

38th Meeting of the European Group of Process Tracing Studies

EGPROC 2019

June 12-14, 2019

EUROPEAN GROUP OF
EGPROC
PROCESS TRACING STUDIES



SCHEDULE

Wednesday, June 12, 2019

09:30 – 16:30	Pre-conference workshop (Marc Jekel)	WIL/C205/U
17:30 – 20:00	Welcome reception	la moka (Rothenburger Straße 27)

Thursday, June 13, 2019

09:00 – 09:30	Welcome address (Stefan Scherbaum)	WIL/C207/U
09:30 – 11:00	Talk session 1 (Raynard, Wulff, Mueller)	WIL/C207/U
11:00 – 11:30	Coffee break	WIL/C206/U
11:30 – 13:00	Talk session 2 (Swarthout, Ritschel, Fuławka, Liu)	WIL/C207/U
13:00 – 14:30	Lunch break	Alte Mensa
14:30 – 15:30	Keynote (Andreas Glöckner)	WIL/C207/U
15:30 – 16:00	Coffee break	WIL/C206/U
16:00 – 17:30	Talk session 3 (Król, Rahal, Lüken, Kjær Børsting)	WIL/C207/U
17:30 – 18:30	Poster session (Kourtidis, Kessler, Müller, Grenke, Schwenke) + Aperitif	WIL/C206/U
19:30 – 22:00	Social evening	Böhme (Sebnitzer Straße 11)

Friday, June 14, 2019

09:30 – 11:00	Talk session 4 (Gordon-Hecker, Schulte-Mecklenbeck, Kremer, Garcia-Guerrero)	WIL/C207/U
11:00 – 11:30	Coffee break	WIL/C206/U
11:30 – 13:00	Open science discussion	WIL/C207/U
13:00 – 14:30	Lunch break	Alte Mensa
14:30 – 16:00	Talk session 5 (Kieslich, Zgonnikov, Grage, Schoemann)	WIL/C207/U
16:00 – 17:00	Closing discussion + coffee	WIL/C206/U
19:00 – 01:00	Dresden Science Night (#LNdWDD)	TUD / Dresden



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Welcome to Dresden

Dear fellow researchers,

we are very happy to welcome you at Egproc 2019 in Dresden. As a process oriented research group, Egproc is one of our favorite meetings in the year. All the more, it is an honor for us, to host this meeting in our home town this year.

Dresden is a town with a turbulent history in recent times - turbulence about right wing movements and the associated lack of rational discourse and typical fake news debates. Despite the irritating aspects of these events, I think, this turbulent history can also be a very motivating background for our meeting. Our science also goes through turbulent times with the debate about the replication crisis - a debate that asks whether this crisis is caused by bad scientific practice and should be addressed with practices as proclaimed e.g. by the open science movement, or whether this crisis may indicate a general lack of theory in the fields of psychology and behavioral economics. We decided to address both points at our meeting. Addressing the potential lack of theory, we wanted to offer more background for theoretical work and formalization that could inform process-tracing studies. I am very happy that the modeling workshop on Wednesday and the key-note lecture by Andreas Glöckner offers ample opportunity to reason about how process tracing models could be implemented and provide us with process-oriented hypotheses for our process tracing studies. Addressing better scientific practice, our open science discussion session will allow us to discuss in a structured session process tracing-specific issues of the open science approach.

However, we will also stay with the tradition of Egproc, first in offering a meeting with a fascinating range of talks that are unified by the process tracing perspective, and second in an extensive social program that aims to offer ample opportunity to discuss and learn from each other, but also to show you the many pleasant sides of Dresden. We wish you a great time at Egproc 2019 in Dresden!

Organizing Committee



Martin Schoemann



Tobias Grage

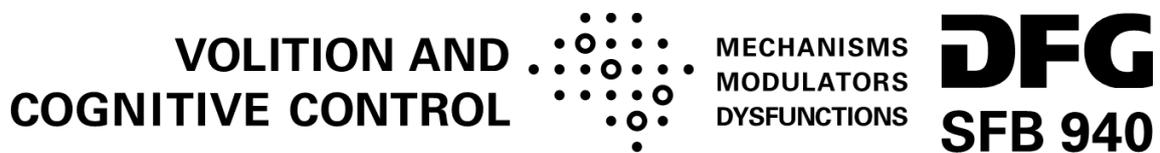


Stefan Scherbaum

Sponsors



This project is part of TU Dresden's Institutional Strategy, funded by the Excellence Initiative of the German Federal and State Governments.



Conference program

Thursday, June 13, 2019

09:00 – 09:30 Welcome address (Stefan Scherbaum)

09:30 – 11:00 Talk session 1

- Fifty years of research on intransitivity of preferences: A process perspective p. 26
Ranyard, Montgomery, Konstantinidis & Taylor
 - Strategic information search in decisions from experience p. 30
Wulff & Spektor
 - Forecasting economic decisions under risk: The predictive importance of choice-process data p. 25
Müller, Ring & Schmidt
-

11:30 – 13:00 Talk session 2

- Choices and scanpaths over risky prospects p. 18
Harrison & Swarthout
 - Preference Reversals: An Eye-tracking Study p. 13
Alós-Ferrer, Jaudas & Ritschel
 - Risky decision making with nonmonetary outcomes: The influence of affect on the choice process p. 14
Fulawka, Leuker & Pachur
 - A process-tracing test of dual-process and pragmatic accounts for processing verbal and numerical probabilities p. 23
Liu, Juanchich & Clarke
-

14:30 – 15:30 Keynote (Andreas Glöckner) p. 11

16:00 – 17:30 Talk session 3

- A novel machine-learning approach to measuring the quality of information extracted via pre-decisional eye movements p. 22
Król & Król
 - Justice is in the eyes of the beholder: Eye tracking evidence on balancing normative concerns in torts cases p. 13
Engel & Rahal
 - The role of alternative-non-attendance in consumer decision making: Evidence from an eye-tracking study p. 24
Lüken, Edenbrandt, Lagerkvist & Orquin
 - Turning the blind eye: The relationship between information avoidance and attention allocation p. 20
Kjær Børsting & Orquin
-

17:30 – 18:30 Poster session (and aperitif)

- The inherent dynamics of the random dot kinematogram: Measurement and model p. 16
Grenke, Scherbaum & Schoemann
 - Framing of Reward: Influence on action dynamics of intertemporal choice p. 18
Kefler, Scherbaum & Kruse
 - Suggesting alternative diagnoses early: Influences on physicians' initial confidence and information search p. 21
Kourtidis, Nurek, Delaney & Kostopoulou
 - Data or interpretations: The consequences of presenting different types of information in assistance systems for fault diagnosis p. 25
Gögel, Bönsel & Müller
 - Towards measuring non-verbal interaction: A new approach to dyadic discounting and its methodical specificities p. 29
Schwenke & Scherbaum
-

Friday, June 14, 2019

9:30 – 11:00 Talk session 4

- Limited supply leads to less equity and greater conflict in allocation decisions p. 17
Gordon-Hecker, Schneider, Shalvi & Bereby-Meyer
 - Higher or lower than 2495 meters? Anchoring effects and their boundary conditions evaluated with mouse-tracking p. 28
Schulte-Mecklenbeck, Wulff & Renkewitz
 - Making strategic decisions under time pressure: A process-based analysis approach to classifying behavior in normal-form games p. 22
Kremer
 - Tracking approach-avoidance decision conflicts p. 15
Garcia-Guerrero, O’Hora, Zgonnikov & Scherbaum
-

11:30 – 13:00 Open science discussion p. 12

14:30 – 16:00 Talk session 5

- Design Factors in Mouse-Tracking: What Makes a Difference? p. 19
Kieslich, Schoemann, Grage, Hepp & Scherbaum
 - Beyond the reach: The effect of motor costs on response dynamics and intertemporal choice p. 30
Zgonnikov, Atiya, O’Hora, Rano & Wong-Lin
 - Lost to translation: How design factors of the mouse-tracking procedure impact the inference from action to cognition p. 16
Grage, Schoemann, Kieslich & Scherbaum
 - Mouse-tracking revisited: Methodological implementations from the beginning p. 27
Schoemann, O’Hora, Dale & Scherbaum
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16:00 – 17:00 Closing discussion (and coffee)

Locations

- **Conference venue**

Technische Universität Dresden
[Willersbau](#)
Rooms [WIL/C205/U \(workshop\)](#),
[WIL/C207/U \(main conference\)](#) and
[WIL/C206/U \(coffee breaks\)](#)
Zellescher Weg 12/14
01069 Dresden

- **Lunch**

[Alte Mensa](#)
Mommsenstraße 13
01069 Dresden

- **Welcome reception**

[la moka](#)
Rothenburger Straße 38 (entry via Böhmisches Straße 27, or between Louisenstraße
46 and 48)
01099 Dresden

- **Social evening**

[Böhme](#)
Sebnitzer Straße 11
01099 Dresden

Social evening



Äußere Neustadt

Welcome reception



Indrichstadt

Magdeburger Straße

Marienbrücke

Innere Neustadt

Albertbrücke

Carolabrücke

Wilsdruffer Vorstadt

Innere Altstadt

Dresden

Pirnaische Vorstadt

Seevorstadt

Main station (Hauptbahnhof)



