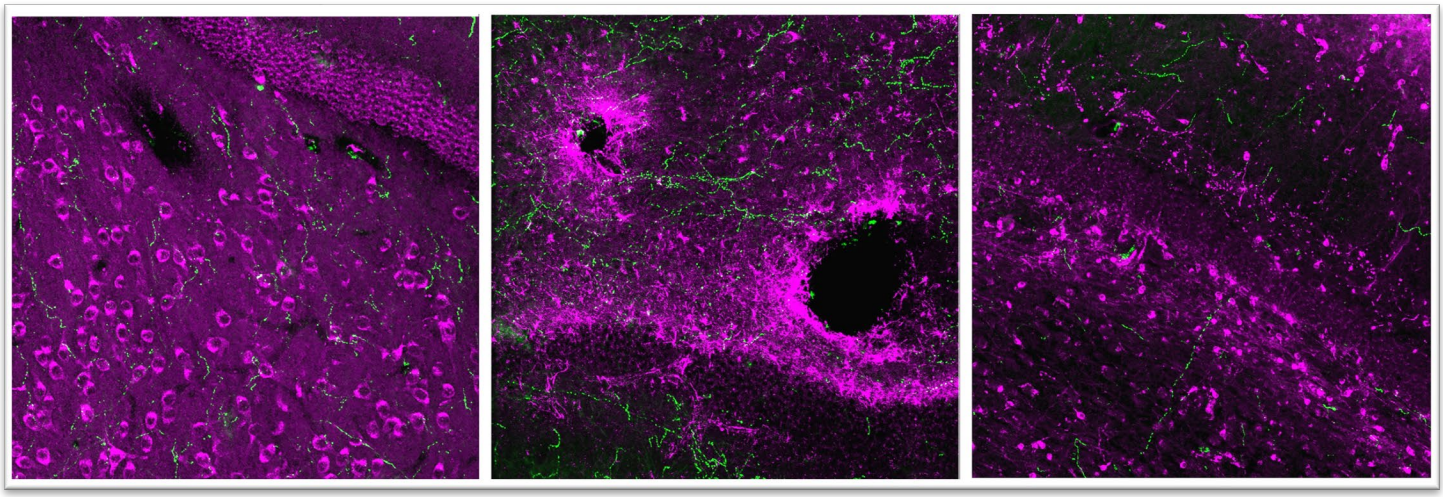
THE UNIVERSITY OF ARIZONA

Evelyn F. McKnight Brain Institute

Full Lives Through Healthy Minds

Annual Report 2023



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THE UNIVERSITY OF ARIZONA

Life Sciences North Bldg.
PO Box 245115
Tucson, AZ 85724-5115
Phone: (520)626-2312

January 21, 2024

Trustees
The McKnight Brain Research Foundation
P.O. Box 620005
Orlando, FL 328962

Dear McKnight Brain Research Foundation Trustees,

The focus of the Tucson Evelyn F. McKnight Brain Institute (EMBI) is to promote longer and fuller cognitive lives for all. Our mission remains the same as it was when we were founded in 2006 – to discover the mysteries of the normally aging brain to achieve a lifetime of brain and cognitive health.

In spite of the challenges that arose for the conduct of research during the pandemic years, the Tucson McKnight Institute Affiliates used this time to write and obtain grants – with 12 new grants awarded in 2022, and 9 new grants in 2023, and they are maintaining 25 continuing grants in 2023. One particularly large grant was awarded to Dr. Meredith Hay in the past year. This grant from the NIH/NIA is to begin human trials on a novel peptide therapeutic that Dr. Hay and her colleagues developed to treat cognitive impairment, involving peptide nuclei acids (PNAs) designed to improve bioavailability, stability, and brain uptake of the drug. Her work has shown that an angiotensin-(1-7) glycosylated mas receptor agonist (PNA5) decreased brain inflammation and improved brain blood flow to protect brain function, which confers it great promise as a candidate for treating vascular conditions that frequently arise in older individuals. This is certainly one of the pieces of the puzzle for solving the complex problem of the causes of memory loss at older ages, and potentially may have preventative applications for maintaining cognitive health across the lifespan. She will be presenting some of her exciting findings at the next McKnight Inter-Institutional meeting in Gainesville.

One aspect of Dr. Hay's important new award that should be pointed out, however, is that she has been working toward the initiation of clinical trials for Ang-(1-7) for some years. This is to acknowledge and illustrate the fact that taking basic science findings through to clinical trials in humans can be a long process. Dr. Hay first approached Dr. Barnes in 2015 to tell Tucson's McKnight Institute Director about collaborations she was conducting with her colleagues in the Department of Physiology, where they were developing an animal model of congestive heart failure, common in older humans, and that results in memory deficits in humans. She wanted to see if I was interested in helping her test her heart failure mice in spatial and recognition memory tests that were sensitive to hippocampus-dependent cognitive function, This behavior testing was one step in the overall goal of being able to test the potential therapeutic agent - Ang-(1-7) - in this animal model. Dr. Hay is an expert in brain renin angiotensin mechanisms in control of circulation, and knew that blood flow was critical for brain and cognition function. The heart failure mice were exposed to ligation of the left coronary artery to induce myocardial infarction, which resulted in a significant reduction in ejection fraction, a measure of heart failure, and the hearts of these animals were significantly damaged. Following this treatment, the mice were significantly memory-impaired. At 8 weeks post heart failure treatment, systemic Ang-(1-7) was administered via a mini-pump to half of the heart failure mice for three weeks. Both spatial and recognition memory were improved in the heart failure-Ang-(1-7)-treated mice, but there was no effect on heart damage. Blood-based inflammatory biomarkers were also reduced

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following this treatment. So the first heart failure model, with cognitive characterization, inflammatory biomarker assessment and heart physiology characterization, that applied Ang-(1-7) treatment was published in 2017 (Hay, M., Vanderah, T. W., Samareh-Jahani, F., Constantopoulos, E., Uprety, A. J., & Barnes, C. A. Cognitive impairment in heart failure: A protective role for Angiotensin-(1-7). Behavioral Neuroscience, 131:99-114). The Ang-(1-7) molecule itself had to be modified for sustained administration for human testing, which also took some time after these initial animal model findings were published. It wasn't until seven years after the first indication that Ang-(17) may be effective in protecting the brain and cognition from inflammatory insults, that the first grant was approved to begin the clinical safety trials for the final compound that was developed for use in humans (PNA5).

Another milestone in reaching the clinical trial process for treating cognitive impairment in aging and Alzheimer's disease (AD) has been made by Dr. Robbie Brinton who has been exploring the effects of Allopregnanolone (ALLO), an endogenous neurosteroid, to promote neurogenesis, oligogenesis and cognitive function in animal models of Alzheimer's disease (AD). Based on positive effects of ALLO on these 3 aspects of brain function, she and her colleagues conducted a randomized-controlled phase 1b/2a multiple ascending dose trial of ALLO in persons with early AD to assess safety, tolerability, and pharmacokinetics. Primary outcome analyses indicated that ALLO was safe and well-tolerated across all doses. Exploratory imaging outcomes in this initial trial were designed to determine whether ALLO impacted hippocampal structure (a critical memory region in the brain), white matter integrity, and functional connectivity of brain regions. Their exploratory data suggested that the rate of decline in hippocampal volume expected in mild AD was slowed, and in some cases reversed in the ALLO group compared to placebo. Additionally, multiple measures of white matter integrity indicated evidence of preserved or improved integrity. Outcomes from this phase 1b/2a clinical cohort supported advancement to a phase 2 proof-of-concept efficacy clinical trial of ALLO as a regenerative therapeutic for mild AD. The Phase 2 award was granted in 2022, ~20 years after Dr. Brinton first began to think about designing experiments to test ALLO's potential. There were no resources or accelerators in academia at that time, which slowed her progress. She was eventually fortunate to get support from 3 philanthropic accelerator funders which allowed her to advance to clinical trials. While these findings in experimental nonhuman AD models, and in humans with mild AD in the phase 1b/2a clinical trials suggest efficacy in disease, it is our hope to study ALLO in normative populations, to determine if this approach would be effective in maintaining or optimizing cognition in normative human populations.

Both Hay and Brinton are part of the Executive Committee of Barnes' U19 award: *Precision Aging Network (PAN): Closing the Gap between Cognitive Healthspan and Human Lifespan.* The novel approaches in PAN to recruiting participants through web-based testing tools (*MindCrowd*) has been very successful this past year, with Matt Huentelman spearheading this effort (Matt is also part of the PAN Executive Committee). We surpassed our original goal of recruiting 350,00 individuals at the end of our grant. Matt had collected survey, cognitive and reaction time data from 287,213 individuals between 2013 and 2021, at the start of the PAN grant. The individuals who take the MindCrowd test are from all regions of the United States, they cross different race/ethnicities, socioeconomic statuses, urban/rural communities, education levels, and sex to test basic learning ability (paired associates) and speed of processing (simple reaction time tests) in individuals 18 years of age to well over 90 years. We have worked hard to improve our outreach across the country, and, as you can see in the figure below, after the launch of the new website in June 2022, which was made possible by the PAN project, the numbers of individuals who have taken the MindCrowd test has continued to increase, so that we surpassed our original goal January 2023 (353,972), and as of the first days of 2024 have reached 447,500 latest takers and have a new target of 600,000 for the

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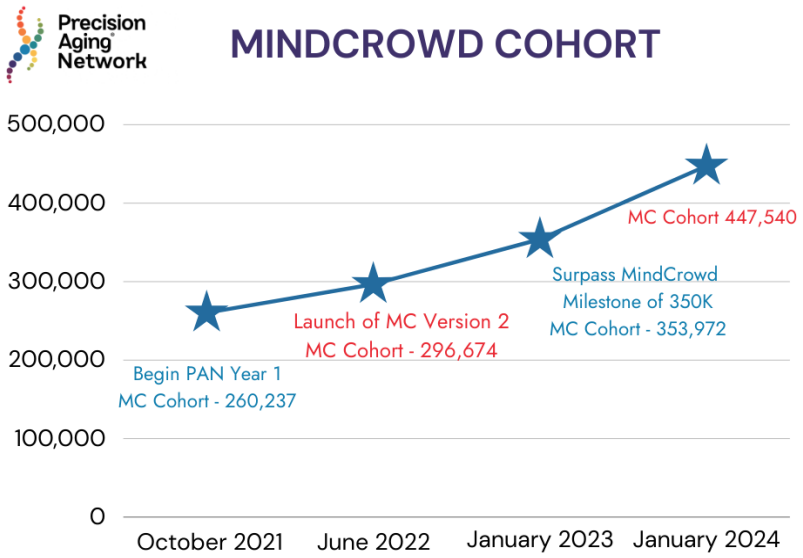
duration of the 5 year grant. From the start of the PAN grant in October 2021 through December 2023 we have witnessed a 71.9% increase in MindCrowd participants.



