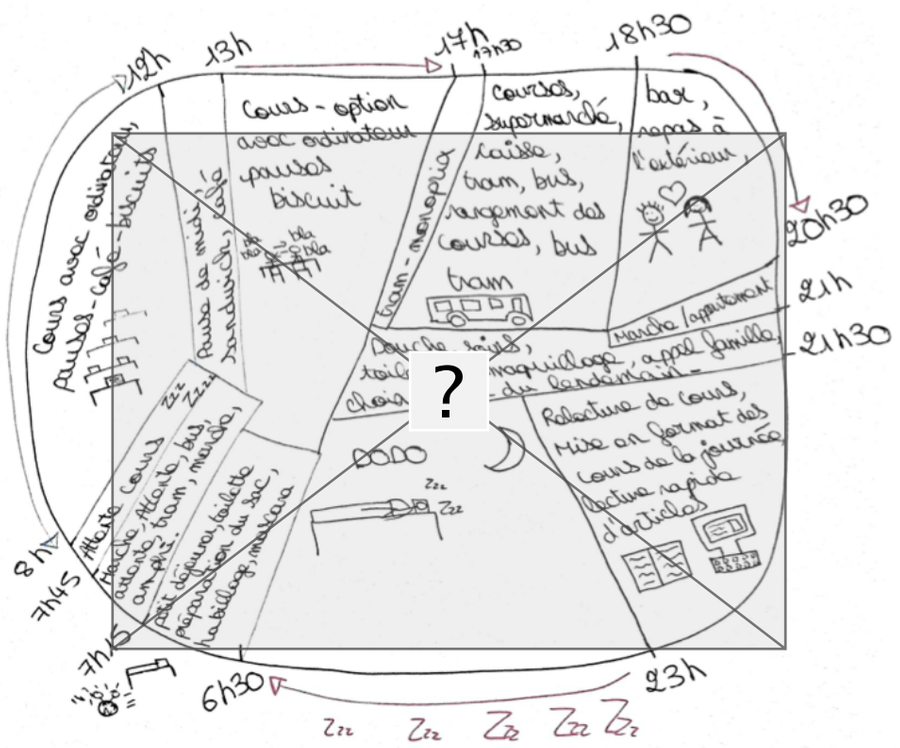
Of the 25 diagrams analyzed,

84% (21) were characterized by a **linear** flow of information.



Results

In this set, **76**% (16) adopted a **left to right horizontal orientation**, while **20**% (4) **alternated left to right and right to lef**t.
90% adopted a **top to bottom vertical orientation**



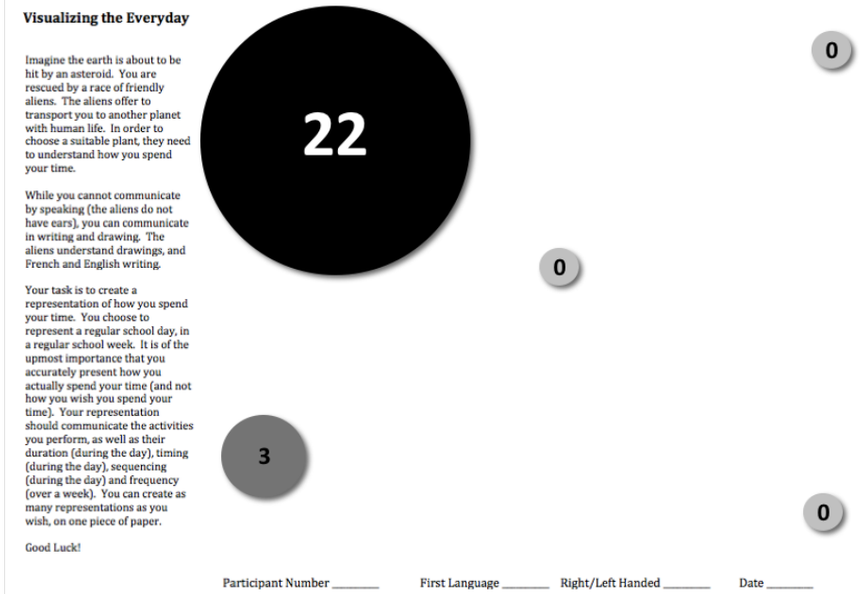
Results

diagram 1 is in the majority right->left, top->bottom

diagram 2 is the “snake” form, we found 4 of these, but they always used line or arrow to indicate the direction of flow was changing.

