

The First Meta-Reasoning Conference

Research Group Conference

4-6 December 2022

**Organized by the IIAS Research Group
"Meta Reasoning: Concepts, Open Issues and Methodology"**

Israel Institute for Advanced Studies
Edmond J. Safra Campus, Givat Ram
The Hebrew University of Jerusalem

Sunday, 4 December

09:30-10:30 Registration & coffee

10:30-10:35 Greetings by Yitzhak Hen, Director of the IIAS

10:35-12:30 Talks I: Reasoning & Problem-solving I

Chair: Tamar van Gog

10:35-11:00 Monika Undorf (University of Mannheim, undorf@uni-mannheim.de) and Rackefet Ackerman (Technion, ackerman@ie.technion.ac.il):

Making Confidence Judgments Does Not Affect Problem-Solving Performance: Evidence from Verbal, Numerical, and Visual Tasks

11:00-11:30 Ian Newman (University of Saskatchewan, ian.newman@usask.ca) and Valerie Thompson (University of Saskatchewan, valerie.thompson@usask.ca):

Judgments of Difficulty in a Perimeter Comparison Task

11:30-12:00 Zoe Purcell (University of Toulouse), A. Roberts, S. Howarth, and Simon J. Handley (Macquarie University):

The Eye's Mind: Gaze and Pupil Dilation Expose Implicit Metacognitive Awareness of Logical Structure

12:00-12:30 Nikita Loginov, V. F. Spiridonov, Artur V. Ammalainen (ammartturi@gmail.com), and V. V. Ardislamov (RANEPa):

Framework for CRA Problem Solving: The Metacognitive Switchers Theory

12:30-13:30 Lunch

13:30-15:00 Welcome address & **Keynote Lecture**

Rakefet Ackerman and Valerie Thompson: Contemporary Developments and Next Steps in Meta-Reasoning

15:00-15:30 Coffee break

15:30-17:00 Talks II: Reasoning and Problem-solving II

Chair: Valerie Thompson

15:30-16:00 Shira Elqayam (De Montfort University, selqayam@dmu.ac.uk), I. Douven (Pantheon-Sorbonne University), K. Morsanyi (Loughborough University) and Valerie Thompson:

Meta-reasoning as a Factor for Inference Within Conditionals

16:00-16:30 L. McCaughey and Klaus Fiedler (Heidelberg University):

Meta-Cognitive Processes in Adapting to Information Search Costs Before Decisions

16:30-17:00 Simon J. Handley (Macquarie University, simon.handley@mq.edu.au) and W. Paterson:

Mindware, Logical Intuitions and Conflict Detection

17:00-17:30 Wim De Neys (CNRS & Université Paris Cité, wim.de-neys@parisdescartes.fr), S. Caparos, N. Franiatte, and E. Boissin (Université Paris Cité):

Metacognition and System 1 de-biasing

17:30 Reception in IIAS Lobby

Monday, 5 December

08:30-09:00 Gathering & coffee

09:00-11:00 Talks III: Individual differences

Chair: Simon J. Handley

09:00-09:30 Maggie Toplak (York University, mtoplak@yorku.ca):

The Actively Open-Minded Thinking Scale: Individual Differences in Willingness to Consider Alternative Evidence

09:30-10:00 Henry Strudwicke (henry.strudwicke@flinders.edu.au), M. W. Christian, J. McLean, Olivia Burton, and N. Weber (Flinders University):

Bayesian Evidence for Differences Between Fast and Slow Correct Responses on the Cognitive Reflection Test

10:00-10:30 M. Law and S. Kleitman (The University of Sydney):

Capturing and Validating Novel Metacognitive Metrics of Relevance to the Meta-reasoning Framework

10:30-11:00 Ran Hassin (ran.hassin@huji.ac.il) and O. Livnat (The Hebrew University of Jerusalem):

In Phenomenology We Trust

11:00-11:30 Coffee break

11:30-12:30 **Keynote Lecture**

Klaus Fiedler (Heidelberg University): **Metacognitive Myopia – A Major Obstacle on the Way to Rationality**

Chair: Shira Elqayam

12:30-13:30 Lunch

13:30-15:00 Interactive poster session

Chairs: Maggie Toplak and Monika Undorf

1. O. R. Burton, G. E. Bodner, and P. Williamson
Unpacking the Relationship between Initial Judgements of Solvability and Problem-Solving Success: Interleaving Impacts Meta-Reasoning
2. Martine Baars (baars@essb.eur.nl)
The Relation between Task Difficulty, Monitoring Accuracy, and Cognitive Load When Solving Problems
3. Yael Sidi (yaelsi@openu.ac.il)
Investigating Mental Effort Appraisals in Problem-solving from a Metacognitive Perspective
4. Felix Markin (alxetar@gmail.com) and I. Yu. Vladimirov
The Time it Takes to Solve an Insight Problem Does Not Affect the Aha-experience Unlike Feedback
5. N. Yu. Lazareva and I. Yu. Vladimirov
The Influence of Mental Set on the Emergence of Insightful Solution
6. R. Dar, N. Sarna, G. Yardeni, and A. Lazarov
Are People with Obsessive-Compulsive Disorder Under-Confident in Their Memory and Perception? A Review and Meta-Analysis

15:00-15:30 Coffee break

15:30-17:30 Talks IV: Creativity

Chair: Linden Ball

- 15:30-16:00 A. Ammalainen and N. Moroshkin
The Changes in Perceptual Processing Fluency Increase the Chances of "Aha!"-like Comprehension of the Solution in Remote Associate Problems

16:00-16:30 Sergei Korovkin (Yaroslavl State University, korovkin_su@list.ru), A. Savinova, J. Padalka, and A. Zhelezova