The PAN in-depth study is led by Dr. Lee Ryan, who is also part of the PAN Executive Committee, and who coordinates the data collection for this component of the grant in Tucson, Miami, Atlanta, and Baltimore. This project is also successfully following their identical protocols, so that the information can be "pre-harmonized" and pooled from all of the sites. The target for this Project is 1620 people tested by the end of 5 years, focusing on nonHispanic White, Hispanic/Latino, and nonHispanic Black participants in the 4 regions of the country. Dr. Huentelman has also begun to include another innovative recruiting method for this large-scale project, which is an "MRI van and lab" that can be driven to people's homes or community centers in order to enable testing of difficult to reach or underserved populations. It is our hope that this method will also lead to expansion of MindCrowd participation.

Among others, two other McKnight Affiliates also are on the cutting edge of technological development designed to inform a better understanding of the factors that impact brain and cognitive health in aging. One is Dr. Matthias Mehl who has developed the *Electronically Activated Recorder* (EAR), which is a method for the naturalistic observation of daily social behavior, a very important component to successful aging The power of the EAR lies in unobtrusively collecting authentic real-life observational data. In preserving a high degree of naturalism at the level of the raw recordings, it resembles ethnographic methods used widely in anthropological investigations. Because the data can be collected remotely for offline analysis and coding, it lends itself to data collection in larger empirical studies that would not be possible in typical laboratory settings. Mehl and Huentelman are working together to determine if a version of the EAR technology could be given to participants in the MindCrowd setting, if those individuals choose to add on additional studies. This would be an amazing enrichment of the PAN database, and Dr. Mehl participates in one of the Cores in the PAN grant that is working towards this possible application. A second Affiliate to mention is Dr. Jessica Andrews-Hanna, who has developed the *Mind Window app*. This app gives users feedback on their personal thought patterns, some of which are positive, and other patterns such as rumination are usually disruptive to the quality of life. This device is enabling the collection of the world's largest database of human internal thought patterns. Through the data collected on this device, she hopes to better understand how different thought patterns affect mental health and well-being,

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as well as how to help individuals redirect thought patterns if they are dysfunctional. The data collected on this device can also potentially be used to evaluate well-being in older individuals, relevant to a number of McKnight-wide projects.

I continue to have interactions with projects in North America and Europe who have as their goal the expansion of our knowledge about brain and cognitive aging in individuals who show better than normal cognitive function for their age (80 and over), and have test scores more like individuals in their 50s or 60s. These individuals are known as “SuperAgers”. The Northwestern University SuperAging Project, began in 2008, and was funded by NIA in 2022 to expand to include 5 total sites in North America, including in Illinois, Wisconsin, Michigan, Georgia, and southern Ontario, Canada, which will allow these groups to collectively recruit larger numbers of SuperAgers (the target being 500 individuals), under similar protocols. I have also been invited to participate in a “Tribunal” for a Ph.D. student who studied a relatively large number of SuperAgers in Spain for her thesis from the Vallecas Project - (a tribunal is equivalent to a PhD thesis defense in the United States, although the examination is set up a bit differently). The Vallecas Project is a longitudinal study begun in 2011 with approximately 1300 older individuals in Spain. Because of this large sample size, it has been possible to identify those among this population that fit a “SuperAging” definition. This has been very interesting to me with respect to both the criteria the Vallecas Project uses to define a ‘SuperAger’, and with respect to their findings. For the most part the definitions and findings are similar to the Northwestern group – one exception of note, is that the Spanish group did not find a difference in the frequency of APOE4 allele carriers between SuperAgers and typical aging adults in their population, something that the Northwestern group found to be different between their participants (with a lower frequency in SuperAgers). It will be important to track the pattern of results between studies, as more data are collected, so that the characterization of these individuals can lead to consensus on potential variables that are replicated and associated with this apparently cognitively resilient phenotype.

Additionally, over the past year I again participated with Yaakov Stern (PI) and the Executive Committee of the grant entitled “Collaboratory on Research Definitions for Cognitive Reserve and Resilience to Alzheimer’s Disease” to organize the final workshop. This final, 4th workshop was designed to bring investigators together from a variety of backgrounds who are interested in brain aging and cognition, and are trying to design experiments to test the ideas outlined in the definitions that were laid out in the final white paper written by the Resilience and Reserve group. This was a consensus statement on definitions of three terms that were discussed over the first 3 workshops on how best to experimentally test for “cognitive reserve”, “brain reserve” and “brain maintenance”. The Executive Committee were considering having the final workshop in a virtual format, but in the end, everyone agreed that having it in person would result in a much higher quality and productive meeting. This turned out to be the case – the workshop was very interactive, we broke into a number of self-identifying groups, each examining how individuals could work together to plan experiments and to share data, with the goal of creating the sample sizes necessary to answer questions about these very important concepts. The work is continuing between the various groups of people, which will likely lead to critical advances in our understanding of brain aging and the factors that lead to the most optimal brain and cognitive outcomes as we age, as well as to lasting collaborative interactions that would have been unlikely to have occurred without this targeted support from NIA for this effort.

The Director of the Tucson EBMI was awarded one additional RO1, during this past year that examines the interaction between the prefrontal cortex and hippocampus during aging, and how this interaction is an important component of the memory changes that we observe across the lifespan. This RO1, plus two others, one focusing on the role that the activity dependent gene

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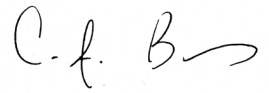
NPTX2 plays in cognitive resilience in aging, and another that examines spatial memory and navigation in aging rats, monkeys, and humans, each have a focus on normal age-related memory loss and the neural underpinnings of these changes. Additionally, she is PI on an NIA-sponsored Training Grant titled *Neurobiology of Aging and Alzheimer's Disease*, and one of the Tucson McKnight Institute Affiliate members has recruited an outstanding new postdoc who is supported by this Training Grant and who will participate in experiments on how typical aging effects brain and cognition. She is going to be present at the Gainesville meeting, and is very excited to meet the group. The McKnight Brain Research Foundation has significantly contributed to stabilizing resources for the Tucson EMBI, which enables collection of preliminary data for the successful acquisition of NIH awards, for which I am extremely grateful. As can be seen in **Section 4** and **Section 13** (illustrating our publications) and **Section 6** (honors and awards, new grants relevant to EMBI's mission), the Tucson EMBI Affiliates continue to be extremely productive and contribute substantively to the overall goals of this Institute, and to the MBRF's mission.

My plans for the upcoming year revolve around implementing the experiments proposed in my funded grants, and preparing manuscripts from the data collected. The Tucson EMBI Affiliates look forward to the upcoming 15th Inter-Institutional meeting in Gainesville and the McKnight poster session at the Society for Neuroscience that will be held in Chicago 2024, which will provide more opportunity to coordinate data collection among us. The group really appreciated the re-initiation of this event in Washington DC last year. We are also committed to continuing community outreach activities at which we publicize both the Tucson EMBI and the Precision Aging Network grant efforts towards understanding the aging process and optimizing cognitive health for all individuals.

Respectfully signed January 21, 2024,



Regents Professor Psychology, Neurology and Neuroscience
Evelyn F. McKnight Chair for Learning and Memory in Aging
Director, Evelyn F. McKnight Brain Institute
University of Arizona

4. FY 2023 at a Glance

Summary of Major Scientific, Programmatic, Outreach or Training Achievements

I review here the findings reported in half of the publications listed in Appendix 2, and bold authors that are Affiliate faculty.

Dollish, Kennedy, Grandner and **Fernandez**
This is a provocative review of melatonin, and its potential therapeutic role in brain and body health and cognition. They describe its action in sleep initiation and circadian timekeeping, but also its impact on a number of activities linked to digestion and contractility of the gut suggesting a role in physiologies that connect circadian changes to metabolism and thermoregulation. In addition, melatonin is a powerful antioxidant system and is involved in neutralizing harmful reactive oxygen species in the brain. The functional relevance of melatonin's antioxidant properties is evident in a number of brain pathologies, as it has been shown to have recovery benefits in stroke and epilepsy as well as being an effective treatment of inflammatory conditions like sepsis. The hypothesis they propose to test is the possibility that melatonin can improve treatment outcomes for neurodegenerative diseases, but also, potentially for helping to optimize brain health in normative aging through its powerful anti-inflammatory capabilities. Because of its general medical safety, and multiple roles in healthy body physiological functions such as sleep and metabolism, it may provide multiple benefits to an aging individual, which would require precise dose timing and monitoring. Because melatonin pathways and mechanisms are largely conserved across animals, they propose that developing a Drosophila model to study effectiveness of interventions in disease and normal aging models would be productive. But it may actually be time to consider such interventions in humans.

Wang, Chen, Shang and **Brinton**
Allopregnanolone (Allo) is a neurosteroid with actions in the brain that includes neurogenesis, increased glucose metabolism and mitochondrial respiration, restoration of synaptic transmission and improved cognitive function. To investigate the mechanism of action of Allo, embryonic hippocampal neurons and astrocytes were cultured in media known as "Aging Model" media to produce an aging cell culture phenotype. Allo significantly increased mitochondrial respiration, reduced oxidative stress and Inflammation markers in these cultures. Collectively the findings from these experiments provide insights into common calcium-mediated and mitochondria-related mechanisms that underlie the action of Allo in early life as well as late life to activate systems that enable the integration of signaling and function in neurons and astrocytes. This strongly suggests that Allo may be an important therapeutic intervention for cognition in normative aging, as well as in Alzheimer's disease.

Zheng, Bao, Doner, Oyao, Forloines**, Grilli, Barnes, Ekstrom**
Advanced age consistently results in reduced performance in spatial navigational tasks, in all species tested. In older rats, hippocampus 'place cells' in hippocampus region CA1 show a reduction in the consistency of receptive field firing, experience to experience, within the same environment, which has been called 'remapping'. When hippocampus region CA3 is examined in old rats, these cells do not 'remap' when they should, when exposed to two environments that are completely different. This deficit suggests that one subregion of the hippocampus does not differentiate between separate environments. Whether remapping or lack of differentiation in hippocamps subregions also occurs in humans had not been tested before. To do this, high

resolution fMRI was conducted on younger and older adults. Participants were first trained to learn the relative location of stores within two different virtual environments, outside of the scanner. Retrieval of these environments was then tested while the participants were inside the scanner, examining whether two of the trained stores within a given environment were either closer to or farther away from a target store - a test of how accurate their spatial representations of the stores were in a given city. Multivariate pattern similarity analyses were applied to assess the distinct patterns of activity within the hippocampus in these conditions, and to create both a remapping index (how similar the activation patterns were within a city, compared to between the two different cities), as well as how distinct the patterns of activity were for each different city. There were both age-dependent and age-invariant effects of these analyses. The age-dependent effect showed lower neural pattern similarity for retrieving the same environment, much like the results obtained in case of remapping in CA1 cells of old rats. The age-independent finding was that the better performing individuals showed more differentiated neural representations regardless of age, a finding that also has parallels in CA3 cells of the rat hippocampus. This cross-species consistency suggests that tests of translational interventions may be a good way to screen potential treatments for these memory deficits with age in humans.