Essener Brücke

Wiener Platz

Parkstraße

Lennéstraße

Stübeliallee

Große Garten

Südvorstadt

Strehleener Straße

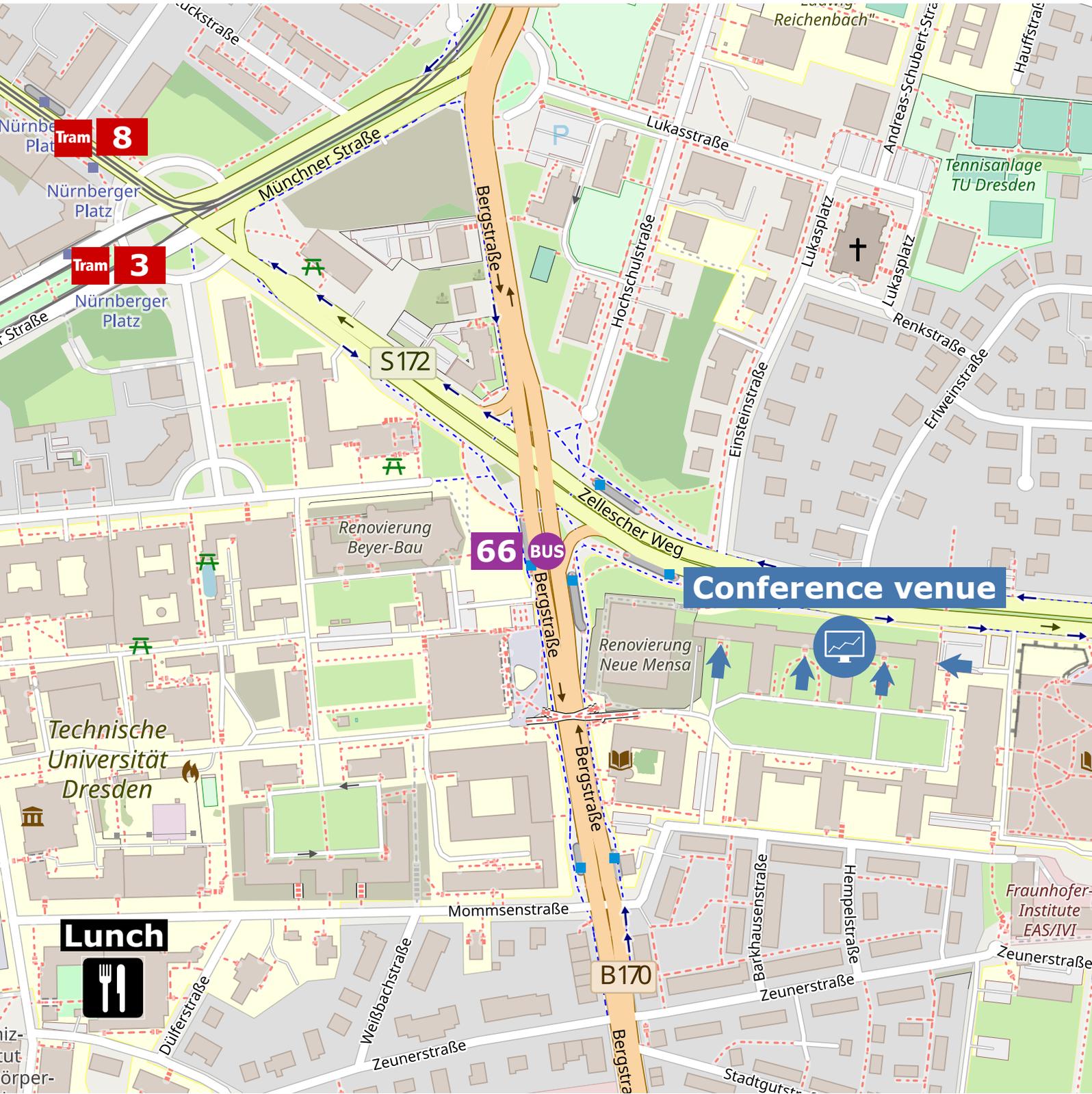
Lunch



Conference venue

S 172

B 170



List of participants

Last Name	First Names	Mail	Affiliation
Barker	Paul	✉	University of Cologne, Germany
Ehrlich	Stefan	✉	TU Dresden, Germany
Fuławka	Kamil	✉	SWPS University of Social Sciences and Humanities, Wrocław, Poland
Garcia-Guerrero	Santiago	✉	National University of Ireland, Galway, Ireland
Glöckner	Andreas	✉	University of Cologne, Germany
Gordon-Hecker	Tom	✉	Ben-Gurion University of the Negev, Be'er Sheva, Israel
Grage	Tobias	✉	TU Dresden, Germany
Grenke	Oliver	✉	TU Dresden, Germany
Hand	Avril	✉	National University of Ireland, Galway, Ireland
Jekel	Marc	✉	University of Cologne, Germany
Kessler	Franziska	✉	TU Dresden, Germany
Kieslich	Pascal J.	✉	University of Mannheim, Germany
Kjær Børsting	Caroline	✉	Aarhus University, Denmark
Kourtidis	Ploutarchos	✉	Imperial College London, UK
Kremer	Marco	✉	University of the Federal Armed Forces, Hamburg, Germany
Król	Michal	✉	The University of Manchester, UK
Liu	Dawn	✉	University of Essex, UK
Lüken	Malte V.	✉	Aarhus University, Denmark
Möschl	Marcus	✉	TU Dresden, Germany
Müller	Steffen Q.	✉	University of Hamburg, Germany
Müller	Martin	✉	University of Vienna, Austria
Müller	Romy	✉	TU Dresden, Germany
Rahal	Rima-Maria	✉	Tilburg University, The Netherlands
Raynard	Rob	✉	Leeds University Business School, UK
Renkewitz	Frank	✉	University of Erfurt, Germany
Ritschel	Alex	✉	University of Zurich, Switzerland
Scherbaum	Stefan	✉	TU Dresden, Germany
Schoemann	Martin	✉	TU Dresden, Germany
Schulte-Mecklenbeck	Michael	✉	University of Bern, Switzerland
Schwenke	Diana	✉	TU Dresden, Germany
Senftleben	Ulrike	✉	TU Dresden, Germany
Surrey	Caroline	✉	TU Dresden, Germany
Swarthout	J. Todd	✉	Georgia State University, USA & University of Cape Town, South Africa
Wulff	Dirk	✉	University of Basel, Switzerland & MPI for Human Development
Zgonnikov	Arkady	✉	Delft University of Technology, The Netherlands

Workshop

Computational cognitive modeling

Wed, 9:30

Marc Jekel
University of Cologne

In the workshop we will discuss why it is beneficial to work with computational process models (session 1), how we can plan optimal studies and compare competitor models based on multiple process and outcome measures (session 2), and how this can be accomplished using the statistical software R (session 3).



Session 1: I will reflect on criteria for evaluating models before data collection (Jekel, in press; Glöckner & Betsch, 2011). We will also discuss why process models are especially helpful for comparing competitor models: Whereas competitor models often predict similar outcomes for (e.g.) decisions between options in a probabilistic inference task, they may differ fundamentally in their assumptions about the process that leads to a decision. I will use the Parallel-constraint Satisfaction Model of Decision Making (Glöckner, Hilbig & Jekel, 2014) and iCodes (Jekel, Glöckner & Bröder, 2018) for illustration.

Session 2: I will introduce you to the Euclidian Diagnostic Task Selection (EDTS; Jekel, Fiedler & Glöckner, 2011). EDTS allows researchers to find tasks that optimally differentiate between competitor models by taking process measures into account. I will also introduce you to the Multiple-Measure Maximum Likelihood strategy classification method (MM-ML; Jekel, Nicklisch & Glöckner, 2010; Glöckner & Jekel, in press). MM-ML allows researchers to integrate outcome and process measures in a single measure of model fit. Extensions, recent developments, and open challenges in testing process models will be briefly discussed.

Session 3: We will apply EDTS and MM-ML in R using data from our lab.

Requirements: A basic understanding (i.e., MA psych level) of null-hypothesis significance testing is required. Knowledge of R is beneficial but not required; we will work with user-friendly packages and code snippets. Please bring your laptop with you. I will send instructions on the software that needs to be installed before the workshop.

Keynote

Testing cognitive models of choice using process data

Thu, 14:30

Andreas Glöckner
University of Cologne

The most important requirement for cognitive models of decision making is that they predict choice outcomes. From a psychological perspective, however, models should also be able to account for the underlying processes. Various classes of process models have been suggested. In early research, there has been a strong focus on (e.g., fast-and-frugal) heuristics, which mainly disappeared from the recent discourse. Subsequently, evidence accumulation and attention drift diffusion models have become popular (and still are). Most recently, interactive activation, leakage and lateral inhibition models have attracted increasing attention. I present results from various studies that (often jointly) use choices, response times, confidence, arousal, visual attention and (active) information search to test these models against each other.



Structured discussion session

Open science and theory in process tracing

Fri, 11:30

Process tracing is a field that poses many methodological and theoretical challenges: On the one hand, the complexity of process tracing methods leads to high degrees of freedom in designing experiments and analyzing data. Especially for the more recent methods, no standards restrict these degrees of freedom. On the other hand, theories and models often offer only predictions for outcomes of processes, but offer none or only underspecified predictions for the processes that lead to the outcomes. These two issues become pertinent when put into the context of the replication crisis. The replication crisis led to a strong methodologically oriented movement, which includes the open science movement. This movement assumes that increased transparency and methodological rigor address the central issues that have led to the replication crisis and will hence lead to better and more reproducible results. However, others have questioned whether methodological weaknesses are the sole reason for the replication crisis and questioned the theoretical work in the behavioral sciences, instead: Do our theories make good and precise enough predictions? Some even ask: Can falsifiable theories even exist in the behavioral sciences?

In our structured discussion session, we aim to bring together the expertise that is present at EGPROC to shed light on these issues. We will focus on clusters of questions that we extracted from pre-conference comments from several scholars.

- What barriers do process tracing researchers run into when applying open science techniques? For example: Do the degrees of freedom and the lack of standards pose a threat to any preregistered study? How do colleagues deal with such barriers? How can the community support fellow process tracers in implementing open science techniques?
- How do you judge the reproducibility and replicability of process tracing studies in your field? What is your judgment of the publication bias in your area of process tracing?
- How do you judge the state of theorizing in your field? Which theories and models make predictions that are applicable to process tracing studies? How much do you see process tracing as an inductive/positivist or a deductive/rationalist approach?

In the final part, we will discuss the consequences that we can draw as a community from the issues raised in the discussion of the three clusters of questions.

Abstracts

Preference Reversals: An Eye-tracking Study

Carlos Alós-Ferrer, Alexander Jaudas & Alexander Ritschel*

*: University of Zurich, Switzerland

Thu, 11:30
Session 2

The economic approach to decision making is based on uncovering individual preferences, as revealed by observable choices. This is fundamental for applied economics, for it allows positive analysis (predicting future choices) and is a prerequisite for welfare evaluations. One key applied strategy to evaluate the desirability of a given policy is eliciting the willingness to pay. This method faces a fundamental problem: a vast amount of experimental evidence shows that such elicitation often yield values which directly contradict actual choices. In the domain of lottery choice (decisions under risk), this is known as the preference reversal phenomenon, which is one of the most robust, stable, and worrying anomalies in individual economic behavior.

