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Editorial

Dear Readers,

We begin this edition with an article by alumnus Rasmus Bruckner, FU Berlin. Rasmus met his co-author Matt Nassar, Brown University, when he was a student assistant working with former LIFE faculty Shu-Chen Li at MPIB and Matt spent time there. Ever since, they have collaborated on various projects. They now introduce computational approaches to psychiatry and aging research and present their own work in this field.

Our next article is by alumnus Martin Dahl, MPIB & University of Southern California. He is collaborating with Mara Mather and LIFE alumnus and faculty Markus Werkle-Bergner and presents their work on the locus coeruleus, a tiny cell cluster in the brain stem, and its role in attentional processes, which has consequences for cognition in old age.

Berlin fellow speakers Michael Geers and Sina Schwarze then provide a report on the Fall Academy that was carried out as a hybrid event, with fellows and faculty from the European LIFE sites attending in person while their peers from the US sites took part online. A commencement event was also possible for this year's new PhDs from Berlin and Zurich. We recommend reading the fellows' abstracts because they showcase the breadth and depth of research being carried out in LIFE.

UM faculty Kai Schnabel Cortina then answers our traditional 10 questions before we introduce Iyad Rahwan and Bernhard Spitzer, new LIFE faculty at MPIB. We also welcome five new fellows to LIFE, two in Berlin and three in Ann Arbor. The list of publications by fellows (and selected ones by alumni) is followed by the latest LIFE news. One item is that UVA alumnus Matt Lerner is this year's winner of the LIFE Outstanding Alumni Award.

Many thanks to all contributors! Stay healthy and enjoy the upcoming holiday season!

Julia Delius

Berlin and Zurich fellows particpating in the Fall Academy 2021 in Zurich

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Reminder

Fellows, alumni, and faculty, please keep us informed about your LIFE-relevant news (e.g., awards, career moves)! Fellows and alumni, please check that your web profiles are up-to-date—they are often the first thing that pops up when your name is googled! Send your updates to delius@mpib-berlin.mpg.de

LIFE Website: https://www.imprs-life.mpg.de

Computational Psychiatry and Aging Research: Building Bridges Between Brain, Cognition, and Application

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Cognitive neuroscience seeks to understand the neurobiological foundations of human cognition by conducting behavioral experiments and measuring brain activity using tools such as fMRI. The field faces several challenges due to the complex relationship between brain, cognition, and behavior. Both neural and behavioral data can only indirectly reveal the cognitive mechanisms underlying mental abilities such as perception, learning, and decision making. Therefore, cognitive neuroscience needs testable theories that render the invisible relationships between the brain, cognition, and behavior visible (Gershman, 2021).

A computational perspective can offer valuable methods to formulate such theories. This perspective holds that the distinct function of the brain is computation, that is, translating sensory information into beliefs and ultimately behavior by constantly re-calibrating how newly arriving information is processed based on prior experiences (Huys et al., 2021). Computational models provide formalized theories on how these computations unfold over time and make testable predictions about the underlying brain processes and the resulting human behavior.

In the past decade, research has begun translating ideas from computational cognitive neuroscience in healthy younger adults to the field of psychiatry and lifespan research. This new approach is often referred to as computational psychiatry and computational aging research, and to date, several initiatives, including the *Max Planck UCL Centre for Computational Psychiatry and Ageing Research* (https://www.mps-ucl-centre.mpg.de), have established computational psychiatry units.

Here, we will provide an overview of this nascent field of research by highlighting new insights in the domains of perception, decision making, and learning. We will first show how these distinct cognitive abilities can be approached from a common computational perspective. From this point of view, biases in cognitive computations can lead to psychopathological symptoms or age-related cognitive deficits. Through examples, we then illustrate how computational models can be applied to identify such computational biases and linked to cognitive malfunctions. Finally, we briefly discuss the potential of computational modeling to develop new precision-psychiatric tools that improve therapeutic interventions.

Predicting the future from past experiences

From a computational perspective, perception, decision making, and learning can be framed as a prediction problem, where our past experiences determine our predictions about the future (Friston et al., 2014; Niv & Schoenbaum, 2008). Concerning perception, the idea is that we do not passively process sensory inputs but actively interpret and classify sensory information based on what we expect to perceive, especially when sensory information is uncertain. Such expectations or predictions, in turn, are assumed to be the consequence of prior experiences. A well-known example in line with this idea is the human tendency to detect faces in paintings and pictures (Figure 1), which may arise from strong expectations due to the ubiquity and importance of faces in everyday life. Thus, even though a picture might not actually show a face, our visual system nudges our interpretation of visual input towards facial patterns (Friston et al., 2014).

Decision making and learning from reward and punishment can be approached from the same prediction perspective. Subsequently, we make choices that we expect to yield a desired outcome. When the choice outcome is revealed, we systematically compare the actual outcome to the predicted outcome to quantify the so-called

Figure 1. Sisyphus (2021) by Ukrainian artist Oleg Shupliak. Humans show a strong tendency to see faces in paintings and pictures. From a computational perspective, this might result from strong *a priori* expectations to see faces in everyday life.

Source: Image reproduced with permission from Oleg Shupliak (cf. https://www.shupliak.art/).

prediction error indicating how accurate our prediction was. Finally, we learn from the prediction error by updating our prediction accordingly. For example, when we visit a restaurant for the first time and lack knowledge about the quality of the offered dishes, we can learn by trial and error how much we like each dish. When observing that a dish is worse than expected, we can utilize the error to adjust our expectations about the dish for the future.

In the following, we will show how psychopathological and age-related changes in these abilities can be interpreted as computational biases, which might help us better understand hallucinations in schizophrenia and altered learning under anxiety and across the human lifespan. Our aim here is not to provide a comprehensive review of the literature but to introduce how computational modeling can be applied to different psychiatric disorders and lifespan questions. For a comprehensive review, we refer to Huys et al. (2021).

Schizophrenia

Schizophrenia is a psychiatric disorder characterized by positive symptoms, most notably in this context, delusions and hallucinations, and negative symptoms such as diminished emotional expression. The *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* defines delusions as "fixed beliefs that are not amenable to change in light of conflicting evidence" (American Psychiatric Association, 2013, p. 87), for example, that one's private thoughts are being transmitted to others. Hallucinations, on the other hand, are defined as unwarranted perceptual experiences in the absence of an external stimulus, for example, hearing voices. Computational psychiatry provides a framework for investigating and understanding the neural mechanisms giving rise to these phenomena.

For example, one recent study conducted by Powers and colleagues (2017) applied computational modeling to behavioral and neuroimaging data to better understand auditory hallucinations in patients with psychotic illness. The key assumption of the underlying computational framework was that our brain actively generates our perceptual experience by combining expectations about what we will perceive and actual sensory input, as described above (Friston et al., 2014). Applying this perspective to hallucinations, the authors derived the hypothesis that auditory hallucinations might be the consequence of overly strong prior expectations that cause a conscious percept despite the absence of actual auditory input.

To test this hypothesis, the authors induced conditioned hallucinations in participants using an audio-visual tone-detection task. Participants were asked to detect a quiet tone that was occasionally presented simultaneously with a visual cue. Initially, the tone was frequently presented above participants' detection thresholds to establish a learned association between visual cues and tones. After that, visual cues were still shown, but tones were more often absent, and when tones were presented, they were quieter such that participants were less likely to detect them.

Strikingly, this procedure reliably induced conditioned auditory hallucinations, occurring when participants reported hearing a tone in response to the presentation of the visual cue without a detectable tone. This conclusion was supported by neuroimaging results indicating an overlapping activity pattern of truly perceived and hallucinated tones. Crucially, the authors compared different groups, specifically people with a diagnosed psychotic illness who reported hearing voices and matched healthy controls. Indeed, the group of patients showed significantly more conditioned hallucinations.

Computational modeling analyses provided a mechanistic explanation for this pattern of results. The authors applied an established learning model capturing how people updated their beliefs about the cue–tone associations across trials. Within this model, hallucinations emerged from the learned association that cues predicted tones established at the beginning of the experiment. On later trials, the cues did not reliably predict tones anymore (either because absent or below threshold), but participants still relied on the previously learned association and, therefore, experienced hallucinations.

In line with the prediction perspective sketched above, the model assumed that participants updated their beliefs about the association based on their prediction errors indicating the difference between presented and expected tones. An essential source of interindividual learning variability is the rate at which we utilize prediction errors to update our future predictions, which is often referred to as the learning rate in computational modeling. In order to extract an individual computational profile of each participant, the study estimated several free parameters of this model governing the individual learning dynamics of the cue–tone association. A key parameter of this model that influenced the learning rate reflected the degree to which a participant relied on their prior expectation about the cue–tone association versus new tone and no-tone trials. Larger parameter values were indicative of lower learning rates. That is, they reflected that participants relied more strongly on their prior expectations and updated their expectations less in the experimental phase with infrequent and quieter tones.

Adaptive perceptual computations are characterized by predictions reflecting a reasonable balance of prior expectations and new perceptual information. Therefore, healthy controls showed parameters in the lower range, i.e., their prior expectations about cue–tone associations had a weaker influence on their predictions than the most recent perceptual input. In effect, after the first phase of the task, when cues did not reliably predict tones anymore, these participants relatively quickly predicted fewer tones when visual cues were presented and consequently experienced fewer conditioned hallucinations. In contrast, patients that reported hearing voices displayed higher parameters, indicating that they relied more strongly on the previously learned cue–tone associations, which increased the occurrence of hallucinations.

