

Session E39

From Cognitive Decline to Brain Health:

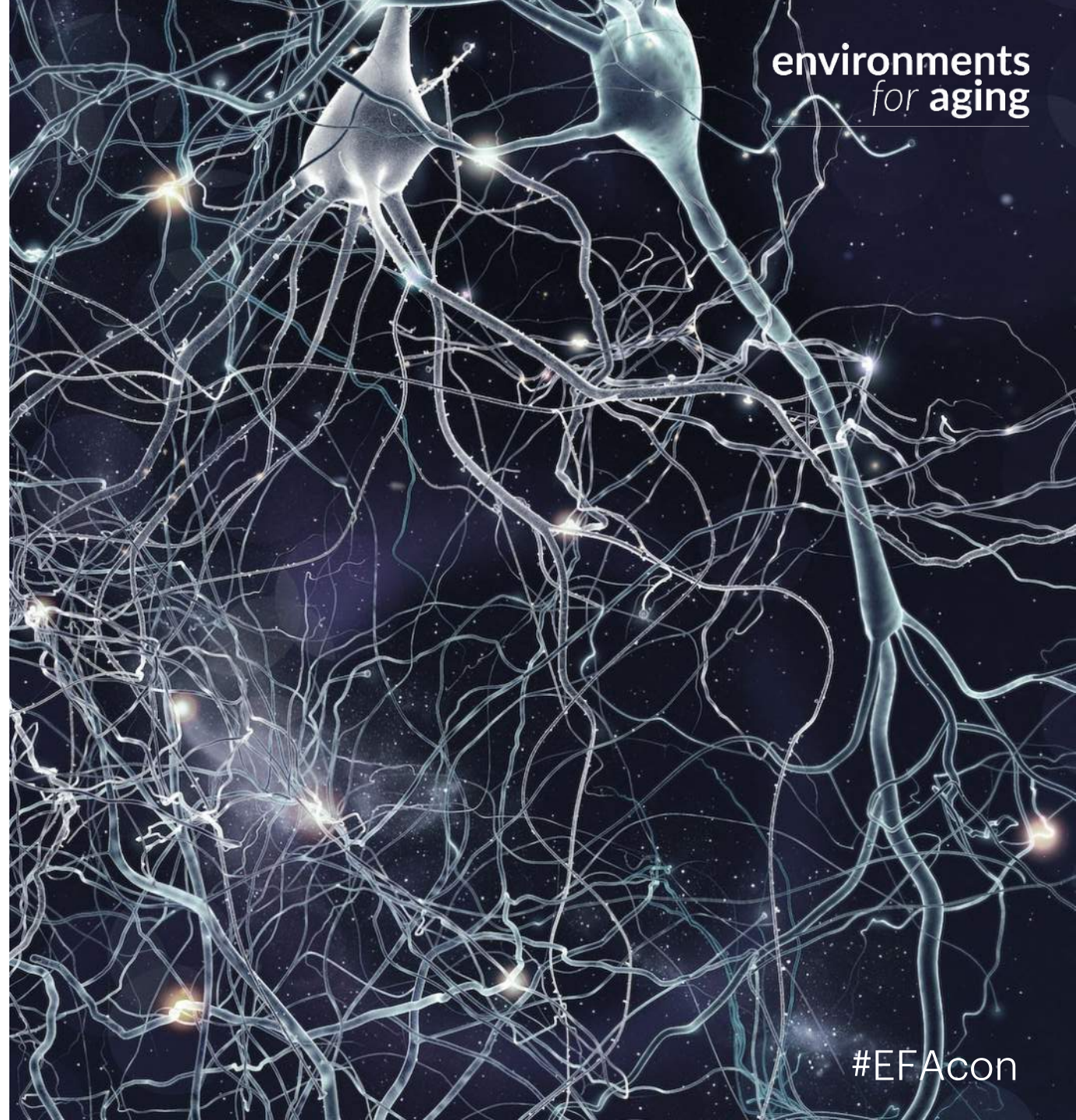
the power of neuroscience-
informed design

Upali Nanda, PhD, Assoc. AIA, EDAC, ACHE

Rebecca Soja, AIA, WELL AP, EDAC, Fitwel Amb, LFA

HKS

environments
for aging



#EFAcon

Mobile App -

If you have not done so already, please download the mobile app through your device's app store.

Session Evaluations - Rate Sessions Through the Mobile App

Instructions:

1. Open and load mobile app
2. In the left sidebar, tap "Schedule"
3. Locate and select the session you are attending
4. After opening the individual session page, tap "Rate Session" at the bottom and fill out/submit the form to complete your session evaluation.



Course Description:

Cognitive impairment is a major health and social issue due to a rapidly aging population. While it is important to understand neurobiological causes and protective factors of age-related cognitive decline, evidence also indicates the brain can generate new cells and grow, even as it ages. Research suggests our environments can positively affect brain structures, thereby slowing cognitive decline. **This interactive session blends neuroscience and empathy to explore how design can go beyond prevention to promote brain health and positive stereotypes of aging.** An open-source report with design prompts and interactive empathy exercises will be shared as a foundation for this evidence-based ideation session.

Learning Objectives:

- Understand results of **neurobiological and environmental psychology studies and concepts that can inform design for aging** including the spectrum of cognitive health, environmental complexity theory, and the dopamine hypothesis.
- Discover the role that “**enriched environments,**” “**complex place,**” and “**active engagement**” can play to actively promote cognitive health.
- Share lived experiences and listening to different perspectives to **translate scientific evidence into design concepts** that are human-centered and inclusive.
- Collaborate during co-design activities to **develop criteria of what constitutes effective enriched space and evaluate strategies** that contribute to enriched environments for promoting brain health that can be applied to your projects.

THANK YOU

to our team of collaborators and contributors from HUME and HKS!

Google to learn more:

Enriched Environments, Brain Health and HKS



Download the full report:

<https://www.hksinc.com/how-we-think/research/enriched-environments-for-brain-health-that-foster-creativity-promote-positivity-and-reduce-stress-a-neurogenesis-hypothesis/>

HU
ME

hume.space

Itai Palti, MArch

Aishwarya Narayana, M.Sc. Neuroaesthetics

Natalia Olszewska, M.D.

Maighdlyn Hadley, MArch

HKS

HKS, Inc.

Upali Nanda, PhD, Assoc. AIA, EDAC, ACHE

Rebecca Soja, Assoc. AIA, WELL AP, EDAC, Fitwel Amb., LFA

Divyal Nautiyal, Assoc. AIA

Melissa Hoetling, Assoc. AIA, WELL AP

Grant Warner

Emily Disque

Laura Pike-Seeley

Quick Poll

30 seconds



When I hear the term
“aging brain” I think of...

Write / sketch your response(s) on the worksheet

Our Question:

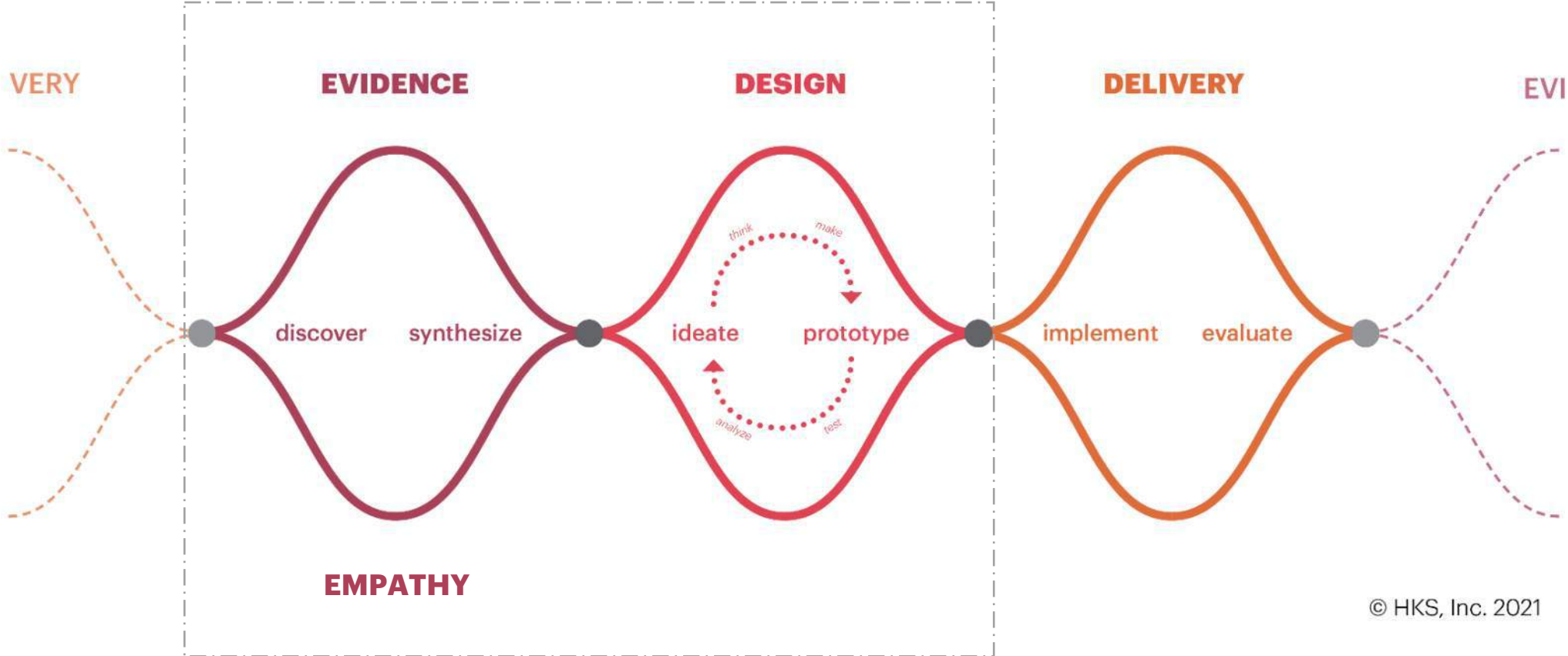
Can Design **Promote**
Brain Health to enable
Healthy Aging and
Quality of Life?

Good **brain health** is a state in which every individual can realize their own abilities and optimize their cognitive, emotional, psychological and behavioral functioning to cope with life situations.