The Compatibility Hypothesis is a promising explanation of preference reversals which argues that the elicitation method creates a disproportional weighting of attributes of the gambles that are closest to the attribute focused on in the elicitation method. We examined this hypothesis with the help of process data. We conducted an eye-tracking experiment analyzing visual fixations while varying the elicitation method. This allows us to investigate possible shifts in attention induced by the elicitation method as a determinant of preference reversals. A first treatment was a standard price-then-choice setting, which activates a monetary frame when evaluating the gambles and leads to the usual preference reversals. A second treatment replaced the pricing phase with a ranking phase where subjects provided ordinal rankings among groups of lotteries. This does not activate the monetary frame and has previously been used to greatly reduce reversals. We examine how the different elicitation methods result in different attentional shifts and how those influence preference reversals, thereby clarifying the attentional determinants of reversals between economic evaluations and preferences revealed by direct choices.

Justice is in the eyes of the beholder: Eye tracking evidence on balancing normative concerns in torts cases

Christoph Engel & Rima-Maria Rahal*

*: Tilburg University, The Netherlands

Thu, 16:00
Session 3

He who violates a legal rule and thereby inflicts harm on another person has to pay. But must the victim be made whole, even if this ruins the perpetrator? Can the court double or triple up the payment if otherwise perpetrators gamble? Should the court use money as a substitute for irreparable harm, say to a person's honor? In such cases, legitimate normative concerns and legal principles collide. We assessed how legal laypeople (N = 103) assessed damages sentences in 16 course case vignettes, where either no normative conflict occurs, compensation is prohibitively costly, the cost of compensation is trivial, or

harm is nonpecuniary. For each case, weights assigned to 9 potentially competing normative concerns are displayed. From the legal perspective, these concerns have incompatible normative foundations, and a decision in normative conflict cases must privilege some normative concerns at the expense of others. Therefore, the decision requires “balancing” (Aleinikoff, 1987), which legal practitioners must carefully undertake. We show that participants take longer to decide in normative conflict cases and disagree with the court’s sentence more often. Using eye-tracking, we show that some conflicts induce a characteristic gaze pattern that resonates with the legal debate. This in particular holds for cases where the damage is so large that making the victim whole would ruin the perpetrator. In such cases, participants focus more often on compensation than in balanced cases, and they focus more on compensation than on alternative normative concerns, like deterrence. The eye tracking data demonstrates that participants carefully weigh the underlying normative concerns before making a judgment, despite the fact that they have neither decision making authority nor professional training. They consider multiple normative concerns, and distribute their attention differently from case to case. This suggests that they try to do the individual conflict justice. Finally, the pattern of fixations in the task at hand predicts whether they will agree with the court. Despite the fact that solutions to these normative conflicts are built on incompatible normative foundations, via balancing them, even laypersons come to a meaningful assessment.

Risky decision making with nonmonetary outcomes: The influence of affect on the choice process

Kamil Fulawka*, Christina Leuker & Thorsten Pachur

*: SWPS University of Social Sciences and Humanities, Wrocław, Poland

Thu, 11:30
Session 2

Empirical results indicate that when people face risky options with nonmonetary outcomes (e.g., side effect of a drug) attention to the probabilities is attenuated, and people focus mostly on avoiding (approaching) the worst (best) possible outcome in the loss (gain) domain. Within the framework of cumulative prospect theory (CPT), this regularity can be captured by assuming a probability weighting function with a very pronounced curvature, which indicates a lower sensitivity to probability differences and a higher pessimism (optimism) in the loss (gain) domain. Reanalyses of existing data on risky decision making with nonmonetary outcomes suggest that affect is an important driver of the extent to which choices are (in)sensitive to probabilities: as the affective value of a nonmonetary outcome increases, the amount of attention given to the outcome’s probability decreases. Additionally, the results suggest that in the nonmonetary domain, as comparing to the monetary domain, people may spend more time comparing outcomes between options.

One important limitation of previous studies is that the nonmonetary outcomes have usually been relatively affect-rich, as compared to the condition with monetary outcomes. As a consequence, it is unclear what role affect plays in choices between risky options with nonmonetary outcomes. Here, our first goal is to fill this gap by comparing affect-poor and affect rich conditions within nonmonetary domain. We expect to replicate the previously observed affect gap: in the affect-rich condition, people will exhibit lower sensitivity to probability differences and a higher level of pessimism than in the affect-poor condition. Second, using eye tracking data, we aim to investigate the cognitive process that

takes place during choices between risky options with nonmonetary outcomes. Based on the above mentioned reanalyses, we expect that in the affect-rich condition (as compared to the affect-poor condition), people will (1) spend more time on comparing outcomes between options; (2) attend to probabilities less.

The study will consist of two main parts. First, participants will be presented with 30 side effects of medical drugs, which they then rate them on an affective scale, one at a time. The ten side effects with the highest ratings and the ten side effects with the lowest ratings will be then mapped onto previously prepared set of choice problems using rank values. Thus, the choice problems in both conditions will have the same structure. Second, participants will make 60 binary, hypothetical decisions within each condition. In each trial, participants have to indicate which of the two medications she would prefer to take, given that each can lead to a specific side effect with some probability. As of the time of writing this abstract, the study is in its final phase of programming. We plan to present the (initial) results during the conference.

Tracking approach-avoidance decision conflicts

Santiago Garcia-Guerrero*, Denis O’Hora, Arkady Zgonnikov & Stefan Scherbaum

*: National University of Ireland, Galway, Ireland

Fri, 9:30
Session 4

In recent years, there has been a rising interest in adopting experimental paradigms that include approach-avoidance conflicts (AACs). AACs are situations consisting of both positive and negative consequences, and thus generate simultaneous motivations to approach and avoid. Such conflicts seem important in understanding how individuals evaluate the complex range of benefits/risks associated with real-world decisions. Such complexity underlies individuals decisions to expose themselves to avoidable aversive consequences to access competing rewards (e.g., addictions to psychotropics), or to expose themselves to avoidable aversive consequences in the absence of rewards, but to postpone more aversive consequences (e.g., enduring a visit to the dentist to avoid toothache later).

Mouse-tracking has been used to investigate a broad range of psychological processes, but it has rarely been used to investigate AACs. In the current study, participants made decisions in a neutral context and a threat context. In the neutral context, participants chose to take or lose a set number of points. In the threat context, choosing to take the points required participants to risk a mild electric shock. Approach-avoidance decision conflict was manipulated by varying the number of points available in each decision.

The results from two experiments showed that the level of AAC affected response trajectories. Overall, approach trajectories were less complex than avoidance. In comparison to low AAC decisions, high AAC decisions reliably manifested more slower and more deflected response trajectories. Consistency in the location of approach and avoidance response options reduced variability in performance enabling more sensitive estimates of dynamic conflict.

The time course of competing influences on response trajectories including trial-to-trial effects and conflict between approach and avoidance was estimated using regression analyses. We discuss these findings in terms of a dynamic theory of approach-avoidance

that we hope will lead to insights of practical relevance in the field of maladaptive avoidance.

Lost to translation: How design factors of the mouse-tracking procedure impact the inference from action to cognition

Tobias Grage*, Martin Schoemann, Pascal J. Kieslich & Stefan Scherbaum

*: Technische Universität Dresden, Germany

Fri, 14:30
Session 5

From an embodiment stance, action and cognition influence each other constantly. This interaction has been utilized in mouse-tracking studies to infer cognitive states from movements, assuming a continuous leakage of cognitive processing into movement. However, it is mostly unknown how this leakage is affected by the variety of possible design choices in mouse tracking paradigms. Here, we study how three design factors impact the leakage of cognition into movement in a Simon task with mouse-tracking. We varied the response selection (i.e., with or without clicking), speed of the mouse cursor, and location of response boxes. Results show that all design factors can blur or even prevent the leakage as reflected by a reduction in movement consistency and action dynamics as well as by the adoption of unsuitable movement strategies. We conclude that deliberate and careful design choices in mouse-tracking experiments are crucial for the continuous leakage from cognition into movements to succeed. We discuss the importance of developing a standard practice in the design of mouse-tracking experiments.

The inherent dynamics of the random dot kinematogram: Measurement and model

Oliver Grenke*, Stefan Scherbaum & Martin Schoemann

*: Technische Universität Dresden, Germany

Thu, 17:30
Poster

The random dot kinematogram (RDK) is a well-known and probed paradigm in research of motion perception and decision making. After over 30 years of application and development, there are still new ways of exploiting its properties.

We investigated the task in the context of dynamic processing, specifically evidence accumulation. The RDK seems to be predestined for process tracing, due to its inherent fluctuation of motion energy - that is the overall motion from signal and, crucially, noise dots, as well as background patterns in a certain direction - over time. It has already been shown, that monkeys are sensitive to perturbation of motion energy at a time scale of as short as 100 ms (Huk & Shadlen, 2005, *J. Neurosci.*). To investigate whether inherent fluctuation have any influence on the decision making process in humans, we use mouse cursor tracking as a behavioral, time-sensitive measure. In a piloting study (N = 5) we explore the connection between the random fluctuation of motion energy and following changes in cursor trajectories via cross correlation. In a second stage, we plan to compare two cognitive models, both based on the drift diffusion model (Ratcliff et al., 1978, *Psychol. Rev.*): one of distinct (Resulaj et al., 2009, *Nature*) against one of dynamic decision making. Using the

before mentioned motion energy as evidence, our aim is to compare model dynamics with the mouse-tracking data obtained earlier. We hope to show, that the RDK in combination with mouse cursor tracking is an easy to apply measurement for the time course of decision making, which could complement test batteries in clinical and economical settings.

Limited supply leads to less equity and greater conflict in allocation decisions

Tom Gordon-Hecker*, Iris Schneider, Shaul Shalvi & Yoella Bereby-Meyer

*: Ben-Gurion University of the Negev, Be'er Sheva, Israel

Fri, 9:30
Session 4

Are equity concerns a privilege? In general, people care about equity and dislike situations in which some people unjustifiably get more than others. However, in order to maintain equity one must sometimes be inefficient and throw resources away rather than allocating them unequally. In this paper we examine the extent to which the preference for equitable yet inefficient distributions is stable when allocating ample versus limited resources. Additionally, we use mouse-tracking techniques to study the conflict people experience when allocating resources, and examine whether its' magnitude is related to the availability of the resources being distributed. Our findings suggest that when resources are limited, people display a greater curve when moving their mouse cursor towards the chosen alternative, suggesting a higher level of conflict. In such allocations, people are less likely to discard resources, and tend to opt for efficiency, even if it means deviating from equity. When resources are ample, however, people are more willing to waste some of the resources in order to maintain equity, and they display weaker conflict when doing so.