Taken together, this work demonstrates that computational models can be relevant to all stages of a cognitive neuroscience study. Computational frameworks such as the prediction perspective sketched above can be used to derive novel hypotheses about the origin of psychiatric symptoms and guide experimental design to test these questions. Computational models can also act as data-analysis tools that describe and quantify useful variables that explain psychological phenomena, such as how prior perceptual expectations can trigger hallucinations in patients with psychosis. Finally, these variables can be linked to neural measures to better understand the neural underpinnings of these effects.

Anxiety

We now turn to an example about learning in anxious individuals, where dysfunctional learning behavior may be related to similar sorts of computational biases. The way we learn from reward and punishment substantially determines our predictions about future events. For example, experiencing an aversive event such as a car accident or an injury initiates a learning process updating our expectations about the probability of a similar negative event in the future. Before the injury, we might have predicted a low chance of having an accident, but in the aftermath, we experience an aversive prediction error indicating that we mispredicted the injury.

Some individuals might more or less ignore the prediction error, reflecting a low learning rate, and if so, they will still predict that accidents are improbable. These individuals might believe that their accident was an unfortunate exception that should not change their minds about similar events in the future. In contrast, others might more strongly consider the prediction error through a high learning rate and update their predictions so that they subsequently expect more accidents. How are these computations linked to anxiety?

Recent work by Aylward and colleagues (2019) provided evidence for the hypothesis that individuals with anxiety present particularly high learning rates for negative events, causing them to update their predictions about negative events more strongly in response to prediction errors. The majority of the study participants had a mixed diagnosis of generalized anxiety disorder and major depressive disorder. Moreover, all participants were unmedicated at the time of the study (and minimally six months before).

The experimental task was a so-called four-armed bandit task, a frequently used paradigm in computational modeling studies on learning and decision making. In each trial, participants were required to choose one of four slot machines that differed in their probability of returning a positive or negative outcome, in this case, pictures of happy versus fearful faces. The participants aimed to select the slot machine with the highest probability of generating a positive outcome, i.e., a happy face.

The computational model that turned out to best describe participants' learning behavior was a Rescorla-Wagner model, which updated its predictions about future outcomes based on prediction errors as described above. A central feature of this model was the distinction between learning rates for positive and negative outcomes. That is, the model updated its predictions about future outcomes differently in response to positive and negative outcomes. The magnitude of the two learning rates was estimated for each individual, yielding insights into whether they systematically showed higher learning rates for negative compared to positive outcomes. Indeed, a systematic comparison of the anxiety group and healthy controls showed higher learning rates for negative outcomes in the anxiety group but comparable learning rates for positive outcomes.

Taken together, this study provides a formalization of the intuition that individuals with anxiety seem to update their future predictions more strongly in response to negative feedback. This oversensitivity to aversive outcomes might turn out to be an important computational mechanism explaining why anxiety is associated with an overestimation of adverse events.

One interesting and open question arising from this work is why anxious individuals might learn more rapidly from negative events. Recent computational modeling and behavioral work suggest that such a policy for faster learning from negative outcomes could emerge if negative outcomes do tend to be good predictors of future outcomes, which is true in some statistical environments, but not others (Nassar et al., 2019; Yu et al., 2021). Could anxiety be provoked through specific types of environments in which aversive outcomes have higher predictive validity? Future work in the computational psychiatry of anxiety will almost certainly address this question.

Lifespan development

Our own research has taken a computational approach to study learning under uncertainty across the lifespan. It is well known that older adults show difficulties in experience-driven learning, especially when outcomes are uncertain. From a computational perspective, such difficulties might arise from aberrant adjustments of the learning rate through which older adults update their predictions in response to errors, similar to the results on anxiety discussed above or learning about our preferred dishes in a restaurant.

In a previous study, we dissociated several potential computational biases that might affect the adjustment of learning rates in older adults more strongly than in younger adults (Nassar et al., 2016). To this end, we applied a learning task that allowed for the dissociation of distinct computational factors related to uncertainty, surprise, and individual assumptions about the changeability of the environment.

The task was framed in an intuitive cover story where a helicopter hovering in the sky dropped bags that had to be caught in a bucket. It challenged our participants in several ways. First, the exact location of the dropped bags was uncertain due to "wind" in the cover story, whereby each bag landed somewhere near the helicopter but not immediately underneath. Second, the helicopter occasionally changed its position, which required a strong bucket adjustment toward the new location. Finally, the helicopter was invisible, meaning participants had to learn its location from trial and error. This learning process was driven by prediction errors (difference between actual and predicted bag location), where learning rates were ideally lower on trials where the helicopter kept its position and higher after a change in the location.

We developed a computational model based on predictive inference (Nassar et al., 2010) that simulated potential computational phenotypes that we hypothesized to underlie learning impairments in older adults: (1) Difficulties in properly adjusting the learning rate in response to smaller prediction errors due to uncertainty as a consequence of wind; (2) surprise insensitivity, formalizing impairments in response to systematic changes in the helicopter location; and (3) biased assumptions about the overall frequency of systematic helicopter changes.

We then collected behavioral data of younger (20–30 years) and older adults (60–80 years) and analyzed their responses using our model. We found that older adults showed lower learning rates than younger adults in the range of smaller prediction errors mainly due to uncertainty over the bag locations ("wind" in the cover story). At the same time, we found no systematic evidence for learning difficulties due to surprise insensitivity or prior assumptions about the changeability of the environment. Altogether, this study thus identified specific learning rate impairments in older adults suggesting that they insufficiently update their predictions in response to smaller errors.

Following up on this work, we were interested in lifespan differences in learning under uncertainty and tested children (8–12 years), younger adults, and older adults using the helicopter task (Bruckner et al., 2020). We found the same pattern of reduced learning rates for small prediction errors in older adults as in our previous work and observed the same effect in children. Moreover, we discovered that the reduced learning rates were mainly driven by perseverative responses in both children and older adults, which indicates that they frequently repeated their predictions about the dropped bags irrespective of the prediction errors.

We then aimed to reduce perseveration by externally determining where participants started updating their predictions (i.e., by randomly relocating the bucket used to catch the dropped bags on each trial). While this manipulation did eliminate perseverative responses in children and older adults, it did not improve their performance and instead increased their deficit relative to young adults. In this case, performance differences were driven by environmental influences: predictions of children and older adults were strongly biased by the externally determined starting value of their predictions. Both increased perseverative responding and an overreliance on available external cues have previously been found in children and older adults (Craik & Bialystok, 2006; Lindenberger & Mayr, 2014; Munakata et al., 2012; Ridderinkhof et al., 2002). However, how can we explain these seemingly contradictory effects in a unifying computational framework?

While we were unable to provide a unified explanation with our original predictive inference models, the discrepant results across the two task conditions led us to consider the dynamics with which individuals updated beliefs in response to a new piece of information. For example, when confronted with a prediction error (worse-than-expected dish at my favorite restaurant), I might iteratively adjust my belief (e.g., about the quality of the restaurant) until my belief reaches some value that is sufficiently consistent with the newly observed data (this restaurant provides good food most of the time). A key advantage of this idea is that it might allow me to minimize the computational cost of belief updating—rather than evaluate the consistency of all plausible beliefs with the observed data, I only need to consider a few—and the lower that I set the bar for "sufficiently consistent" the fewer possible beliefs I need to evaluate.

Based on this idea, we developed a new computational model that captures the opposing pattern of results. We argue that both groups rely on a satisficing strategy, which is a coined word that stands for "satisfy" and "suffice" (Simon, 1956). As in the example, children and older adults update their predictions until reaching a criterion value at which predictions are good enough, but not necessarily as accurate as possible. When the updating process begins at a previously predicted location, the initial location is often above the satisficing criterion, indicating that the prediction is sufficiently accurate, resulting in perseveration. In contrast, predictions are outside of the criterion when the updating process starts from an externally determined location. Therefore, participants update their predictions but stop updating when reaching the criterion, which leads to a small but consistent bias toward the externally determined initial location.

A critical factor that might determine the satisficing criterion could be the amount of cognitive resources available for learning. Lower cognitive resources in children and older adults might lead to more satisficing in order to solve a trade-off between accurate predictions and invested resources. Therefore, placing satisficing into a learning framework provides a promising basis for future computational studies on learning under uncertainty in the face of limited cognitive resources across the lifespan or different pathological groups.

Future considerations

Based on three examples, we have introduced computational approaches to psychiatry and aging research. The key to this perspective is that the brain is a computational organ that constantly processes new information to form beliefs about the environment that guide our behavior. Consequently, biases in such computational functions can manifest in mental illness and age-related cognitive impairments.

This emerging field of inquiry hopes that insights into the computational mechanisms underlying mental dysfunctions ultimately lead to precision-psychiatric benefits and person-specific psychological interventions. A promising approach links mediators of treatment effects of cognitive-behavioral therapy to computational cognitive models to better understand the targets of such interventions (Reiter et al., 2021). Moreover, it could be possible to use computational methods to improve assistive technology in adulthood and old age by studying under which conditions resource demands can be reduced and cognitive benefits can be maximized (Lindenberger et al., 2008). Future work examining these questions will certainly benefit from a longitudinal approach to capture how such interventions affect the respective cognitive computations over time.

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Winner of the

LIFE Outstanding Alumni Award 2021

Matthew D. Lerner

UVA alumnus, now Associate Professor Professor of Psychology, Psychiatry, & Pediatrics, at Stony Brook University.

He will receive the award and give a lecture at one of the next LIFE academies.

Congratulations, Matt!