Deoni, Burton, Beauchemin, Cano-Lorente, De Both, Johnson, **Ryan, Huentelman**
This manuscript describes a break-through method for obtaining brain MRI images outside University or Hospital settings. While a number of reliable tests for cognition or movement can be collected remotely, the size and other requirements of1.5 or 3.0 Tesla magnet systems are impractical for testing people outside of controlled facilities. Many neuroimaging studies have been conducted on normal older adults, people with MCI, and AD. Patterns of brain change have been mapped across the lifespan, and such studies in normal individuals have provided a rich source of information about the aging brain, and cognitive consequences of altered brain anatomy and function. Recent advances in imaging technology have created MRI systems that operate at lower magnetic field strengths as an alternative to conventional systems, which has enabled the possibility of “residential MRI” scans, where ‘scan vans’ can actually carry the scanning device to individual homes. The participants were asked to take the MindCrowd memory and reaction time tests, consisting of a paired associates memory test and a simple reaction time test, which are completed on-line. Participants were consented to take the cognitive tests and to participate in brain scanning. The results were in general agreement with prior reported outcomes of gray matter volume change with age and significant brain volume and memory performance relationships. This new method of obtaining scans from older individuals who do not live close to universities or hospitals that have facilities for brain imaging, opens up an important recruitment window for understanding brain aging and memory changes that are expected at older ages in populations of individuals that are not typically included in research studies. The ability to go to people’s homes to accommodate individual participation should usher in a new age of sampling, and sample sizes that are necessary to better reflect population changes in brain and cognition across the lifespan. Recent commentaries on the state of brain aging research have estimated the need to recruit 100,000 people into clinical trials for preventative or therapeutic AD treatments. This new low-field MRI system, which can be conducted in hard-to-reach neighborhoods, will definitely play a role in achieving these important goals.

Mizell, Wang, Frisvold, Alvarado, Farrell-Skupny, Keung, Sundman, Franchetti, **Chou, Alexander, Wilson** (2023)
The decision to explore unknown opportunities or to exploit well-known options is a large part of our everyday lives. This phenomenon has come to be known at the “explore-exploit dilemma. In young individuals, there are two distinct strategies used to solve these decision-making

problems: directed exploration and random exploration. In directed exploration, choices on these sorts of tasks appear to be driven by a bias to collect information to make the most informed decision. In random exploration on the other hand, choices appear to be driven by inserting noise into the system so that a wider variety of choices may be sampled. It was unknown whether older adults use the same strategies as younger adults, and what other factors may impact these decision approaches. The outcome of these experiments suggested that older adults tended to have greater "uncertainty aversion" and "behavioral variability" at baseline and, decreased random exploration in their decision-making than did mature adults. Interestingly, these findings are consistent with the hypothesis that decreasing exploration and increasing exploitation as we age may be an adaptive behavior. This builds on theories of optimal foraging, which propose that early in our lives we should be more predisposed to explore in order to gain information about the world, but as we age, the balance should shift towards more exploitation than exploration once we have gained enough information to live effectively. The fact that older adults actually performed better on the task that benefited from exploitation than did younger adults supports the overall idea that this may be a 'healthy aging change.

Palmer, **Huentelman, Ryan**
This review article gives an overview and perspective on the impact of the APOE ε4 genotype on AD and on normative aging brain. Several very large recent studies have changed the perspective of how APOE ε4 increases the risk for Alzheimer's disease. Older estimates suggested that 60% of homozygotes for ε4 would develop AD by age 85. A more recent longitudinal study suggests that 81% of ε4 homozygotes did not develop dementia over a 20-year period. And other recent longitudinal studies have found similar results. The authors of this review asked the question - how does APOE ε4 affect brain and cognition outside of its association with AD pathology. Cross sectional studies using neuropsychological tests have reported poorer cognitive performance among older APOE ε4 carriers compared with noncarriers, with verbal episodic memory being studied the most. Newer studies have shown that episodic memory tasks derived from the cognitive aging literature suggest that this may be due to the fact that these APOE ε4 carriers underutilize episodic details and relay to a greater extent on familiarity-based information when retrieving memories. Thus, newer studies suggest that carriers either fail to encode spatial and temporal detail into memory representation, or they rely on gist-like representations when retrieving information about past events. They suggest a number of productive lines of experiments to try to uncover how the APOE ε4 genotype impacts cognition in aging, including examining astrocyte function (these cells express the highest levels of APOE among brain cells), and neurovascular function (APOE alters neurovascular function in multiple ways, including impacts on the function of the blood brain barrier). They emphasize that any given individual may experience cognitive dysfunction due to APOE ε4 in manner specific to multiple personal factors that interact with the APOE genotype, and argue for an individualized approach to therapeutic interventions.

Acevedo-Molina, Thayer, Horn, NIkulu, **Ryan, Andrews-Hanna, Grilli**
It is known that remembering and imagining personal events that are rich in episodic details is compromised in older adults who have mild cognitive impairment, a risk factor for AD. It is less clear whether normal older adults also show this deficit, especially if the normal older person is a genetic carrier of APOE ε4. To examine this association directly, the experiment was designed to compare demographically and neuropsychologically similar carriers and non-carries of APOE ε4 The APOE ε4 carriers showed significantly lower ability to recall episodic details when remembering past events, and when imagining future events. The authors conclude that

carrying the APOE ε4 genotype is specifically associated with the ability to perform specific types of memory tests.

McVeigh, **Mehl**, Polsinelli, Moseley, Sbarra, **Glisky, Grilli**
Because social interaction is theorized to have an important impact on cognition, one hypothesis for some of the cognitive changes observed with age is that a variety of social factors may be part of the reason for these changes. Executive functions are among those cognitive operations that are consistently impacted by age. Loneliness and social isolation, factors that capture unique but intertwined experiences, have been implicated in adverse health outcomes and cognitive decline, but the literature linking poor social interactions with cognition has been inconsistent. Improved methods to quantitatively measure social isolation and a more complete battery of executive function tests were used here in an attempt to clarify the discrepancies found in the literature in relation to this important topic. Along with a cognitive test battery that measured multiple aspects of executive functions, the participants wore the Electronically Activated Recorder (EAR) to collect ambient sounds that can objectively measure the amount of time spent alone, and the kinds of social interactions engaged in, providing an objective measure of social isolation, as well as taking a self-report measure, the loneliness scale from the NIH toolbox. In this way, both objective and subjective measures of loneliness could be compared to performance in the different measures of executive functions. Neither loneliness nor social isolation measures were significantly related to overall executive function, or any specific component of these functions such as working memory, shifting or attention. These data suggest that among cognitively normal older adults, there is unlikely to be a compelling association between executive functions and subjectively experienced loneliness or objectively observed social isolation.

Palitsky, **Wilson**, Feidman, Ruiz, Sullivan, **O'Connor**
Epidemiological research has suggested that bereavement is thought to increase the risk of all-cause mortality in older individuals. This is the first study to directly examine bereavement severity (using the Prolonged Grief Scale) along with measurements of cardiovascular risk factors. They used an interview protocol for eliciting bereavement-associated distress ('grief pangs'), and collected systolic and diastolic blood pressure measurements before the grief recall procedure in a 'baseline neutral period,' and after the protocol to monitor whether there were cardiovascular changes following the recall, as well as to monitor recovery of these changes. There were differences in blood pressure measurements immediately after the grief recall treatment, with significant increases in both diastolic and systolic measurements. Analysis of severity of grief and blood pressure changes indicated no association with diastolic measures, but there was a significant relationship with grief severity and systolic changes. There were also no relationships found between blood pressure recovery and grief severity. They hypothesize that systolic blood pressure may be more sensitive to emotions that elicit sympathetic activation. Knowledge of how bereavement affects health is an important step to determine how these cardiovascular correlates can be controlled to counteract the negative consequences of bereavement in older individuals.

Most important MBRF-relevant scientific achievements of FY23

The 20 most relevant publications from EMBI Affiliate Faculty are listed in Section 13 Appendix 2, and the significant new grants that were funded to members of the Tucson EMBI are listed in Section 6.

MBI Budget and Endowment Investment Reports

Annual Report

McKnight Brain Research Foundation
Sponsored Institutes and Research Programs
(Include activity of all McKnight supported faculty and trainees)
Report Period: July 1, 2022 to June 30, 2023

Financial Summary Format

Evelyn McKnight Brain Institute Endowed Chair at the University of Arizona

Summary for 12 months ended June 30, 2023

Account Name: McKnight Chair

A.	Beginning Balance on July 1, 2022	$ 906,473
B.	Investment Growth	$ 66,215
C.	Distributions	$ (38,721)
D.	Additional Contribution	$ N/A
E.	Ending Balance on June 30, 2023	$ 933,967
F.	Unmatched Balance (if applicable)	$ N/A

DEFINITIONS

DISTRIBUTION is the money transferred from the account to the spendable/operating account for the designated use.

BALANCE is the market value of the account as of the first or last day of the reporting year.

ADDITIONAL CONTRIBUTION is additional contribution by MBRF, the reporting institution, match etc.

INVESTMENT GROWTH (Loss) is the total undistributed interest, dividends, and realized and unrealized gains and losses.

BALANCE is the value of the account's corpus including all contributions, and applicable state match monies as of the date indicated.

Annual Report

McKnight Brain Research Foundation
Sponsored Institutes and Research Programs
(Include activity of all McKnight supported faculty and trainees)
Report Period: July 1, 2023 to November 30, 2023

Financial Summary Format

Evelyn McKnight Brain Institute

As of the end of October 2023 *
*The UArizona Foundation has provided a financial report to the McKnight Foundation with an end date of June 30, 2023. This is to provide the most up-to-date financial information.

Account Name: 40-10-4500 E.F. McKnight Brain Institute

A.	Beginning Balance on July 1, 2023	$ 10,467,549.49
B.	Investment Growth	$ (265,278.31)
C.	Distributions	$ (181,563.39)
D.	Additional Contribution	$ 161,587.81
E.	Ending Balance on October 31, 2023	$ 10,182,295.60
F.	Unmatched Balance (if applicable)	$ 207,954.85

DEFINITIONS

DISTRIBUTION is the money transferred from the account to the spendable/operating account for the designated use.