Aha! Experience, Elegance of a Solution, and Mental Schemes

16:30-17:00 Beth Richardson (bhrichardson@uclan.ac.uk), Linden Ball, Z. D. Hughes, and J. E. Marsh

Partial Metacognitive Awareness of the Disruption to Insight Problem Solving Caused by Task-Irrelevant Sound

17:00-17:30 Yoed Kenett (Technion, yoedk@technion.ac.il), N. Gooz, and Rackefet Ackerman

Evaluating the Conceptual Distance of Responses in Creative Ideation

Tuesday, 6 December

09:00-09:30 Gathering & coffee

09:30-11:00 Talks V: Social and Cultural Aspects

Chair: Klaus Fiedler

09:30-10:00 Mário B. Ferreira (University of Lisbon, mferreira@fp.ul.pt):

The Social Metacognition of Moral Judgments

10:00-10:30 Brendan Conway-Smith (Carleton University, brendan.conwaysmith@carleton.ca):

Meta-reasoning and the Influence of Culture

10:30-11:00 Matthew Fisher (Matthewfisher@smu.edu) and D. M. Oppenheimer (Southern Methodist University):

Who Knows What? How Outside Assistance Leads to Overconfidence

11:00-11:30 Coffee break

11:30-12:30 **Keynote Lecture**

Asher Koriat (University of Haifa, akoriat@univ.haifa.ac.il): **Talking about Reasoning: Where do ideas come from?**

Chair: Rakefet Ackerman

12:30-13:30 Lunch

13:30-15:30 **Talks VI: Applications**

Chair: Sabina Kleitman

13:30-14:00 Tamara van Gog (Utrecht University, t.vangog@uu.nl)
Calibrated and in Control: Improving Students' Self-regulated Learning in STEM-domains

14:00-14:30 Kinda Al Sayed (University of Sussex & Carleton University, k.al-sayed@sussex.ac.uk; kindaalsayed@cunet.carleton.ca)
Is metacognition indispensable for decision-making in design?

14:30-15:00 Daniel Gopher (Technion, dgopher@ie.technion.ac.il)
The Early and Long-term Impact of Confidence Rating on the Performance of a Primary Visual Task

15:00-15:30 Trent Cash (tcash@andrew.cmu.edu) and D. M. Oppenheimer (Carnegie Mellon University)
Metareasoning and Metacognitive Knowledge of Preferences in Policy Relevant Decisions

15:30-17:30 Israel Museum tour

Abstracts

K. Al Sayed

Is metacognition indispensable for decision-making in design?

This paper presents a theoretical and methodological description of metacognition in architectural design. In a design task, participants were required to think aloud and report confidence levels in judgment at equal intervals over the course of design. Their verbal protocols were transcribed into semantic data. This was further coded into declarative, conditional, and procedural metacognition. The semantic data was further modelled into a linkograph, and few measures such as centrality betweenness, entropy and number of critical design moves (distinguishing clusters of design moves that link distant actions) as measures or indicators of metacognition. Evidence on metacognition indicates potentials for a higher order understanding of causalities and consequences of design actions. Confidence levels reported by participants were further modelled to highlight how and when architects operationalize metacognition at different degrees of confidence to navigate and switch between different problem spaces. The semantic data was further coded in terms of design constraints, and design constraints were modelled into knowledge graphs, in order to expose how architects navigate the conceptual problem space, and selectively utilize knowledge to construct the solution space. This type of coding would enable us to judge on whether metacognition is indispensable for problem solving in design, and how far confidence levels are deterministic in terms of number and range of problems solved within each design episode. An understanding of the role of metacognition and confidence levels in design would enable us to discursively illuminate the parts-whole structure of problem decomposition and solution synthesis that characterizes design activity.

A. Ammalainen and N. Moroshkin

The Changes in Perceptual Processing Fluency Increase the Chances of "Aha!"-like Comprehension of the Solution in Remote Associate Problems

In two experiments, we tested the hypothesis that Aha! experience might result from an abrupt increase in processing fluency of the problem (Topolinski & Reber, 2010). We suggested that if the “Aha!” as a fluency effect hypothesis is correct, we should be able to influence the Aha! experience judgements by changing features that do not directly relate to the problem’s content. We used remote associate (RAT) problems and manipulated perceptual fluency by mirroring one letter in each clue word of a problem. In the first experiment ($N = 38$), participants were given 6 seconds to intuitively judge the solvability of the RAT problems. The results showed coherent problems with mirrored writing have less chance to be judged as solvable than coherent problems with normal writing, which indicates that mirrored letters decrease the processing fluency of the problems. In the second experiment ($N = 80$), participants judged whether they comprehended solutions with or without Aha! experience when they were presented with correct or false solutions to the RAT problems. RAT problems could be written normally or with mirrored letters, but mirrored letters changed to normal with the presentation of the solution. Therefore, there were trials with constant writing (i.e., constant fluency) and trials with changing writing (i.e., changing fluency). We showed that correct solutions are more likely to yield an “Aha!”-like comprehension when the writing changed from mirrored to normal than if it was normal all along. The results are in favour of the idea of changes in processing fluency as one of the sources of Aha! experience.

M. Baars

The Relation between Task Difficulty, Monitoring Accuracy, and Cognitive Load When Solving Problems

Monitoring accuracy is central to making optimal regulation choices during learning. Moreover, optimal monitoring and regulation of learning is related to academic success. That is, inaccurate monitoring can result in hampered learning, whereas accurate monitoring can enhance learning and lead to better study results. Yet, it often seems difficult for learners to monitor their learning progress, especially in difficult tasks inducing high cognitive load. It is, therefore, crucial to understand the precise mechanisms behind monitoring accuracy to ensure that learners can employ monitoring techniques to enhance their learning. Nonetheless, the exact interplay between monitoring, task difficulty, and cognitive load is not known.