Selected Publications

Mayor Torres, J. M., Clarkson, T., Hauschild, K. M., Luhmann, C. C., Lerner, M. D., & Riccardi, G. (2021). Facial emotions are accurately encoded in the brains of those with autism: A deep learning approach. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. Advance online publication. https://doi.org/10.1016/j.bpsc.2021.03.015

Gates, J. A., Kang, E., & Lerner, M. D. (2017). Efficacy of group social skills interventions for youth with autism spectrum disorder: A systematic review and meta-analysis. *Clinical Psychology Review, 52,* 164–181. https://doi.org/10.1016/j.cpr.2017.01.006

Mendelson, J. L., Gates, J. A., & Lerner, M. D. (2016). Friendship in school-age boys with autism spectrum disorders: A meta-analytic summary and developmental, process-based model. *Psychological Bulletin, 142*(6), 601–622. https://doi.org/10.1037/bul0000041

How the Brain's Blue Spot Shapes Cognition and its Decline in Later Life

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The locus coeruleus, literally the "blue spot", is a tiny cluster of cells at the base of the brain. As the main source of the neuromodulator noradrenaline, it helps us control our attentional focus. Synthesizing evidence from animal and human studies, we—researchers from the MPIB and the University of Southern California—have now developed a novel framework describing how the blue spot regulates our brain's sensitivity to relevant information in situations requiring attention.

Noradrenaline also plays a key role for maintaining cognitive functions in later life. However, the blue spot is vulnerable to changes over the course of the lifespan. For instance, the small nucleus is among the first brain sites to harbor the abnormal tau (the major microtubule-associated protein of a mature neuron) that is related to Alzheimer's disease. To shed light on early mechanisms of disease development, we investigated the blue spot in carriers of mutations that cause Alzheimer's disease. Our findings link the degeneration of the blue spot to memory decline and cortical tau burden and highlight a role for noradrenaline in Alzheimer's disease. For an overview, see Dahl, Mather, and Werkle-Bergner (2021).

Noradrenergic modulations of rhythmic neural activity shape attention

Our attention fluctuates. Sometimes we are distracted and things slip by our awareness, while at other times we can easily focus on what is important. Imagine you are walking home after a day at work; perhaps you are preparing the list of groceries to buy for dinner in your mind—you are in a state of inattentiveness. However, when a car you did not notice suddenly honks, you are readily able to redirect your attention and respond to this new situation (Corbetta et al., 2008).

But how does the brain shift from a state of inattentiveness to one of focused attention? During states of inattentiveness, our brains are governed by slow, rhythmic fluctuations of neural activity. In particular, neural rhythms at a frequency of around 10 Hz, termed alpha oscillations, are thought to suppress the active processing of sensory inputs during inattentiveness (Jensen & Mazaheri, 2010; see Figure 1a). For instance, previous research demonstrated that when study participants engaged in mental imagery (such as putting together their list of groceries), alpha oscillations in sensory brain regions shielded them from external information. However, when the same participants performed tasks that require them to redirect their attention and interact with their environment instead, the alpha oscillations disappeared (Ray & Cole, 1985). Thus, alpha oscillations can be understood as a filter that regulates our brain's sensitivity for external information (Dahl, Ilg, et al., 2019; see Figure 1b). While the link between the waxing and waning of alpha oscillations and attention has been established for some time, less is known about what makes these rhythmic firing patterns come and go.

To approach this question, we focused on the blue spot (locus coeruleus), a tiny cell structure that is located in the brainstem, hidden deep under the cortex. This cell cluster is only about 15 mm in size, but it is connected to most of the brain via an extensive network of long-ranging nerve fibers (see Figure 1a). The blue spot is made up of neurons that are the main source of the neuromodulator noradrenaline. By regulating neural communication, noradrenaline contributes to the control of stress, memory, and attention (Poe et al., 2020).

Due to its small size and its location deep in the brainstem, it was previously almost impossible to investigate the noradrenergic nucleus noninvasively in living humans (Astafiev et al., 2010). Fortunately, over the past years, animal research has revealed that fluctuations in pupil size are linked to the activity of the blue spot. Thus, our eyes can be regarded as a window to a brain region that long seemed inaccessible (Joshi & Gold, 2020; Privitera et al., 2020).

To study whether the blue spot's noradrenaline could be one factor regulating alpha oscillations,

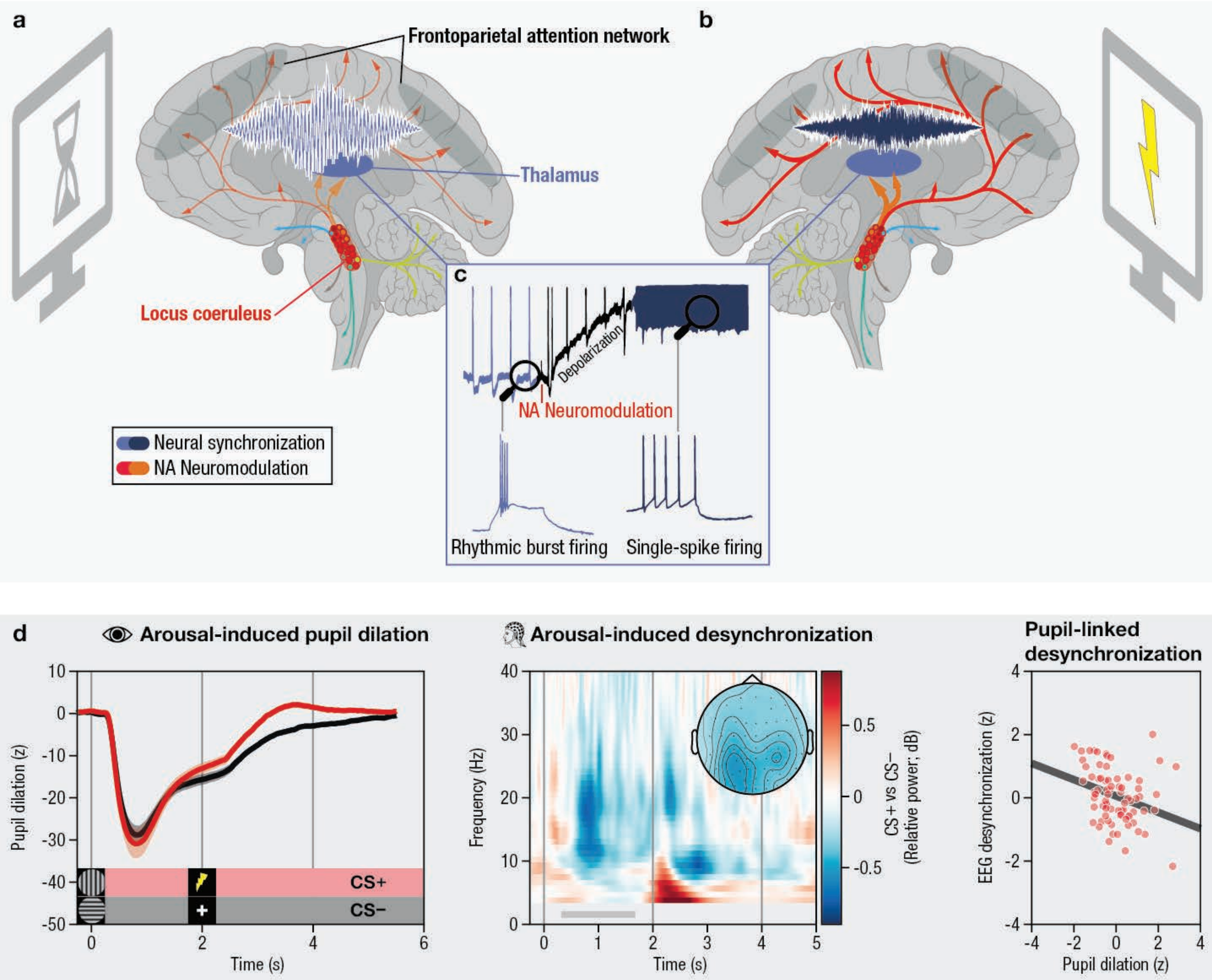

Figure 1. How the blue spot shapes patterns of cortical synchronization during attention.
(a) Via long-ranging axons, the blue spot (locus coeruleus) releases noradrenaline (NA) throughout most parts of the brain, prominently including the thalamus and frontoparietal network (shown in blue, grey, respectively). During states of inattentiveness, cortical networks are governed by slow rhythmic fluctuations of activity (alpha oscillations; light blue) that are generated by thalamic pacemakers.
(b) Situations that require the reorienting of attention are associated with a transient increase in the blue spot's activity. The resulting surge of noradrenaline shifts thalamic alpha generators from a rhythmic firing pattern to a mode of activity that allows for reliable information transfer (single-spike firing; see c).
(c) Alpha oscillations in thalamocortical attention networks disappear and are replaced by high-frequency activity (desynchronization; dark blue), supporting the processing of attended stimuli.
(d) Pupil dilation, an index of noradrenergic neuromodulation, is linked to the desynchronization of alpha rhythms (for details, see Dahl, Mather, Sander, et al., 2020). Left: Arousing, fear-conditioned stimuli elicit a transient dilation of the pupil relative to perceptually matched control stimuli, suggesting heightened activity in the blue spot. Middle: Concurrent assessments of cortical rhythms via electroencephalography indicate a desynchronization in the alpha–beta frequency band. Right: Importantly, larger pupil dilation shows a negative association with alpha–beta rhythms, in line with a role of the blue spot in shaping cortical synchronization during attention.

Credits: Reproduced, with permission, from Dahl et al. (2021).
Sagittal brain section adapted from Patrick J. Lynch under a Creative Commons Attribution 2.5 License 2006.

we combined recordings of pupil size and neural oscillations while participants solved a demanding attention task. As expected, during moments of larger pupil size, indicative of higher noradrenergic activity, alpha oscillations disappeared (see Figure 1d). Moreover, participants who showed stronger pupil and alpha responses were better at solving the attention task. These findings suggest that by modulating alpha oscillations, the blue spot can help us focus our attention (Dahl, Mather, Sander, et al., 2020).