BALANCE is the market value of the account as of the first or last day of the reporting year.

ADDITIONAL CONTRIBUTION is additional contribution by MBRF, the reporting institution, match etc.

INVESTMENT GROWTH (Loss) is the total undistributed interest, dividends, and realized and unrealized gains and losses.

BALANCE is the value of the account's corpus including all contributions, and applicable state match monies as of the date indicated.

University of Arizona Foundation
E. F. McKnight Brain Inst/Endowed
SCNC - College of Science
0423 - Psychology

Financial Report for the 2024 Fiscal Year
Activity for the Period July 01, 2023 - October 31, 2023

Fund Number: 40-10-4500

Fund Performance

Financial Summary

Beginning market value at 7/1/2023	$	10,467,549.49
Investment performance		(265,278.31)
Endowment payout		(146,738.96)
Endowment fee		(34,824.43)
New gifts and additions		161,587.81
Ending market value at 10/31/2023	**$**	**10,182,295.60**
Historical gift value at 10/31/2023	**$**	**9,618,045.16**

Historic Gift Value at 10/31/23 Consists Of:

McKnight Foundation Gifts Net of UDF	4,826,000.00
UAF/Matching Gifts Net of UDF	4,792,045.15
	9,618,045.15

Remaining Matching Gift Obligation	207,954.85

University Earnings Shortfall Match made in FY 2024	$	10,625.00

Projected Budget – July 1, 2023 – June 30, 2024

Evelyn F. McKnight Brain Institute	Budget
Personnel	$635,000
Operations	$105,000
Total	$740,000

Expenditures – July 1, 2023 – June 30, 2024

Evelyn F. McKnight Brain Institute	Budget
Personnel	$635,000
Operations	$105,000
Total	$740,000

Permanent Endowment Expenditures

The Evelyn F. McKnight Institute account distributes funds from the permanent endowment to cover personnel and operational expenses.

Permanent Endowment Unmatched Balance

The UA Foundation current unmatched balance is $207,954, a 49% reduction in FY24. The UA Foundation will continue to direct all undesignated gifts to the McKnight Endowment until the match is received.

5. Collaborative Projects with McKnight Institutes and Non-McKnight Institutes

Investigators: PI: **Barnes** (UA); Project/Core Leads and Co-Leads: Albert (JHU) **Brinton** (UA), NK Chen (UA), Z. Chen (UA), **Brinton** (UA), **Huentelman** (TGen), LaFleur(UA), Lah (Emory), Levey (Emory), **Ryan** (UA), **Rundek** (UM), Runyon (UA), Schork (TGen), Sternberg (UA), Worley (JHU)
Project Title: Precision Aging Network: Closing the Gap Between Cognitive Healthspan and Human Lifespan
Sponsor: National Institute on Aging U19 AG065169
Project Dates: 09/30/2021 – 08/31/2026
Total Award: $59,988,951
Description: The strategic goal of the Precision Aging Network (PAN) is to develop the essential scientific knowledge and appropriate technologies to predict individual brain health risks and discover personalized solutions to maximize cognitive healthspan. Because of the enormous heterogeneity in brain and cognitive function among older individuals, the urgent challenge for science, medicine and healthcare providers is to discover interventions that are individually effective in delaying or preventing the onset of symptoms that arise from aging or brain disorders such as AD and AD-related dementias. To bridge existing gaps in our knowledge of the drivers of brain dysfunction, we will study very large, diverse, well-characterized and longitudinally sampled populations across the lifespan.

Investigators: UA Institute: **Grilli** (UA) **Huentelman** (TGen)
Project Title: Uncovering and Surveilling Financial Deception Risk in Aging
Sponsor: McKnight Brain Research Foundation
Project Dates: 07/01/2021 – 06/30/2023
Total Award: $199,369
Description: This study examines internet-based deception risk in aging. Grilli will examine whether individuals at higher risk for Alzheimer's disease exhibit alterations in online scam-related decision making. **Huentelman** will provide our expertise in APOE genotyping from dried blood and saliva specimens as well as recruitment activities via the existing MindCrowd cohort.

Investigators: **Alexander** (UA) **Bowers, Woods** (UF)
Project Title: Revitalizing Cognition in Older Adults at Risk for Alzheimer's Disease with Near-Infrared Photobiomodulation
Sponsor: McKnight Brain Research Foundation
Project Dates: 08/01/19 – 04/30/24
Total Award: $3,797,247
Description: The goal of this project is to determine whether NIR stimulation has potential for enhancing cognition in cognitively normal but "at risk" individuals for Alzheimer's disease.

Investigators: Co-Investigators: **Wilson** (UA), **Ebner, Lighthall** (UA)
Project Title: Characterizing and modulating neurocognitive processes of learning to trust and distrust in aging.

Sponsor: NIH/NIA R01 AG072658
Project Dates: 03/01/2022 - 04/30/2027
Total Award: $2,100,000
Description: This project will (i) characterize basic neurocognitive processes in learning to trust in aging; and (ii) determine if trust-related decision making can be optimized via neurofeedback training.

Investigators: Co-Investigators: **Grilli, Andrews-Hanna, Mehl** (UA), **Huentelman** (Tgen)
Project Title: Tracking autobiographical thoughts: a smartphone-based approach to identify cognitive correlates of Alzheimer's disease biomarkers and risk factors in clinically normal older adults.
Sponsor: National Institute on Aging R01 AG068098
Project Dates: 07/1/2022-06/30/2027
Total Award: $4,600,829
Description: Tracking autobiographical thoughts: a smartphone-based approach to identify cognitive correlates of Alzheimer's disease biomarkers and risk factors in clinically normal older adults.

Investigators: Co-Investigators: **Ekstrom, Wilson** (UA)
Project Title: A neurocomputational model of age-related differences in navigation
Sponsor: National Institutes of Health/National Institute on Aging R21 AG081558-01
Project Dates: 4/01/2023-3/31/2025
Total Award: $191,875
Description: Declines in spatial navigation often accompany advanced age and with a growing aging population, understanding the basis for age-related navigation differences is urgent. Developing experimental paradigms and models that can account for age-related differences in navigation is important to predicting who may be at risk for getting lost or having trouble finding their medicine, either as part of healthy or pathological aging.

Investigators: Co-Investigators: **Hay,** Vanderah (UA)
Project Title: PNA5: A Novel Mas Receptor Agonist for Treatment of Cognitive Impairment in Patients at Risk for Vascular Dementia and Alzheimer's Disease Related Dementia: an FDA required Toxicology Study
Sponsor: National Institute on Aging U01AG082617
Project Dates: 09/01/2023 – 08/31/2027
Total Award: $8,208.081
Description: To complete 6-month and 9-month formal GLP toxicology studies in 2 species for PNA5.

Investigators: PI: **Hay,** Co-Investigators Bellal, **Ryan,** Hishaw**,** Chen, Hsu, Salijuqi (UA)
Project Title: Angiotensin-(1-7): A Treatment for Neuropsychological and Memory Impairments Following Moderate to Severe Traumatic Brain Injury
Sponsor: Department of Defense
Project Dates: 8/1/2023 – 07/31/2027
Total Award: $3,004,651
Description: To complete a proof-of-concept Phase 1b/2a randomized, double-blind, placebo-controlled, clinical trial to determine the safety and efficacy of treatment with the neuroprotective and anti-inflammatory peptide Angiotensin-(1- 7) (Ang-[1-7]) to decrease cognitive impairment (CI) and

neurodegeneration bloodbased biomarkers in subjects with moderate to severe traumatic brain injury (TBI)

Investigators: Co-Investigators: **Andrews-Hanna**, **Grilli**, **Hovhannisyan** (UA)
Project Title: Neural correlates of age-related alterations in imaginative thinking
Sponsor: AZ Dept Health Services / Arizona Alzheimer's Consortium Match Projects
Project Dates: 07/01/2023-6/31/2024
Total Award: $30,000
Description: This project aims to determine the underlying neural correlates of different forms of imaginative thought and autobiographical memory in younger and older adults.

Investigators: Co-Investigators: **Brinton**, Rodgers (UA)
Project Title: Translational Research in Alzheimer's Disease and Related Dementias [TRADD]
Sponsor: National Institute on Aging
Project Dates: 09/01/23 – 08/31/2028
Total Award: $1,472,295
Description: T32 Training program to advance translational research on Alzheimer's Disease and AD related dementias [AZ-TRADD] is designed to address knowledge and experience gaps in AD therapeutic discovery and preclinical translational development.

Investigators: PI: **Cowen,** Co-Investigator: **Ryan** (UA)
Project Title: Assessing hippocampal-prefrontal communication during memory guided and sensorimotor behaviors using a transgenic rodent model of Alzheimer's disease.
Sponsor: Arizona Alzheimer's Consortium Match Project
Project Dates: 08/01/23 - 08/31/24
Total Award: $30,990
Description: Determine if neural communication between the hippocampus and prefrontal cortex is disrupted in a novel rat model of Alzheimer's disease using high-density neural recording methodologies.

Investigators: Co-Investigators: **Cowen** (UA), Gibson (Applied Universal Dynamics)
Project Title: An automated system for post-surgical health and environmental monitoring with real-time alerts for laboratory rodents using scalable hardware and deep learning.
Sponsor: NIH Office of the Director R43 OD034043-01A1 SBIR
Project Dates: 06/01/2023 – 05/31/2024
Total Award: $256,488
Description: Develop a within-cage monitoring system to track the health of laboratory animals following surgical procedures.

Investigators: PI: **Cowen** (UA)
Project Title: The effects of opioid use and chronic pain on the physiology of sleep and neural circuits involved in pain and addiction.
Sponsor: Center for Excellence in Addiction and Pain Research Pilot grant
Project Dates: 08/15/2022 - 08/14/2023
Total Award: $30,000

Description: Determine if sleep-associated oscillatory activity is impacted by chronic pain and opioid receptor agonism and antagonism.

Investigators: PI: **Barnes**, Co-Investigator **Cowen** (UA),
Project Title: Frontal and Temporal Lobe Interactions in Rat Models of Normative Aging and Alzheimer's Disease
Sponsor: National Institute on Aging R01 RF1AG081767
Project Dates: 05/15/2023-04/30/2028
Total Award: $3,266,421
Description: Determine if neural interactions between the frontal cortex and hippocampus are impaired in a transgenic rat model of Alzheimer's disease.