Therefore, the aim of our mixed designs experiment was to gain insight on how increasingly difficult tasks in problem solving influence monitoring accuracy, cognitive load, and performance, and also how monitoring influences cognitive load, and performance. This relationship was examined in 60 university students who were presented with 10 problems to solve on the topic of genetics. The cognitive load was measured both with subjective mental effort ratings, and objective electrodermal activity signals. Surprisingly, the results of the study did not show any effect of monitoring on cognitive load, and performance, and there was also no effect of task difficulty on monitoring accuracy.

O. R. Burton, G. E. Bodner, and P. Williamson

Unpacking the Relationship between Initial Judgements of Solvability and Problem-Solving Success: Interleaving Impacts Meta-Reasoning

The first instance of monitoring during meta-reasoning is the initial Judgement of Solvability (JOS). The JOS indicates a reasoner's beliefs about whether a problem is solvable and whether they can solve it. Studies have shown that JOSs can discriminate solvable from unsolvable problems and can predict effort regulation and problem-solving success, but this evidence has tended to vary depending on the study design used to measure JOSs. To clarify this mixed evidence, our study examined whether JOS discrimination and predictiveness varies depending on the type of study design used to measure JOSs. Participants judged whether each of 40 briefly presented anagrams was solvable or unsolvable (or reported having already solved it). Solving attempts either followed each JOS (interleaved design) or occurred after all 40 JOSs had been made (blocked design). JOSs were more accurate and predictive of successful problem-solving when interleaved with solving attempts than when blocked. A second manipulation, whether anagrams were presented for 2 s or 4 s on JOS trials, influenced the likelihood of solving the anagram during the JOS process, but did not moderate the influence of design on either JOS accuracy or predictiveness. In sum, our findings indicate that interleaving JOSs and solving attempts can bootstrap metacognitive accuracy, effort regulation, and problem-solving success.

T. N. Cash and D. M. Oppenheimer

Metareasoning and Metacognitive Knowledge of Preferences in Policy Relevant Decisions

Decision makers often lack the necessary metareasoning skills to successfully monitor their own decision-relevant cognitive processes, and thus lack metacognitive knowledge of the reasons for which they make the decisions that they do. This limitation is evident in numerous studies that have demonstrated that decision makers often self-report preferences, cue weights, and decision strategies that are inconsistent with their behavior (e.g., Nisbett & Wilson, 1977; Suk & Yoon, 2012). Despite this, many social policies (e.g., school choice, nutrition labels) attempt to improve decision making by giving decision makers novel information, while tacitly assuming that they will be able to use the information in a way that is consistent with their preferences. While this assumption would seem to run contrary to the extant literature, it is plausible that the salience, importance, and cultural relevance of the domains in which these policies are implemented (e.g., education, health) could motivate decision makers to engage in high levels of metareasoning. To test this hypothesis, we selected one policy-relevant domain – school choice – and conducted four experimental studies ($N_s = 191, 214, 998, 198$) in which participants were asked to choose between sets of hypothetical schools based on a set of provided attributes and then self-report the weight they placed on each attribute. To self-report attribute weights that accurately reflected the cognitive processes underlying their choices (i.e., to display metacognitive knowledge of their preferences), decision makers would have had to engage in introspective metareasoning processes in which they self-reflect on the factors that influenced their decisions. Results across the four studies indicated that attribute weights derived from the participants' choices were inconsistent with their stated attribute weights, thus suggesting that decision makers' metacognitive knowledge of their preferences – a critical metareasoning skill – is limited, even in high stakes, policy-relevant domains.

B. Conway-Smith

Meta-reasoning and the Influence of Culture

How are meta-reasoning processes shaped by culture? We propose that culture can influence which epistemic cues a person will prioritize. Here, we adapt Proust's (2013) dual-system account of metacognition toward meta-reasoning. Proust explains that System-1 and System-2 are sensitive to different epistemic norms, that is, cues that determine whether a cognitive action "should" take place. System-1 is considered non-conceptual, and sensitive to epistemic feelings such as the "feeling of rightness". Epistemic feelings can contain correct signals of knowledge, yet are not always reliable (Hart, 1965). Strong yet incorrect epistemic feelings have been called "cognitive illusions", that can be overridden by System-2 formal rules (Kahneman, 2011). System-2 is conceptual, and sensitive to epistemic signals appropriate to propositional knowledge, such as truth and coherence. Whether individuals prioritize the epistemic signals from System-1 meta-reasoning or System-2 meta-reasoning can depend on culture. Societies can hold different values toward epistemic cues, prioritizing those of System-1 or System-2. For instance, when deciding whether a new medical innovation is safe.

Cultures and sub-cultures that prioritize System-1 epistemic feelings will result in more individuals' cognitive processes being driven by epistemic feelings. Individuals with this epistemic commitment are more likely to halt their meta-reasoning processes upon detecting epistemic feelings, rather than continuing with rational analysis. Alternately, a culture that esteems propositional truth more highly will result in more individuals' prioritizing System-2 epistemic cues such as logical coherence. In summary, cultures implicitly or explicitly communicate epistemic priorities, which are adopted by individuals' System-2 meta-reasoning, that then direct System-1 meta-reasoning processes.

R. Dar, N. Sarna, G. Yardeni, and A. Lazarov

Are People with Obsessive-Compulsive Disorder Under-Confident in Their Memory and Perception? A Review and Meta-Analysis

People with obsessive-compulsive disorder (OCD) tend to distrust their memory, perception, and other cognitive functions, and many OCD symptoms can be traced to diminished confidence in one's cognitive processes. For example, poor confidence in recall accuracy can cause doubt about one's memory and motivate repeated checking.