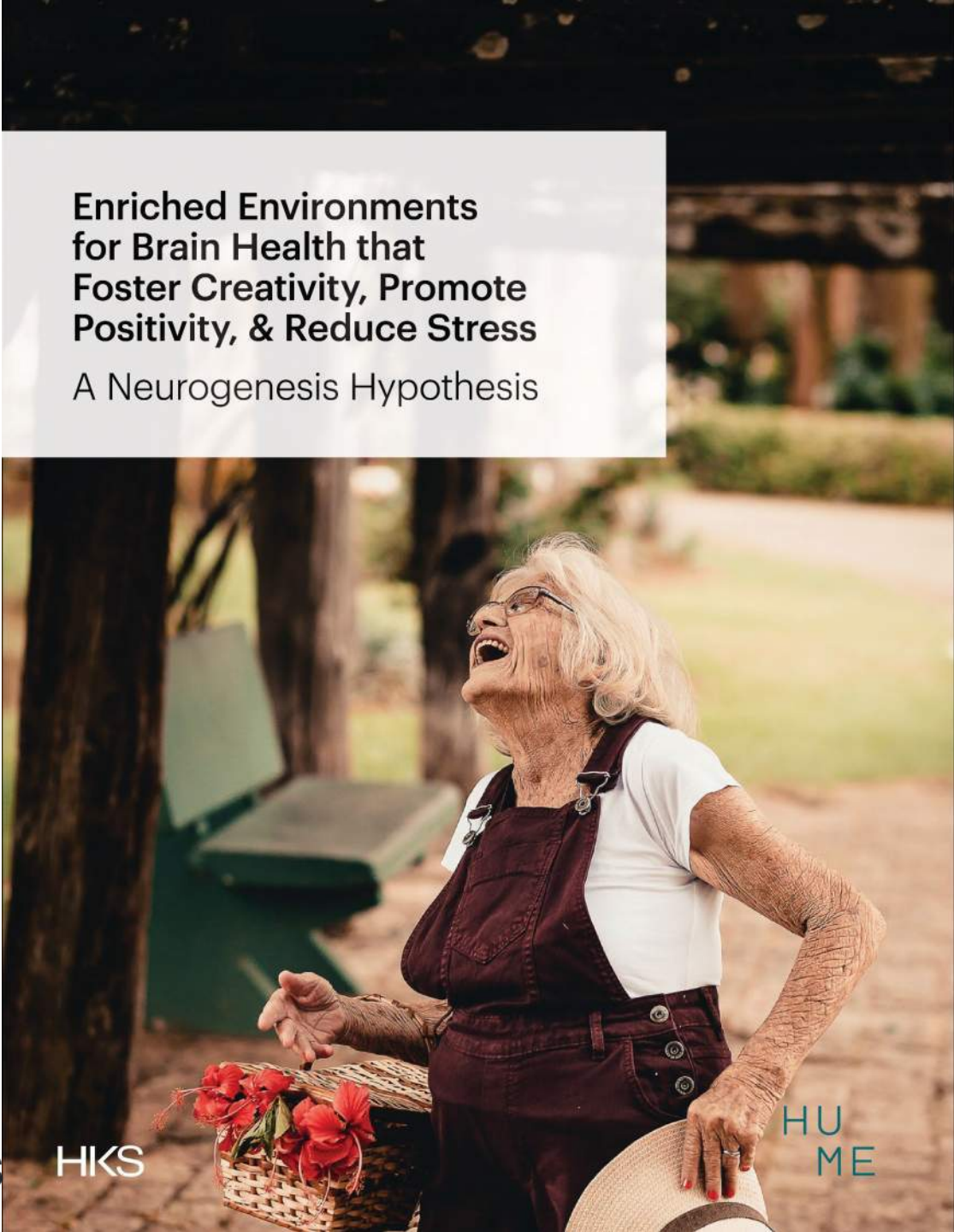
- *World Health Organization*



Our Approach



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**Enriched Environments
for Brain Health that
Foster Creativity, Promote
Positivity, & Reduce Stress**

A Neurogenesis Hypothesis

A Report-Workbook

**Ideation Session +
Design Thinking Toolkit**

**Impact: Design for Aging
across all sectors**

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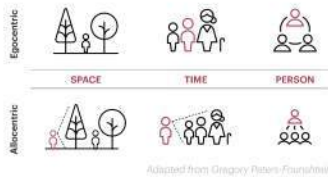
Evidence

Enriched Environments

The aging process happening within the hippocampus affects spatial memory and consequently the ability to navigate in space. Research suggests that humans spatial capabilities rely on the construction of predominantly two types of spatial representations:

- **allocentric perspective** constituted by object-to-object representations created based on inferences about spatial relations between objects.
- **egocentric perspective** which involves a self (or body)-to-object representational system⁹³

It is allocentric processing that deteriorates with age, and the egocentric tends to remain unaffected⁹⁴. Specifically speaking, the ability to uptake and learn new information about the environment deteriorates, however the old memory of landmarks and general layout remains intact. It implies that memory for the layout of long familiar city landmarks doesn't differ dramatically between young and older participants, however older population tends to make many more errors in learning new routes⁹⁵. Interestingly,



the ability to read maps does not seem to be impaired⁹⁶. Growing evidence suggests that environmental factors often help to preserve cognitive abilities⁹⁷.

Neurogenesis and environmentally-mediated neuroplasticity remain the main candidates for a biological foundation explaining how the built environment could support healthy physiological aging. Animal models demonstrate that so-called '**enriched environments**' are capable of stimulating positive behavioral changes⁹⁸, i.e. animal's curiosity and exploration^{99, 100} linked to creativity in humans, and are beneficial in a number of psychiatric and neurodegenerative disorders^{101, 102, 103}. Environmental enrichment (EE), is defined as "housing condition in which animals benefit from the sensory, physical, cognitive and social stimulation provided, on brain and cognitive functions usually impaired during aging"¹⁰⁴.

The **lifespan theory of human development** created by Paul Baltes and his colleagues¹⁰⁵ distinguishes between two different mechanisms: '**neurobiological mechanics**' (individual genetic makeup, maturation and decline of neurological processes, etc.) and '**socio-cultural pragmatics**' which interact in a reciprocal fashion across the lifespan and constitute human cognitive adaptive balance at all ages. This theory implies also that there is no 'end state' that an individual aims for and that growth and change is possible at all stages of life. Social and environmental input is required to maintain stability¹⁰⁶.

Santiago Ramón y Cajal, a founding pioneer of modern neuroscience and the Nobel Prize winner from 1906, was the first one to propose that mental activity might trigger morphological changes in brain structure. The studies conducted almost 100 years later with the use of magnetic resonance imaging (MRI) demonstrated that experience can affect human brain volume and cortical thickness, as in the famous case of London's taxi drivers whose hippocampus were more developed comparing to control group due to navigational demands¹⁰⁷.

STANDARD VS. ENRICHED ENVIRONMENTS



Inspired by "Environmental Enrichment as a Positive Behavioral Intervention Across the Lifespan" 104

- Motor
- Somatosensory
- Social
- Cognitive

We now know much more about the role of 'place' in memory formation. Memories that involve personal experiences are encoded in a specific time and place. In 1972 a neurocognitive system supporting recollection of such memories was differentiated from other types of memory systems, and named **episodic memory**¹⁰⁸.

Place is an important part of encoding episodic memories and scientists since the 1970s have studied its influence on the process of memory recall¹⁰⁹. Pieces of information that can trigger the recall are called **retrieval cues**¹⁰. Physical context is important because it helps to reinstate a memory. When exposed to a large number of retrieval cues from the environment, a person experiences a process of physical reinstatement and remembers a thought encoded together with these cues¹¹.

Nevertheless it was demonstrated that recall of information improves within so-called **complex-place context** (a combination of environmental cues and individual internal factors related to a performed task, i.e. motivation, engagement) comparing to **simple-place context** (reliance on surroundings only)¹².

This finding implies that engagement with place can potentially improve the process of recall of information.

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as a Positive Behavioral Intervention Across the Lifespan. *Current Neuropharmacology*
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 101. Laviola et al. (2008). Effects of enriched environment on animal models of neurodegenerative diseases and psychiatric disorders. *Neurobiology of Disease*
 102. Anastasiu et al. (2009). Enriched environment protects the nigrostriatal dopaminergic system and induces an astroglial reaction in the 6-OHDA rat model of Parkinson's disease. *J Neurochem*.

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Synthesis

KEY TAKEAWAY

Spatial coherence and engagement with the physical context of place can help with memory retrieval.

Sensory, physical, cognitive & social stimulation create enriched environments.

Enriched environments can preserve cognitive abilities.

Recall of information improves with complex-place context, environmental cues, and internal engagement.

DESIGN PROMPTS

HOW CAN WAY-FINDING DESIGN OR PROGRAMMING AND MASTER PLAN STRATEGIES CATER TO BOTH ALLOCENTRIC AND EGOCENTRIC PERSPECTIVES?

HOW MIGHT DESIGN ENFORCE SPATIAL COHERENCE?

HOW CAN A DESIGN ENGAGE MULTIPLE FORMS OF INTERACTION (SPATIAL, SENSORY, SOCIAL, EMOTIONAL...)?

HOW MIGHT WE EXPAND OUR THINKING ABOUT PLACE-MAKING TO INCLUDE ACTIVE ENGAGEMENT WITH PHYSICAL CONTEXT?

Engaging with Empathy



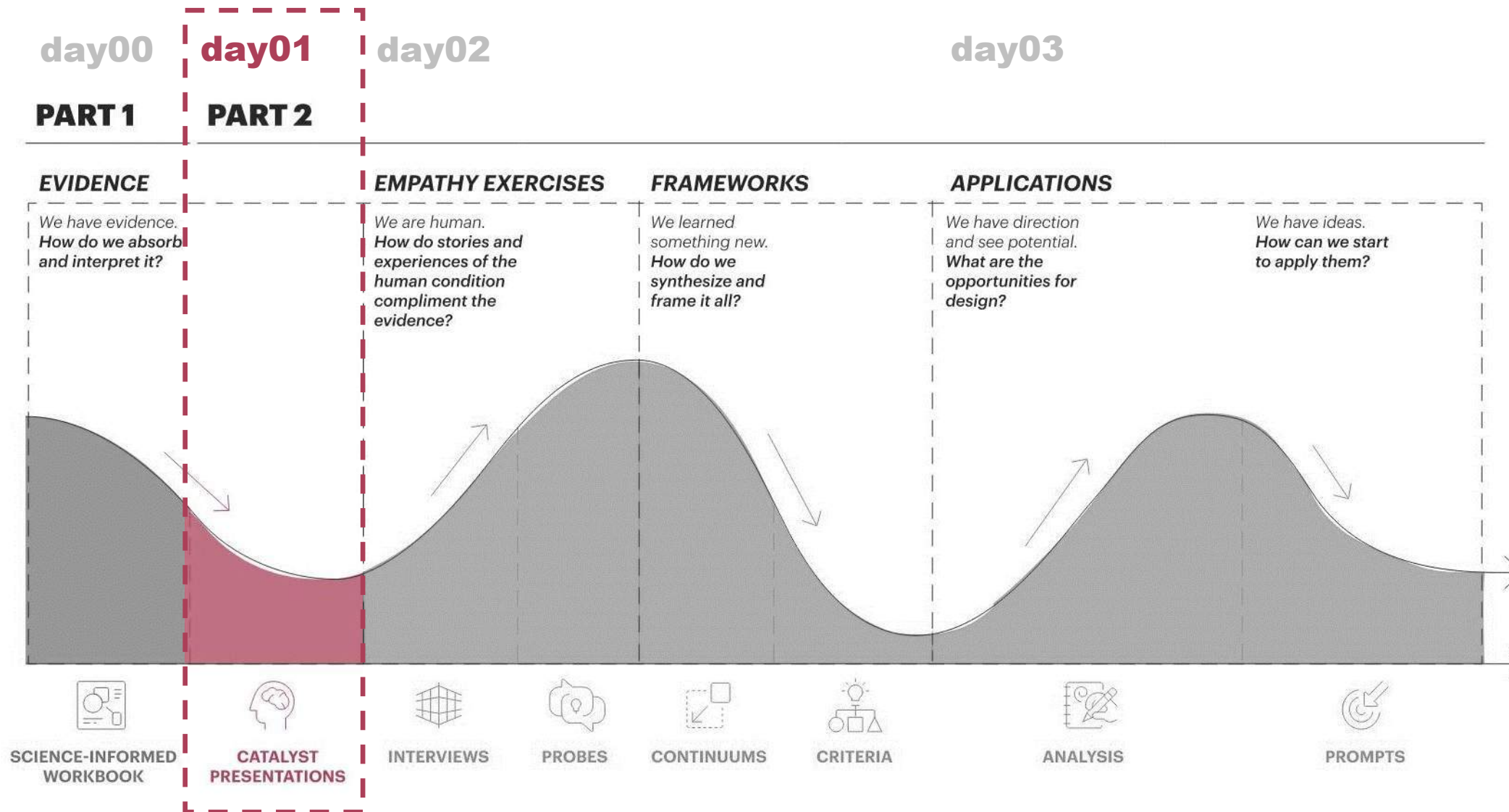
In 2021, we went **VIRTUAL**.