Investigators: Co-Investigators: **Cowen,** Co-Investigator: **Ryan** (UA)
Project Title: Investigation of age-associated changes in neural coordination in behaving animals
Sponsor: Arizona Alzheimer's Consortium Match Projects
Project Dates: 08/01/2022 – 07/31/2023
Total Award: $31,000
Description: Test and advance Neuropixels technology for 1000+ site recording in awake and behaving rats to study age-associated cognitive changes.

Investigators: Co-Investigators: Taylor, **Grilli** (UA)
Project Title: Accelerated treatment for co-occurring insomnia, nightmares, and PTSD
Sponsor: Department of Defense GRANT13453862-PR210654
Project Dates: 08/31/2023 – 01/31/2029
Total Award: $6,322,300
Description: The study aims to test an integrated, accelerated treatment targeting clinically significant symptoms of three common and interrelated disorders among military personnel: insomnia, nightmares, and PTSD.

Investigators: Co-Investigators: **Grilli, Andrews-Hanna** (UA)
Project Title: Neural correlates of age-related alterations in imaginative thinking
Sponsor: Arizona Department of Health Services
Project Dates: 07/01/2023 – 06/30/2024
Total Award: $30,633
Description: This study will use fMRI to uncover the relationship between the default mode network and imaginative thinking

Investigators: Co-Investigators: **Ekstrom, Grilli, Wilson** (UA)
Project Title: A neurocomputational model of age-related differences in navigation
Sponsor: National Institute on Aging R21 AG081558-01
Project Dates: 04/01/2023 – 01/31/2025
Total Award: $275,000
Description: This proposal will use immersive virtual reality and state of the art computational modeling to better understand age-related declines in spatial navigation

Investigators: Co-Investigators: Baker (Rutgers), Peters (UC Irvine), **Wilson** (UA)
Project Title: Beyond Computational Behaviorism: The Structure of Thought in Naturalistic Behaviors
Sponsor: Research Corporation for Science Advancement

Project Dates: 01/01/2023 – 12/31/2023
Total Award: $50,000
Description: The goal is to devise new methods to study high-level cognition.

Investigators: Co-Investigators: **Huentelman** (Tgen), **Rogalski** (Northwestern)
Project Title: Cognitive SuperAging: A model to explore resilience and resistance to aging and Alzheimer's disease.
Sponsor: National Institute on Aging R21 AG081558-01
Project Dates: 05/01/2020 – 01/31/2025
Total Award: $397,866
Description: The proposed research will characterize, in an interdisciplinary and longitudinal manner, a cohort of 80+ year- olds who display exceptionally successful cognitive aging and whom we have termed SuperAgers. This proposal will explore the mechanisms of the unique biologic and genetic features associated with SuperAging.

Investigators: Co-Investigators: **Huentelman** (Tgen), **Rogalski** (Northwestern)
Project Title: Study to uncover pathways to exceptional cognitive resilience in aging (SUPERAging)
Sponsor: National Institute on Aging U19 AG073153
Project Dates: 10/01/2021 – 05/31/2026
Total Award: $4,127,147
Description: Investigation of factors that may contribute to the SuperAging phenotype and will help identify potential targets for interventions that will allow normal elderly to preserve cognitive function and combat dementia.

Investigators: PI: **Barnes** (UA), Co-Investigators: **Huentelman** (Tgen), Worley (JHU)
Project Title: NPTX2: Preserving memory circuits in normative aging and Alzheimer's Disease
Sponsor: National Institute on Aging 1R01AG072643-01
Project Dates: 05/01/2021 – 04/30/2026
Total Award: $3,480,634
Description: Studies will examine the impact of NPTX2 reduction in human brain specimens and in neuronal circuits modeled in vitro using RNA and protein profiling, and the functional consequence of NPTX2 reduction on cognitive and behavior-linked circuit function using innovative rat models, and will provide fundamental new insights into memory, cognitive resilience, aging, and Alzheimer's disease.

Investigators: PI: **Barnes,** Co-Investigator: **Ekstrom** (UA)
Project Title: Neurobehavioral Relations in Senescent Hippocampus
Sponsor: National Institute on Aging R01AG003376
Project Dates: 09/30/1990 – 05/31/2026
Total Award: $ 2,912,362
Description: The outcome of the proposed project will have a significant impact on our understanding of the neural basis of episodic memory in rodents, nonhuman primates and humans and how specific brain regions contribute to age-associated memory deficits.

Investigators: Co-Investigators: **Wilson, Alexander** (UA)
Project Title: Evaluating the Neurocomputational Mechanisms of Explore-Exploit Decision Making in Older Adults
Sponsor: National Institute on Aging R01AG061888
Project Dates: 09/01/2019 – 08/31/2024
Total Award: $ 1,765,250
Description: The objective of this proposal is to develop and test a neurocomputational model that describes explore-exploit decision making throughout the lifespan.

Investigators: PI: **Cowen** (UA)
Project Title: Pilot Project Research Core
Sponsor: National Institute on Drug Abuse
Project Dates: 07/01/21 - 06/31/26
Total Award: $135,075
Description: Develop core facilities at the UA to support research at the intersection of addiction and pain management.

6. Honors, Award and New Grants

Honors and Awards

Roberta Brinton received 2023 College of Science Alumni of the Year

Mary-Frances O'Connor received the Patricia R. Barchas Award in Sociophysiology, American Psychosomatic Society

Mary-Frances O'Connor was named a Fellow, American Psychosomatic Society

Lee Ryan was elected Vice President-Elect of the board for the Federation of Associations in Behavioral & Brain Sciences (FABBS)

Jessica Andrews Hanna was named to the Association for Psychological Science Fellow; Research Leadership Institute Fellow, University of Arizona

New Grants

Investigators:	Co-Investigators: **Hay,** Vanderah (UA)
Project Title:	PNA5: A Novel Mas Receptor Agonist for Treatment of Cognitive Impairment in Patients at Risk for Vascular Dementia and Alzheimer's Disease Related Dementia: an FDA required Toxicology Study
Sponsor:	National Institute on Aging U01AG082617
Project Dates:	09/01/2023 – 08/31/2027
Total Award:	$8,208.081
Description:	To complete 6-month and 9-month formal GLP toxicology studies in 2 species for PNA5.

Investigators:	PI: **Hay,** Co-Investigators: Bellal, **Ryan,** Hishaw**,** Chen, Hsu, Salijuqi (UA)
Project Title:	Angiotensin-(1-7): A Treatment for Neuropsychological and Memory Impairments Following Moderate to Severe Traumatic Brain Injury
Sponsor:	Department of Defense
Project Dates:	8/1/2023 – 07/31/2027
Total Award:	$3,004,651
Description:	To complete a proof-of-concept Phase 1b/2a randomized, double-blind, placebo-controlled, clinical trial to determine the safety and efficacy of treatment with the neuroprotective and anti-inflammatory peptide Angiotensin-(1- 7) (Ang-[1-7]) to decrease cognitive impairment (CI) and neurodegeneration bloodbased biomarkers in subjects with moderate to severe traumatic brain injury (TBI)

Investigators:	PI: **Mehl** (UA)
Project Title:	Long-term mobile sensing for human-autonomy teaming
Sponsor:	United States Army Contracting – CA W911NF2320236
Project Dates:	09/01/2023-09/01/2024
Total Award:	$117,251

Description: This grant is focused on large-scale, real-time, and real-world data on people's behaviors, interactions, and environments improve psychological measurement, or lead to customized psychological interventions

Investigators: PI: **Trouard** (UA)
Project Title: 3T MRI scanner for Advanced Brain Imaging
Sponsor: National Institutes of Health NIH S10OD032166
Project Dates: 3/15/2023-3/15/2025
Total Award: $2,000,000
Description: This high-end instrumentation grant will bring a state-of-the-art 3T MRI to the University of Arizona for brain imaging.

Investigators: Co-Investigators: **Huentelman** (Tgen), **Reiman** (Banner)
Project Title: Identification of polygenic risk scores associated with verbal memory performance in non-demented individuals
Sponsor: Arizona DHS/ Banner Health CTR057001
Project Dates: 07/01/2023-06/30/2024
Total Award: $116,667
Description: Identification of polygenic risk scores associated with verbal memory performance in non-demented individuals.

Investigators: Co-Investigators: **Ekstrom, Wilson** (UA)
Project Title: A neurocomputational model of age-related differences in navigation
Sponsor: National Institutes of Health/National Institute on Aging R21 AG081558-01
Project Dates: 4/01/2023-3/31/2025
Total Award: $191,875
Description: Declines in spatial navigation often accompany advanced age and with a growing aging population, understanding the basis for age-related navigation differences is urgent. Developing experimental paradigms and models that can account for age-related differences in navigation is important to predicting who may be at risk for getting lost or having trouble finding their medicine, either as part of healthy or pathological aging.

Investigators: PI: **Barnes**, Co-Investigator: **Cowen** (UA),
Project Title: Frontal and Temporal Lobe Interactions in Rat Models of Normative Aging and Alzheimer's Disease
Sponsor: National Institute on Aging R01 RF1AG081767
Project Dates: 05/15/2023-04/30/2028
Total Award: $3,266,421
Description: Determine if neural interactions between the frontal cortex and hippocampus are impaired in a transgenic rat model of Alzheimer's disease.

Investigators: Co-Investigators: Taylor, **Grilli** (UA)
Project Title: Accelerated treatment for co-occurring insomnia, nightmares, and PTSD
Sponsor: Department of Defense GRANT13453862-PR210654
Project Dates: 08/31/2023 – 01/31/2029
Total Award: $6,322,300
Description: The study aims to test an integrated, accelerated treatment targeting clinically significant symptoms of three common and interrelated disorders among military personnel: insomnia, nightmares, and PTSD.

Investigators:	Co-Investigators: **Brinton**, Rodgers (UA)
Project Title:	Translational Research in Alzheimer's Disease and Related Dementias [TRADD]
Sponsor:	National Institute on Aging
Project Dates:	09/01/23 – 08/31/2028
Total Award:	$1,472,295
Description:	T32 Training program to advance translational research on Alzheimer's Disease and AD related dementias [AZ-TRADD] is designed to address knowledge and experience gaps in AD therapeutic discovery and preclinical translational development.