At the same time, people with OCD also display performance deficits in a variety of cognitive tasks, so their reduced confidence must be evaluated in relation to their actual performance. To that end, we conducted an exhaustive review and meta-analysis of studies in which OCD participants and non-clinical control participants performed cognitive tasks and reported their confidence in their performance. Our search resulted in 19 studies that met criteria for inclusion in the quantitative analysis, with all studies addressing either memory or perception. We found that both performance and reported confidence were lower in OCD than in control participants. Importantly, however, confidence was more impaired than performance in participants with OCD. These findings suggest that people with OCD are less confident in their memory and perception than they should be, indicating a genuine *under-confidence* in this population.

We discuss potential mechanisms that might account for this finding and suggest avenues for further research into under-confidence and related meta-cognitive characteristics of OCD. The meta-reasoning framework offers a promising perspective for a better understanding of the processes undermining the confidence of people with OCD.

W. De Neys, S. Caparos, N. Franiatte, and E. Boissin

Metacognition and System 1 de-biasing

In the last decade studies have indicated that biased reasoners can show some minimal error sensitivity as it is expressed, for example, in lowered response confidence for correct vs incorrect intuitive answers. This meta-cognitive uncertainty has been conceived as a determinant of System 2 engagement. However, the precise role of this signal has been questioned given that there is often no clear link with reasoning accuracy. Here I will review a set of findings from de-bias training studies that indicate that the signal predicts the efficiency of de-bias interventions. Biased participants who show the strongest error or conflict signal in a pre-test are the most likely to show performance improvement after training. We discuss key theoretical and practical implications.

S. Elqayam, I. Douven, K. Morsanyi, and V. Thompson

Meta-reasoning as a Factor for Inference Within Conditionals

According to the philosophical theory of Inferentialism, and its psychological counterpart Hypothetical Inferential Theory, the meaning of a conditional centrally involves the strength of inference from antecedent to consequent, thus providing an essential linchpin connecting conditionals to inference more generally. In this talk, we explore the psychological mechanisms underlying the way we gauge the strength of this inference. Drawing on work in meta-reasoning, we hypothesised an inference heuristic, cued by fluency and experienced as positive affect. We predicted, and found, that positive affect, measured by liking, was a significant positive predictor of inference strength, as well as the percentage of conditionals evaluated as true.

M. B. Ferreira

The Social Metacognition of Moral Judgments

Haidt's (2001) Social Intuitionist Approach to Moral Judgment not only claims for the prevalence of intuitive (emotional-laden) over reasoned judgments but also for the importance of social influence.

But when do moral intuitions progress into judgments without deliberation and when do people engage in more controlled processing when exposed to others judgements? This question calls for a metacognitive level of understanding of people's monitoring of the correctness of their intuitions when presented with others' judgments.

To achieve this goal, we manipulated the perceived moral competence and moral orientation (deontological or utilitarian) of the "other" in a two-response paradigm (Thompson et al., 2011). This allowed us to study the impact of others not only on participants' moral judgments, but also on participants' level of confidence (on these judgments) and subsequent likelihood to engage in controlled processing.

Our results suggest that social influence depends a) on how the Self perceives her own competence in relation to that of the other; and b) on the Self-other moral conflict - greater conflict leads to lower confidence, additional deliberation and increased revision of initial moral intuitions.

Our findings thus suggest moral flexibility: people are strongly motivated to do the “right thing” but the social context influences which moral beliefs are brought to bear in different situations.

K. Fiedler

Metacognitive Myopia – A Major Obstacle on the Way to Rationality

The notion of metacognitive myopia refers to a conspicuous weakness of the quality control of memory and reasoning processes. Although judges and decision makers are often remarkably sensitive even to complex samples of information, their uncritical and naïve tendency to take the validity of sampled information for granted constitutes a major obstacle to rational behavior. After illustrating this phenomenon with reference to prominent biases (base-rate neglect, misattribution, perseverance), we decompose metacognitive myopia into distinct facets of two intertwined component functions of metacognition, monitoring and control. We offer an explanation for why effectively monitoring the biases resulting from information sampling in an uncertain world is so difficult and why the control function is severely restricted by the lack of propositional control over the executive cognitive system. Because of these and other intricacies, metacognitive myopia constitutes a major obstacle to rational judgment and decision making.

M. Fisher and D. M. Oppenheimer

Who Knows What? How Outside Assistance Leads to Overconfidence

Cognitive ability consists not only of one’s internal competence but also of the augmentation offered by the outside world. How much of our cognitive success is due to our own abilities, and how much is due to external support? Can we accurately draw that distinction? We explored when and why people are unaware of their reliance on outside assistance.

After teaming with knowledgeable partners (artificially intelligent agents or human teammates) on a trivia quiz, people overestimated how well they would perform on future quizzes for which help was not available; this bias was not evident for participants who never received help. Moreover, overconfidence was insensitive to whether assistance was provided on hard versus easy problems, or even whether the assistance was accurate. Receiving outside assistance creates an ambiguity regarding who deserves credit for success or blame for failure. When this ambiguity is removed, people become better calibrated. Further, we explore how “nudges” can create a similar illusion, where people misattribute outside help to themselves. These results indicate that reliance on technology and outside knowledge may change our view of ourselves—convincing us we are more capable than we really are.

D. Gopher

The Early and Long-term Impact of Confidence Rating on the Performance of a Primary Visual Task

A Confidence rating requirement was added to target location pre-cues manipulation, in 600 trials of a Landolt gap, visual acuity task. Performance was compared with another group, which received tDCS stimulation to the V1 brain area. tDCS stimulation and confidence rating, were performed only in the first 200 practice trials and eliminated in the following 400 test trials. Location cue validity, influenced performance in both practice and test. However, cue effects were additive and did not interact with confidence rating. When compared to cues only and tDCS stimulation, confidence rating increased accuracy while location cues and tDCS primarily influenced response times. An important outcome is that the initial effects of confidence rating remained and increased in power, during the following 400 test trials, performed without confidence rating. Hence, the confidence rating requirement had both early and long term effects on the performance of the visual acuity task. The implication of these findings are discussed with reference to metacognition research and the use of confidence rating as a prime measure.