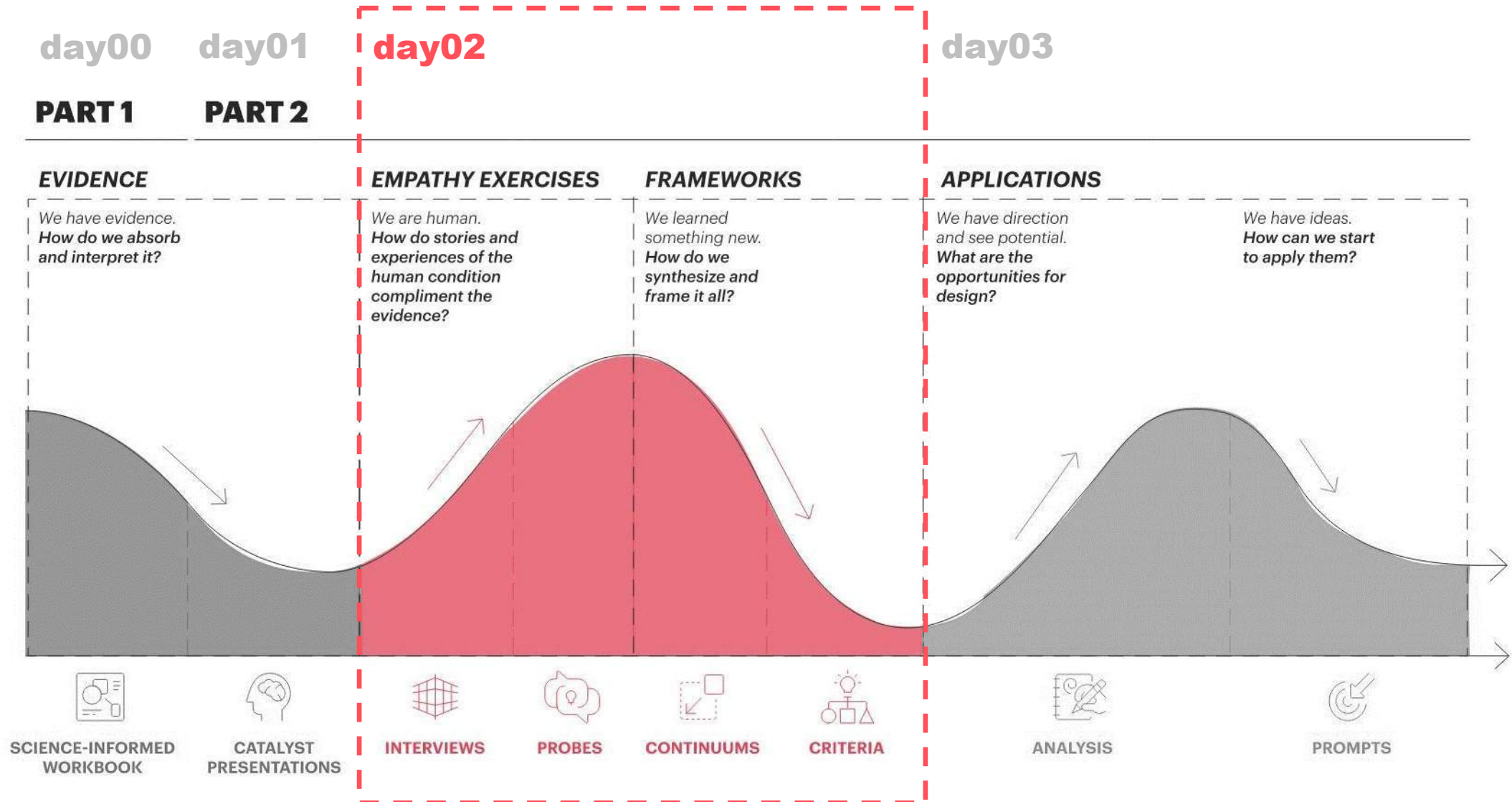
It presented us with an opportunity to go from...

...charrette to **think tank**

...Design to **science-informed** design

...ideas to **application**





day00

day01

day02

day03

PART 1

PART 2

EVIDENCE

We have evidence.
How do we absorb and interpret it?

EMPATHY EXERCISES

We are human.
How do stories and experiences of the human condition compliment the evidence?

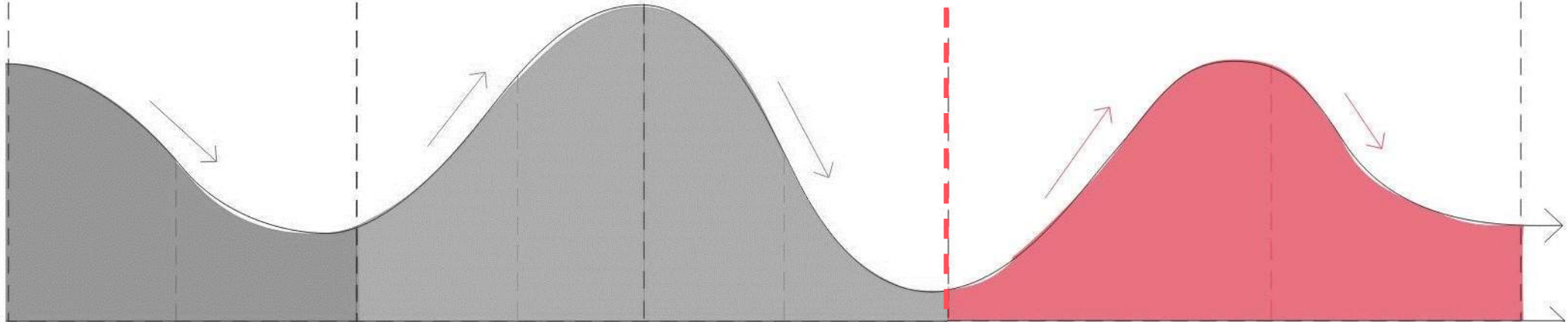
FRAMEWORKS

We learned something new.
How do we synthesize and frame it all?

APPLICATIONS

We have direction and see potential.
What are the opportunities for design?

We have ideas.
How can we start to apply them?



SCIENCE-INFORMED WORKBOOK



CATALYST PRESENTATIONS



INTERVIEWS



PROBES



CONTINUUMS



CRITERIA



ANALYSIS



PROMPTS

Friday
March 26th
Frame 5



Saturday (morning)
March 27th
Frame 6



Sunday (morning)
March 28th
Frame 3



Sunday (afternoon)
March 28th
Frame 4



Monday (morning)
March 29th



Saturday (afternoon)
March 27th
Frame 11



Synthesized ideas for presentation



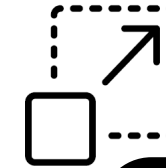
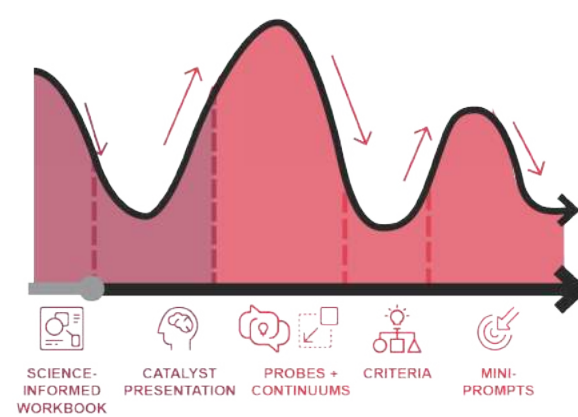
Synthesized ideas for presentation



**4-hr
intensive**

day00 day01

prep / homework condensed and accelerated ideation



scalable

Options to *optimize workshop outcomes* based on the amount of time and resources your project has available.

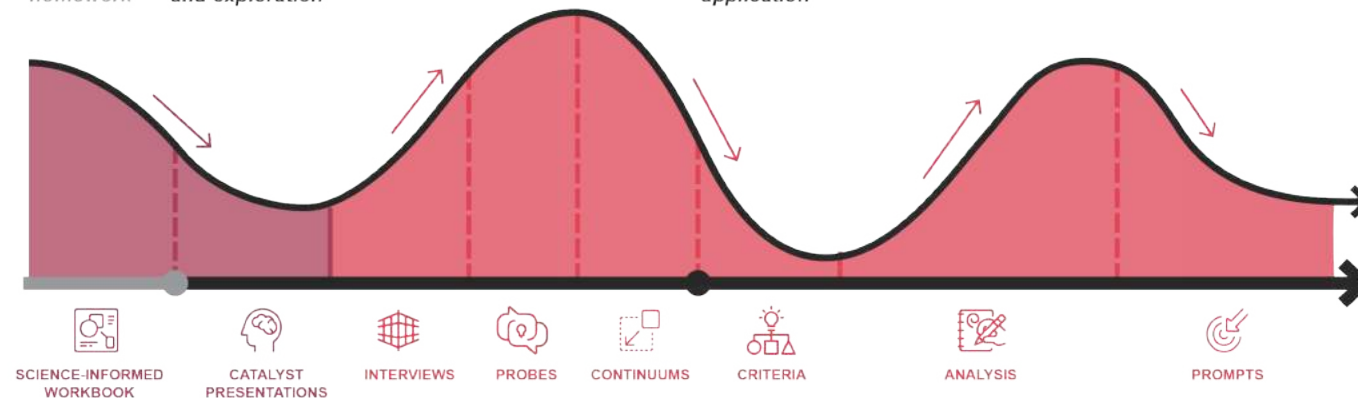
**2-day
comprehensive**

day00 day01

prep / homework comprehension and exploration

day02

synthesis and application



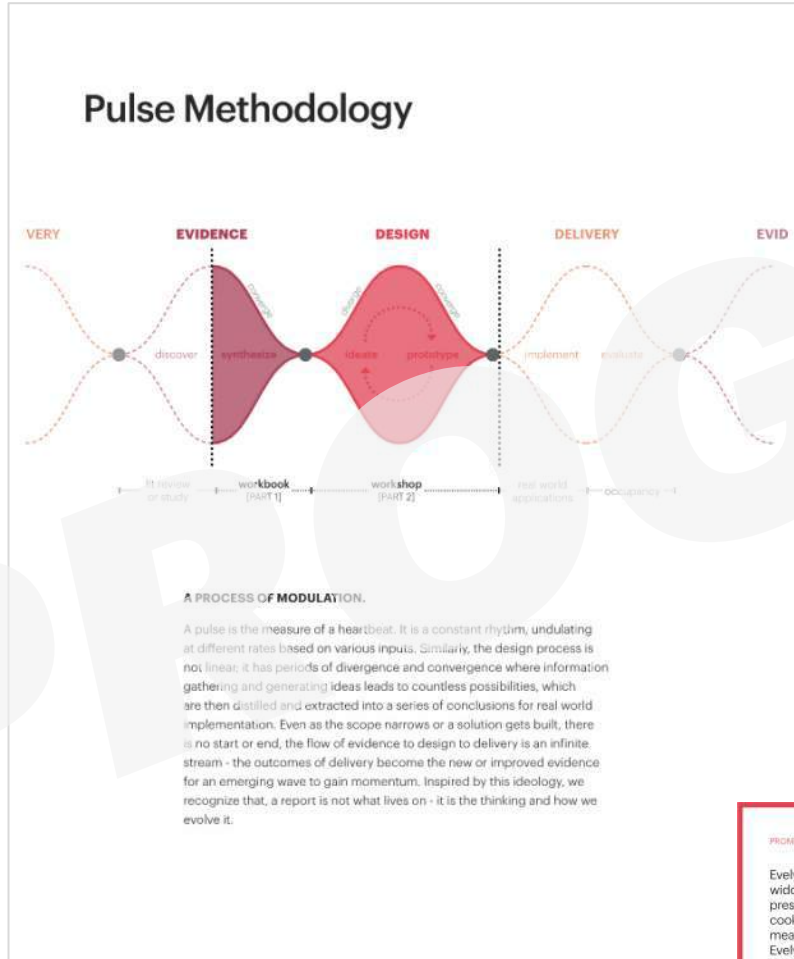
Evidence-Based Ideation: Science + Empathy



Guided explorations at the intersection of neuroscience, aging, and design



Engage with science. Focused time. Beautifully messy.