diagram 3 is a typical circular form

diagram 4 is the only CCW circular representation

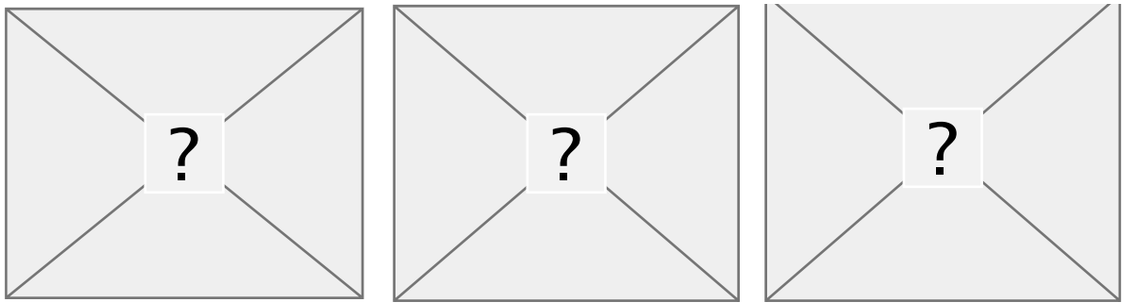


Results

Nearly all of the students (**88**%) depicted the start of their day in the upper left corner of the page.
Of the remaining three, two were circular representations and one was linear.

Use of Form

PATTERN	LINEAR																						CIRCULAR				
ID	14	4	28	7	16	10	11	26	27	18	24	21	20	1	6	8	5	17	12	13	23	29	2	22	9	TOTAL
NUMBER	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	23
TEXT	1	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	21
ARROW		1	1		1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	21
DRAWING			1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1		1	1	1	19
COLOR										1	1	1	1	1	1	1	1	1	1	1	1				1	13



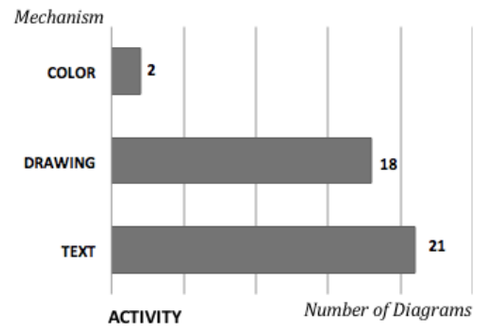
Results

The most frequently used form was **numbers** at, with the least frequent being **color** at **52**%.

Five diagrams made use of all five types of form evaluated.

Visual examination of the frequency distribution suggests a relationship between the use of number and text, and drawing and color, though the sample was too small to evaluate statistical correlation.

Primary Mechanisms



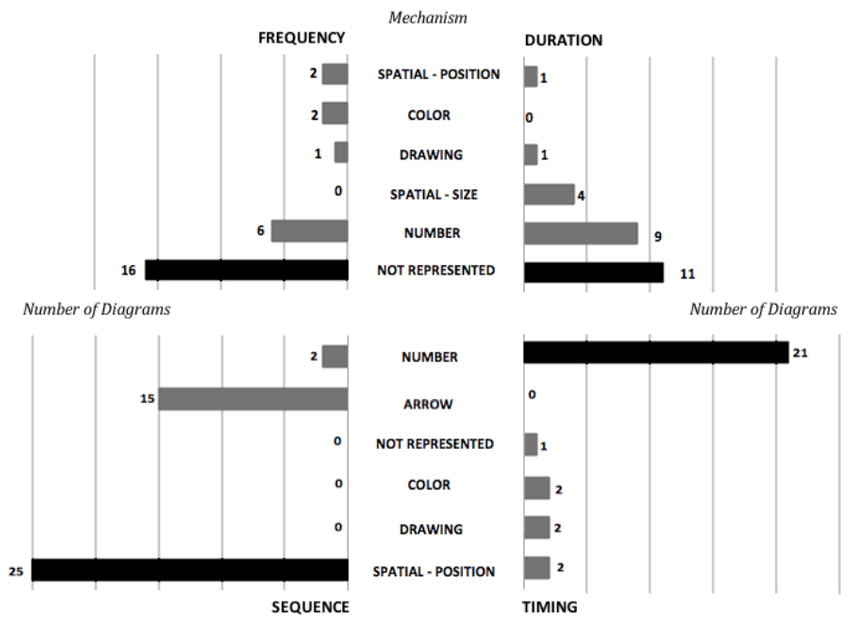
Results

Our first prediction was the use of realistic drawings and text to depict activities.