S. J. Handley and W. Paterson

Mindware, Logical Intuitions and Conflict Detection

A controversial claim in contemporary dual process models of reasoning is that reasoners show intuitive sensitivity to logical structure, as reflected in lower confidence and longer latencies on problems in which there is a conflict between logical and belief-based responses. 'Logical intuitions' are assumed to arise because reasoners possess logical mindware; learned logical skills that became automatized through practice. In this paper we report the results of three experiments which examined the role of mindware in the detection of belief-logic conflict, utilizing the belief-logic instructional paradigm. Our findings show that reasoners who score higher on a mindware measure, are more accurate under logical instructions, but show enhanced effects of conflict under belief instructions, indicating stronger logical intuitions. These findings extend to speeded task conditions and are independent of the effect of cognitive ability. We discuss the findings in the context of research in meta-reasoning and contemporary dual process accounts of reasoning.

R. R. Hassin and O. Livnat

In Phenomenology We Trust

Our conscious experiences – from simple perceptions to thoughts, and from impressions to insights – are produced by non-conscious processes, yet we are blind to the amount of work that goes into this production. This blindness means that we experience our phenomenology as simply given and we therefore assume, often implicitly, that it is true and unbiased.

In this new line of research, we argue that the degree to which we trust our conscious experiences is a general trait that characterizes people and contexts. Furthermore, we argue that the degree to which one trusts her phenomenology has important downstream consequences for behaviors and decisions.

We report a series of experiments. In the first studies we developed the Trust in Phenomenology Scale (TiPS), and we show that it is reliable. The degree to which one trusts her visual, auditory, and tactile perceptual experiences, is highly

correlated with the degree to which she trusts her thoughts, intuitions and impressions. We also show that there are two independent factors in TiPS, one that has a clear reference in the outside world, and another that mainly concerns experiences that originate from within the person. To validate our measure and begin testing possible downstream consequences, we examine how TiPS correlates with (over)confidence in a novel behavioral paradigm, and with the Cognitive Reflection Test. Implications and future directions will be discussed.

Y. N. Kenett, N. Gooz, and R. Ackerman

Evaluating the Conceptual Distance of Responses in Creative Ideation

A main component of generating creative ideas—creative ideation—is the ability to “move away” from prototypical, salient, non-creative responses. Recent computational advances in Natural Language Processing and mathematical graph theory have propelled the ability to quantify such theoretical notions of conceptual distance, via a quantitative operationalization of semantic distance.

Yet, the role of such semantic distance in the evaluation of creative ideas is largely unknown. Here, we will directly address this issue. First, we will describe the role of semantic distance in creative ideation. Next, we will discuss previous studies showing that semantic distance can be manipulated via instructions, and how such manipulation impacts participants’ creativity. Finally, we will present results from our recent study examining the role of semantic distance in self-assessment of one’s own originality—Originality Judgments. In our study, we demonstrate this association by reanalyzing previously published studies, by quantifying the semantic distance of participants’ ideas, and examining the significance of this cue, compared to other meta-cognitive cues, in predicting Originality Judgments. Next, we conducted an empirical study where we orthogonally manipulated semantic distance (close vs. far) and originality (original vs. unoriginal) by the examples provided as part of the task instructions. The results consistently show that semantic distance is a significant cue underlying Originality Judgments. We will conclude by arguing for the need to advance the research of creativity from a meta-cognitive perspective.

A. Koriat

Talking about Reasoning: Where Do Ideas Come from?

I will talk about some old work on creativity. First, I will sketch a general conceptual framework about creativity that distinguishes between two levels of experience and the communication between them. Second, I will report briefly on research, published and unpublished, that explored predictions of that conceptual framework. Finally, I will mention a few examples from my own research experience, which seem to illustrate some aspects of the conceptual framework outlined.

S. Korovkin, A. Savinova, J. Padalka, and A. Zhelezova

Aha! Experience, Elegance of a Solution, and Mental Schemes

Why correct insightful solutions during problem solving are often described as beautiful and elegant? Moreover, some early theorists considered elegance as the inner property of correct solutions. We assume that the basic principle for both Aha! experience and elegance is a scheme encoding of a solution. Elegance is not an evaluation of some objective properties of harmony between elements, but an evaluation of the ease of checking a complex problem based on compact schemes in working memory. The compactness of the schemes allows grasping the entire solution, which is experienced as enlightenment or insight. To provide evidence for this statement, we used the ten-penny insight problem that has two types of solution. The first is a schema type which can be portrayed as a simple shape (a star). The second is an asymmetric type described by a system of rules and restrictions. Two experiments were conducted in which participants were asked to find both solution types and evaluate each of them using Aha! experience scales with an additional elegance scale.

Both experiments indicated that the scheme type solution was rated as more insightful, elegant, and sudden compared to the asymmetric type. In both experiments, we found no significant correlation between elegance and insightfulness. However, we cannot be sure that elegance and insightfulness are independent parameters, or that both parameters are connected by a nonlinear

correlation and depend on many factors in problem solving. This study was supported by a project MD-2164.2022.2.

M. Law and S. Kleitman

Capturing and Validating Novel Metacognitive Metrics of Relevance to the Meta-reasoning Framework

Metacognition and reasoning are among key factors to good decision making (e.g., de Bruin, Parker & Fischhoff, 2007; Kahneman & Tversky, 2013; Kleitman & Stankov, 2007). Based on the meta-reasoning model (Ackerman & Thompson, 2017), metacognition and cognition are interlinked; with metacognitive processes overseeing and regulating reasoning. By monitoring feelings of certainty and uncertainty, individuals can determine whether to provide an answer, as well as change or terminate their reasoning process. This talk will summarize the results of two studies (N=176 and N=370), each using the individual differences approach to operationalize several different constructs postulated in the Meta-reasoning model (Ackerman & Thompson, 2017).