Criteria

DESIGN - FRAMEWORKS

A CUSTOMIZED 'CHECKLIST' FOR BRAIN HEALTH.

A lot of reports are prescriptive; they determine what the best practice or requirements are to achieve a desired result. In contrast, the workbook and workshop of this approach empowers the design team to arrive at those conclusions for themselves. In this way, the criteria that drives decisions can be more original and inclusive by reflecting the unique voices and interpretations within the team.

DIFFICULTY
easy

TIME
30 minutes

PARTICIPANTS
all attendees (design team, users, client, etc.)

WHAT YOU'LL NEED

in-person

- pens, markers, etc.
- post-its
- pin-up wall or large table surface
- alt. dry-erase board

virtual

- digital collaboration workspace (e.g. Miro)
- video conferencing platform (e.g. Zoom)

STEPS

1. Based on what you've learned from the science, the experts, the experiences, and the conversations, establish the criteria that constitutes an enriched environment.
2. With one person as scribe, use post-its, posterboard, or dry-erase board to record a list of criteria for an enriched environment.
3. If virtual, using the chat feature in the video conferencing platform is a great tool for those who might otherwise not speak up :)

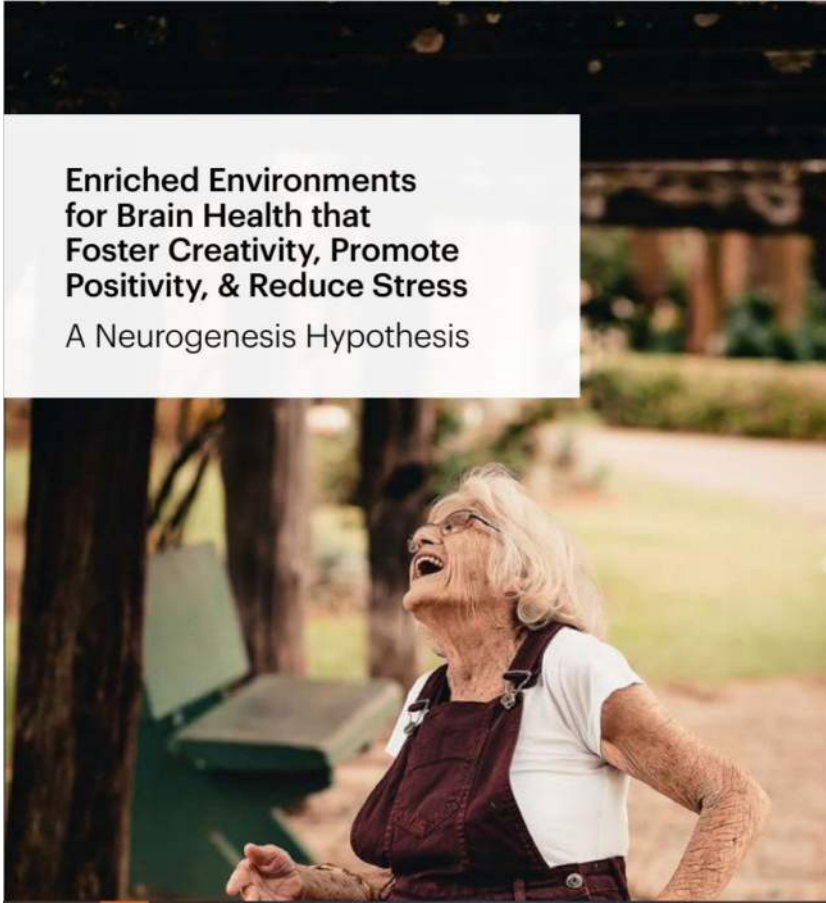
PRICIPLE

Evelyn is a woman in her early 70s who is retired, recently widowed, and planning to downsize. Her geriatrician has prescribed a healthy diet and she wants to become a better cook so she can source ingredients and prepare healthy meals. Ideate and map the environments experienced by Evelyn at her new place of residence (age-restricted active-adult, independent living).

PRICIPLE

Evelyn is a woman in her early 70s who is retired, recently widowed, and planning to downsize. Her geriatrician has prescribed a healthy diet and she wants to become a better cook so she can source ingredients and prepare healthy meals. Ideate and map the environments experienced by Evelyn at her new place of residence (age-restricted active-adult, independent living).

lead your team through an immersive and engaging informed brainstorming session



**Enriched Environments
for Brain Health that
Foster Creativity, Promote
Positivity, & Reduce Stress**
A Neurogenesis Hypothesis



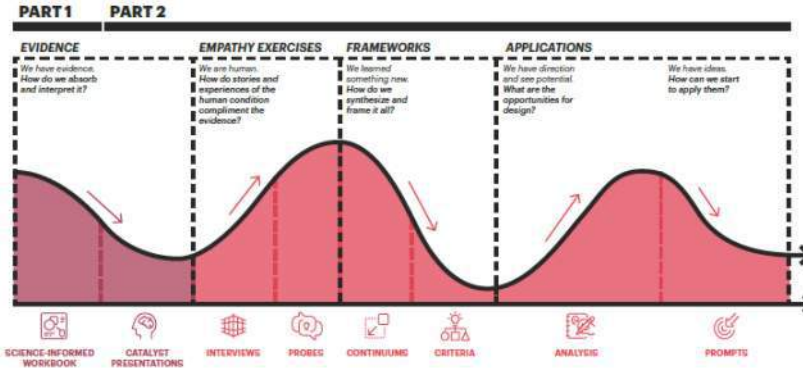
Evidence-based Ideation Workshop Designing for Brain Health in Older Adults

HKS provides intensive and comprehensive workshops where a team of design researchers and experienced practitioners walk novice or experienced designers, owners and operators through neuroscience-based evidence, provocative catalyst presentations, and interactive empathy exercises, to ideate and develop applicable design concepts that can change the conversation around designing for aging from preventing cognitive decline to promoting brain health to achieve systemic outcomes for healthy aging.

Contact HKS Research at research@hksinc.com for a 4 hour intensive or 2 day comprehensive guided explorations workshop that combines evidence & empathy - and results in new innovative ideas to promote brain health BY design in older adults.



**Innovation
& Impact**



Session Format

Super **Sprints** to design for **Brain Health**

1. Present a key takeaway and relevant evidence
2. Think critically about that evidence with a conversational probe / prompt (fill out your worksheet!)
3. Repeat

1

Aging is a **global** trend and affects **ALL** of us.

We must **avoid negative stereotypes** associated with aging.



The Problem

We are all aging.

THERE WILL BE **2.1 BILLION PEOPLE** WORLDWIDE **AGED 60+ BY 2050** AND GROWING...

CAUSES

- + Widening gap of future caregivers for elderly
- + High rate of growth of population aged 60+
- + Increased life expectancy
- + Low birth rate
- + Reduced fertility
- + Age-related physiological and cognitive decline

Understanding the causes and protective factors of cognitive impairment is paramount.

CHALLENGES



Quick Poll

30 seconds



What do you **fear** most
about aging?

Write / sketch your response(s) on the worksheet

The “Bigger” Problem

We are **biased about** aging

Ageism

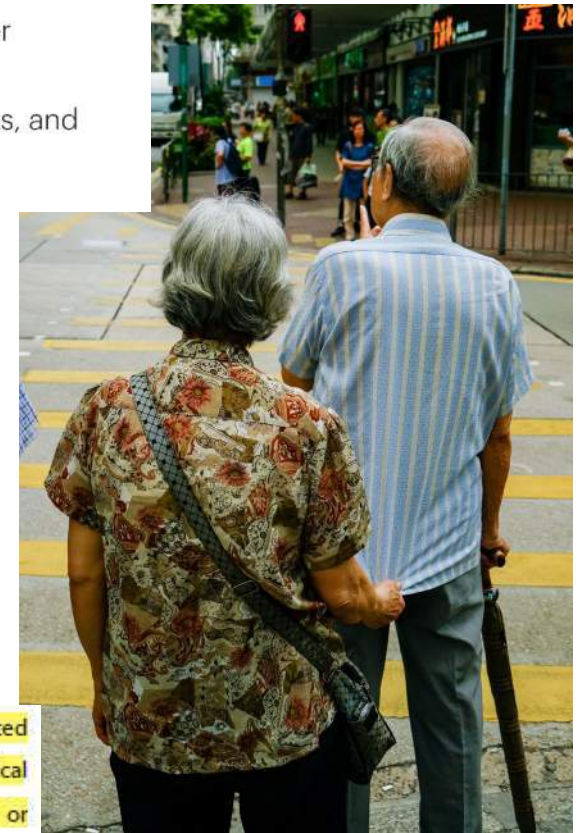
One major challenge faced by aging populations is the multifaceted **positive and negative stereotypes constructed around aging and elderly**. Some of them are culture dependent.

The most common negative stereotypes about older populations include: decreased views of physical attractiveness, decreased capability to perform tasks, and decreased ability to learn.

However, this outlook on aging is being challenged³⁰. **Reinforcement of positive stereotypes could counteract the effect of negative stereotypes**. Realistic positive stereotypes can have a positive impact on performance. Some studies found **positive stereotypes were correlated with an increase in older adults memory, swingtime, and walking speed and balance³¹**.

older men exposed to negative health related stereotypes were less likely to seek medical attention out of fear of appearing sick or weak²⁹. The majority of people perceive aging

Social stereotypes actively reinforce institutionalized ageism^{25, 26} which is defined by the WHO as the stereotyping, prejudice, and discrimination against people on the basis of their age²⁷. Research suggests that



Long-term care facilities turned out to be perfect virus incubators. Their residents, who often have many **comorbidities** are more susceptible to severe Covid-19 infections, and many of them need assistance with basic activities making it more likely they could get an infection from the aides working often in several facilities²⁰. The layout of



During COVID, our seniors have been disproportionately affected. As we move forward, there is risk that we only address physical rather than **social and cognitive needs**.

Multisensory integration becomes more important during aging as it helps to counteract the often-destructive consequences of unisensory deterioration.

Mozolic et al. (2012)

High frequency sounds compromised

Increase in sensitivity thresholds

Reduction in eyesight

Depressed taste and smell



Social Needs



Prompt

3 minutes



WHAT ENVIRONMENTS OR SCENARIOS HAVE YOU EXPERIENCED OR OBSERVED THAT ARE EXPLICITLY OR IMPLICITLY **AGEIST**?

Older adults are not **“them”**, they are a future version of “us”.

Write / sketch your response(s) on the worksheet

The Shift in Thinking

From **Managing** Cognitive Decline to **Promoting** Brain Health

2

Not all abilities **decline equally** with age.

Speed of processing, memory, spatial ability and reasoning are particularly vulnerable.



Healthy Aging

QUALITY OF LIFE + WELLBEING

HEALTHY AGING



Psychosocial

- social integration
- values and beliefs
- education and income level
- behaviors / lifestyle (nutrition, physical activity, self-care)

Neurobiological

- genetic make-up
- normal or abnormal maturation and decline of neurological processes
- brain volume, cortical thickness, number of neurons, dopamine receptors, etc.