Participants were asked to decide how to allocate points among other participants. Allocators had to choose between an allocation that preserved equity but was less efficient (i.e., allocated less resources overall) and an allocation that maximized the amount of resources being allocated but allocated more points to one of the recipients. Results revealed that participants were more likely to opt for equity at the expense of efficiency when resource were limited compared to when they were abundant. That is, when participants had to choose between allocating four points to both recipients or allocating five points to one recipient and four to the other they were more likely to be inefficient and prefer the equitable allocation compared to a trial in which they had to choose between allocating zero points to both recipients or allocating one point to one recipient and zero to the other.

Experiments 2 & 3 replicated the results of Experiment 1. Furthermore, we used a mouse tracking technique to measure participants' experienced conflict when choosing a preferred allocation. The mouse tracking results complemented the behavioral results, showing that participants experience the greatest conflict when allocating limited resources. When resources are abundant, people discard them rather easily to maintain equity. However, when resources are limited their value increases, causing equity to be more costly, which leads to a greater conflict when deliberating on whether to violate equity or not.

Taken together, our findings suggest that equity considerations are a privilege of abundance. When the resources being allocated are limited, people find it harder to waste them, and experience a conflict between their desire to be fair and their reluctance to waste a valuable resource. However, when the resource being allocated is just one out of a large pool

of the same resources, it eases the allocator's need to be efficient and allows him to favor other principles, such as equity.

Choices and scanpaths over risky prospects

Glenn W. Harrison & J. Todd Swarthout*

*: Georgia State University, USA & University of Cape Town, South Africa

Thu, 11:30
Session 2

We present the results of an eye-tracking experiment involving choices over risky prospects. We analyze the ability of eye movement data to help understand the determinants of decision making over risky prospects. We start with structural models of choice under risk and use that structure to inform what we identify from the inclusion of process data. We find that eye movement process data do significantly affect the extent and nature of probability weighting behavior. Our structural model allows us to show the pathway of the effect, rather than simply identifying a reduced form effect. Further, by varying the visual display of lotteries, we can examine how differences in visual presentation format interact with both process and choice data. We also observe that decision response duration is no substitute for the richer information provided by eye-tracking. Our goals in analyzing the process data from this experiment include: 1. informing our knowledge of “behaviorally plausible” decision-making algorithms that may be used by decision makers facing risky prospects; 2. suggesting descriptive explanations as to why some individuals tend to weight probabilities in the Rank Dependent Utility (RDU) sense; and 3. identifying the subset of visual information that is not attended, in absolute or relative terms, in order to provide insights for the normative evaluation of choices under risk.

Framing of Reward: Influence on action dynamics of intertemporal choice

Franziska Keßler*, Stefan Scherbaum & Johanna Kruse

*: Technische Universität Dresden, Germany

Thu, 17:30
Poster

Intertemporal choices are abundant in everyday life as people frequently have to choose between options that differ not only in terms of their value but also in their time of delivery. Often individuals show a tendency to prefer smaller rewards delivered sooner over larger rewards delivered later (temporal discounting). A variety of models have been proposed describing this decision behavior in mathematical terms, but these models lack information on how decisions evolve over time as they solely concentrate on analyzing choice outcomes. Going beyond the search of the best fitting model recent studies used mouse tracking as a continuous measure of the decision process. The trajectories of mouse movements, by which participants indicated their decisions in intertemporal choice tasks, were continuously recorded. Analyzing these decision action dynamics with a multiple regression approach provided insights into the underlying mechanisms of the decision process itself. This study aims at broadening this body of knowledge by investigating the effect of framing the reward as either an image of bank notes or as a number on the action dynamics in an

intertemporal choice task. Participants ($N = 23$) had to choose between a sooner/smaller and a later/larger reward indicating their decision by moving the mouse cursor from the bottom of the screen to either top right or top left. We found less direct mouse trajectories when participants decided for the sooner/smaller option which can be attributed to the fact that these choices represent a deviation of the default choice, hence requiring more reflection. Framing the reward as an image decreased the amount of temporal discounting. However, this effect did not reach significance and needs to be further substantiated in a larger sample. The analysis of the action dynamics suggests that the delay of the reward had a weaker impact on the decision process in the image condition compared to the number condition which supports the notion of less temporal discounting. This finding may be ascribed to a more low-level construal of time induced by the presentation of the reward as an image. However, we also found a stronger influence of the value information in the number condition which might be due to the experimental set-up. In conclusion, this study emphasizes that mouse tracking as a continuous measure can further advance the understanding of intertemporal choices by supplying additional information on temporal patterns of influences on the decision process, thus extending the scope of interpretations of underlying mechanisms.

Design Factors in Mouse-Tracking: What Makes a Difference?

Pascal J. Kieslich*, Martin Schoemann, Tobias Grage, Johanna Hepp & Stefan Scherbaum

*: University of Mannheim, Germany

Fri, 14:30
Session 5

The investigation of cognitive processes by tracking and analyzing mouse movements has become a popular method in many psychological disciplines, including language, social cognition, perception, decision-making, and memory. When creating mouse-tracking experiments, researchers face a number of design choices, for example, whether participants indicate responses by clicking on the corresponding button or by just entering the button area. Hitherto, many different settings have been employed, but little is known about how these methodological differences affect mouse-tracking data and their theoretical interpretation.

We conducted a series of experiments to systematically investigate the influence of three central design factors, using a classic mouse-tracking paradigm, in which participants classify typical and atypical exemplars into one of two categories. In separate experiments, we manipulated the design factors response indication, mouse sensitivity, and starting procedure. The core finding that mouse movements deviate more towards the non-chosen option for atypical exemplars was replicated in all conditions. However, the size of this effect varied. Specifically, it was larger when participants indicated responses via click and when instructed to initialize movement early. Trajectory shapes also differed between setups. For example, a dynamic start led to mostly curved trajectories, responses via click to a mix of straight and “change of mind” trajectories, and responses via touch to mostly straight trajectories. Moreover, the distribution of curvature indices was classified as bimodal in some setups and as unimodal in others.

Because trajectory curvature and shape are frequently used to make inferences about psychological theories, such as differentiating between dynamic and dual-system models, this study shows that the specific design must be carefully considered when drawing theoretical inferences from mouse-tracking data. All methodological designs and analyses were implemented using open-source software and are available from <https://osf.io/xdp7a>.

In addition to the completed studies, I will present results from a number of ongoing experiments that investigate additional design factors and their implications for designing and analyzing mouse-tracking studies.

Turning the blind eye: The relationship between information avoidance and attention allocation

Caroline Kjær Børsting* & Jacob Lund Orquin

*: Aarhus University, Denmark

Thu, 16:00
Session 3

Most people are familiar with seeing homeless people in the streets; we are often reluctant in talking and giving money to them, but still instantly experience the bad conscience when walking by them. Consequently, we end up staring intensely in the ground to spare ourselves from the cognitive dissonance that accompanies these conflicting emotions.

We know the phenomenon as information avoidance, which entails any behaviour intended to prevent acquisition of available and relevant information.

To date, most research on information avoidance has focused on why and when this avoidance strategy is employed; for instance, it is suggested that the objects are avoided to help managing conflicting emotions, as well as avoiding decisions altogether and protecting one's intuitive preferences. Also, individuals avoid paying attention to this information despite using it if readily available, which proves the information to be relevant for their decision making.

Various cheating paradigms using eye-tracking have found that individuals shift attention away from undesirable information when dishonesty pays off. Using a similar paradigm, we investigate by means of eye tracking whether there is more to the portrayal of top-down modulated attention as being either allocation of attention to relevant objects or a non-allocation to irrelevant objects. Concretely, we hypothesise that participants display different gaze behaviour when avoiding relevant stimuli versus ignoring irrelevant stimuli, which is tested through two within-subject conditions: task-relevant and task-irrelevant objects.

A visual search task is created in which participants are instructed to find a target object hidden on the screen. In half of the trials, a second target will appear as well, which should either be ignored or avoided dependent on experimental condition. By employing linear mixed models, it will be assessed whether task relevancy is a significant predictor of gaze behaviour.

Suggesting alternative diagnoses early: Influences on physicians' initial confidence and information search

Thu, 17:30
Poster

Ploutarchos Kourtidis*, Martine Nurek, Brendan Delaney & Olga Kostopoulou
*: Imperial College London, United Kingdom

Previous research has highlighted the importance of physicians' early diagnostic hypotheses for the accuracy of their final diagnoses. It has also been shown that physicians' diagnostic accuracy improves when they are presented with a list of suggested diagnoses to consider *at the start* of the patient encounter. This doctoral programme of research aims to investigate the psychological mechanisms underlying this phenomenon, which would be of particular importance for the design of diagnostic decision aids.

The first hypothesised mechanism that we tested focused on initial confidence. We hypothesised that by presenting physicians with a list of diagnostic suggestions early on, their confidence in their initial diagnosis would be reduced; this would make them more likely to change diagnosis when encountering new information.

We recruited 194 GPs to participate in an online study. In a within-participant design, GPs saw two patient cases, one with and the other without diagnostic suggestions, assigned at random. The cases were constructed in such a way that certain initial diagnoses were expected. After a short patient description, GPs provided an initial diagnosis and their confidence. After this, and in the aided case only, GPs read a list of diagnostic suggestions. They were then shown additional patient information, which was designed to introduce the possibility of other diagnoses. GPs updated their confidence in their initial diagnosis and provided a final diagnosis. We expected that when GPs received diagnostic suggestions, they would reduce their initial confidence more and would change their initial diagnosis more frequently.

We found that initial confidence was negatively associated with diagnostic changes, and that the reduction in initial confidence was positively associated with diagnostic changes. However, there were no significant differences in either the number of diagnostic changes or confidence reductions between aided and unaided cases. Thus, the study failed to demonstrate an effect of diagnostic suggestions. It is possible that the specific cases did not allow such an effect to manifest.

In a study currently planned, we aim to investigate the role of information search as a mediator between early diagnostic suggestions and subsequent diagnostic changes. We hypothesise that seeing a list of diagnostic suggestions encourages GPs to seek information that tests different hypotheses and consider information from different angles and not merely as supportive of their initial diagnosis. GPs will see two patient cases online. After a short patient description, GPs will select one of two possible diagnoses and indicate their confidence. Then, half of the GPs will read a list of diagnostic suggestions. GPs will then be given the names of ten clinical cues that they can request, half relating to one diagnosis and the other half to the other diagnosis. GPs will be allowed to select up to five cues. After all the information requested is revealed, they will update their diagnosis and confidence. We expect that when GPs receive diagnostic suggestions, they will request more cues about the diagnosis that they did not initially select and will change diagnosis more frequently.