We investigated individual differences in feelings of confidence (how certain are you that your answer is correct?) and uncertainty, based on 'I don't know' and termination responses. Different metrics of uncertainty judgements were captured—frequency of giving up and response time. These metrics were used to determine different profiles of giving up tendencies based on their termination responses being either reflective or intuitive. The results also indicated that frequency of giving up appears to be systematic across tasks, defining a Giving Up Factor which is distinct from the metacognitive Confidence trait and Cognitive Ability. Furthermore, there appear to be both internal (i.e., individual differences) and external (i.e., task characteristics) variables that affect giving up tendencies (frequency and duration).

Evidence for the predictive validity of Giving up tendencies on general decision-making and academic performance was mixed. The implications of the proposed measurement model and these results are discussed.

N. Yu. Lazareva and I. Yu. Vladimirov

The Influence of Mental Set on the Emergence of Insightful Solution

A fundamental problem of the psychology of thinking is the problem of the influence of past experience on creative thinking. According to the theory of S.Ohlsson, the key moment in the insightful solution is the impasse, which arises due to the construction of an incorrect initial representation of the problem (Ohlsson,1992). According to the number of study results, it can be assumed that fixedness on a solution's certain principle affects the emergence of an insightful solution. Apparently, fixedness on the wrong solution strategy creates an incorrect representation of the problem, leading to the impasse, which then needs to be overcome insightfully. The purpose of our research is to study the influence of fixedness on the incorrect representation formation and the insightful solution emergence.

Method:

Participants: 40 subjects.

Hypothesis: 1) the insight assessment in the conditions of fixedness formation will be significantly higher than in the conditions without fixedness; 2) additional cognitive load will interfere with the fixedness formation and there will be no differences in the insight assessment between conditions with and without fixedness.

Stimuli:

- Modified Luchins' water-jar problems for mental set formation (Luchins,1942).
- Specialized dual-task battery for prevent mental set formation.
- Post-experimental questionnaire (Novick,Sherman,2003) for insight assessment.

Results:

Critical problem (extinction problem) after mental set series is assessed as significantly more insightful than after no mental set series ($U=79.5, p=0.02, \text{rank correlation}=0.6$).

There are no significant differences in the insight assessment of the extinction problem in conditions of simple and complex additional cognitive load. Both hypotheses were confirmed.

N. I. Loginov, V. F. Spiridonov, A. V. Ammalainen, and V. V. Ardislamov

Framework for CRA Problem Solving: The Metacognitive Switchers Theory

The current state of affairs in the research area of problem solving forms a request for complex models, that is, theoretical constructions that are not a local explanatory model of one cognitive mechanism, but a framework structure that would include a whole complex of interacting mechanisms that affect behavior in the process of problem solving. The existing high-level theories that should offer such framework constructions currently have several significant drawbacks.

Existing theoretical constructions either describe the problem solving process in an excessively specific language that does not correspond well with models of other cognitive processes, or vice versa loses the specifics of thinking and reduces the solution of problems to a simple combination of basic processes. We will try to discuss how such models can be built for the compound remote associate problems (CRA, RAT).

Modern models of problem solving should take into account, on the one hand, that the same problem can be solved in different ways, and also that the solution process itself is not homogeneous and is divided into different stages. These two key points push us to describe the process of solving a problem as a tree of possible ways of solving, in which switching between branches of this tree allows you to move from one stage to another. The research question about the mechanisms of switching from one stage of the solution to another allows us to formulate a hypothesis about the existence of specific metacognitive mechanisms necessary for this.

As part of the report, we plan to discuss a special class of mechanisms from the area of Meta-reasoning that allow solvers to move from one stage of the solution process to another and, accordingly, switch between problem solving modes.

F. N. Markin and I. Yu. Vladimirov

The Time it Takes to Solve an Insight Problem Does Not Affect the Aha-experience Unlike Feedback

This study of the aha-experience in an insight solution depending on the time spent on the problem and the type of feedback.

32 participants solved text insight problems assessing their proximity to the solution and reported their aha-experience. First, we determined the standard task solving time (ST) for each participant (average time for solving 2 tasks without intervention). Further, the time for solving problems was limited: in half of the cases, after 1/2 ST, in the other half, after ST-10 seconds. Only half of the questions were answered. The experimenter presented answers to only half of the problems. After solving each problem, the participants answered the aha-experience questionnaire, which consisted of scales: pleasure, suddenness, surprise, relief, confidence, and drive (Danek et. al., 2016) + change of representation and wit. Every 15 seconds, participants rated their proximity to a solution (warmth rating, Metcalfe et. al., 1987).

Results. The type of feedback (solving without intervention / the experimenter gave the answer / the solving without feedback) has a significant impact on aha-experience: $F(126, 2) = 53,467$; $p < 0,001$; $\eta p^2 = 1$. The duration of the solution (1/2 ST / ST-10 seconds) does not affect the aha-experience scores. The combined influence of the type of feedback and the duration have a significant impact effect only on wit: $F(126,2) = 3,471$; $p = 0,034$; $\eta p^2 = 0,64$.

Warmth rating: two patterns can be distinguished – with and without the presence of the dynamics of assessments, the average answers are low. Consequently, the aha-experience is a complex reaction, reflecting both the very receipt of the answer and the effort expended on solving the problem.