Environmental

- physical surroundings
- natural and manufactured elements of built environment
- spatial context
- urban, suburban, or rural

environmental factors can be designed to influence neurobiological and psychosocial outcomes

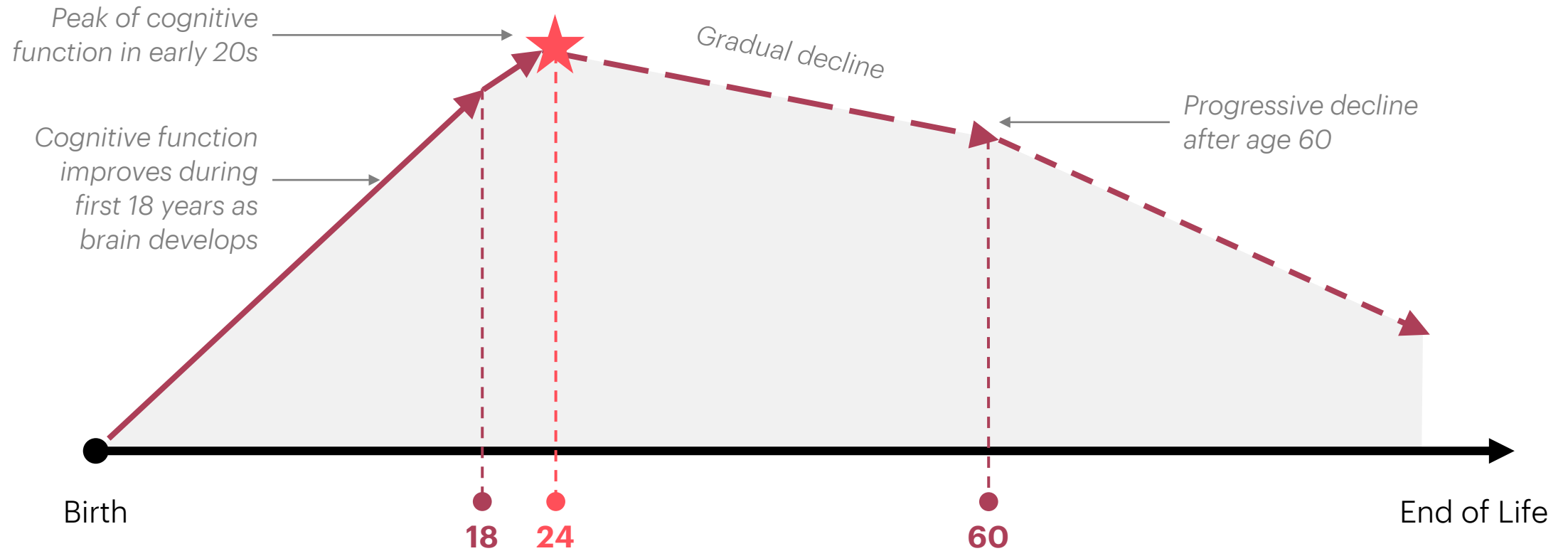


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Brain Health

Biological and Psychosocial aspects

SPECTRUM OF COGNITIVE HEALTH



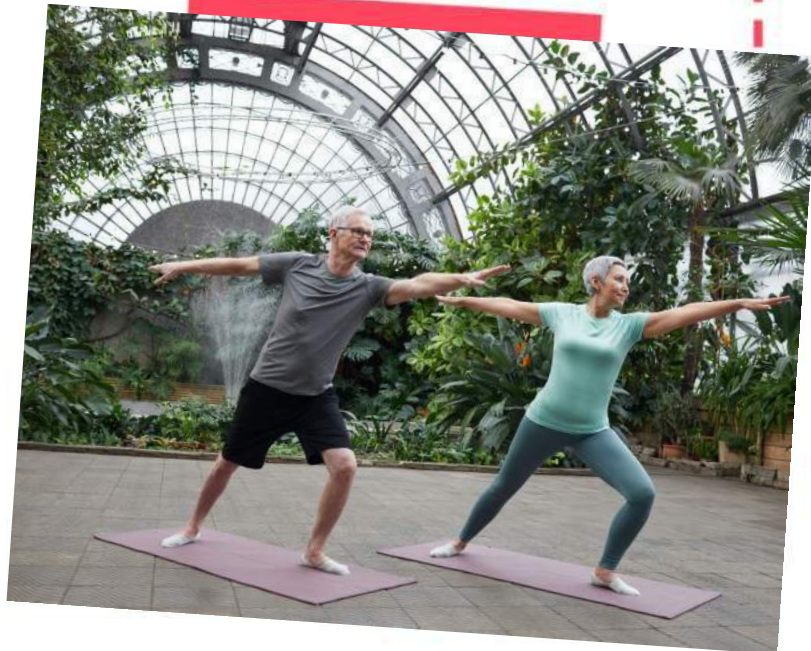
Cognitive Activity

Cognitive activity, next to physical activity, cardiovascular health and nutrition, could constitute a group of **'protective factors'** for cognitive decline and dementia.



Prompt

3 minutes



WHAT ARE SOME CHALLENGES
PEOPLE MAY FACE IN THEIR
ENVIRONMENTS RELATED TO
**ABILITIES PRONE TO COGNITIVE
DECLINE?**

Write / sketch your response(s) on the worksheet

3

The brain is malleable and can generate new connections through **neurogenesis**.



The Power of Positivity

Ashby, Isen, and Turken's (1999) were among the first ones to put forward the **dopamine hypothesis**⁷¹. This theory proposes that **positive affect** influences performance on many cognitive tasks and positive affect is associated with increased brain dopamine levels.



General cognitive abilities are related to dopamine receptor turnover in the brain; age-related **cognitive decline** is linked to a **decrease in dopamine receptors**

Environmental Complexity Theory

Environmental Complexity hypothesis suggests that environments that have a positive effect on cognitive function are complex, whereas simple environments have a negative impact on cognition. The complexity of the environments depends on the diversity of the stimuli, the number of decisions to be undertaken including the number of considerations included in the decision making process.



Psychosocial

Cognitive Reserve Hypothesis

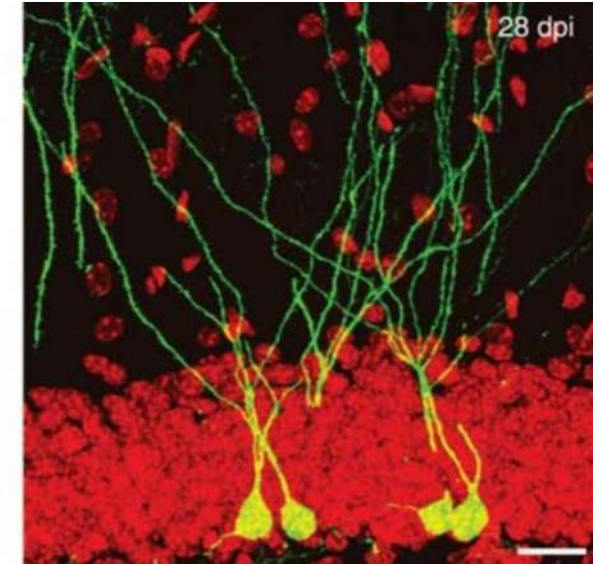
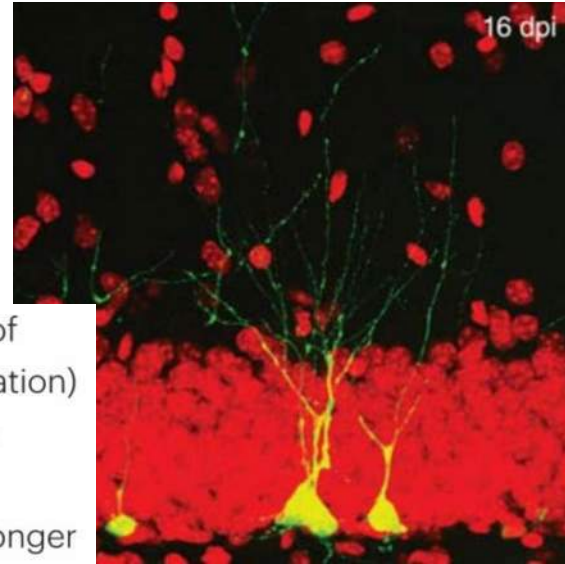
(neuroanatomical) model of cognitive reserve implies that the brain size or the number of brain neurons and synapses constitute the reserve which is determined genetically, and environment can influence it to a certain degree. The **active (functional) model of reserve** (most commonly used to speak about 'cognitive reserve') is concerned with 'neural processing' and 'synaptic organization' and suggests that they are sensitive to active environmental influences⁹⁰.

neurophysiological



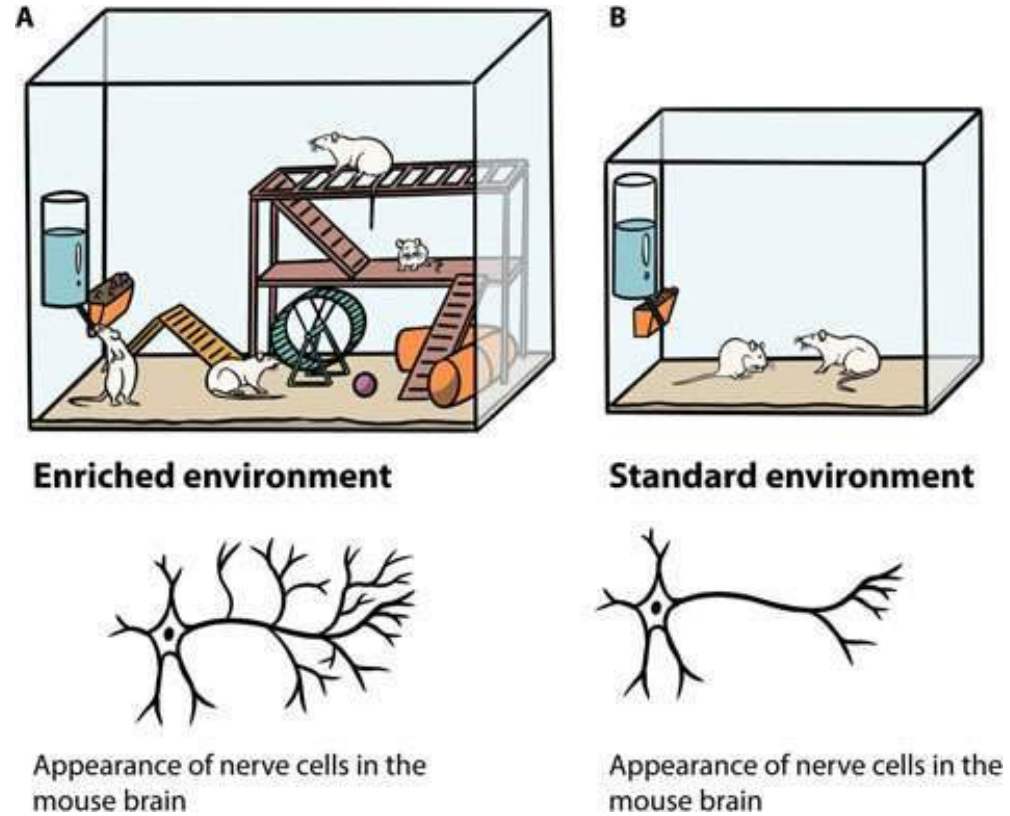
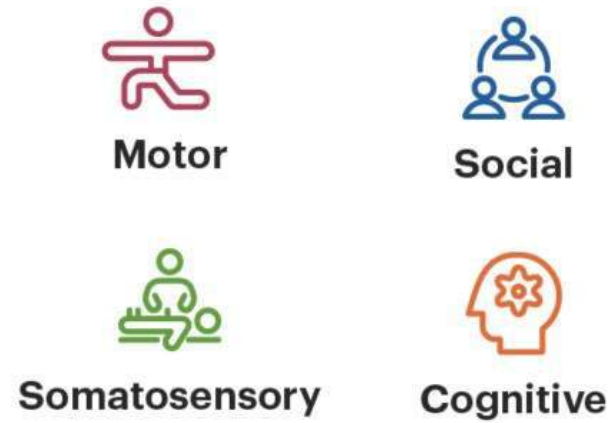
Neurogenesis Hypothesis

stimulation and exercises boost **neurogenesis** (the growth of new neural cells), increases **synaptogenesis** (synaptic formation) and reduces deposition of beta-amyloid plaques involved in Alzheimer's disease. Recent research findings suggest that neurons being a product of adult neurogenesis mature for longer and grow larger compared to neurons created during infancy, suggesting that adult-born neurons may have a more powerful function and may play a critical role in **neuroplasticity**⁹¹.