What remained unanswered in this study is how noradrenaline influences alpha oscillations. To address this question, we turned to previous animal research that recorded neural activity directly from neurons in the thalamus, a region in the middle of the brain that functions as a pacemaker of the alpha rhythm. Importantly, the rhythmic firing of these neurons at rest gives rise to the cortical alpha oscillations seen during states of inattentiveness (Jensen et al., 2019). However, adding noradrenaline to these neurons abolishes their rhythmicity (see Figure 1c) (McCormick, 1989; Rodenkirch et al., 2019). Assembling the findings across studies, we were able to describe how noradrenaline and the thalamus might interact to control alpha rhythmic activity: by blocking thalamic alpha generators, the blue spot's noradrenaline regulates our brain's sensitivity to process relevant information (Dahl et al., 2021). Thus, during situations requiring a sudden shift in attention, a surge of noradrenaline helps us refocus—and quickly dodge the approaching car.

In upcoming studies, we plan to assess both the locus coeruleus and thalamus in the same participants to shed new light on the neural mechanisms of attention and its decline in aging and disease.

The blue spot is linked to tau burden and memory loss in Alzheimer's disease

In Germany, like in many western societies, birth rates are decreasing while life expectancies are rising.[1] According to current estimates, this demographic development will double the cases of age-associated neurodegenerative diseases, like Alzheimer's dementia, over the next 30 years.[2]

The cognitive symptoms of Alzheimer's, such as characteristic memory loss, become evident in late adulthood. However, the underlying brain changes already begin decades earlier (Jagust, 2018). Studies examining the brains of deceased indicate that most people show some indicators of Alzheimer's disease, abnormally phosphorylated tau, by the time they are middle-aged. Crucially, this accumulation of abnormal tau starts deep in the brainstem, in the blue spot (Braak et al., 2011). Thus, finding ways to image the blue spot in living people may shed light on the disease development years before the outbreak of cognitive symptom (Betts et al., 2019; Grinberg & Heinsen, 2017).

Fortunately, previous research that combined high-resolution magnetic resonance imaging (MRI) and histology showed that the blue spot can be revealed as a cluster of bright voxels in specialized MRI sequences (Betts et al., 2019; Dahl, Mather, et al., 2019; Keren et al., 2015) (see Figure 2a). To probe the utility of MRI to detect Alzheimer's related changes in the blue spot, we tested participants carrying mutations that cause a rare, inherited form of Alzheimer's as well as family members without the mutation (Bertram et al., 2010; Van Cauwenberghe et al., 2016).

As expected, we observed that the blue spot had lost its characteristic color in participants who showed cognitive deficits due to Alzheimer's disease. In particular, on the MR scans we detected that the blue spot's brightness was lower in symptomatic participants relative to healthy controls (see Figure 2b), which may indicate a degeneration of noradrenergic cells. But we wanted to be sure whether this is really the case. We thus additionally investigated the blue spot in an independent set of people with the same rare mutations who had died and donated their brains for research purposes. Importantly, histological analyses confirmed that the blue spot indeed became pale, an indicator for its substantial cell loss (see Figure 2b). Thus, the histological analyses corroborated a degeneration of the blue spot in Alzheimer's disease.

Finally, to explore the implications of this noradrenergic decline, we linked our MRI marker of the blue spot to estimates of cortical tau burden, a hallmark of Alzheimer's, and episodic memory. We found that a healthier blue spot was linked to lower tau pathology throughout most of the brain

[1] Source: https://www.destatis.de/EN/Themes/Society-Environment/Population/Population-Projection/_node.html

[2] Source: https://www.alzheimer-europe.org/Publications/Dementia-in-Europe-Yearbooks

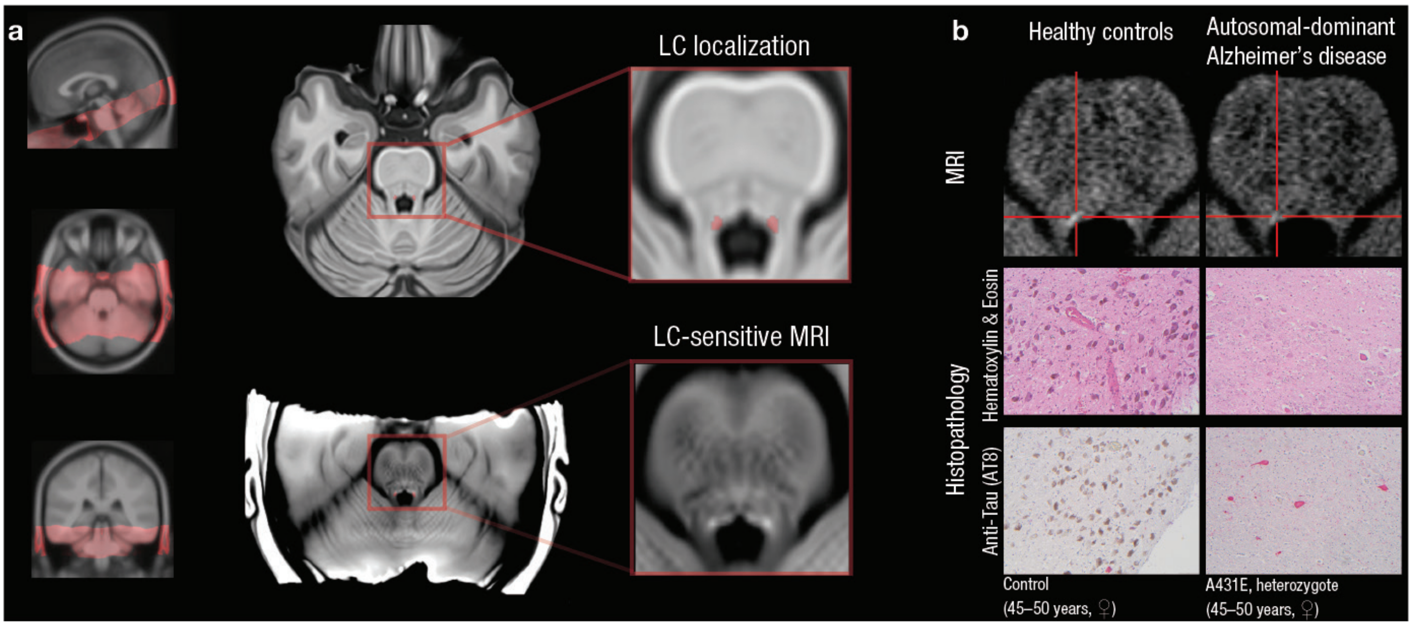

Figure 2. Magnetic resonance imaging of the blue spot in aging and disease.
(a) Left: The red overlay shows the orientation of a typical magnetic resonance imaging (MRI) sequence that is sensitive for the blue spot. Middle: The location of the blue spot is highlighted (in red) on a standard anatomical scan. The specialized locus coeruleus-sensitive sequence below reveals the blue spot as a cluster of bright voxels (for details, see Dahl, Mather, et al., 2019).
(b) In participants showing cognitive decline due to Alzheimer's disease, the blue spot shows a reduced brightness on the MRI images that corresponds to noradrenergic neurodegeneration in histopathological analyses. In particular, hematoxylin and eosin staining reveals that the blue spot becomes pale in Alzheimer's (i.e., absence of the dark, granular neuromelanin). In addition, immunostained slides with anti-tau (AT8) show a higher tau pathology within the blue spot's cells (red).

Credits: Reproduced, with permission, from Dahl et al. (2021).

and maintained memory performance. Taken together, our findings suggest that this small brainstem nucleus plays a big role in the development of Alzheimer's disease (Dahl, Mather, Werkle-Bergner, et al., 2020).

Outlook

In upcoming studies, we plan to follow participants who carry mutations causing Alzheimer's over time to estimate the time point when the blue spot degenerates relative to the onset of dementia symptoms. Taken together, our work highlights how noradrenergic neuromodulation shapes cognition and its decline in later life.

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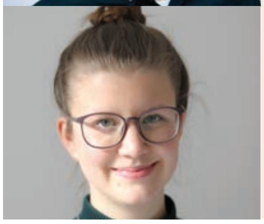

Fellows' Report on the Hybrid Fall Academy in Zürich

Michael Geers[1] & Sina Alexandra Schwarze[2]

Berlin Fellow Speakers

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After three virtual LIFE academies in Virginia, Berlin, and Michigan amid the COVID-19 pandemic, we were very excited to travel to Zurich and finally participate in an in-person academy. Indeed, for many of us, it was the first ever in-person LIFE academy. Not only did we get to meet the Zurich fellows, but we also met many of the other Berlin fellows in person for the first time—like each other, for example.

Most of us Berlin fellows arrived in Zurich on Sunday, October 10, one day before the official start of the academy. Some of us were early enough to enjoy the sunshine and explore the city a bit, before we gathered with Zurich fellows and faculty for a welcome dinner. This gave us the opportunity to not only touch base with other LIFE members, but also to get acquainted with Swiss culture and cuisine.

After a restful night, we started the next morning with a tour of the old town of Zurich and the UZH historic main building organized by the local fellows. On all mornings of the academy, we had time to explore the city and its surroundings and/or to talk about our experiences during our PhD work with the other fellows there. In addition, the mornings provided opportunities for self-organized meetings with the attending faculty to discuss research and other (academic) matters. After 1.5 years of virtual work and conferences, we greatly appreciated these opportunities for informal exchanges and face-to-face conversations with faculty members, and we hope to enjoy these aspects of the LIFE academies again at the next academy with Michigan and Virginia fellows.