Making strategic decisions under time pressure: A process-based analysis approach to classifying behavior in normal-form games

Marco Kremer

Helmut-Schmidt-University/ University of the Federal Armed Forces, Hamburg,
Germany

Fri, 9:30
Session 4

Though many strategic economic decisions face a severe time constraint, time pressure raised little attention in the emerging research field of behavioral game theory yet. Works from Sutter et al. (2003), Kocher et al. (2006) and Lindner et al. (2013) count as pioneer studies, despite numerous psychological investigations, which are all lacking the strategic component. The first two addressed studies laid focus on the influence of time pressure on the quality of decision making, based on Equilibrium behavior in the case of an Ultimatum Game and a Beauty Contest Game. The study from Lindner et al. (2013) might be the first investigating personal sophistication in terms of cognitive hierarchy and thus switching the general point of view to an individual. In order to experimentally determine the distribution of the level-k-reasoning -types, they use Arad & Rubinstein's (2012) 11-20-Game. To their own surprise and contrary to the findings of Sutter et al. (2003) and Kocher et al. (2006) they find a shift to Equilibrium play under growing time pressure, which they explain by chance.

Applying a more process orientated approach, similar to Costa-Gomes et al. (2001), proved to give better insights into the decision-making behavior of people. We, therefore, developed a process theoretical framework, including adjusted mouse tracking, which we based on the findings of Costa-Gomes et al. (2001) on decision types. We then conducted an ample online experiment in order to investigate the influence of time limitation and task complexity on the individual decision-making process in normal-form games.

The empirical dataset was analyzed for fifteen behavior properties. The results of data clustering point to the existence of different types of decision-makers pursuing individual strategies to deal with time pressure. Those findings specify the qualitative response schema of individuals acting under time pressure, first reported by Miller (1960), for the case of normal-form game tasks. Their characteristics, as well as the key facts for the elaboration of the process tracing techniques, will be presented.

A novel machine-learning approach to measuring the quality of information extracted via pre-decisional eye movements

Michal Król & Magdalena Ewa Król

*: The University of Manchester, United Kingdom

Thu, 16:00
Session 3

We propose a new way of using eye-tracking and machine-learning to quantify the quality of information extracted from visual stimuli by human subjects while making decisions. We demonstrate it by comparing the way in which two groups of people – autistic vs. typically developing subjects – make judgments about others' emotions based on facial images.

In the first step of the analysis, we test if the two groups' scanpaths are significantly different. We begin by addressing the problem that, in a large set of stimuli (essential for

external validity), locations of key facial regions vary, even across different images of the same person. Thus, to avoid laborious and error-prone manual AOI encoding, we use a recently developed machine-learning algorithm (Bulat & Tzimiropoulos, 2017) which identifies key facial landmarks, allowing us to use numerical optimization to map fixations onto an average ‘mannequin’ face, in a way that preserves their position relative to the landmarks. Fixations are then assigned to AOIs (landmarks) based on proximity, and the resulting scanpaths are compared pairwise using ScanMatch (Cristino, Mathôt, Theeuwes & Gilchrist, 2010). Next, we use the t-SNE algorithm (Maaten & Hinton, 2008) to project scanpaths onto a low-dimensional space in such a way that the resulting Euclidean distances between them reflect the pairwise ScanMatch similarities. Finally, using linear mixed regression modelling, we show that the low-dimensional scanpath representations, accounting for both their spatial and temporal aspects, are indeed significantly different across the two groups of subjects. We argue that this novel way of using *pairwise* scanpath comparison tools to statistically test differences between *groups* of scanpaths is applicable to other problems in which judgments are made based on visual stimuli.

In the second step, for each set of fixations registered during a decision trial points, larger points represent longer fixations), we compute the smooth kernel density estimate of fixation distribution (see e.g., Frank, Vul & Johnson, 2009), and convolve it with a Gaussian blur of the image. This convolution, revealing more high-frequency information in densely-fixated areas, is provided as input to a state-of-the-art deep neural network emotion-recognition algorithm (Mollahosseini, Chan & Mahoor, 2016), trained on hundreds of thousands of images from across all major publicly available databases. The algorithm’s emotion classification error constitutes our measure of the quality of visual information extracted by the subject. In particular, a mixed-model analysis revealed that the differences between subjects’ scanpaths established in the first step of the analysis translate into differences in information quality, which is greater for typically developing than for autistic subjects. In contrast, no such differences were found in a control task in which subjects viewed the images without having to judge emotions. We argue that, using artificial intelligence algorithms appropriate for the given choice domain, our approach can readily extend to other decision-making problems.

A process-tracing test of dual-process and pragmatic accounts for processing verbal and numerical probabilities

Dawn Liu*, Marie Juanchich & Alasdair Clarke

*: University of Essex, United Kingdom

Thu, 11:30
Session 2

A weather forecast can be delivered using either a numerical probability (e.g., ‘a 70% chance of rain’) or a verbal one (e.g., ‘it is likely to rain’). Assuming people understand the scale by which the probabilities are interpreted, using a verbal or numerical format to express the forecast should have a similar impact on judgement and decision-making. However, past work has indicated that people are more influenced by the nature of the decision outcome when they process verbal than numerical quantifiers. Two different theoretical accounts could explain this difference. A dual-process account posits that verbal quantifiers encourage people to be more intuitive in their decision-making, thus making them more prone to relying on the positive or negative affect generated by the contextual

information to make a quick judgement. Relying on context rather than probabilities is therefore a bias. Conversely, a pragmatic account posits that the same influence of the contextual information on one's decision is part of a rational decision, as people use the speaker's choice of a verbal quantifier as a pragmatic signal to infer the amount of attention they should pay to the context. Both theoretical accounts predict that people will judge the same positive event (e.g., the likelihood of sunshine) more positively with a verbal than an equivalent numerical probability, and vice versa for a negative event (e.g., the likelihood of rain). However, they differ in their predictions about the cognitive processes behind these judgements. Specifically, the dual-process account predicts that the judgement occurs because people are paying less attention to the information, whereas the pragmatic account predicts that the judgement occurs because people are paying more attention to one aspect of the information: the event. Our research builds on previous work that tested these competing hypotheses while overcoming two methodological shortcomings. First, we account for inter-individual variation in interpreting verbal probabilities by having participants translate the verbal probabilities into numerical ones. Second, we use events presented as images, to rule out effects of format matching between events and probabilities. Using eye-tracking, we trace participants' attention to events and probabilities in weather forecasting. In a 2 (format: verbal or numerical) \times 2 (event valence: positive [sunny] or negative [overcast]) \times 2 (probability: slight chance or likely) within-subjects design, we track participants' eye movements as they judge how much they like the weather and whether forecast would persuade them to use sunscreen. Data collection is currently in progress for a pre-registered target sample of 134. We expect to find participants will pay more attention, as measured by fixations (e.g., number, duration) on an interest area, to the context of the probability (i.e., the weather event) when given a verbal compared to a numerical probability. I will present the findings from this study and discuss their implications for dual-process and pragmatic theories of how people process quantified information.

The role of alternative-non-attendance in consumer decision making: Evidence from an eye-tracking study

Malte Lüken*, Anna K. Edenbrandt, Carl-Johan Lagerkvist & Jacob L. Orquin

*: Aarhus University, Denmark

Thu, 16:00
Session 3

The term consideration set refers to the number of alternatives included in a decision-making process. Many studies have modelled consumer choice behavior taking the consideration set of the decision maker into account. However, little is known about the attentional processes that determine which alternatives are included in the consideration set and how this inclusion process affects the choice behavior. Therefore, the present study investigates alternative-non-attendance in a food choice experiment by using eye-tracking as a measure of visual non-attendance. Previous studies suggest that the position of an alternative plays a crucial role in whether it is attended to or not. In consequence, we hypothesize that alternatives in the center, middle-top, and middle-left positions of a symmetric array are more likely to be attended. We use a symmetric array consisting of 3 \times 3 meat package alternatives each with 3 attributes (animal welfare, organic vs. conventional, and price). The attribute levels are determined using a D-efficiency criterion and assuming

a multinomial logit model. The position of alternatives is randomized across participants and between trials. From alternative position we will predict alternative-non-attendance. Consideration sets will be inferred from alternative- non-attendance by using latent class analysis. Finally, we will analyze alternative utilities and choice behavior across consideration sets. By measuring alternative-non-attendance through eye-tracking, we expect enhanced prediction of choice behavior in our sample. We further anticipate this methodological improvement to contribute to the consideration set literature by emphasizing the role of attentional processes in the set formation.

Forecasting economic decisions under risk: The predictive importance of choice-process data

Steffen Q. Mueller*, Patrick Ring & Maria Schmidt

*: University of Hamburg, Germany

Thu, 9:30
Session 1

We investigate various statistical methods for forecasting risky choices and identify important decision predictors. Subjects (N = 44) are presented a series of 50/50 gambles that each involves a potential gain and a potential loss, and subjects can choose to either accept or reject a displayed lottery. From this data, we use information on 8800 individual lottery gambles and specify four predictor-sets that include different combinations of input categories: lottery design, socioeconomic characteristics, past gambling behavior, eye-movements, and various psychophysiological measures that are recorded during the first three seconds of lottery-information processing. The results of our forecasting experiment show that choice-process data can effectively be used to forecast risky gambling decisions; however, we find large differences among models' forecasting capabilities with respect to subjects, predictor-sets, and lottery payoff structures.

Data or interpretations: The consequences of presenting different types of information in assistance systems for fault diagnosis

Christina Gögel, Rica Bönsel & Romy Müller*

*: Technische Universität Dresden, Germany

Thu, 17:30
Poster

In the food industry, fault diagnosis can be supported by assistance systems that use algorithms to infer fault causes from sensor data. But what information should these systems make available to operators? The present study investigated the impact of three presentation strategies on information sampling behaviour and solution times. One strategy is to provide the most likely cause based on an algorithm's interpretation of sensor data (e.g., "products on the conveyor belt are too wide", inferred from a long signal of a light barrier). However, the same data can have different origins (e.g., products are positioned incorrectly, conveyor belt is too slow). Faced with only an interpretation, people might be discouraged from examining alternative causes by checking process parameters. Therefore, another strategy is to present the underlying sensor data (e.g., "sensor signal is too long"). However, such data might be hard for people to interpret, forcing them to check

many irrelevant parameters. Therefore, a third strategy is to provide sensor data along with several possible interpretations.