7. Technology Transfer

International and U.S. Provisional Applications (all evenly divided attribution)

Pau S, Grandner MA, **Fernandez F**, and Mason BJ. Circadian Rhythm Restoring Bl Blockers.
Attorney Docket: 044974-8065.US00 (UA21-174)
PCT/US2022/038207, U.S. Patent Application No. 63/225, 727

Pau S, Grandner MA, **Fernandez F**, and Mason BJ. Blue Enhancer Glasses.
Attorney Docket: 044974-8066.US00 (UA21-175)
PCT/US2022/038215, U.S. Patent Application No. 63/225, 753

Pau S, Grandner MA, **Fernandez F**, and Mason BJ. Pink Blue Blockers.
Attorney Docket: 044974-8067.US00 (UA21-176)
PCT/US2022/038220, U.S. Patent Application No. 63/225, 785

Pau S, Grandner MA, **Fernandez F**, and Mason BJ. Green Enhancer Glasses.
Attorney Docket: 044974-8068.US00 (UA21-233)
PCT/US2022/038233, U.S. Patent Application No. 63/225, 806

Pau S, Grandner MA, **Fernandez F**, and Mason BJ. Melanopsin Blocker.
Attorney Docket: 044974-8069.US00 (UA21-234)
PCT/US2022/038235, U.S. Patent Application No. 63/225, 848

Chang, R, **Brinton, R** Kaddurah-Daouk Rima. Converted to a nonprovisional patent - Phytoestrogenic Formulations of Cognitive Function, Sleep Quality and Mood Symptoms.
Published as WO2023069671A1

8. Were any funds used for a Prohibited Purpose during the report period?

No

9. Do you recommend any modification to the Purpose or mandates in the Gift Agreement?

No

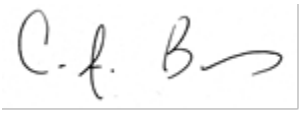
10. Did all activities during the report period further the Purpose?

Yes

11. Additional Comments (items that are not covered elsewhere in the report, including any negative events, loss of full-time employees (FTEs), impending departures, space, or budget that could have an impact on carrying out the Gift Agreement.)

None

Respectfully Submitted,



C.A. Barnes, Ph.D.
Regents' Professor, Psychology, Neurology and Neuroscience
Evelyn F. McKnight Chair for Learning and Memory in Aging
Director, Evelyn F. McKnight Brain Institute

12. Appendix 1

List of McKnight Affiliate Faculty and their area of focus, and Department Affiliations, including a list of post-doctoral and pre-doctoral trainees (CVs needed only for new faculty/collaborators)

No new Affiliate Faculty were appointed in the Tucson EMBI in 2023, thus there are no new curriculum vitae to append.

Primary Faculty

Gene E. Alexander, Ph.D., Professor, Psychology, UA
Area of Focus: He studies brain-behavior relationships in the context of healthy aging and age-related, neurodegenerative disease. He uses multimodal neuroimaging techniques, including structural and functional magnetic resonance imaging (MRI) and positron emission tomography (PET), in combination with measures of cognition and behavior to address research questions on the effects of brain aging and Alzheimer's disease.

Jessica Andrews-Hanna, Ph.D., Associate Professor, Psychology, UA
Area of Focus: Her research is centered on understanding the mysteries of our inner mental lives – the thoughts, memories, feelings and emotions that make us unique as individuals. Her work is particularly relevant to EMBI in that she is trying to determine how internally guided processes develop throughout adolescence and change into old age.

Carol A. Barnes, Ph.D., Regents Professor, Psychology, UA
Area of Focus: Her research has focused on the aging brain, and how cognition changes during the course of normal aging. She uses animal models of human aging (rodents and nonhuman primates) that allow a detailed examination of the brain mechanisms of age-related changes in learning and memory, and the circuits responsible for complex cognitive functions. More recently she is also studying normative age-related cognitive changes in humans.

Robbie Brinton, Ph.D., Regents Professor, Pharmacology, UA
Area of Focus: She investigates the mechanisms of bioenergtic and regenerative aging of the brain. Translationally, the pathways involved in these mechanisms that are activated by neurosteroids provide the basis for personalized interventions that target stages of bioenergetic aging in both female and male brains to prevent and delay brain aging and susceptibility to Alzheimer's disease.

Ying-hui Chou, Ph.D., Associate Professor, Psychology, UA
Area of Focus: She works in the area of cognitive and clinical neuroscience of aging and neurodegenerative disorders. Within this framework, her laboratory is particularly interested in integrating brain imaging and transcranial magnetic stimulation (TMS) techniques to develop therapeutic TMS protocols for individuals with mild cognitive impairment and potentially normative aging. The development of TMS-derived and image-based biomarkers for early diagnosis and prediction of therapeutic outcomes will be important to many EMBI faculty.

Stephen Cowen, Ph.D., Associate Professor, Psychology, UA,
Area of Focus: His interest is in understanding how interacting groups of neurons represent the value of anticipated outcomes, planned actions, and physical space. He is specifically interested in determining the neural origins of age-associated memory loss and the role of sleep in the memory formation process.

Arne Ekstrom, Ph.D., Professor, Psychology, UA
Area of Focus: His work revolves around the important question of the neural basis of human memory, with a particular interest in spatial navigation. With respect to aging, the hippocampus is critical for spatial navigation, and he is conducting experiments using high resolution MRI and immersive VR technologies to examine how spatial navigation changes during aging.in humans.

Fabian Fernandez, Ph.D., Associate Professor, Psychology, UA
Area of Focus: His laboratory is interested in circadian timekeeping, which is fundamental to human health. He is particularly interested in how chronic and quick, sequenced light exposure can be designed to promote normal healthy aging and strengthen adaptive cognitive/emotional responses to being awake in the middle of the night.

Matt Grilli, Ph.D., Associate Professor, Psychology, UA
Area of Focus: His primary interest is in understanding how we store and retrieve memories, with an emphasis on autobiographical memory, which refers to memories of personal experiences. Ongoing projects are investigating how autobiographical memory is affected in several populations, including older adults, as well as how decision-making operations are altered in aging.

Meredith Hay, Ph.D., Professor, Physiology, UA
Area of Focus: Her interests are in cardiovascular neurobiology and aging, and in the development of novel peptides that are neuroprotective. She is particularly interested in peptides that inhibit inflammatory cascades and improve brain blood flow, which has applications in both normative aging and in age-related diseases.

Matthew Huentelman, Ph.D., Division Director and Professor, Neurogenomics Division, TGen
Area of Focus: His lab is using genomics and transcriptomics to better understand why some individuals exhibit better cognitive aging when compared to others. The hope is that through the better understanding of these differences we may someday be able to develop therapeutics that could enable a larger portion of the population to exhibit better cognitive aging.

Matthias Mehl, Ph.D., Professor, Psychology, UA
Area of Focus: He is a health psychologist who is interested in the psychological implications of our daily lives. He develops behavioral assessment methods for studying everyday life using naturalistic observation of social interactions and quantitative text analysis of natural language use across the lifespan.

Mary-Frances O'Connor, Ph.D., Associate Professor, Psychology UA
Area of Focus: She is interested in understanding individual differences in response to loss, especially the death of a loved one, both psychologically and physiologically. For the latter, she examines neurobiological, immune, and autonomic parameters that vary between individual grief responses, and across age.

Lee Ryan, Ph.D., Professor and Department Head, Psychology, UA
Area of Focus: Her research focuses on the neural basis of memory, age-related changes in memory, and how these changes relate to brain functioning. She has a special interest in the impact of cardiovascular health for maintaining memory function as we age, and decreasing risk for age-related disorders.

Ted P. Trouard, Ph.D., Professor, Biomedical Engineering, UA
Area of Focus: His interests involve the development and biomedical application of magnetic resonance imaging technologies to experiments that seek to monitor brain changes over time – whether it is in normative aging, or in age-related diseases, such as AD. He is also expert in small animal imaging and collaborates with several EMBI faculty on such studies. Additionally, he is working on a project involving focused ultrasound for drug delivery that has many potential applications.

Robert Wilson, Ph.D., Associate Professor, Psychology
Area of Focus: His research interests mix theoretical and computational modeling, psychophysics, pupillometry, EEG and fMRI to probe the neuroscience of learning and decision making in humans, and across the lifespan.

Secondary Faculty

Heather Bimonte-Nelson, Ph.D., Associate Professor, Psychology, ASU
Paul Coleman, Ph.D., Research Professor, Biodesign Institute, ASU
Ralph F. Fregosi, Ph.D., Professor, Physiology, UA
Andrew J. Fuglevand, Ph.D., Professor, Physiology, UA
Elizabeth L. Glisky, Ph.D., Professor Emeritus, Psychology, UA
Katalin M. Gothard, M.D., Ph.D., Professor, Physiology and Neurology, UA
Asta Håberg, M.D, Ph.D., Professor, NTNU, Norway
Al Kaszniak, Ph.D., Professor Emeritus, Psychology, UA
Anita Koshy, M.D., Assistant Professor, Neurology, UA
Lalitha Madhavan, M.D., Ph.D., Assistant Professor, Neurology, UA
Diano Marrone, Ph.D., Professor, Psychology, Wilfrid Laurier Univ.
Elliott Mufson, Ph.D., Professor, Neurobiology, Dignity Health, Phoenix
Lynn Nadel, Ph.D., Regents' Professor, Emeritus, UA
Janko Nikolich-Zugich, M.D., Ph.D., Department Head, Immunobiology, UA
Mary Peterson, Ph.D., Professor, Psychology, Director Cognitive Science Program, UA
Naomi E. Rance, M.D., Ph.D., Professor Emeritus, Pathology, UA
Steven Z. Rapcsak, M.D., Professor, Neurology, Psychology, and Speech, Language and Hearing Sciences, UA
Eric Reiman, M.D., Executive Director, Banner Alzheimer's Institute, Phoenix
Linda L. Restifo, M.D., Ph.D., Professor, Neurology, UA
Anne Smith, Ph.D., Sage Therapeutics, Massachusetts

Predoctoral Trainees

Monica Acevedo-Molina (Grilli)
Madeline Ally (Alexander)
Eric Andrews (Andrews-Hanna)
Amanda Bernal (Mehl)
Pradyumna Bharadwaj (Alexander)
Avnish Bhattrai (Brinton)
Ellen Carroll (Mehl)
Yu Jung Chen (Barnes)
Patricia Chilton (Mehl)
Lizzie Church (Barnes)