L. McCaughey and K. Fiedler

Meta-Cognitive Processes in Adapting to Information Search Costs Before Decisions

Decisions are almost always preceded by information search aimed at finding the option that is most preferable. How much information people search for before making a decision should depend on how costly the information is and how valuable the potential outcome is. However, it is also influenced by how sure people want to be that they are choosing the better option – their aspired confidence level. Presumably, the confidence level is an important aspect of regulating the amount of information searched for before a decision.

In an attempt to disentangle evidence and confidence levels we conducted an experiment, in which 100 participants made binary decisions based on self-truncated information. In the first phase, one condition received feedback that was distorted to be more negative to make participants feel less confident about their ability to identify the better option.

The other condition received accurate feedback. In the following phase, both conditions worked through 56 decisions without any feedback reporting their confidence after each.

As expected, the distorted-feedback condition collected significantly more information than the control condition, on average. Nevertheless, the distorted-feedback condition also reported significantly lower confidence levels than the control condition and tended to truncate their decision at a very similar amount of evidence. A regression revealed that higher evidence was positively correlated with confidence for both conditions, but the distorted-feedback condition needed more evidence to reach the same confidence level as the control condition.

Hence, situational influences may influence how much evidence we need to reach an aspired confidence level in addition to influencing that confidence level directly to help us adapt.

I. Newman and V. Thompson

Judgments of Difficulty in a Perimeter Comparison Task

Problem solving begins with an initial assessment of the problem: a metacognitive judgment of its difficulty or solvability. The surface cues of the problem that are

available to a problem solver for these judgments of difficulty can be reliable or misleading. In the shape comparison task, the goal is to select, of two geometric shapes, which has the longer perimeter. On this task, participants will often apply a more A – more B rule: the shape with a larger area must also be the shape with the longer perimeter. There are a variety of reliable and misleading cues to the solution in the shape comparison task, but little is known about whether metacognitive judgments of difficulty are sensitive to these cues. The relative area difference of the two shapes is a misleading cue, as a larger area does not always equate to longer perimeter. One reliable cue is the relative perimeter difference of the two shapes within a trial, where the larger the difference, the easier it is to discern which shape has the larger perimeter. The visual complexity of the shapes may be a salient visual cue to difficulty. A square or rectangle (flat sides) is of low complexity with an easy to calculate perimeter. An uneven shape with few or no flat sides could be considered as high complexity.

Other visual cues like similarity or symmetry of shapes could serve as a similar visual cue that problem solvers rely on for their initial judgments. In this talk, I will discuss a shape comparison experiment where problem solvers made prospective judgments of difficulty. Our goal was to investigate which cues were problem solver sensitive, both reliable and misleading, and whether these cues influenced the probability of selecting the correct solution. Our results suggest that people base their judgments of difficulty on relative perimeter and relative area (both of which predict solution success), but also on relative complexity (that does not predict solution success).

Z. A. Purcell, A. Roberts, S. Howarth, and S. J. Handley

The Eye's Mind: Gaze and Pupil Dilation Expose Implicit Metacognitive Awareness of Logical Structure

Our beliefs can affect our ability to reason logically, resulting in what is known as Belief Bias. According to the Logical Intuition Dual Process account of thinking, reasoning based on both the believability and the logical validity of an argument can occur at a fast and intuitive (i.e., Type-1) level of processing.

Although research demonstrates that beliefs often ‘win out’, leading to erroneous responses, recent evidence shows that we are not only sensitive to the logical structure of an argument but also to potential conflict that occurs between validity and belief. It is theorised that, in some instances, conflict detection engages reflective (i.e., Type-2) processing, which allows us to override the Belief Bias effect. Somewhat paradoxically, evidence substantiating instances of implicit Type 1 processes, including the measurement of conflict detection, is obtained through some form of explicit Type 2 judgment by the participant (e.g., endorsement rates, accuracy, and response latencies). Using syllogistic reasoning tasks and physiological measures – gaze movements and pupil dilation – we examine whether people are sensitive to logical structure despite giving belief-based responses. Our results provide largely consistent evidence that people are sensitive to logical structure, they suggest that people have implicit metacognitions about conflicting information, and they contribute to the growing body of research using eye movements and pupil dilation to help us understand the mind.

B. H. Richardson, L. J. Ball, Z. D. Hughes, and J. E. Marsh

Partial Metacognitive Awareness of the Disruption to Insight Problem Solving Caused by Task-Irrelevant Sound

Two experiments explored the impact of auditory distraction (to-be-ignored speech) on problems that are typically solved through insight processes. Experiment 1 demonstrated that the solution to compound remote associates was impaired by the presence of meaningless speech with additional disruption from meaningful speech as compared with quiet. However, Experiment 2 demonstrated disruption to Rebus puzzle solutions only from meaningful speech as compared with meaningless speech and quiet. In both experiments, participants were asked to prospectively rate the extent to which they believed they would be distracted by meaningful speech and by meaningless speech. After each problem-solving trial participants were also asked to judge whether the auditory distraction had benefited or disrupted their performance. In Experiment 1, participants correctly judged that the presence of speech, regardless of its meaning, would disrupt their problem-solving performance. However, they failed to demonstrate any prospective or retrospective metacognitive awareness of the greater disruption caused by meaningful speech over meaningless speech.

In Experiment 2, participants incorrectly judged that the presence of speech, regardless of its meaning, would disrupt their problem-solving performance, whereas it was only the meaningful speech that was disruptive. Implications of these findings are considered in the context of theoretical accounts of metacognitive awareness in the presence of distraction during problem solving.

Y. Sidi

Investigating Mental Effort Appraisals in Problem-solving from a Metacognitive Perspective

It is well-established that metacognitive monitoring of performance (e.g., confidence in provided answers) is based on heuristic cues rather than on actual success in the task. Mental workload is commonly measured using subjective self-reports regarding the difficulty of each task item or the perceived amount of mental effort invested.