The official part of the academy started at 2:30 pm every day to allow virtual attendees from Michigan and Virginia to participate. To kick off this part, faculty members briefly introduced themselves and their research. This enabled us to get a better grasp of LIFE's academic diversity and the opportunities this provides—we look forward to this introduction round becoming a permanent feature of future academies. As fellows, we presented either a talk or poster on our ongoing work (see pp. 19ff. for the abstracts). It was particularly fun to see participants virtually gather around posters via the GatherTown platform, simulating the experience of an in-person conference. These formats provided ample opportunity for scientific exchange among and between fellows and faculty. In fact,

Virtual group photo on GatherTown

Exploring the UZH’s main building

All photos by Michael Geers & Laura Buchinger many of the discussions that started during the Q&A sessions even sparked lively conversations over dinner. Another highlight on the last evening of the academy was the commencement dinner at a beautiful Indonesian restaurant, where the Berlin and Zurich fellows who have completed the program received their LIFE certificate.

While this hybrid format obviously cannot entirely replace the experience of a completely face-to-face academy, we felt that the opportunity to reflect on the academy experience with other fellows and faculty in person was a great advantage over the earlier, entirely virtual academies.

In closing this article, we would like to express our warmest thanks to Alexandra Freund, the Zurich fellows and faculty, and all the other organizers who made our stay in Zurich such a unique and memorable experience. We sincerely hope that we will be able to permanently return to in-person academies in the future and to finally also meet the Michigan/Virginia fellows and faculty. To this end, we very much look forward to warmly welcoming many LIFE members to Berlin to the 2022 Fall Academy. Fellows and faculty, make sure you don't miss out on this event!

Department of Psychology at Campus Oerlikon

The view from Lindenhof to the old town across the river Limmat

Enjoying dinner with faculty and fellows

Congratulations to Fall 2021 Commencees from Berlin and Zurich!

Tania Bermudez, Wolfgang Bierbauer, Julia Brehm, Ebru Ger, Ira Kurthen, Lea Mörsdorf, Felix Molter, & Karola Schlegelmilch

Hiking trip to Zürichberg

Berlin and Zurich fellows on the banks of Lake Zurich

Fall Academy 2021 in Zurich: Fellows' Abstracts

Talks and posters in alphabetical order by author respectively

Contact information available at https://www.imprs-life.mpg.de/people

Talks

Maternal depressive symptoms and adolescents' unhealthy behavior: Timing and possible pathways
Laura Bechtiger, UZH
Advisor: Lilly Shanahan

The accumulation of unhealthy behaviors in adolescence is common and contributes to cardiovascular disease burden. Understanding malleable risk factors and pathways of risk to unhealthy behaviors is crucial for effective prevention and intervention. Yet, longitudinal analyses of common family risk factors such as maternal depressive symptoms are rare. We examined maternal depressive symptoms as a putative risk factor for unhealthy behaviors and possible pathways through children's depressive symptoms and body mass index (BMI). Data came from a prospective-longitudinal community sample (N = 203) spanning 15 years (children aged 2–17 years). Regression analyses examined whether maternal depressive symptoms in early childhood (ages 2–5), middle childhood (ages 7–10) and adolescence (age 15) were associated with adolescents' unhealthy behaviors (ages 16–17). Indirect effects were examined in a path model.

Maternal depressive symptoms experienced in middle childhood and in adolescence were significantly associated with more unhealthy behaviors. Maternal depressive symptoms in early childhood were associated with unhealthy behaviors through indirect effects involving children's depressive symptoms and the continuity of maternal depressive symptoms.

Maternal depressive symptoms are associated with an accumulation of adolescents' unhealthy behaviors. Supporting mothers' mental health may reduce adolescents' unhealthy behaviors—directly and through the prevention of maladaptive pathways of risk.

Development of generalization and memory specificity in childhood

Elisa S. Buchberger, MPIB
Advisor: Markus Werkle-Bergner

An adaptive memory system is caught in a fundamental tension: extracting commonalities from similar experiences to generate novel inference (i.e., generalization), while at the same time forming separate representations of similar events (i.e., episodic specificity). These mnemonic functions show tremendous age-related improvements over the course of early to middle childhood. However, whether they are contingent on one another remains largely unknown. Further, previous research postulates sleep as a key facilitator for memory consolidation. The differential impact of sleep on different memory processes in children is, however, still poorly understood.

In this study we therefore investigated measures of generalization and mnemonic specificity in a sample of 141 children aged 4–8 years, immediately after learning and after one night of sleep. The results of this study suggest notable age effects in generalization and memory specificity over the course of childhood. We further find generalization to be contingent on object memory and semantic similarity across age groups. Lastly, we show age effects in overnight maintenance across all memory processes and in overnight gains for generalization. In sum, this study highlights important differential effects in the development of generalization and specificity across childhood, as well as their interdependence and the effect of a sleep-filled delay.

Mother-child similarity in brain structure: A comparison of structural characteristics of the brain's reading network

Plamina Dimanova, UZH
Advisor: Nora Raschle

Intergenerational neuroimaging allows the assessment of structural and functional brain similarity in caregiver-child dyads, thus informing about transfer effects relevant for skill development (e.g., reading). Brain morphology can be characterized by different metrics, including surface area (SA), gyrification index (GI), gray matter volume (GMV) or cortical thickness (CT); each with distinct developmental trajectories and hereditary influences. Structural brain data were collected for 69 mother-child dyads (children's mean age ~11 years; 28 females) and processed using FreeSurfer. Dyadic similarity in the human reading network (left-hemispheric inferior parietal lobule, inferior frontal gyrus and fusiform gyrus) was measured by correlation coefficients and it revealed significant similarity in mother-child dyads for GI, SA and GMV ($r = 0.349/0.534/0.542$). The similarity was higher in mother-child as opposed to random adult-child pairings indicating familial specificity. Furthermore, similarity was higher for SA and GMV compared to CT ($z = 2.54/2.42$). Examining intergenerational transfer effects of different brain metrics may help to unravel some of the inherited versus acquired mechanisms impacting brain development and inform about biological intervention targets or markers for treatment success.

Understanding the sharing of misinformation across the lifespan

Michael Geers, MPIB
Advisor: Ralph Hertwig

American adults aged 65 years and older are exposed to and share more articles from "fake news" domains than young adults. However, the factors that underlie older adults' pronounced susceptibility to misinformation remain poorly understood. In a hybrid lab-field Twitter study, we will investigate why older adults share more misinformation than young adults. Specifically, we will combine participants' digital traces on Twitter (i.e., their sharing and liking behavior) with panel surveys and activity-driven microsurveys eliciting their motives for sharing/liking. Together, these data will allow us to explore in depth participants' engagement with misinformation on Twitter. In my talk, I elaborate on the planned design of our study, which is currently in the pilot phase.

Neural mechanisms of task switching in children: Age differences and plasticity

Sina A. Schwarze, MPIB
Advisors: Yana Fandakova & Ulman Lindenberger

The ability to flexibly switch between tasks is key for enabling goal-directed behavior, and continues to improve across middle childhood. Children show larger mixing costs (mixed vs. single task blocks) than adults, presumably due to weaker engagement of sustained control. Additionally, children show larger switch costs (repeat vs. switch trials in mixed blocks), suggesting less engagement of transient control. On the neural level, sustained and transient control processes are associated with frontoparietal regions, which show protracted development and may underlie children's difficulties with task switching.

The first project of my dissertation addresses this hypothesis by examining age differences in the neural underpinnings of transient and sustained control, in particular how connectivity is modulated by different control demands in children (8–11 years, $N = 89$) and adults ($N = 53$). Children showed less upregulation of sustained (mixed > single) and transient (switch > repeat) activation in the inferior frontal junction (IFJ) and superior parietal lobe (SPL), two key task switching regions. Furthermore, children showed greater increase in connectivity from the IFJ and SPL to regions in the superior frontal cortex and angular gyri between single and repeat trials, suggesting an alternative mechanism to deal with insufficient upregulation of control activation of frontoparietal regions in children.

Behavioural variability and structure learning over the lifespan
Alexander Skowron, MPIB
Advisor: Douglas D. Garrett

One common finding in the aging literature is that older adults show increased intraindividual performance variability, which has been related to lower mean performance levels on various measures of cognitive functioning (e.g., MacDonald, Li, & Bäckman, 2009). It has been proposed that increased behavioral variability with age may relate to more noisy processing in distributed neural networks. On the other hand, there is also evidence for less dynamic neural processing in ageing (e.g., Grady & Garrett, 2014) and that behavioral variability can confer adaptive performance benefits (e.g., Glaze et al., 2018). We propose that older adults may actually show less variable behavior when accounting for sensory and motor noise and as a result should show poorer adaptation to different task environments. I will present an ongoing study in which we try to address this hypothesis. In this study we employ a variant of a standard perceptual decision-making paradigm with an added change-point inference component. We expect high performers to learn about the structure of a given environment (i.e., the change-point frequency) to aid decision-making by exploring potential environmental states, which is expressed in more variable behavior. I will present preliminary pilot data to address this research question.

How nature nurtures: Amygdala activity decreases after a one-hour walk in nature
Sonja Sudimac, MPIB
Advisor: Simone Kühn

Living in a city, even though it has many advantages, is associated with high incidence of psychiatric disorders, such as anxiety disorders and schizophrenia. Therefore, it is essential to understand how urban and natural environments affect mental health and the brain. Even though the beneficial effects of nature exposure on stress have been repeatedly shown, the neural underpinnings of these effects are still unknown. To fill this gap, the first study within my dissertation focuses on the neural correlates of stress after a one-hour walk in the urban vs. natural environment. In this study, fMRI stress paradigms were utilized to induce stress in 63 participants in the scanner, before and after the walk, while stress-related brain regions were measured. Our findings reveal that activation of the amygdala, a stress-related brain region, decreased after the walk in nature, whereas it remained stable after the walk in urban environment.