Comparison of frequency in the coded data supports this hypothesis, with **80**% of the sample using **text**, and **70**% using **drawings**.

Two novel representations **differentiated** activities through the use of **color**.

60% of the drawings used **both text and drawing**, and all three raters noted the use of text to mitigate poorly executed sketches.



Results

Only four individuals managed to represent all four components of time use.

Frequency was the most commonly neglected component, followed by duration, then timing.

When represented, **numbers** were consistently used to depict **frequency and duration**.

Our second hypothesis was that duration and frequency would be described using statistical graphs, independent of the more depictive activity data. Surprisingly, none of the results diagrams included statistical graphs.

Our last hypothesis was the use of spatial positioning on the horizontal dimension to represent timing and sequence.

100% of the drawings used spatial position to represent sequence, however only 2 diagrams used it to represent timing.

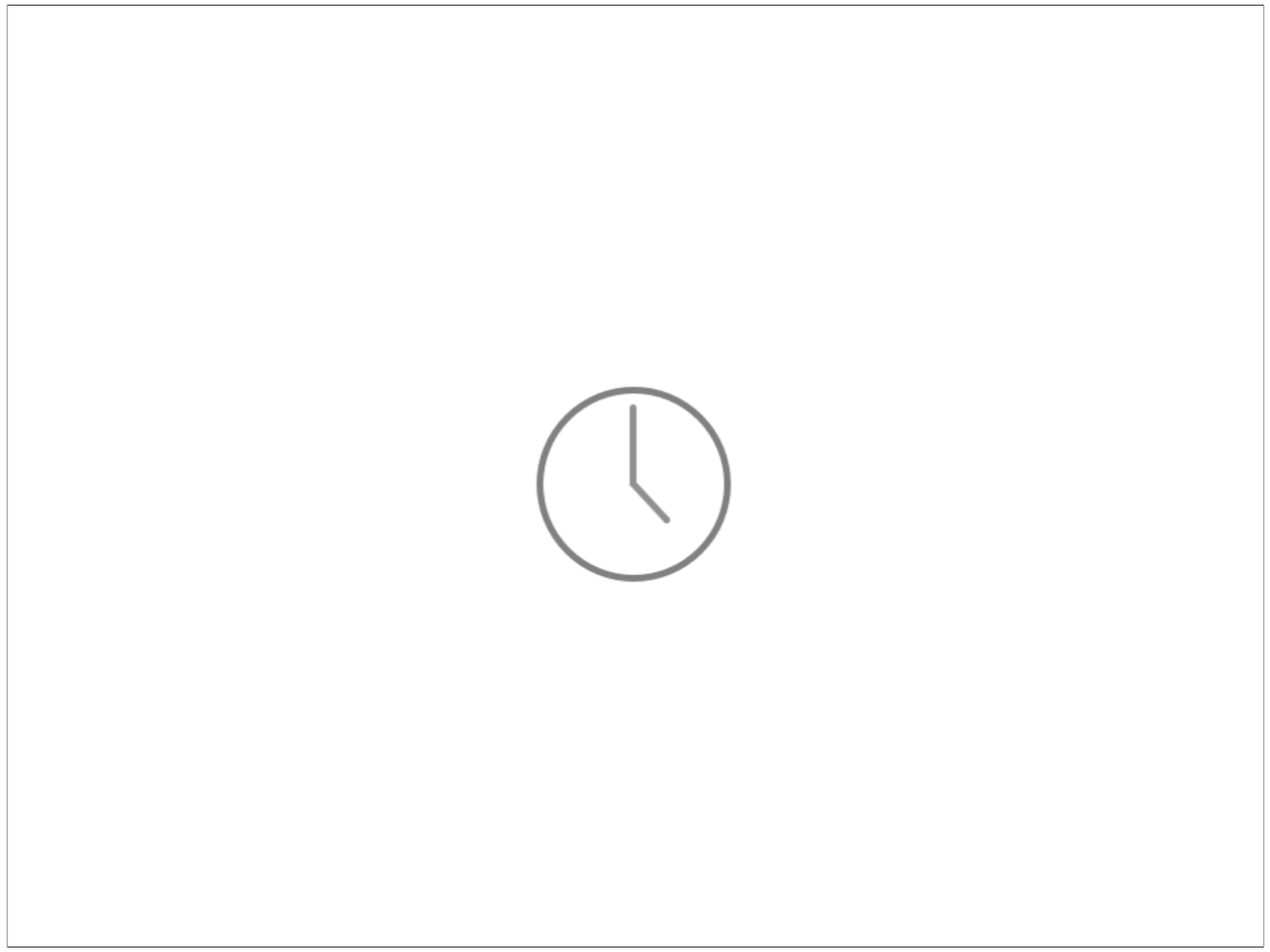
These two novel representations were both circular, positioning activities around the corresponding place in space on the face of a clock to indicate the time they occurred.