The present study contrasted these presentation strategies in a computer-based chocolate packaging scenario. 20 participants were assigned to each strategy: sensor data, sensor data and three interpretations, or only one interpretation. Their task was to identify the fault cause in 29 trials. To do so, they could check more than 50 process parameters by clicking on the parameter name (e.g., chocolate type, temperature), which revealed the parameter's current value, and one parameter always indicated the cause. With only sensor data, the only support participants received in selecting parameters was the identity and function of the sensor. With sensor data and three interpretations, one interpretation was always correct and indicated the faulty parameter to check. With only one interpretation, this interpretation was correct in all but two trials (position 23 and 28), with the latter serving as catch trials. Thus, before facing the first catch trial, participants had had ample opportunity to learn that they could rely on the assistance system's interpretation and refrain from cross-checking.

The results revealed that with sensor data only, participants checked 13.8 parameters on average, while with sensor data and interpretations they checked 3.6. With only one interpretation they checked 1.6 parameters in standard trials and 14.4 in catch trials. Thus, they did not refrain from cross-checking, and when the interpretation did not match, they checked as many parameters as participants with only sensor data. At the same time, their solution times in catch trials were three times longer than those of participants with only sensor data at the respective trial positions, and at the level of the latter participants' very first trial. With sensor data and three interpretations, only a few relevant parameters were checked and solution times were short overall. The results indicate that highly pre-processed, interpreted information provided by an assistance system might work well when it is correct, but keep people from learning about relevant information sources. In contrast, providing several different causes can optimize performance both in terms of solution times and information sampling effort.

Fifty years of research on intransitivity of preferences: A process perspective

Rob Ranyard*, Henry Montgomery, Emmanouil Konstantinidis & Andrea L. Taylor

*: Leeds University Business School, United Kingdom

It is fifty years since Amos Tversky presented evidence of intransitive preferences in his seminal 1969 article. Early replications of his main study, which involved choices between simple monetary lotteries, corroborated his findings. However, later research has cast doubt on the strength of evidence of intransitive choices in this task. For example, Regenwetter et al. (2011) concluded that "unambiguous evidence is currently lacking" of "empirical evidence of intransitivity by individual decision makers" (p. 42).

In this paper we aim to shed light on this issue, which is at the core of human decision making, by further exploring Tversky's theoretical insights, which were based on the notion of dimensional processing. The analysis we present here aims to build on Tversky's

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Session 1

work in ways that have previously been neglected. As well as adopting a process perspective, our treatment has several distinctive features. First, previous research has tended to neglect descriptions of choice behavior, instead focusing on how well theoretical models fit the choice data. As Tukey (1980) has argued, however, exploring and describing data is just as important as model testing. In this spirit we present an exploratory descriptive analysis of choice patterns in Tversky's lottery context. We see this as a crucial component in developing a process account of intransitive and transitive preferences. Second, it is surprising that most previous treatments propose alternative models but do not evaluate the goodness of fit of the models proposed by Tversky. We take steps towards this by assessing the fit of one of his models to the available data. We develop a two-parameter specification of a nonlinear, additive difference (NLAD) model, and describe the relationship between the model's parameters and the transitivity or intransitivity of choice in the original lottery choice task. That is, we identify the conditions under which the two-parameter NLAD model predicts intransitive, or alternatively, transitive preferences. We further show how different specifications of the model correspond to different dimension-based decision strategies and heuristics.

Using the above framework, we review and reanalyze previous choice data from six replications of Tversky's lottery choice experiment: Cavagnaro & Davis-Stober, (2014), Kalenscher et al. (2010), Montgomery (1977), Ranyard (1977), Tsai and Böckenholt (2006) and Regenwetter et al. (2011). In conjunction with this we reconsider decision process evidence from verbal reports (Montgomery, 1977; Ranyard, 1982). Our analysis estimates the NLAD model's parameters for each individual data set, using the maximum likelihood estimation (MLE) method, and examines the goodness of fit of the model and specific variants. We then classify choice patterns by decision strategy type, and whether they are transitive or intransitive.

We find that the two-parameter NLAD model has a very good fit to nearly all individual choice patterns reviewed, with many being systematically intransitive. Furthermore, we find that most transitive patterns correspond to the application of simple, one-dimensional 'take the best' heuristics. The findings support the view that human decision making is routinely based on dimensional processing in such a way that evaluations of decision alternatives are relative to the set under consideration.

Mouse-tracking revisited: Methodological implementations from the beginning

Martin Schoemann*, Denis O'Hora, Rick Dale & Stefan Scherbaum

*: Technische Universität Dresden, Germany

The measurement and analysis of cursor movements is a relatively new but already prominent approach to infer cognitive processes from observable behavior. During its early period, researchers have demonstrated impressive methodological ingenuity with respect to the implementation of mouse-tracking paradigms. However, recent research indicates that methodological differences in the design of mouse-tracking paradigms affect cursor movement and their theoretical interpretations. Those studies have important implications for the design of future paradigms. In order to evaluate the implications for the past research, however, a systematic compilation of the methodological differences is necessary.

Fri, 14:30
Session 5

Therefore, we conducted a systematic literature review across three databases (PubMed, PsychInfo, and Scopus). We classified the identified studies with respect to several properties of the paradigms. We reviewed 114 full-text articles and found substantial variation with respect to most properties of the mouse-tracking paradigms. Additionally, we revealed a serious lack of transparency with respect to methodological reporting.

This study attests to the resourcefulness during the early years of mouse-tracking research, and thereby depicts the distribution of the methodological properties that had been implemented during this period. In interaction with the research on how methodological characteristics affect cursor movement and their theoretical interpretations, our work might guide the reevaluation of past mouse-tracking research, and hence, the identification of important studies for conceptual replications.

Higher or lower than 2495 meters? Anchoring effects and their boundary conditions evaluated with mouse-tracking

Michael Schulte-Mecklenbeck*, Dirk U. Wulff & Frank Renkewitz

*: University of Bern, Switzerland

Fri, 9:30
Session 4

Anchoring effects have a long history in JDM going back to Kahneman & Tversky's (1974) seminal paper where they asked participants whether the number of African nations in the UN was larger or smaller an arbitrary number (65% versus 10%). Their results demonstrated that participants' responses were dragged toward the respective anchor with an average response of 45% in the high-anchor and 25% in the low-anchor condition. The anchoring and adjustment effect has been studied, replicated and varied in many studies since and represents one of the apparently stable phenomena in JDM research. What has been missing in the literature is a process account of anchoring and adjustment beyond the 'assumption of a process' or the implying of a process based on choice data.

We provide data from an anchoring and adjustment experiment using mouse-tracking technology to gain insight into processes mapped with high resolution (on a time and spatial level). We ask two simple questions: 1) on a choice level: can we replicate anchoring effects with simple judgements of mountain heights? 2) on a process level: what are the cognitive/movement processes during estimating actual heights of mountains?

Based on the work of the original authors we hypothesize a two stage process where movement trajectories are influenced by the anchor first, followed by a second stage, of adjusting the ultimate estimation, right before the final choice.

Data from 100 participants were collected in a mouse-tracking paradigm. Each participant went through two stages within a trial. In the first stage participants got a question about the height of a mountain (e.g.: How high is the Eiger?) and then got anchored to a specific height (e.g., 2315 m) while having to judge whether the mountain is higher or lower than the given anchor. Heights were selected from a large range of heights of actual mountains from Europe, South-America and Asia (to gain enough variability across the whole scale range). Anchors were selected in adding/withdrawing 30% from the true value generating a high/low anchor, respectively. In a second stage participants had to estimate the height of the given mountain on a scale.

We find that, on a choice level, the anchor clearly influences the binary choices between higher or lower than the anchor. With a high anchor choice percentages move the the ‘lower than’ option and vice versa. On a process level there are two noteworthy observations: 1) the anchor consistently influences the mouse trajectories from the beginning of the movement to the final choice, 2) the adjustment phase, toward the end of the mouse movement, right before the choice, allows for corrections and fine tuning of one’s estimation.

In this work we demonstrate the benefit of a process based approach to tasks studied only with choices up to this point and show a two-stage decision process in anchoring and adjustment.

Towards measuring non-verbal interaction: A new approach to dyadic discounting and its methodical specificities

Diana Schwenke* & Stefan Scherbaum

*: Technische Universität Dresden, Germany

Thu, 17:30
Poster

The tendency to devalue delayed rewards, a phenomenon referred to as ‘discounting behavior’, has been studied by wide-ranging research examining individuals choosing between sooner but smaller (e.g., 5 € in 1 day) or later but larger (e.g., 10 € in 7 days) rewards. Despite the fact that many real life choices are embedded in a social context, the question of whether or not social collaboration can have an impact on such choices has not been addressed empirically. With this research we aimed to fill this gap by implementing a dynamic approach working on two major lines. First, we studied dyadic discounting to reveal the possible benefit of social collaboration on discounting and identify which mechanism causes the expected dyadic variation. Second, we addressed the lack of experimental paradigms to study dyadic as opposed to individual discounting. We therefore modified classical discounting tasks by implementing a new procedure of choice selection to study the interactive dynamics between two participants: In order to execute a choice, both participants had to reach mutual consent only interacting via jointly regulated cursor movements. This allowed us to dissect the sequence of decision making into its elements, starting from the very first individual preferences to a solution of possible conflicting preferences.

Strategic information search in decisions from experience

Thu, 9:30
Session 1

Dirk U. Wulff* & Mikhail Spektor

*: University of Basel, Switzerland & MPI for Human Development

Past research has found individuals to be efficient information foragers, who engage in frugal information search and adapt the amount of search to the nature of the environment. However, our understanding of the cognitive processes underlying search is incomplete. To provide needed groundwork, we analyze a large data set of information search in decisions from experience (Wulff et al., 2018), including the data of 25 papers and about 1.2 million sampling decisions. Focusing not only on search length, but also on the allocation of samples and search's impact on the average experiences of individuals, we find that individuals' exploration exhibits strong signals of strategic behavior. Specifically, individuals employ different stopping rules and engage in discover-directed search that impacts individuals' experiences. These strategic elements are not accounted for by existing descriptive and normative models of information search and, thus, provide important benchmarks for building accurate models of human information search.