To account for different age groups and populations, the second study will examine the effects of acute exposure to natural vs. urban environments on mothers' and their infants' stress, by measuring the stress hormone cortisol.

Understanding neural mechanisms behind nature's beneficial effects aims to influence the design of physical environments in ways that will improve citizens' mental health and well-being.

Exploring psychological responses to interior architecture presented in Virtual Reality
Nour Tawil, MPIB
Advisor: Simone Kühn

There has been a recent interest in how architecture affects the human brain and behavior, motivated by the fact that we spend the majority of our waking time inside built spaces. Some studies have investigated the psychological responses to indoor design parameters, such as contours, and proposed that curved spaces, as opposed to angular, are aesthetically preferred and induce higher levels of positive emotion. Using virtual reality, the present study aimed to systematically examine this hypothesis and further explore the impact of contours on affect, behavior, and cognition. We exposed 42 participants to four randomized and fully-controlled furnished living rooms presenting contrast in contour (angular vs. curved) and style (modern vs. classic). Subjects freely explored the simulated rooms inside which they performed a repeated mental arithmetic task and rated their mood and spatial experience. Out of the 33 outcome variables measured, only two eventually confirmed differences in the contours analysis, in favor of angular rooms. The present results provide evidence against the curvature preference hypothesis, suggesting that the psychological response to contour in architectural settings could be more multifaceted. This study, therefore, helps to communicate a more complete scientific view and highlights the necessity of further investigations by providing directions for future research.

Posters

Parenting practices and parental agreement in association with socio-emotional development in early childhood

Sabrina Beck, UZH
Advisor: Moritz Daum

Children whose parents share the same values, attitudes and behaviors towards parenting show less internalizing and externalizing problematic behavior and higher social competence. Furthermore, perceived parental agreement is positively associated with higher relationship satisfaction and parents' mental health—factors that contribute significantly to the psychological adjustment of children. Based on a family systems perspective, mothers' and fathers' parenting styles are conceptualized as being interdependent. This study focuses on actual vs. perceived parental agreement on parenting practices and its association with child's temperament in early childhood.

Therefore, an online survey will be conducted with at least 80 first-time parent couples that are living together and having an only child between 12 and 36 months old. Both parents will fill out three questionnaires in total: a self-assessment questionnaire on parenting practices as well as an assessment questionnaire on the partner's parenting practices, and an additional questionnaire on their child's temperament. We expect high parental agreement to be associated with a higher level of agreement assessing the child's individual temperament as well as with higher levels of openness/extraversion and effortful control as temperamental traits of the child.

The development of life goals over the adult lifespan

Laura Buchinger, German Institute for Economic Research (DIW Berlin)
Advisor: David Richter

Life goals are important organizing units for individual agency in human development. Yet, they are often neglected in personality development research. This cohort-sequential longitudinal study uses data from the German Socio-Economic Panel (SOEP, $N = 52{,}052$; age range: 18–84 years) to investigate the importance trajectories of nine life goals over the adult lifespan with a focus on differences regarding gender, lifetime parental status, and education. Applying latent growth curve modelling, we found family-related goals to be relatively independent of age-specific opportunities and constraints. Having children even increases in perceived importance around retirement, for both parents and those who remained childless. A low educational background was associated with a steeper increase in the importance of prosocial goals. Strong gender differences concerned having a happy relationship which was more important for women until midlife, but more important for men in late adulthood. Parental status amplified gender difference in the work and family domain. We find differences between parents and childless individuals as early as aged 18, supporting a selection into parenthood effect.

Bi-directional associations between loneliness and self-reported and actigraphy-assessed sleep: A daily intensive longitudinal study in vulnerable individuals

Christine Dworschak, UZH
Advisor: Andreas Maercker

Sleep and loneliness are key determinants of health and well-being. A number of studies has confirmed robust cross-sectional associations between sleep and loneliness. However, the temporal order of these variables and the direction of this association remains unclear. This study examined bi-directional associations between sleep and loneliness on a day-to-day basis using both objective as well as self-reported sleep indices in a sample of stress-exposed medical students during their first medical internship. Over the period of seven consecutive days during the internship, participants were asked to wear an actigraph and to report their state-level sleep and loneliness every evening before going to bed and every morning after waking up. In addition, we used questionnaire data on trait-level loneliness and sleep collected before and during the internship. Sleep and loneliness were found to be bi-directionally associated on both the trait and state level, indicating a downward spiral where both variables continue to negatively influence each other.

Training-induced brain changes during motor skill learning in humans and mice
Maike Hille, MPIB
Advisors: Simone Kühn & Ulman Lindenberger

There is accumulating evidence for experience-dependent structural and functional brain changes during skill acquisition. However, the exact time course of training-induced plastic changes as well as the molecular mechanisms that regulate plasticity in adulthood are not well understood (Kühn & Lindenberger, 2016). Human research suggests that changes in gray matter volume in response to motor training are non-monotonic, meaning that a phase of expansion is followed by a phase of renormalization (Wenger, Brozzoli et al., 2017). Similar patterns of expansion followed by renormalization have been found in animal models (Makino et al., 2016). In the current study, motor-skill learning in humans will be used to investigate behavioral, volumetric, neurochemical and functional brain changes over multiple observations. The training-induced brain volume changes in humans will be related to brain volume as well as cellular changes in mice. The main aim of the project is to bridge the gap between animal models and human research in order to delineate the mechanisms that regulate experience-dependent plasticity during motor skill acquisition in humans. Furthermore, the project will test the predictions of the expansion-exploration-selection-refinement model of human skill learning (Lindenberger & Lövdén, 2019; Lövdén et al., 2021).

The transition to grandparenthood: No consistent evidence for change in the Big Five personality traits and life satisfaction
Michael D. Krämer, DIW Berlin
Advisor: David Richter

Intergenerational relations have received increased attention amidst an aging demographic and increased childcare responsibilities taken on by grandparents. For the Big Five, the transition to grandparenthood has been proposed as a developmental task in middle adulthood and old age contributing to personality development through this new role adoption—in line with the social investment principle. In this preregistered study, we used panel data from the Netherlands ($N = 250$) and USA ($N = 846$) to analyze first-time grandparents' Big Five and life satisfaction development in terms of mean-level changes, interindividual differences in change, and rank-order stability. To address confounding bias, we employed propensity score matching in two procedures: matching grandparents with parents and nonparents.

Longitudinal multilevel models demonstrated mostly stability of the Big Five and life satisfaction over the transition to grandparenthood. The few small effects of grandparenthood on personality development did not replicate across samples. Contrary to expectations, we also found no consistent evidence for larger interindividual differences in change in the grandparents or for smaller rank-order stability compared to the controls. Our findings add to recent critical re-examinations of the social investment principle and are discussed in light of characteristics specific to grandparenthood that might moderate personality development.

Regularized continuous time dynamic networks
Jannik H. Orzek, HU
Advisor: Manuel Völkle

There is an increasing use of network models in research on psychopathology (Robinaugh, Hoekstra, Toner, & Borsboom, 2020). Existing longitudinal network models in this field, however, are limited by the strong assumption of equally spaced measurement occasions. In practice, this assumption is almost always violated (e.g., in experience sampling studies). The problem is aggravated by the possibly large number of variables in a network, potentially resulting in a situation where each variable for each person is observed at a different point in time. To resolve these problems, we propose regularized continuous time dynamic models. Here, the exact time point of a measurement is considered in the parameter estimation procedure. This allows for any arbitrary measurement scheme. Regularization reduces the risk of overfitting in small samples and allows for a sparse drift matrix to simplify model interpretation.

Regularized continuous time dynamic models are implemented in the R (R Core Team, 2018) package regCtsem. We demonstrate the use of regCtsem in a simulation study, which shows that the proposed regularization improves the parameter estimates, especially in small samples. The approach correctly identifies true-zero parameters while retaining true-nonzero parameters. We present an empirical example and end with a discussion on current limitations and future research directions.

Using functional connectivity to understand age differences in neural category specificity
Claire Pauley, MPIB
Advisor: Myriam C. Sander

Neural dedifferentiation, the finding that neural representations become less distinctive with advancing age, is commonly implicated in senescent memory decline. It has been proposed that age differences in functional connectivity (FC) may be an underlying mechanism for age-related neural dedifferentiation. We sought to investigate this theory in an fMRI study with a group of younger and older adults.

Participants performed an incidental encoding task consisting of face and house images and subsequently completed a surprise old/new recognition memory task. First, we used a representational similarity analysis (RSA) searchlight approach in order to identify brain regions that show category-specific activity during recognition: greater pattern similarity of stimuli from the same category (i.e., house-house) compared to stimuli between categories (i.e., house-face). This analysis revealed a bilateral area of occipital and ventral visual regions demonstrating high category specificity for houses. Second, we assessed whole-brain, voxel-based FC to this region of high category specificity. Using partial least squares correlation, we identified a latent variable that optimally represented the multivariate relationship between voxel-wise connectivity and category specificity across all participants. Thus, we provide novel evidence for a link between category specificity and distributed FC patterns, revealing FC as a possible mechanism for age-related neural dedifferentiation.