Notably, these two measures differ in the subject of evaluation: whereas difficulty items refer to the task, mental effort items ask for reflection about the process. In the present study we aimed to examine the underlying bases and the validity of difficulty and mental effort appraisals in problem-solving tasks by applying metacognitive concepts and paradigms. In three experiments participants faced misleading verbal logic problems and two non-verbal reasoning tasks. In a between-participant design, facing each task item was followed by either difficulty, mental effort, or confidence appraisals. We examined the associations between the various appraisals, response time, and success rates. Consistently across all experiments, we found that difficulty and mental effort appraisals were associated more strongly than confidence did with response time. Further, while all appraisals were highly predictive of solving success, the strength of this association was similar for difficulty and confidence appraisals, which were stronger than predicting success by mental effort appraisals.

We conclude that difficulty and mental effort appraisals are prone to misleading cues like all other metacognitive judgments and based on different underlying processes. These findings challenge the accepted notion that mental effort appraisals can serve as pure reflection of mental workload.

H. W. Strudwicke, M. W. Christian, J. McLean, O. R. Burton, and N. Weber

Bayesian Evidence for Differences Between Fast and Slow Correct Responses on the Cognitive Reflection Test

Research has found that the Cognitive Reflection Test (CRT) predicts several individual difference factors, such as cognitive ability, numeracy, and actively open-minded thinking. The CRT has also been linked to lower paranormal belief and more accurate reasoning and metacognition during reasoning (i.e., meta-reasoning). While some researchers posit that the CRT derives its predictiveness in terms of meta-reasoning through incorrectly cued intuitive responses, recent studies have found that correct answers on similar problems are often arrived at rapidly and intuitively. Thus, error-correction is not always required. We investigated whether fast-intuitive correct responses predominate in a two-response version of the 7-item CRT.

Further, we tested whether the two types of correct responses (i.e., fast-intuitive and slow-deliberative) differentially predict the above individual difference factors, paranormal belief, and reasoning and meta-reasoning on two heuristics-and-biases tasks. In our two-response CRT, participants responded to each item twice – an initial response under time pressure and a final response without time pressure. Correct responses at both stages signalled fast-intuition, whereas an initially incorrect response and correct final response signalled slow-deliberation. We found a greater proportion of fast-intuitive versus slow-deliberative correct answers. Bayesian analyses revealed that slow-deliberation (vs. fast-intuition) differentially predicted greater open-mindedness, lower paranormal belief, more accurate reasoning, and more calibrated meta-reasoning. In sum, although fast-intuitive responses make up a larger proportion of correct answers, our findings indicate that slow, deliberative meta-reasoning may drive the CRT effect.

M. E. Toplak

The Actively Open-Minded Thinking Scale: Individual Differences in Willingness to Consider Alternative Evidence

The Actively Open-Minded Thinking (AOT) scale measures how much individuals are willing to consider alternative opinions and to process evidence that is

contradictory to their current beliefs. AOT is a thinking disposition that is conceptually and empirically separable from cognitive ability. The AOT scale is a strong predictor of performance on heuristics and biases tasks. It can often predict unique variance in these tasks even after statistically controlling for cognitive ability. The AOT scale has been the strongest and most consistent predictor of performance on heuristics and biases tasks, relative to other thinking disposition measures in the literature. It is conjectured that the AOT is such a good predictor of performance on heuristics and biases tasks because it taps important processes of cognitive decoupling. These processes aid in many rational thinking tasks because many paradigms are designed to elicit response conflict. The talk will also discuss the paradox that although AOT scales are potent predictors of performance on most rational thinking tasks, they do not predict the avoidance of myside thinking.

M. Undorf and R. Ackerman

Making Confidence Judgments Does Not Affect Problem-Solving Performance: Evidence from Verbal, Numerical, and Visual Tasks

A growing literature shows that making metacognitive judgments during learning affects memory. In contrast, very few studies have examined reactive effects of providing confidence judgments in problem-solving tasks. In the seven published and unpublished experiments reported here, participants either indicated or did not indicate their confidence in their solutions to verbal (Experiments 1 and 2), numerical (Experiment 3), and visual (Experiments 4 to 7) problems. Making confidence judgments increased success rates in one experiment, decreased success rates in another experiment, and did not affect success rates in the remaining experiments. Meta-analyses of the current experiments revealed no reactivity for success rates, problem-solving times, or problem-solving efficiency. These results indicate that making confidence judgments does not affect problem-solving performance.

T. van Gog

Calibrated and in Control: Improving Students' Self-regulated Learning in STEM-domains

Engaging in self-regulated learning of problem-solving tasks in STEM-domains requires that students are calibrated (able to monitor/assess their own performance) and in control (able to select a new task that is suitable given their performance, i.e., is within their zone of proximal development). My team has developed an effective method for training students' self-assessment and task-selection skills, based on video modeling examples. Students who received this training prior to engaging in a self-regulated learning phase (in which they had to choose 8 tasks themselves), performed better on a subsequent posttest than students in a control condition (Kostons et al., 2012; Raaijmakers et al., 2018a). However, there was substantial variability in the effectiveness of the training for students in the training condition, and room for further improvement of the training. A first attempt at further improving the training by providing feedback on students' self-assessment accuracy (a pre-condition for accurate task selection) proved unsuccessful (Raaijmakers et al., 2019). Moreover, there are mixed findings as to whether students are able to transfer the trained self-assessment and task-selection principles to other types of problem-solving tasks or contexts (Raaijmakers et al., 2018a, 2018b). In a new project, that I would like to discuss and get the attendees' input on during this presentation, we will start to tackle these important issues, looking into individual differences (self-efficacy), and cognitive, affective, and social processes that might influence the uptake of feedback and the ability to transfer.