Chloe Cobb (Alexander)
Daniel Cohen (Grilli)
Andrea Coppola (Andrews-Hanna)
Helena Cortez Flores (Brinton)
Nicole Delatorre (Brinton)
Loi Do (Trouard)
Sydney Friedman (O'Connor)
Coco Victoria Gomez Tirambulo (Brinton)
Lesley Guareña Espinosa (Ryan)
Gabe Holguin (Cowen)
Mariam Hovhannisyan (Andrews-Hanna)
Christina Hoyer-Kimura (Hay)
Yinqi Huang (Wilson)
Daniella Johnson (Alexander)
Sarah Leighton (Mehl)
Kelsey McDermott (Barnes)
Will McLean (Brinton)
Katelyn McVeigh (Grilli)
Rae Mendoza (Fernandez)
Simona Merlini (Brinton)
Alana Muller (Ekstrom)
Devon Murphy (Trouard)
David C. Negelspach (Fernandez)
Justin Palmer (Ryan)
Yvette Pino (O'Connor)
Vannia Puig Rivera (Andrews-Hanna)
Quentin Raffaelli (Andrews-Hanna)
Stella Rocci (Alexander)
Sameer Sabharwal-Siddiqi (Ekstrom)
Sarah Seger (Ekstrom)
Dominique Simms (O'Connor)
Hyun Song (Alexander)
Samantha Smith (Alexander)
Sahana Srivathsa (Barnes)
Colin Tidwell (Mehl)
Alma Tejeda Padron (Mehl)
Angelique Townsend (Alexander)
Hannah Van Rossum (Brinton)
Abhilasha Vishwanath (Cowen)
Sophia Von Hippel (Brinton)
Da'Mere Wilson (O'Connor)
Gabriel Winter (Cowen)
Haley Wiskoski (Trouard)
Hanbo Xie (Wilson)
Huadong Xiong (Wilson)
Jinming Xue(Wilson)
Marc Zempare (Barnes)

Postdoctoral Trainees

Monica Chawla, Ph.D. (Barnes)
Fabrizio Ecca (Huentelman)
Daniel Gray, Ph.D. (Barnes)
Diego Guevara Beltran (Andrews-Hanna)
Gerson Hernandez (Brinton)
Paul Hill (Ekstrom)
Aya Kamzina (Huentelman)
Adam Lester, Ph.D. (Barnes)
Shanshan Ma (Andrews-Hanna)
Stephanie Matijevic (Ryan)
Leigh Nicholson (Huentelman)
Valeria Pfeifer (Mehl)
Caroline Phelps (Wilson)
Adam Raikes (Brinton)
Yuan 'Raymond' Shang (Brinton)
Irina Sinakevitch, Ph.D. (Barnes)
Sabina Srokova (Ekstrom)
Teodora Stoica (Grilli)
Emily Van Etten (Alexander)
Francesca Vitali (Brinton)
Tian Wang (Brinton)
Li Zheng (Ekstrom)
Nahla Zaghloul (Brinton)

13. Appendix 2

Top 20 publications from FY 23 relevant to MBRF

These 20 publications include Affiliate Faculty from the Tucson EMBI, and faculty from the other EMBI Institutes, attesting to the collaborative nature of McKnight Faculty.

Acevedo-Molina MC, Thayer SC, Horn K, Nkulu H, **Ryan L**, **Andrews-Hanna JR**, **Grilli MD**. Past and future episodic detail retrieval is reduced among clinically normal older adults at higher genetic risk for late-onset Alzheimer's disease. Neuropsychology. 2023 Feb;37(2):194-203. doi: 10.1037/neu0000866. Epub 2022 Nov 28. PMID: 36442007; PMCID: PMC10129290.

Branigan GL, Torrandell-Haro G, Chen S, Shang Y, Perez-Miller S, Mao Z, Padilla-Rodriguez M, Cortes-Flores H, Vitali F, **Brinton RD**. Breast cancer therapies reduce risk of Alzheimer's disease and promote estrogenic pathways and action in brain. iScience. 2023 Oct 24;26(11):108316. doi: 10.1016/j.isci.2023.108316. PMID: 38026173; PMCID: PMC10663748.

Chang R, Trushina E, Zhu K, Zaidi SSA, Lau BM, Kueider-Paisley A, Moein S, He Q, Alamprese ML, Vagnerova B, Tang A, Vijayan R, Liu Y, Saykin AJ, **Brinton RD**, Kaddurah-Daouk R; Alzheimer's Disease Neuroimaging Initiative† and the Alzheimer's Disease Metabolomics Consortium. Predictive metabolic networks reveal sex- and APOE genotype-specific metabolic signatures and drivers for precision medicine in Alzheimer's disease. Alzheimers Dement. 2023 Feb;19(2):518-531. doi: 10.1002/alz.12675. Epub 2022 Apr 28. PMID: 35481667; PMCID: PMC10402890.

Danvers, A.F., Efinger, L.D., **Mehl, M.R**., Helm, P.J., Raison, C.L., Polsinelli, A.J., Moseley, S.A., Sbarra, D.A. (2023) Loneliness and time alone in everyday life: A descriptive-exploratory study of subjective and objective social isolation, Journal of Research in Personality, 107. doi: 10.1016/j.jrp.2023.104426.

Dollish H.K., Kennedy K.E.R., Grandner M.A., and **Fernandez F-X**. Melatonin, circadian rhythms, and sleep: An opportunity to understand mechanisms for protecting against neurodegenerative disease in Drosophila. Healthy Ageing and Longevity Book Series: Sleep and Clocks in Aging and Longevity (Springer Nature), 18: 521-561, 2023. *Corresponding Author

Ekstrom A.D. & Hill P.F. (2023). Spatial navigation and memory: A review of the similarities and differences relevant to brain models and age. Neuron. 111(7): 1037-1049. PMID: 37023709. PMCID: 10083890.

Grilli MD, Sheldon S. Autobiographical event memory and aging: older adults get the gist. Trends Cogn Sci. 2022 Dec;26(12):1079-1089. doi: 10.1016/j.tics.2022.09.007. Epub 2022 Oct 1. PMID: 36195539; PMCID: PMC9669242.

Hooyman A, **Huentelman MJ**, De Both M, **Ryan L**, Schaefer SY. (2023). Establishing the Validity and Reliability of an Online Motor Learning Game: Applications for Alzheimer's Disease Research Within MindCrowd. Games Health J. Feb 6. doi: 10.1089/g4h.2022.0042. Epub ahead of print. PMID: 36745382.

McAvan AS, Du YK, Oyao A, Doner S, **Grilli MD**, **Ekstrom A**. Older Adults Show Reduced Spatial Precision but Preserved Strategy-Use During Spatial Navigation Involving Body-Based Cues. Front Aging Neurosci. 2021 Apr 12;13:640188. doi: 10.3389/fnagi.2021.640188. PMID: 33912024; PMCID: PMC8071999.

McVeigh KS, **Mehl MR**, Polsinelli AJ, Moseley SA, Sbarra DA, Glisky EL, **Grilli MD**. Loneliness and social isolation are not associated with executive functioning in a cross-sectional study of cognitively healthy older adults. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. 2023 Oct 22:1-18. doi: 10.1080/13825585.2023.2270208. Epub ahead of print. PMID: 37865921.

Mosconi L, Jett S, Nerattini M, Andy C, Yepez CB, Zarate C, Carlton C, Kodancha V, Schelbaum E, Williams S, Pahlajani S, Loeb-Zeitlin S, Havryliuk Y, Andrews R, Pupi A, Ballon D, Kelly J, Osborne J, Nehmeh S, Fink M, Berti V, Matthews D, Dyke J, **Brinton RD**. In vivo Brain Estrogen Receptor Expression By Neuroendocrine Aging And Relationships With Gray Matter Volume, Bio-Energetics, and Clinical Symptomatology. Res Sq [Preprint]. 2023 Feb 27:rs.3.rs-2573335. doi: 10.21203/rs.3.rs-2573335/v1. PMID: 36909660; PMCID: PMC10002830

Muller A, Garren JD, Cao K**, Peterson MA**, **Ekstrom AD**. Understanding the encoding of object locations in small-scale spaces during free exploration using eye tracking (2023). Neuropsychologia. 2023 Jun 6;184:108565. doi: 10.1016/j.neuropsychologia.2023.108565. Epub 2023 Apr 18. PMID: 37080425; PMCID: PMC10289170.

Palitsky, R, Wilson, DT, Freidman, SE, Ruiz, JM, Sullivan, D, **O'Connor, MF**. (2023). The relationship of prolonged grief disorder symptoms with hemodynamic response to grief recall among bereaved adults. Psychosomatic Medicine, 85, 545-550, doi: 10.1097/PSY.0000000000001223.

Palmer JM, **Huentelman M**, **Ryan L**. More than just risk for Alzheimer's disease: APOE ε4's impact on the aging brain. Trends Neurosci. 2023 Sep;46(9):750-763. doi: 10.1016/j.tins.2023.06.003. Epub 2023 Jul 16. PMID: 37460334

Palmer, JM, **Grilli, M.D**., Lawrence, A.V., and **Ryan, L**. (2023). The impact of context on pattern separation for objects among younger and older APOE ε4 carriers and noncarriers. J Int Neuropsychol Soc. 29:439-449.

Seeley SH, **Andrews-Hanna JR**, Allen JJB, **O'Connor MF**. Dwelling in prolonged grief: Resting state functional connectivity during oxytocin and placebo administration. Hum Brain Mapp. 2023 Jan;44(1):245-257. doi: 10.1002/hbm.26071. Epub 2022 Sep 10. PMID: 36087094; PMCID: PMC9783453.

Seger SE, Kriegel JLS, Lega BC, **Ekstrom AD**. Memory-related processing is the primary driver of human hippocampal theta oscillations. Neuron. 2023 Oct 4;111(19):3119-3130.e4. doi: 10.1016/j.neuron.2023.06.015. Epub 2023 Jul 18. PMID: 37467749; PMCID: PMC10685603.

Sheldon S, Sheldon J, Zhang S, Setton R, Turner GR, Spreng RN, **Grilli MD**. Differences in the content and coherence of autobiographical memories between younger and older adults: Insights from text analysis. Psychol Aging. 2023 Jul 20. doi: 10.1037/pag0000769. Epub ahead of print. PMID: 37470991.

Wang T, Chen S, Mao Z, Shang Y, **Brinton RD**. Allopregnanolone pleiotropic action in neurons and astrocytes: calcium signaling as a unifying mechanism. Front Endocrinol (Lausanne). 2023 Dec 22;14:1286931. doi: 10.3389/fendo.2023.1286931. PMID: 38189047; PMCID: PMC10771836.

Zheng L, Gao Z, Doner S, Oyao A, Forloines M, **Grilli MD**, **Barnes CA**, **Ekstrom AD**. Hippocampal contributions to novel spatial learning are both age-related and age-invariant. bioRxiv [Preprint]. 2023 Nov 2:2023.06.28.546918. doi: 10.1101/2023.06.28.546918. Update in: Proc Natl Acad Sci U S A. 2023 Dec 12;120(50):e2307884120. PMID: 37425879; PMCID: PMC10326977.