Work or leisure? The impact of subjective expectations on exhaustion and recovery
Victoria Schüttengruber, UZH
Advisor: Alexandra M. Freund

How can the same activity promote recovery on one occasion and induce exhaustion on another? Our hypothesis is that people associate work with exhaustion and leisure with recovery, although they pursue strenuous and relaxing activities in both life domains. People expect—and experience—the same activity as being more exhausting and providing less opportunity to recover when it is framed as work rather than leisure. Building on a process model integrating the potential effects of these expectations, the poster presents our plans to empirically manipulate life domains and capture the impact of categorizing the very same activity as work or leisure on exhaustion and recovery. An online study will test the manipulation by assessing to what degree participants associate the instruction of a vigilance task (work: attention check as air traffic controller; leisure: online game for fun) and the setups of the lab rooms (work: office at airport; leisure: cozy lounge) with work or leisure. In the subsequent between-subjects lab experiment, participants will complete the vigilance task either for work or leisure. Self-report ratings related to exhaustion and recovery and participants' skin conductance level will measure the impact of the hypothesized expectations. Results will inform the process model, research on "work-life balance," and motivation.

10 Questions

Kai Schnabel Cortina, Professor of Psychology, University of Michigan

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How did you get involved in the study of educational psychology?

A researcher at the Max Planck Institute for Human Development got a hold of my psychology diploma thesis, which was a statistical study that involved LISREL, the first user-friendly structural equation program. They were planning a longitudinal study and needed someone with advanced statistics skills. The name of the researcher was Jürgen Baumert who later became a director at the MPIB (and LIFE faculty member), and the study later became famous under the acronym BIJU[1] (e.g., Schnabel et al., 2002). When I moved to the University of Michigan in 2000, I started to collaborate with Jacque Eccles, one of the masterminds of the LIFE program.

Could you name books or articles that have profoundly influenced your own thinking about the field?

The German original of Heinz Heckhausen's book on motivation (*Motivation und Handeln*, 1980) helped me get a deeper understanding of the relation between theoretical constructs (achievement motivation in particular) and how to operationalize them. Another book that I read twice was the 1976 book by Peter M. Roeder and my dear friend Achim Leschinsky, *Schule im historischen Prozeß*, which profoundly influenced my critical view on schools as educational institutions in their historic context. I can still impress people with my knowledge of Prussian history I learned from this book.

What do you consider the two main current debates within the field?

The key debate in education is the role of the internet/new media for schooling and the re- or dis-organization of information and knowledge it has caused. The debate has been going on for 25 years but became most apparent during the Covid crisis. The role of teachers in building a coherent knowledge base from kindergarten to high school will be redefined profoundly in the next 10 years.

Another perennial problem that has become more salient during Covid is the reproduction of social inequity through our educational institutions. In the United States, this debate revolved around systemic racism; in Germany it is accentuated by the discourse around inclusion, i.e., the integration of special and general education.

What research topics have been neglected or have not received enough attention so far?

I am always struck by how little we know about the lifespan relevance of schooling. The few longitudinal studies that exist usually demonstrate little predictive power of school learning on later life outcomes. In my opinion we tend to use the wrong empirical paradigm that is based on simplistic causal models. School provides opportunities to develop many skills. When choosing which career to further pursue, we don't necessarily opt for careers that lead to a high income 20 years later.

One of your current foci is on mind wandering. Can you tell us more about this?

It is not really my focus but a research paradigm developed by our former graduate student Han Zhang who is interested in making academic reading more efficient using eye-tracking technology (cf. Zhang, Miller, et al., 2020; Zhang, Qu, et al., 2020). Who has not experienced the phenomenon that you want focus on the textbook only to realize that you were not processing the last three pages you read? Wouldn't it be great if you could wear a pair of glasses while reading and a little bell would ring whenever the system discovers that you are not really processing, suggesting that you re-read the last paragraph?

[1] Bildungsverläufe und psychosoziale Entwicklung im Jugend- und jungen Erwachsenenalter [Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood]. LIFE MPIB alumnus Michael Becker now heads this seven-wave longitudinal study (e.g., Becker et al., 2020). See BIJU website for more information: https://ifs.ep.tu-dortmund.de/en/research/team-becker/projects/biju/

How can your research be applied to everyday life?

Most if not all my research projects have a direct link to practical problems in education. Currently, I am analyzing the importance of the GRE test (Graduate Record Examination) for admission to graduate school in psychology. While a required test for most graduate programs in the social sciences in the United States, we demonstrate that its role in the admission process is overrated. Applicants could save a lot of money (for the test itself and the expensive prep courses) if universities would decide to drop them.

What are you currently working on?

I am working with Blake Ebright, an incoming LIFE fellow, on the question how to measure critical thinking in college with the goal to demonstrate that (a) it can be measured accurately via performance tasks and (b) college education actually improves it. We are having a lot of fun developing tasks based on real-world problems we get from the news, ranging from handling local pollution crisis to decisions about where to build wind turbines.

What do you get out of LIFE?

I have worked and published with many students from across the Atlantic (e.g., Caro et al., 2015; Wölfer et al., 2012). The collaboration would simply not have happened without LIFE because it always included the respective fellow's two- or three-month stay in Ann Arbor. Yes, you can work long-distance by sending documents back and forth, but it will never be the same as being in the same context for a while. I cannot wait for academies to happen again in person.

What is the added value of LIFE's internationality?

Every academic institution ticks slightly differently, including the interaction between graduate students and faculty. I always find it refreshing to see how much easier it is to minimize status hierarchies for the benefit of the intellectual discourse around a shared research interest.

Has the COVID pandemic changed the way you work?

Unfortunately, it has, yes. Last year's Zoom-only teaching was initially not bad but got old quickly. It did not help that public schools in Ann Arbor were remote-only for over a year, so my children were at home too. We managed because we have a large house, so everybody had their own room. But my research lab fell almost completely dormant because data collection was limited to online questionnaires and I do not like them.

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New LIFE Faculty in Berlin

Iyad Rahwan founded and directs the Center for Humans and Machines at MPIB. He is also an honorary professor of Electrical Engineering and Computer Science at the Technical University of Berlin. Until June 2020, he was an Associate Professor of Media Arts & Sciences at the Massachusetts Institute of Technology (MIT). A native of Aleppo, Syria, Rahwan holds a PhD from the University of Melbourne, Australia. His work lies at the intersection of computer science and human behavior, with a focus on collective intelligence, large-scale cooperation, and the societal impact of Artificial Intelligence and social media. His early work explored how social media can be used to achieve unprecedented feats, such as searching an entire continent within 9 hours, and re-assembling shredded documents. He led the winning team in the US State Department's Tag Challenge, using social media to locate individuals in remote cities within 12 hours using only their mug shots.

Recently, Rahwan led a team that crowdsourced 40 million decisions from people worldwide about the ethics of autonomous vehicles. Through a series of projects, he also exposed tens of millions of people world-wide to new implications of AI, such as bias in machine learning, human-AI creativity and the ability of AI to induce fear and empathy in humans at scale.

Another theme that interests Rahwan is the future of work and human-machine cooperation. He demonstrated the world's first human-level strategic cooperation by an AI, and innovated new methods to anticipate the potential impact of AI on human labor.

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Key publications

Rahwan, I., Cebrian, M., Obradovich, N., Bongard, J., Bonnefon, J.-F., Breazeal, C., Crandall, J. W., Christakis, N. A., Couzin, I. D., Jackson, M. O., Jennings, N. R., Kamar, E., Kloumann, I. M., Larochelle, H., Lazer, D., McElreath, R., Mislove, A., Parkes, D. C., Pentland, A., Roberts, M. E., Shariff, A., Tenenbaum, J. B., & Wellman, M. (2019). Machine behaviour. *Nature, 568,* 477–486. https://doi.org/10.1038/s41586-019-1138-y

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Bernhard Spitzer is a Senior Research Scientist and PI at the Max Planck Institute for Human Development (Center for Adaptive Rationality). He previously held postdoctoral appointments at the University of Oxford, Freie Universität Berlin, and the Bernstein Center for Computational Neuroscience at the Charité Berlin.

As a cognitive neuroscientist, he is interested in memory and decision-making processes and their dynamic interplay. The work in his group combines techniques like electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and eye-tracking with computational modeling to study how flexible transformations of information (e.g., in working memory) enable adaptive behaviour despite limited cognitive resources.

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Key publications

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New LIFE Fellows in Ann Arbor and Berlin

Warsha Barde. I am a doctoral student at the Deutsches Zentrum für Neurodegenerative Erkrankungen e.V. (DZNE), Dresden. My research interests lie in understanding the neural mechanisms of hippocampal cognitive processes like learning and memory, spatial navigation, decision-making, etc.—how they evolve over the human lifespan and how they are compromised during healthy aging, Alzheimer's, and other neurological disorders. Under the supervision of Gerd Kempermann, I am studying the neurobiology of individuality; and how environmental enrichment and adult hippocampal neurogenesis contribute towards the emergence of individual traits.
In 2015, I received my Bachelor's degree in Biotechnology from the National Institute of Technology, Rourkela, India. I then moved to the Indian Institute of Science, Bengaluru for my Master's degree in Neuroscience (2020). Here, under the supervision of Sachin Deshmukh, I studied hippocampal place cells and grid cells in the medial entorhinal cortex (mEC), the key components of the spatial navigation system, and investigated how their spatial representation is influenced by features like scale and boundaries of the environment.

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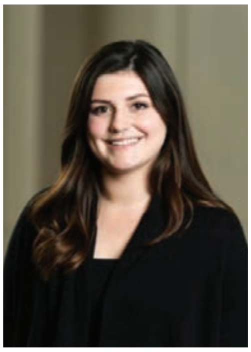

Madison Fansher. I am a doctoral candidate in the Cognition and Cognitive Neuroscience area at UM, working with Priti Shah and John Jonides. I graduated from Purdue University in 2018 with a B.S. in Brain and Behavioral Sciences and I am currently an NSF GRFP fellow. I am broadly interested in higher order cognition and applications to education. I aim to study individual differences in willingness to exert cognitive effort as well as the biological processes underlying subjective feelings of pain when engaged in complex cognitive tasks. As such, I am also interested in math anxiety and the development of working memory capacity across the lifespan. In another line of research, I study the cognitive processes underlying scientific reasoning and develop interventions to teach scientific reasoning principles to children and adults.