Beyond the reach: The effect of motor costs on response dynamics and intertemporal choice

Fri, 14:30
Session 5

Arkady Zgonnikov*, Nadim Atiya, Denis O'Hora, Inaki Rano & KongFatt Wong-Lin

*: University of Aizu, Aizuwakamatsu, Fukushima, Japan

Executing an important decision is often as easy as reaching towards the preferred option with a hand or a mouse cursor. But would we decide differently if choosing required walking a few steps towards an option? More generally, is our preference invariant to how we signal it? Previous research demonstrated that asymmetric motor costs can nudge the decision-maker towards a less costly option. However, virtually all traditional decision-making theories predict that increasing motor costs symmetrically for all options should not affect choice in any way. This prediction is disputed by the theory of embodied cognition, which suggests that motor behavior is an integral part of cognitive processes, and that motor costs of deciding can affect our choices. In this preregistered study, we investigated whether varying motor costs of responding affects response dynamics and final choices in decisions between a readily available small reward and a larger but delayed reward. Our study included two versions of an intertemporal choice task: in a baseline condition, the subjects responded using a computer mouse; in a more motor costly walking condition they physically walked towards the preferred option. First, we investigated whether relative values of the intertemporal choice options affect walking trajectories in the same way as they affect mouse cursor dynamics. Second, we tested a hypothesis that in the walking condition, increased motor costs of a preference reversal would decrease the number of changes-of-mind and therefore increase the proportion of impulsive, smaller-but-sooner choices. Overall, this study opens up new ways to investigating the complex interplay between cognitive processes and full-body movement.

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Public transport and schedules

Ticket overview

Dresden provides an excellent, reasonably priced public transportation system run by [DVB](#). A single, disposable paper ticket (2.40 €, 1 fare zone) is probably the best option if you only plan to use the train, bus, or tram once. However, the one-day passes (6.00 €, 1 fare zone) or the one-week pass (21.90 €, price level A1) can save you money if you plan to use the bus, or tram more frequently and over a longer period of time. Additionally, you can also purchase 4-trip tickets either for short trips (up to four stations, 5.50 €) or 1 fare zone (8.60 €).

Where to get tickets

In general, the most reliable way to purchase a ticket is paying with coins!

- **Ticket machines at tram and bus stops**

You can find one at Nürnberger Platz (route 3 and 8) as well as Hauptbahnhof (main station, route 3, 8 and 66). Apart from cash, both machines *almost always* accept girocard, Maestro, VPay, MasterCard and Visa (there have been some issues with non-cash payments in the past).

- **On the tram**

There is a small ticket machine in every tram where you can purchase a limited range of tickets (e.g., single tickets, one-day passes). Note that this machine *only* accepts coins.

- **On the bus**

Bus drivers sell a limited range of tickets directly (cash only).

- **Smartphone**

Tickets can be purchased via the "DVB mobil" app ([iOS](#), [Android](#)).

Bicycle rental

As a healthy alternative, [sz-bike](#) provides a fully automated bike rental system which is run by Sächsische Zeitung and nextbike. The pricing is 1 € for 30 minutes which is sufficient for most distances within Dresden. Additionally, there is the Bike&Ride-Ticket (10.00 €) which covers the same benefits as the DVB one-day pass plus 24 hours of biking.



Richtung: **Freital** Haltestelle: **Technische Universität**

Stunden	Minuten		
MONTAG bis FREITAG			
4	07C	34	54
5	13	33	53
6	14	34	54
7	10C	16	38 58
8	18	38	53§S 58
9	03§S	13§S	18 38 58
10	18	38	43§S 53§S 58
11	03§S	18	38 58
12	18	33§S	38 43§S 53§S 58
13	18	38	58
14	18	33§S	38 43§S 53§S 58
15	18	38	58
16	18	23§S	38 43§S 58
17	03§S	18	38 43§S 58
18	03§S	08S	28 50
19.....20	18	48	
21	19	35Z	
22	00Z	28Z	58Z
23.....0	28Z	58Z	
SONNABEND			
4	37C	58Z	
5	28Z	58	
6.....7	28	58	
8.....9	18	48	
10	18	49	
11.....16	20	50	
17	20	48	
18.....20	18	48	
21	19	35Z	
22	00Z	28Z	58Z
23.....0	28Z	58Z	
SONN- und FEIERTAG			
4	37C	58Z	
5.....6	28Z	58Z	
7	28	58	
8	28	48	
9.....20	18	48	
21	19	35Z	
22	00Z	28Z	58Z
23.....0	28Z	58Z	

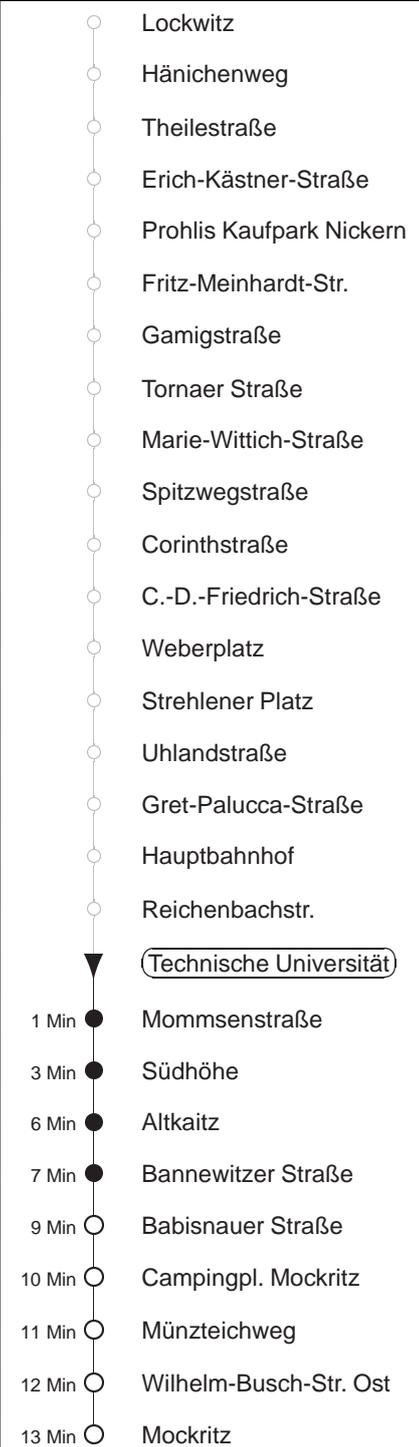


S = bis Südhöhe
C = bis Coschütz
Z = bis Freital-Burgk, Zschiedge
§ = Studentenshuttle, verkehrt vom 07.01. bis 01.02., vom 01.04. bis 12.07.
(nicht vom 11. bis 14.06.) und ab 14.10.19



Richtung: **Mockritz** Haltestelle: **Technische Universität**

Stunden	Minuten		
MONTAG bis FREITAG			
4	54	ⓉⓂ	
5	28		43
6	04		24 44
7	04		27 48
8.....17	08		28 48
18	18		38
19	03		33
20	03		33 AK
21	03	AK	35 ⓉⓂ
22	00	ⓉⓂ	28 ⓉⓂ 58 ⓉⓂ
23.....0	28	ⓉⓂ	58 ⓉⓂ
SONNABEND			
4	58	ⓉⓂ	
5.....7	28	ⓉⓂ	58 ⓉⓂ
8	33	AK	
9.....10	03		33
11	04		35
12.....16	05		35
17	05		34
18.....19	03		33
20	03		33 AK
21	03	AK	35 ⓉⓂ
22	00	ⓉⓂ	28 ⓉⓂ 58 ⓉⓂ
23.....0	28	ⓉⓂ	58 ⓉⓂ
SONN- und FEIERTAG			
4	58	ⓉⓂ	
5.....7	28	ⓉⓂ	58 ⓉⓂ
8	28	ⓉⓂ	58
9	33		
10.....19	03		33
20	03		33 AK
21	03	AK	35 ⓉⓂ
22	00	ⓉⓂ	28 ⓉⓂ 58 ⓉⓂ
23.....0	28	ⓉⓂ	58 ⓉⓂ



AK = verkehrt bis Altkaitz
ⓉⓂ = ab Südhöhe Taxianschl. n. Kaitz auf Bestellg. Tel.: 0351/857-1111



Richtung: **Lockwitz** Haltestelle: **Technische Universität**

Stunden	Minuten
MONTAG bis FREITAG	
4	25 ^N 45 ^N 59
5	15 ^N 28 41 ^N 52
6	02 ^N 12 22 ^N 33 43 ^N 53
7.....8	03 ^N 13 23 ^N 33 43 ^N 53
9	00 [§] H 03 ^N 10 [§] H 13 20 [§] H 23 ^N 33 43 ^N 53
10	03 ^N 13 23 ^N 33 43 ^N 50 [§] H 53
11	00 [§] H 03 ^N 10 [§] H 13 23 ^N 33 43 ^N 53
12	03 ^N 13 23 ^N 33 40 [§] H 43 ^N 50 [§] H 53
13	00 [§] H 03 ^N 13 23 ^N 33 43 ^N 53
14	03 ^N 13 23 ^N 33 40 [§] H 43 ^N 50 [§] H 53
15	00 [§] H 03 ^N 13 23 ^N 33 43 ^N 53
16	03 ^N 13 23 ^N 30 [§] H 33 43 ^N 50 [§] H 53
17	03 ^N 10 [§] H 13 23 ^N 33 43 ^N 50 [§] H 53
18	03 ^N 13 17 [§] S 20S 23 ^N 37 52 ^N
19	07 22 ^N 37 52 ^N
20	07 22 ^N 37 53 ^N
21	08 23 ^N 43
22	03 ^N 25 [⊙] N 55 [⊙] N
23	25 [⊙] N 55 [⊙] N
0	25 [⊙] N 55 [⊙] P
1	25S
SONNABEND	
4	55 [⊙] N
5.....6	25 [⊙] N 55 [⊙] N
7	25 [⊙] N 55 ^N
8	10 22 ^N 37 52 ^N
9.....19	07 22 ^N 37 52 ^N
20	07 22 ^N 37 53 ^N
21	08 23 ^N 43
22	03 ^N 25 [⊙] N 55 [⊙] N
23	25 [⊙] N 55 [⊙] N
0	25 [⊙] N 55 [⊙] P
1	25S
SONN- und FEIERTAG	
4	55 [⊙] N
5	25 [⊙] N 55 [⊙] N
6.....7	25 ^N 55 ^N
8	22 ^N 52 ^N
9.....19	07 22 ^N 37 52 ^N
20	07 22 ^N 37 53 ^N
21	08 23 ^N 43
22	03 ^N 25 [⊙] N 55 [⊙] N
23	25 [⊙] N 55 [⊙] N
0	25 [⊙] N 55 [⊙] P
1	25S