The Neurogenesis Hypothesis:

How Design Can Keep the Brain Healthy and Help Grow New Nerve Cells



Prompt

3 minutes



Artechouse exhibit

WHAT ARE SOME EXAMPLES OF
ENVIRONMENTAL COMPLEXITY
YOU HAVE EXPERIENCED OR
OBSERVED?

Write / sketch your response(s) on the worksheet

4

Complex-place

contexts (enrichment + engagement) and positive associations can help strengthen cognitive activity and reduce stress.

Engagement with place via **creativity and art** can create complex-place context to aid memory retrieval.



Place and Memory Formation



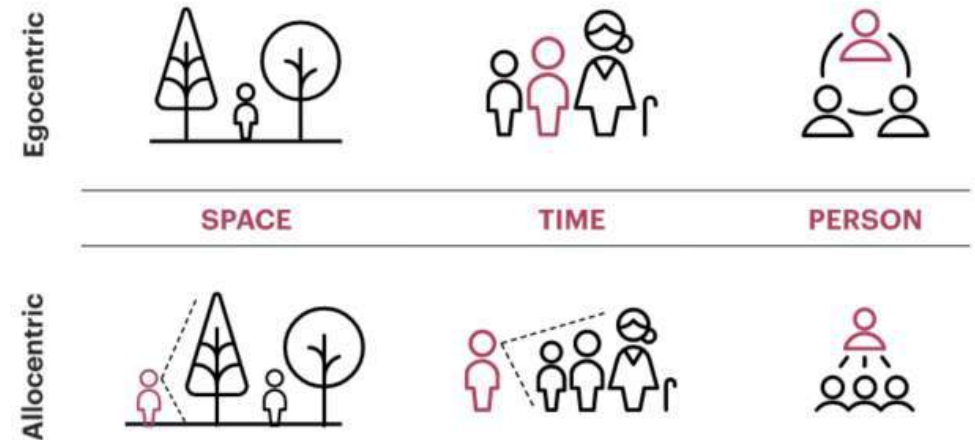
allocentric perspective constituted by object-to-object representations created based on inferences about spatial relations between objects,



egocentric perspective which involves a self (or body)-to-object representational system⁹³



The ability to learn new information about the environment deteriorates, but **old memories of landmarks and city layouts remain intact.**



Adapted from Gregory Peters-Founshtein

Place and Memory Formation

Nevertheless it was demonstrated that recall of information improves within so-called **complex-place context** (a combination of environmental cues and individual internal factors related to a performed task, i.e. motivation, engagement) comparing to **simple-place context** (reliance on surroundings only)¹¹².

This finding implies that engagement with place can potentially improve the process of recall of information.

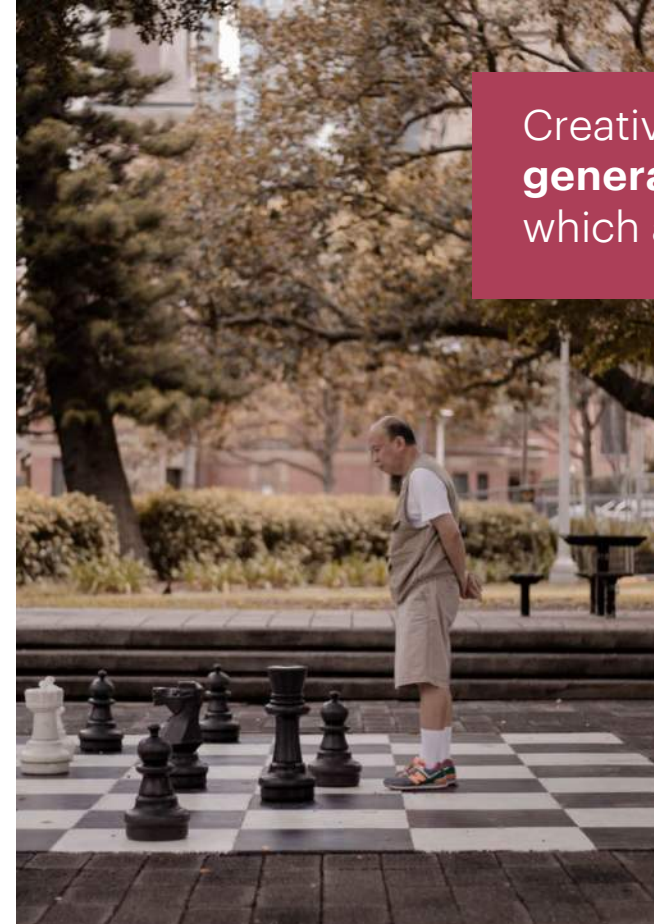
It isn't enough to be "in" a place, we must "engage" with it.



Creativity as a Design Strategy

Other studies on creativity in aging population indicate that creativity can also lessen effects of depression and dementia

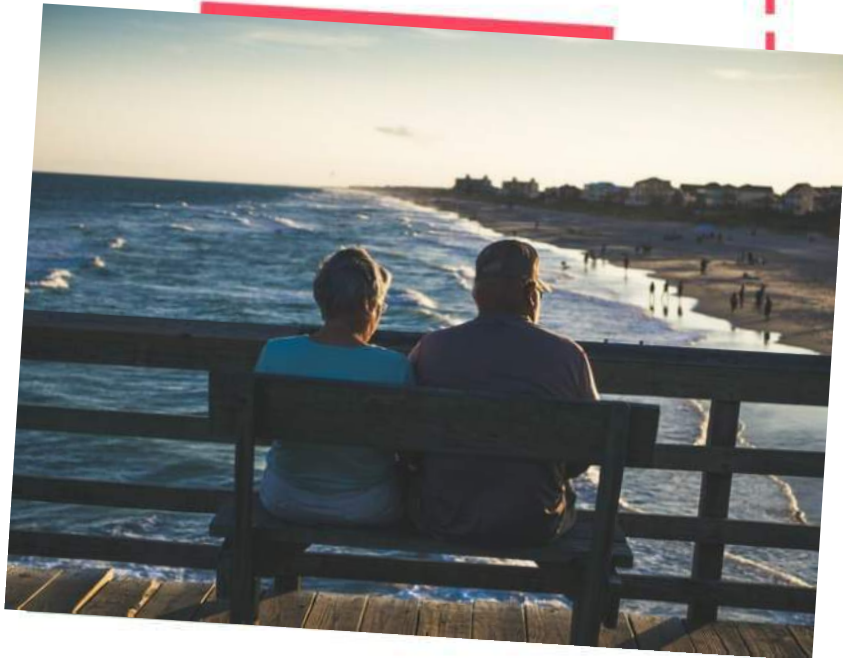
Research conducted on a group of patients with Alzheimer's disease encourages the view that performing creative tasks has the potential of improving memory, reading, writing, and word games. It can increase one's vocabulary and defend against memory loss¹²⁶. The process of idea generation can be understood as a state of focused internally-directed attention (reflective attention) and involves controlled semantic retrieval. The generation of new ideas, as opposed to the retrieval of old ideas, was associated with stronger activation within a brain region (left inferior parietal cortex) known to be involved in mental simulation, imagining, and future thought¹²⁷.



Creative tasks involve **generating new ideas** which activates the brain

Prompt

3 minutes



HOW CAN A DESIGN OFFER
MULTIPLE FORMS OF
INTERACTION (SPATIAL,
SENSORY, SOCIAL, EMOTIONAL)
WITH **PLACE**?

HOW MIGHT DESIGN FOSTER
ENGAGEMENT THROUGH
CREATIVITY OR THE **ARTS**?

Write / sketch your response(s) on the worksheet

5

Enriched environments that promote **sensory, motor, cognitive, and social engagement** can aid neurogenesis and prevent cognitive decline.



Enriched Environments

Neurogenesis and environmentally-mediated neuroplasticity remain the main candidates for a biological foundation explaining how the built environment could support healthy physiological aging. Animal models demonstrate that so-called **'enriched environments'** are capable of stimulating positive behavioral changes⁹⁸, i.e. animal's curiosity and exploration^{99 100} linked to creativity in humans, and are beneficial in a number of psychiatric and neurodegenerative disorders^{101 102 103}. Environmental enrichment (EE), is defined as "housing condition in which animals benefit from the sensory, physical, cognitive and social stimulation provided, on brain and cognitive functions usually impaired during aging"¹⁰⁴.

STANDARD VS. ENRICHED ENVIRONMENTS



Inspired by "Environmental Enrichment as a Positive Behavioral Intervention Across the Lifespan" 104.