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Marlene Hecht. I am a doctoral student in Psychology at the Center for Adaptive Rationality (ARC), MPIB. My research interests lie in the areas of judgement and decision making, social cognition, and information search. Specifically, under the supervision of Christin Schulze and Thorsten Pachur, I am currently examining how individuals sample information from (online) social networks to infer characteristics of the world at large. Prior to joining ARC, I earned a MSc in Psychology at HU. Before this, I completed a BSc in Psychology and a BA in Communication Science at the Ludwig-Maximilian-Universität München. My dissertation project is entitled "Social sampling in online social networks: Information search, adaptive use and developmental differences."

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Rita Xiaochen Hu. I am a doctoral candidate in the Joint Program in Social Work and Developmental Psychology at UM, working with Toni Antonucci and Jacqui Smith. I am interested in the development and consequences of ageism across the lifespan. Specifically, (1) the development and internalization of age-related stereotypes through social relationships across the lifespan, and (2) the time-varying nature of age-related stereotypes' effect on older adults' psychosocial well-being. I am also interested in exploring age-related stereotypes among service providers such as home health aides and the potential effects on older adults' health and well-being.

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Wilson Merrell. I am a doctoral candidate in Social Psychology at UM, working with Josh Ackerman and Arnold Ho. I graduated from Macalester College in 2016 with a BA in Economics and Psychology, and worked for two years as an economic consultant at the Brattle Group in Washington DC before starting my doctoral studies in Ann Arbor. I am broadly interested in how fundamental (evolutionary) motivations shape judgment and decision-making in modern contexts. In one line of research, I examine how status-seeking motives influence perceptions of different consumer behaviors. In another, I am testing how motives to avoid physical harm shape stereotype formation in intergroup contexts. Broadly, I hope to integrate these, and other, lines of inquiry across evolutionary and ontogenetic levels of analysis to understand how fundamental motives shift and drive social outcomes across the lifespan.

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LIFE-Related Publications

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LIFE News

- The *Fall Academy 2021* took place as a hybrid event in Zurich (see pp. 15ff. for the fellows' report and the abstracts).
- The *Spring Academy 2022* is in planning in Charlottesville and will take place as an online event from May 9 to 11.
- It will hopefully be possible to meet again in person at the following *Fall Academy 2022* in Berlin from October 13 to 16.

Exchanges

- Most exchange activities are on hold again due to the pandemic, which has regained momentum in Europe.

LIFE Berlin

- *Warsha Barde* (Deutsches Zentrum für Neurodegenerative Erkrankungen [DZNE], Dresden) and *Marlene Hecht* (Center for Adaptive Rationality [ARC], MPIB) have joined LIFE as new fellows (see pp. 28f. for more information).
- *Iyad Rahwan*, Director of the Center for Humans and Machines, and Senior Scientist *Bernhard Spitzer*, ARC, MPIB, have joined the Berlin LIFE faculty (see pp. 27f. for more information).
- Berlin fellow speakers *Elisa Buchberger* and *Maike Hille* have been succeeded by *Michael Geers* and *Sina Schwarze*. Special thanks to Elisa and Maike for their work over the last year!
- Fellow *Michael Geers* received a SSRC/Summer Institutes in Computational Social Science Research Grant (2021) for "Public attitudes towards digital field experiments" by V. Straub, J. Burton, & M. Geers ($1,764).
- FU faculty *Hauke Heekeren* has been elected to become the next President of Universität Hamburg next year.
- FU fellow *Felix Molter* has submitted his dissertation entitled "The Role of Visual Attention in Preferential Choice: Model-Based Analyses of Choice and Eye Movement Data."
- This semester's LIFE seminar on decision making has been organized by faculty and alumnus *Nico Schuck* and involves sessions led by faculty, alumni, MPIB colleagues, and guests. It is being held in a hybrid format, with approximately half of the Berlin fellows attending in person and the others taking part online.
- Alumna Maike Kleemeyer held an online workshop on research data management for the Berlin fellows in November.

LIFE Michigan

- *Madison Fansher*, *Rita Xiaochen Hu*, and *Wilson Merrell* have joined LIFE as new fellows (see pp. 28f. for more information).
- Fellow *Esra Ascigil* has been awarded an Undergraduate Research Opportunities Program (UROP) Small Research Grant, UM's Rackham Graduate Student Research Grant, and and agrant from the Robert B. Zajonc Scholars Fund.
- Alumnus *Peter Felsman* has taken up a position as assistant professor at the Social Work Department, Northern Michigan University, in Marquette.
- Alumna *Hannah Giasson* has taken up a position as assistant professor in the College of Nursing and Health Innovation at Arizona State University. Her research considers the complex interplay between views of aging and individuals' health and well-being as they grow older.
- Fellow *Rita Hu* has been awarded the Elizabeth "Libby" Douvan Junior Scholars Fund in Life Course Development and the Karl C. K. Ma Endowed Scholarship.
- The Society for the Psychological Study of Social Issues (SPSSI) has awarded the 2021 Kurt Lewin Award posthumously to *James S. Jackson*. The Lewin Award is SPSSI's highest scholarly honor and premier career recognition for distinguished research on social issues. He was honored for his outstanding contributions to the development and integration of psychological research and social action, and his research on racial health disparities.
- Alumna *Jasmine Manalel* has taken up a new position as Senior Research Associate at the Hunter Brookdale Center for Healthy Aging in New York.

- Alumnus *Steven O. Roberts*, Stanford University, is a Visiting Scholar with the Russell Sage Foundation in the academic year 2021/22.
- Alumnus *Alvin Thomas*, Assistant Professor at the University of Wisconsin, Madison, has received the Louise Kidder Early Career Award from the Society for the Psychological Study of Social Issues (SPSSi), APA's Division 9. The award recognizes social issues researchers who have made substantial contributions to the field early in their careers.

LIFE Virginia

- Alumnus *David Dobolyi* is now Assistant Research Professor of Information Technology, Analytics, and Operations in the Mendoza College of Business at the University of Notre Dame.
- Fellow *Evan Giangrande* received the Thompson Award for the best oral presentation at the 2021 Behavior Genetics Association meeting. His talk was entitled "Biometric analysis of within-person Flynn Effects."
- *Evan Giangrande* has also proposed his dissertation titled, "Longitudinal Dynamics of Gene-Environment Interplay Across Cognitive Development."
- Fellow *Jesse Grabman* has proposed his dissertation titled, "Understanding Eyewitness Verbal Confidence." He has accepted a postdoc position with LIFE faculty *Per Sederberg* at UVA.
- Alumna *Jessica Kansky* has completed her predoctoral clinical internship at the Charleston Consortium and has started a postdoctoral fellowship in Couples and Family Psychology at the Ralph H Johnson VA Medical Center in Charleston, SC.
- Alumnus *Matthew Lerner* has received the LIFE Outstanding Alumni Award 2021 (see p. 9).
- Fellow *Sean Womack* has proposed his dissertation titled, "Genetic and Environmental Correlates of Physical and Cognitive Development in Twins: A Prospective Study of Recovery from Early Bio-Environmental Adversity."

LIFE Zurich

- *Moritz Daum* has become the LIFE Zurich Speaker. *Alexandra Freund* is continuing as Co-Speaker.
- *Plamina Dimanova* has replaced *Carla Eising* as Fellow Speaker and joins *Zita Mayer* in this role.
- *Alexandra Freund* has been elected as member of the German National Academy of Sciences Leopoldina.
- Together with colleagues from different areas (Neuroscience, Education, Pediatrics), *Alexandra Freund* and *Moritz Daum* received seed funding from UZH for the "Developmental Science Network Zurich" (DSN-ZH; website at http://www.developmentalscience.uzh.ch due to be launched soon). The DSN-ZH is an interdisciplinary research network for researchers contributing to the field of Developmental Science. The main aims of this network are to provide a platform that allows researchers from different disciplines of developmental science, to exchange theoretical, methodological, and empirical knowledge, and to foster cooperation among scholars from different areas of developmental research.
- Alumna *Wenke Möhring* has taken up a W3 professorship for Developmental and Educational Psychology at Pädagogische Hochschule [University of Education] Schwäbisch Gmünd, Germany. She will continue to work on cognitive and motor development and spatial cognition as well as MINT learning (see publication list for some of her most recent publications).
- *Elisa Weber* has successfully defended her dissertation entitled „Longitudinal Co-development of Well-being and Emotional Experiences in Dyadic Partner Relationships in Old Age." She is now working as a postdoc with Wiebke Bleidorn, Professor for Individual Differences and Assessment at UZH.

Frequently used acronyms in LIFE

CRTD: Center for Regenerative Therapies Dresden

DIW: Deutsches Institut für Wirtschaftsforschung [German Institute for Economic Research]

DZA: Deutsches Zentrum für Altersfragen [German Centre of Gerontology]

DZNE: Deutsches Zentrum für Neurodegenerative Erkrankungen Dresden [German Center for Neurodegenerative Diseases]

FU: Freie Universität Berlin

HU: Humboldt-Universität zu Berlin

LIFE: International Max Planck Research School on the Life Course

MPIB: Max-Planck-Institut für Bildungsforschung [Max Planck Institute for Human Development]

UM: University of Michigan

UVA: University of Virginia

UZH: University of Zurich

LIFE Newsletter

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Aim of the newsletter
The LIFE newsletter encourages collaboration and interaction among people within the LIFE program. It provides an information platform where fellows, alumni, and faculty members can learn more about each other's research, and identify colleagues with similar interests and possible projects for collaboration.

Contributions
Please send contributions, suggestions, and input to the editor.

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