Conclusion

- Preference for linear over circular
- Directionality consistent with written language
- Variety of forms
- Difficult to represent all components in 1 diagram
- Spatial-position to represent sequence

- *Preference for single integrated diagram*
- *Many resembled agendas and calendars*

- quantitative content analysis w/ large random sample
- differentiate communicative purpose
- students of different majors
- correlation with attitude toward time
- correlation with planning methods



At a first glance, everyday life seems to be very ***simple*** and everybody has experiences from it, but when we try to investigate it from a scientific perspective, its **complexity is overwhelming.**

- Kajsa Ellegård

(Ellegård, 2004)

CONCLUSION

In conclusion this afternoon, I'd like to leave you with another quotation, this time from Kajsa Ellegard, a student of Thorsten Hagerstrand.

This semester I learned that time use is the study of how we use our time… but it's complexity is overwhelming. This complexity reflects a wealth of opportunity for investigation in both cognitive science and visualization.

UN. (2013). Guidelines for Harmonizing Time-Use Surveys (p. 129).

Eurostat. (2008). Harmonised European time use surveys: 2008 Guidelines. Statistics Office of the European Union.

Hägerstrand, T. (1989). Reflections On “What About People in Regional Science?” *Papers of the Regional Science Association*, *66*, 1–6.

Thrift, N. (1977). An introduction to time-geography. Geo Abstracts, University of East Anglia.

Ellegård, K., & Cooper, M. (2004). Complexity in daily life–a 3D-visualization showing activity patterns in their contexts. electronic International Journal of Time Use Research, 1(1), 37–59.

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), 1–25.

Lesnard, L. (2004). Schedules as sequences: a new method to analyze the use of time based on collective rhythm with an application to the work arrangements of French dual-earner couples. electronic International Journal of Time Use Research, 1(1), 60–84.

Michelson, W., & Crouse, D. (2004). Examining large-scale time-use files through graphic representation. electronic International Journal of Time Use Research, 1(1), 85–100.

Aigner, W., Miksch, S., Müller, W., Schumann, H., & Tominski, C. (2008). Visual methods for analyzing time-oriented data. IEEE transactions on visualization and computer graphics, 14(1), 47–60. doi:10.1109/TVCG.2007.70415

Tversky, B., Kugelmass, S., & Winter, A. (1991). Cross-cultural and developmental trends in graphic productions. Cognitive Psychology, 23, 515–557. doi:10.1016/0010-0285(91)90005-9

Tversky, B. (2011). Visualizing Thought. Topics in Cognitive Science, 3(3), 499–535. doi:10.1111/j.1756-8765.2010.01113.x

Marsh, E., & White, M. (2006). Content analysis: A flexible methodology. Library trends, 55(1), 22–45. doi:10.1353/lib.2006.0053

Hayes, A. F., & Krippendorff, K. (2007). Answering the Call for a Standard Reliability Measure for Coding Data. *Communication Methods and Measures*, *1*(1), 77–89. doi:10.1080/19312450709336664

?