Motor



Somatosensory



Social



Cognitive

Enriched Environments for Rehab

SOCIAL

SENSORY



PHYSICAL

COGNITIVE

Prompt

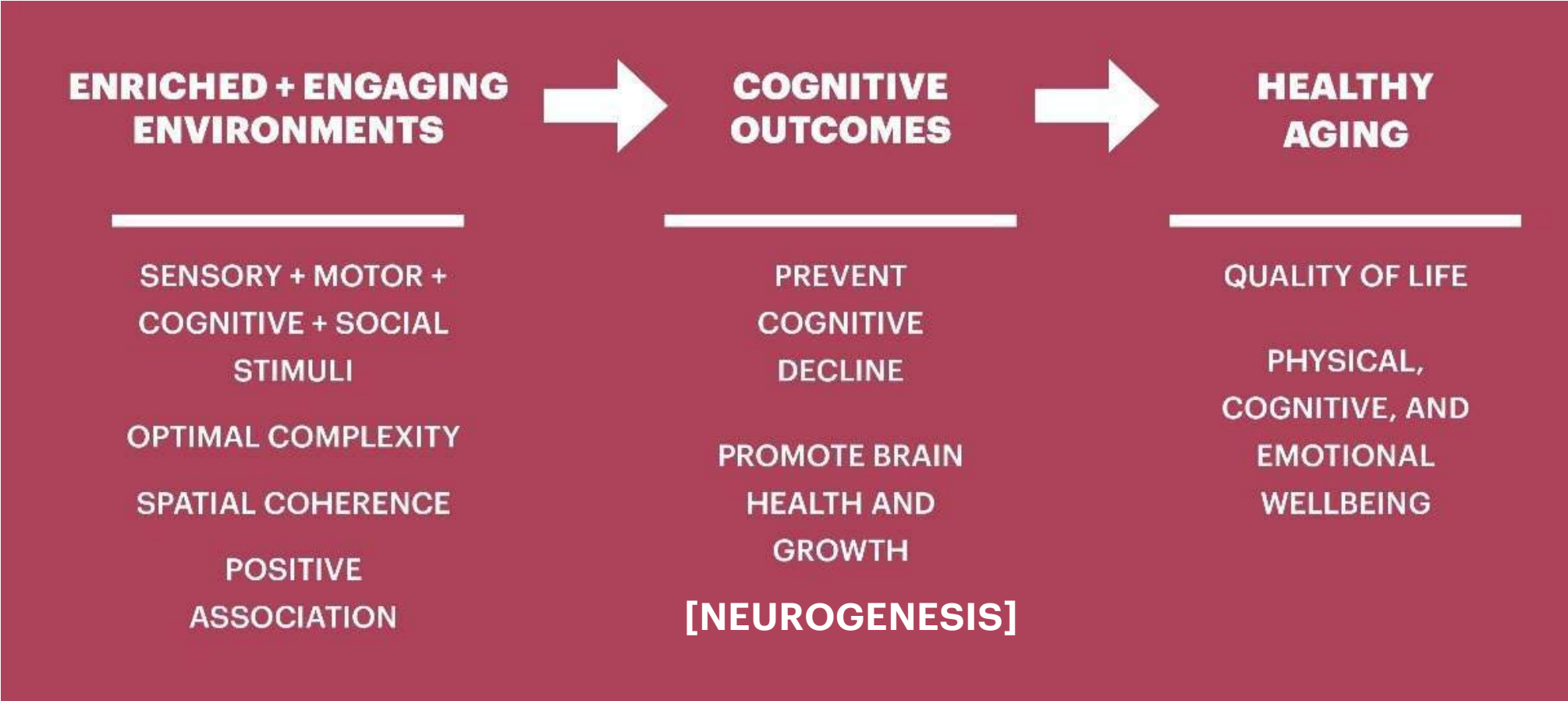
3 minutes



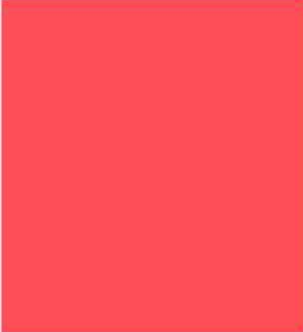
BASED ON THE EVIDENCE AND
YOUR INTERPRETATION, WHAT
CRITERIA CONSTITUTES AN
ENRICHED ENVIRONMENT?

Write / sketch your response(s) on the worksheet

Summary



Case Study



Special thanks to the MADF fellows:

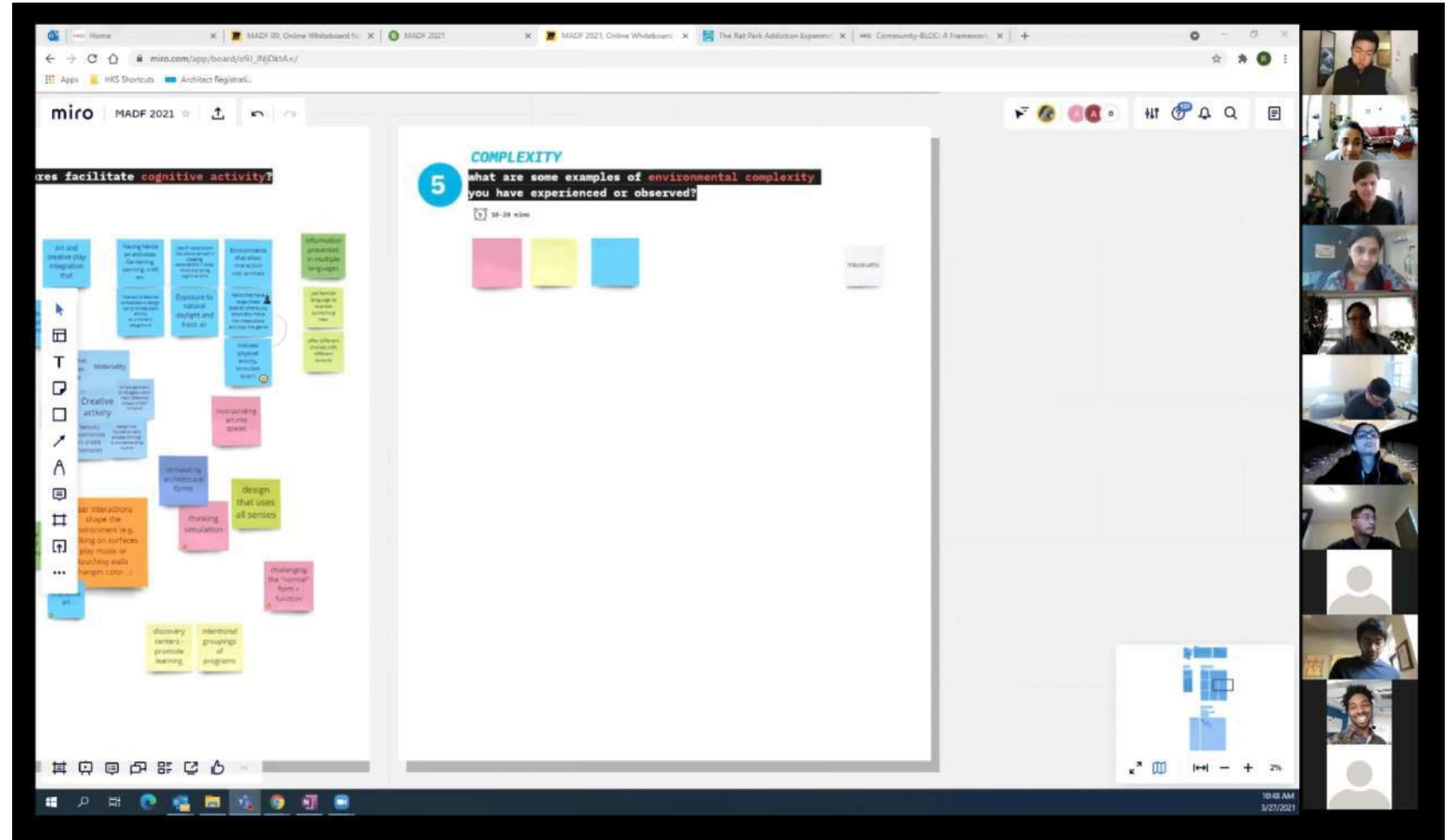
- Austin Rivers
- Austin Tsailin
- Daniel Kim
- Denise Lee
- Gloria Kim
- Harsh Shah
- Ishita Parmar
- Michael Bell
- Ryan Griffin
- Sharanya Reddy

the **3-day** incubator

what environments have you experienced or observed that are explicitly or implicitly *ageist*?

consider the *spectrum of cognitive health*. what range of user needs (and aspirations) may you need to design for?

what are some examples of *environmental complexity* you have experienced or observed?



the*process*

the *continuum*

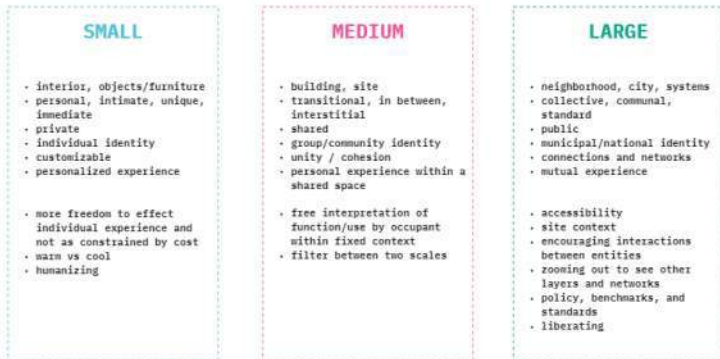
How do you define each scale from a confluence of *physical, experiential, or emotional* perspectives?

Frame 34

ANALOGY

small = eating dinner at your dining room table
medium = eating dinner in a restaurant
large = eating in a park or very large gathering

Frame 33

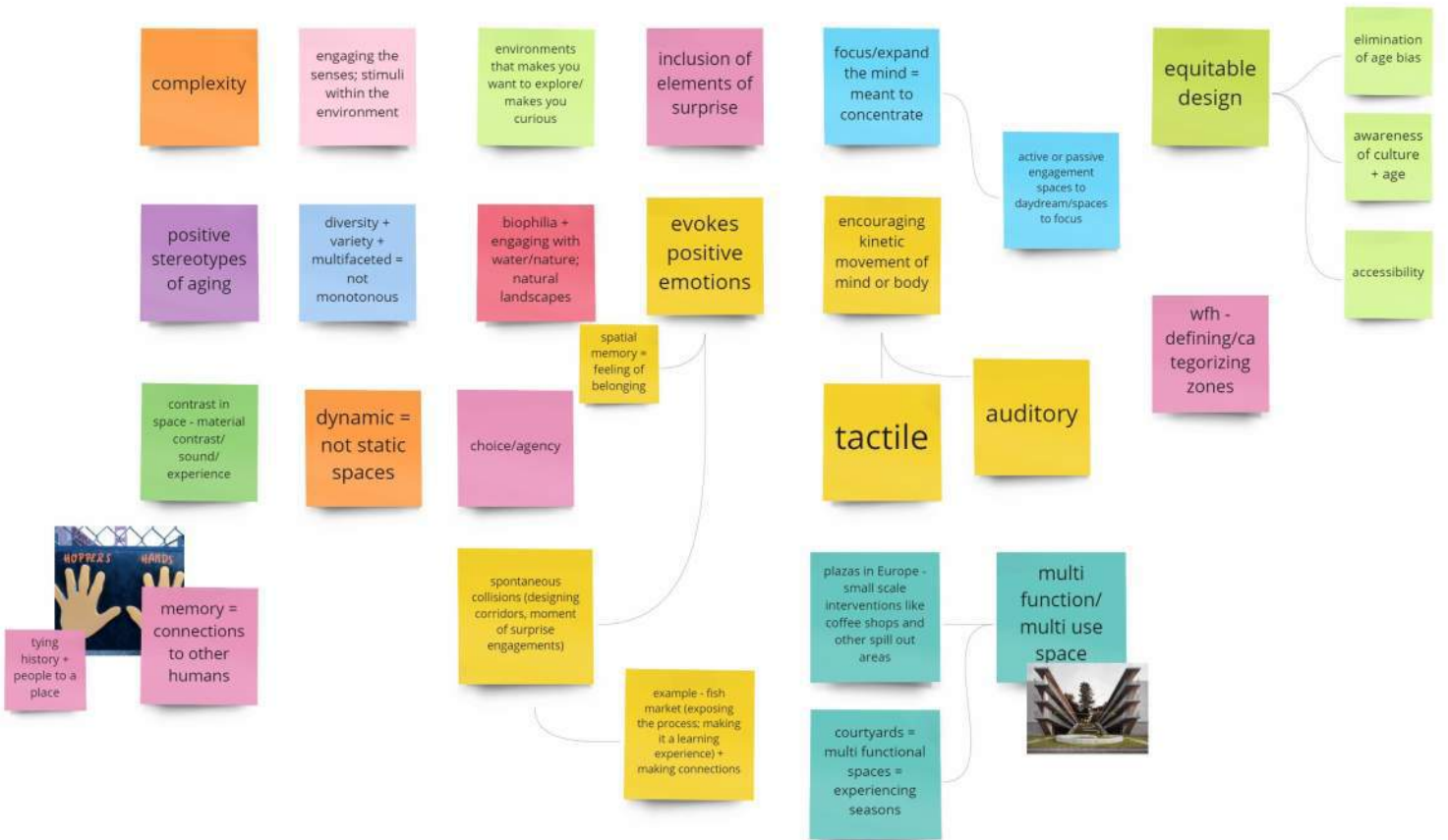


What constitutes an *enriched environment*?