14. Appendix 3

Top 10 presentations at scientific or public meetings relevant to the MBRF

Scientific Presentations

Andrews-Hanna - Symposium Speaker, 2023 International Neuropsychological Society Conference, San Diego, CA "Minds at Rest: Characterizing clinical and demographic sources of variability in spontaneous cognition during the resting state." (February 2023)

Barnes, PDN Adrian Seminars in Neuroscience series, Region-selective hippocampus contributions to altered cognition in aging, University of Cambridge, Cambridge, England, (February 2023)

Barnes, Annual Angeliki Georgopoulos Lecture in Brain Sciences, University of Minnesota, Contribution of synapse change to cognitive decline in aging, Minneapolis, MN, (November 2023)

Brinton - Innovations in Healthy Aging Fall Seminar Series. "Regenerating the Alzheimer's Brain and Other Splendors of Science to Achieve Vibrant Brains that Last a Lifetime", Tucson, AZ (October 2023)

Ekstrom - iScan 2023 Magdeburg Germany, All is not lost: Surprisingly intact navigation in healthy older adults. (December 2023)

Fernandez – 2023 The Society of Behavioral Sleep Medicine, San Diego, CA, Science and Research Webinar, “BSM Principles Derived from Animal Models.” (November 2023)

Grilli - Cruz L, Griffith C, Andrews-Hanna JR, Grilli MD). Real World Goal Setting in Young and Older Adults. Poster presented at: International Neuropsychological Society Annual Conference, San Diego, (February 2023)

Hay - Hoyer-Kimura, C., Konhilas, J., Pires, P., Banek, C., Dennis, M., Salcedo, V., and M. Hay. A novel therapeutic Ang(1-7) analogue improves neurovascular function in mice with vascular contributions to cognitive impairment and dementia. American Physiology Summit, Long Beach, California (April 2023).

Mehl, M. R.- MULTICAST Kick-Off Symposium, University of Zürich, Switzerland. Our words, our worlds: Studying language and social interactions in everyday life. Invited keynote address, (June 2023).

Wilson - Global Minds Explore and/or Valorise Call Ghent University, Belgium, Information and Randomization in Exploration and Exploitation, (March 2023)

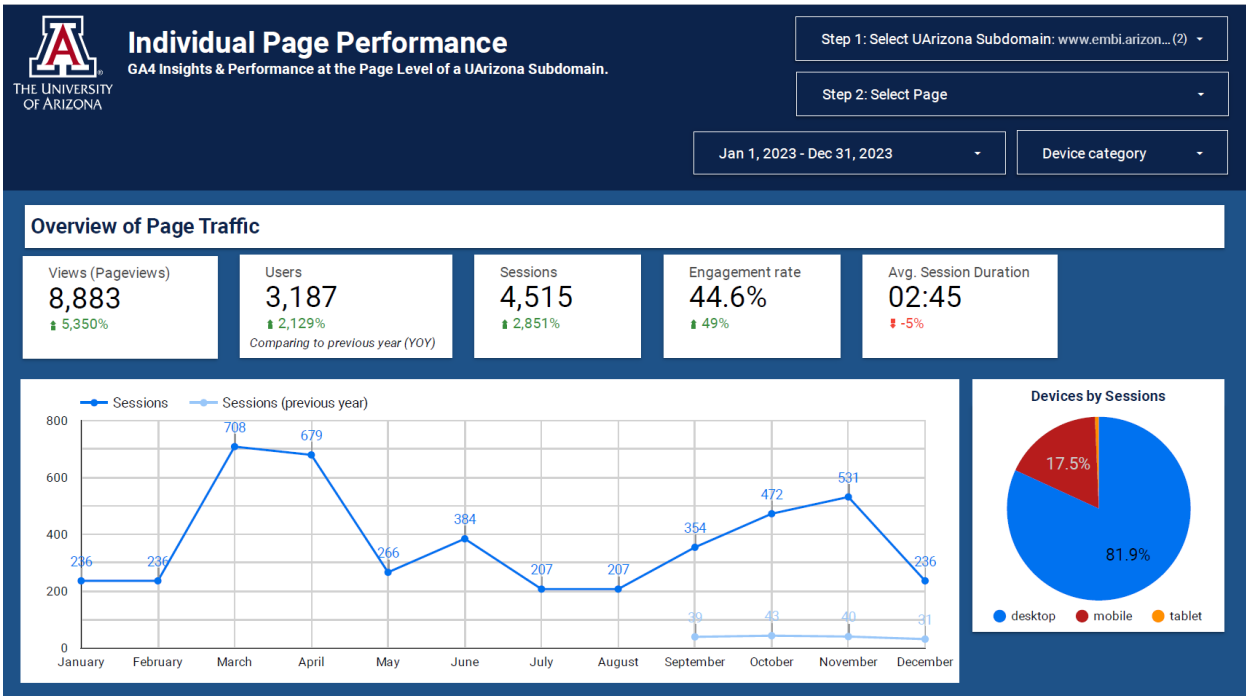
15. Appendix 4

Highlights of website development, media coverage and/or social media audience development

Website Development

EMBI Arizona Website

During the past year the Tucson EMBI continues to make a significant effort to update and improve its website content, continually providing fresh content.

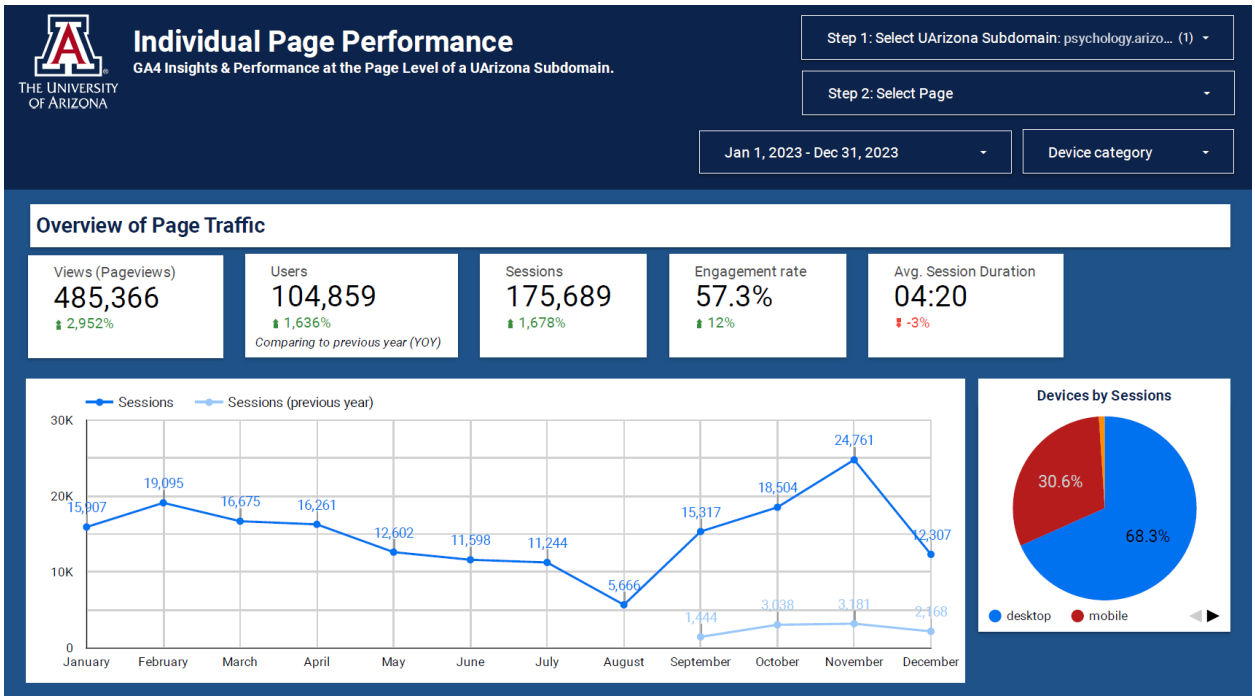


Engagement Overview

	Top Menu Clicks	Event name	Event count ▾	% Δ	% of Total
1.	Research	uaqs_www_menu	234	387.5%	18%
2.	Affiliate Faculty	uaqs_www_menu	123	232.4%	9%
3.	Precision Aging Network	uaqs_www_menu	119	395.8%	9%
4.	Administrative Staff	uaqs_www_menu	113	88.3%	9%
5.	Contact us	uaqs_www_menu	112	286.2%	9%
6.	Home	uaqs_www_menu	89	345.0%	7%
7.	Present Members	uaqs_www_menu	82	203.7%	6%
8.	About EMBI	uaqs_www_menu	80	100.0%	6%
9.	Full Directory	uaqs_www_menu	76	230.4%	6%
1...	News	uaqs_www_menu	71	208.7%	5%
		Grand total	**1,302**	**132.9%**	**100%**

<u>Psychology Department Website</u>

The total user number is significantly higher than it was the year before, which was attributed to having two websites when the new website was first launched so there was technically two data sources for a time.



Engagement Overview

	Top Menu Clicks	Event name	Event count ▼	% Δ	% of Total
1.	Faculty	uaqs_www_menu	4,411	148.5%	14%
2.	Clinical Psychology	uaqs_www_menu	2,280	141.5%	7%
3.	Academic Advisors & Appointments	uaqs_www_menu	2,263	253.6%	7%
4.	B.A. Psychology	uaqs_www_menu	1,968	143.0%	6%
5.	Graduate Students	uaqs_www_menu	1,299	190.0%	4%
6.	Research Areas	uaqs_www_menu	1,273	139.3%	4%
7.	Research, Internship & Teaching Experiences	uaqs_www_menu	1,231	352.6%	4%
8.	Overview	uaqs_www_menu	1,178	151.2%	4%
9.	B.S. Psychological Science	uaqs_www_menu	1,149	148.7%	4%
1...	Apply	uaqs_www_menu	1,044	77.6%	3%
		Grand total	**30,957**	**178.2%**	**100%**

Psychology Department Social Media

The Facebook, Instagram and LinkedIn accounts continue to attract interest. The Facebook account has 1.1 K followers, Instagram account has 1,384 followers and the LinkedIn account has 1,080 followers.

Media Coverage

Huentelman - TGen's MindCrowd initiative to gather data on brain aging, Arizona PBS, November 20, 2023.

Ekstrom - https://news.arizona.edu/story/why-do-some-older-adults-show-declines-their-spatial-memory announcement about our PNAS paper with Li Zheng and Carol Barnes
Article also posted to social media.

Wilson - 2023 Ars Technica BBC quiz show with Gestapo-inspired design offers study on stress responses https://arstechnica.com/science/2023/11/quiz-show-mastermind-yields-psychological-insight-in-the-blink-of-an-eye/2/

Trouard – University of Arizona News - https://news.arizona.edu/story/state-art-mri-machine-advance-research-brains-inner-workings. June 12, 2023

Hay – University of Arizona News - Dr. Hay earns grant to develop new therapeutics for vascular dementia. November 15, 2023

Alexander – UA@Work - Understanding the link between sedentary lifestyles and dementia, and how to help aging parents – a Q&A with a brain behavior expert. October 2, 2023