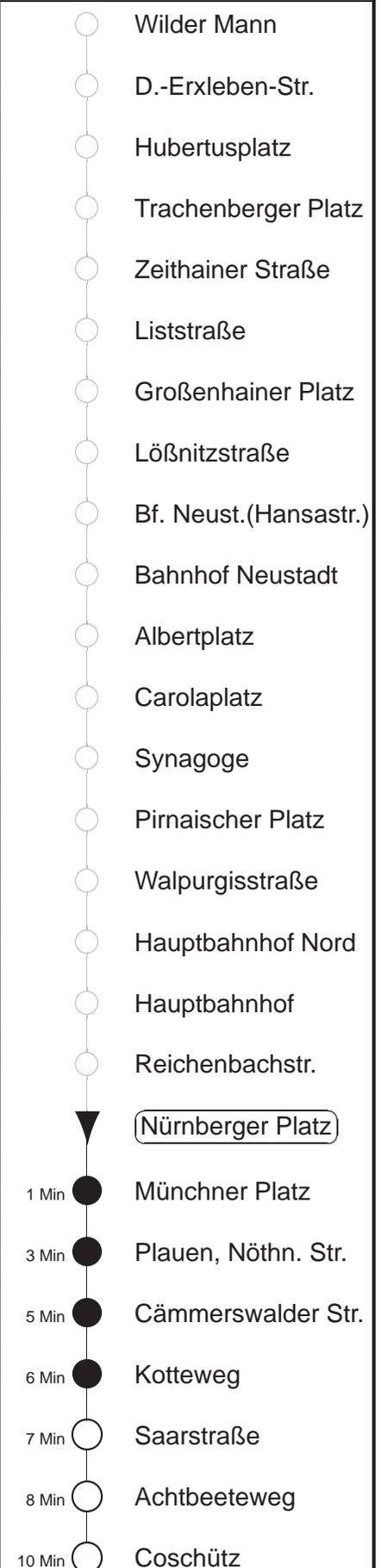


S = bis Strehleener Platz
H = bis Hauptbahnhof
P = bis Prohlis, Gleisschleife
^N = ab Erich-Kästner-Straße nach Nickern
[⊙] = ab Prohlis Taxi n. Lockwitz auf Bestellg. (20 min vorher) Tel.: 0351/857-1111
[§] = Studentenshuttle, verkehrt vom 07.01. bis 01.02., vom 01.04. bis 12.07.
(nicht vom 11. bis 14.06.) und ab 14.10.19



Richtung: **Coschütz** Haltestelle: **Nürnberger Platz**

Stunden	Minuten	
MONTAG bis FREITAG		
4	23	53
5	10	30 43 50
6	03	13 23 33 44 54
7	04	10 [§] Ⓟ 14 20 ^Ω 24 34 44 54
8	04	14 24 34 44 54
9	00 [§] Ⓟ	04 10 [§] Ⓟ 14 24 34 44 54
10.....13	04	14 24 34 44 54
14	04	14 20 [§] Ⓟ 24 34 44 54
15	04	14 24 34 44 54
16	00 [§] Ⓟ	04 14 20 [§] Ⓟ 24 34 44 54
17	04	14 24 34 44 54
18	04	14 23 33 43 53
19	03	13 23 33 46
20	01	16 31 46
21	01	16 31 49
22	01	19 31 53
23.....0	23	53
1.....2	23 [◇]	53
3	23 [◇]	42 53
SONNABEND		
4.....7	23	53
8	24	43 54
9	06	16 31 46
10	01	16 28 38 48 58
11.....17	08	18 28 38 48 58
18	08	18 28 38 48
19.....20	01	16 31 46
21	01	16 31 49
22	01	19 31 53
23.....3	23	53
SONN- und FEIERTAG		
4.....8	23	53
9	24	54
10.....11	04	19 34 49
12	04	19 34 46
13.....20	01	16 31 46
21	00	18 30 53
22.....0	23	53
1.....2	23 [◇]	53
3	23 [◇]	42 53



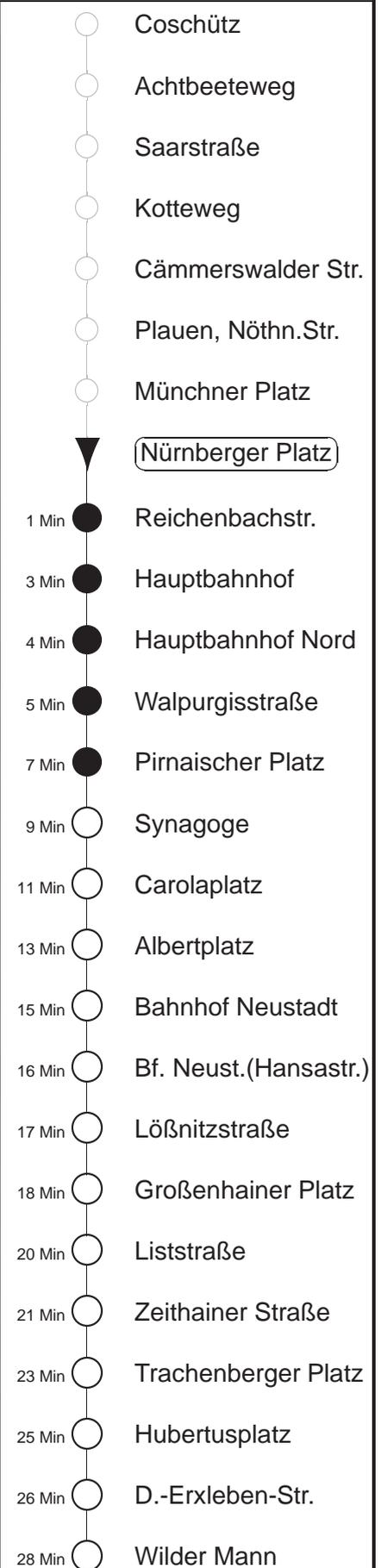
Ω = Schülerverkehr, vom 04.03. - 18.04. u. 29.04. - 05.07.19 (nicht 31.05.)
 Ⓟ = bis Plauen, Nöthnitzer Straße
 § = Studentenshuttle, verkehrt vom 01.04. - 12.07.19 (nicht am 31.05. und 11.06. - 14.06.19)
 ◇ = verkehrt nur in den Nächten vor Samstag, vor Sonntag und vor Feiertag



Richtung: **Wilder Mann**

Haltestelle: **Nürnberger Platz**

Stunden	Minuten	
MONTAG bis FREITAG		
4	02	32
5	02	21 ⁸ 28 48
6	08	19 29 39 49 59
7	09	19 24 [§] Tr 29 39 44 ^Ω Tr 49 59
8	09	19 29 39 49 59
9	09	14 [§] Tr 19 24 [§] Tr 29 39 49 59
10.....13	09	19 29 39 49 59
14	09	19 29 34 [§] Tr 39 49 59
15	09	19 29 39 49 59
16	09	19 24 [§] Tr 29 34 [§] Tr 39 49 59
17.....18	09	19 29 39 49 59
19	09	23 29 38 53 59Tr
20	08	23 38 53
21	08	26 38 56
22	08	32 47Tr
23.....0	02	32
1.....3	02 [◇]	32
SONNABEND		
4.....7	02	32
8	02	32 53
9	08	23 38 53
10	08	19 29 39 49 59
11.....17	09	19 29 39 49 59
18	09	23 30Tr 38 53
19	00Tr	08 23 38 53
20	08	23 38 53
21	08	26 38 56
22	08	32 47Tr
23.....3	02	32
SONN- und FEIERTAG		
4.....8	02	32
9	02	32 56
10.....11	11	26 41 56
12	11	26 38 53
13.....20	08	23 38 53
21	16	32 47Tr
22.....23	02	32
0	02	32 47Tr
1.....3	02 [◇]	32



Ω = Schülerverkehr, vom 04.03. - 18.04. u. 29.04. - 05.07.19 (nicht 31.05.)
 Tr = ab Trachenberger Platz zum Betriebshof Trachenberge
⁸ = Fahrt der Linie 8
[§] = Studentenshuttle, verkehrt vom 01.04. - 12.07.19 (nicht am 31.05. und 11.06. - 14.06.19)
[◇] = verkehrt nur in den Nächten vor Samstag, vor Sonntag und vor Feiertag



Richtung: **Hellerau**

Haltestelle: **Nürnberger Platz**

Stunden	Minuten					
MONTAG bis FREITAG						
5	21 ³	41	56			
6	09	27	37	47	57	
7.....18	07	17	27	37	47	57
19	12	27	42	57		
20	12	27	42			
21	12	42				
22	12	44				
23	14	44				
0	14S	44S				
SONNABEND						
8	42	57				
9	12	32	47			
10	02	17	31	46		
11.....17	01	16	31	46		
18	01	11	26	41	57	
19	12	27	42	57		
20	12	27	42	57S		
21	12	42				
22	12	44				
23	14	44				
0	14S	44S				
SONN- und FEIERTAG						
12	57					
13.....19	12	27	42	57		
20	12	27	42	57A		
21	12	44				
22.....23	14	44				
0	14S	44S				



S = bis Infineon Süd
A = ab Albertplatz zum Betriebshof Trachenberge
³ = von Plauen, Abfahrt an der Haltestelle der Linie 3



Richtung: **Südvorstadt**

Haltestelle: **Nürnberger Platz**

Stunden	Minuten	
MONTAG bis FREITAG		
5	34	47
6	07	27 46 56
7.....17	06	16 26 36 46 56
18	06	16 25 35 45 55
19	05	15 25 37 52
20	06	21 36 51
21	06	36
22	06	36 58
23	28	58
0	28	
SONNABEND		
8	29	
9	01	21 36 51
10.....20	06	21 36 51
21	06	36
22	06	36 58
23	28	58
0	28	
SONN- und FEIERTAG		
12	51	
13.....20	06	21 36 51
21	06	36 58
22.....23	28	58
0	28	



References

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