the *criteria*

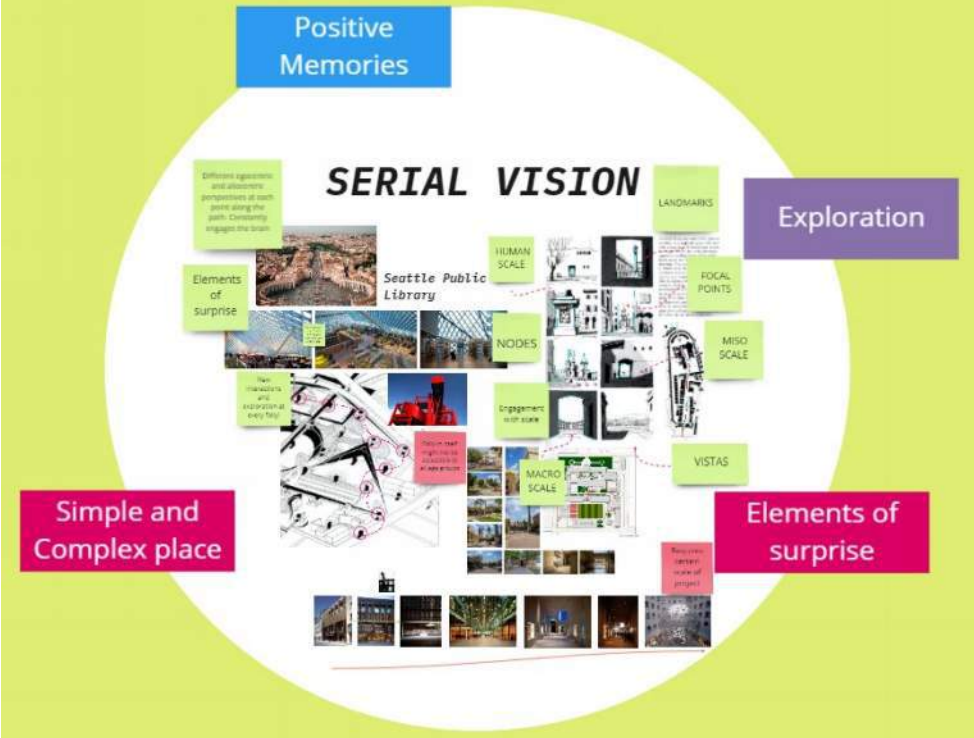


what criteria constitutes an **ENRICHED ENVIRONMENT**?



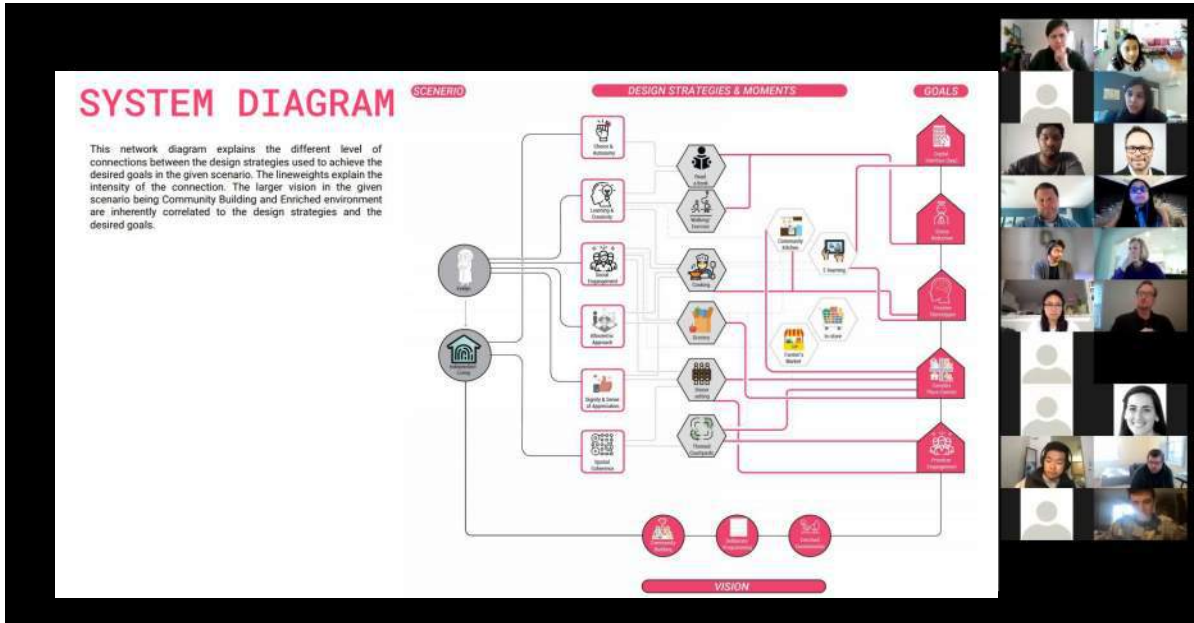
exploring design strategies for enriched space

Pick a design element and analyze its effectiveness to contribute to an "enriched space"



exploring design strategies for enriched space – pick a design element and analyze its effectiveness to contribute to “enriched space”

the *analysis*



the *big*idea

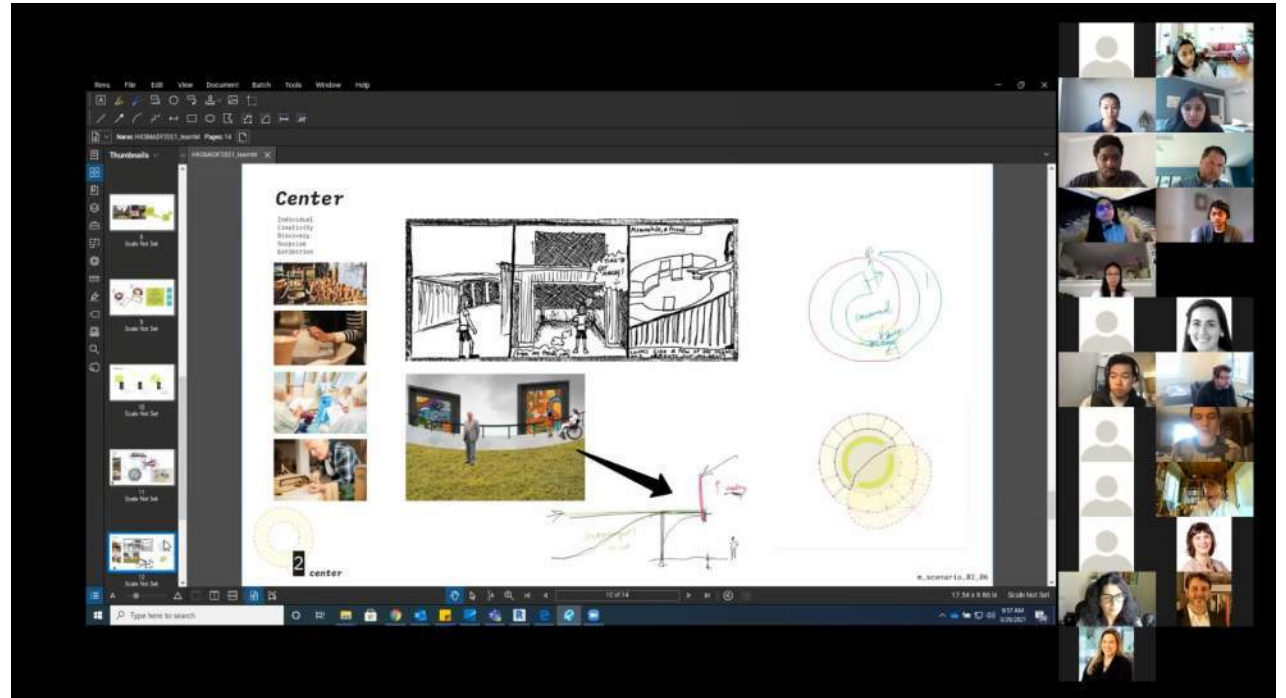
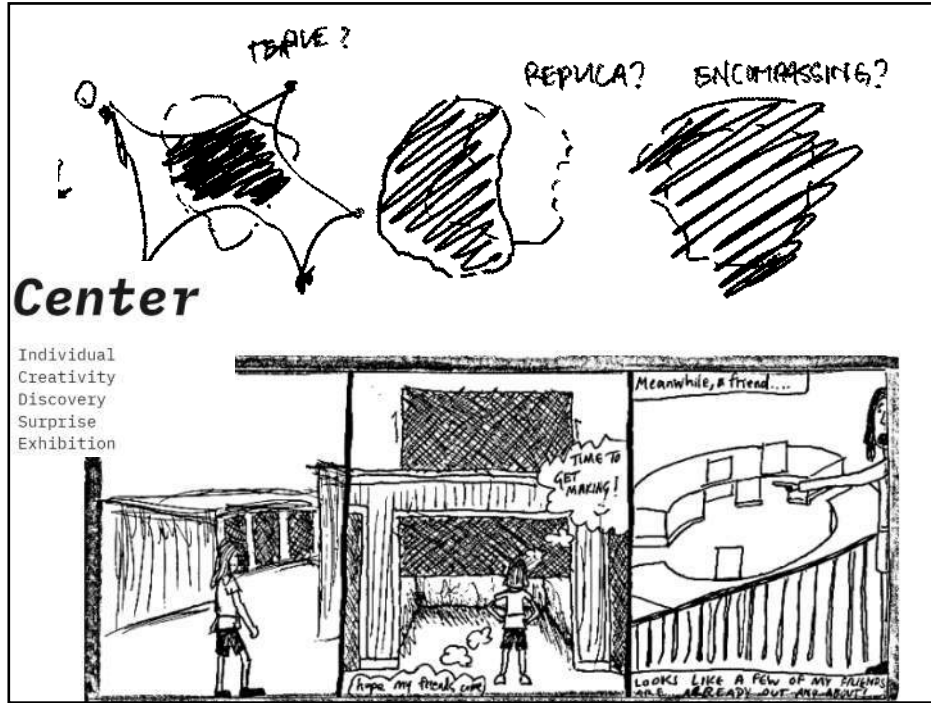
Way-Learning
vs Way-Finding

Using ***sensory cues*** to improve way learning, memory making



the *big*idea

Design for inter-generational ***spontaneous collisions, positive associations***



Designing spaces to **daydream**/ spaces to **focus**

Designing for **curiosity**

the **big**idea



the *big*idea

Play to learn

Designing for *active/*
passive
experiences

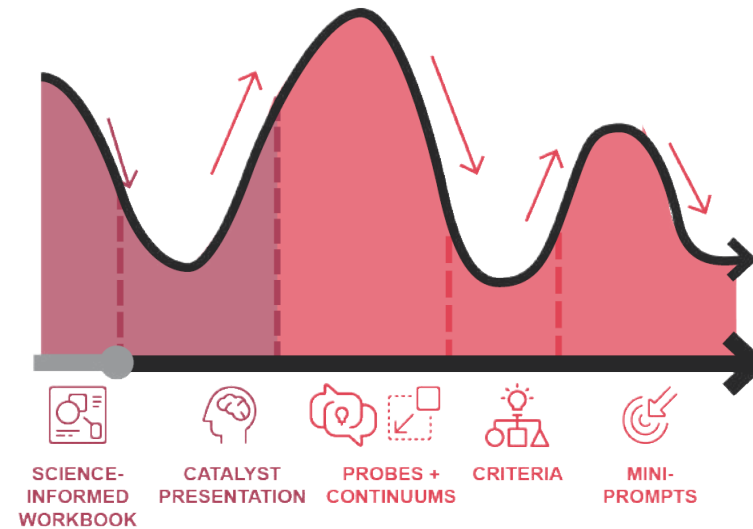
Design for *mobility*

Would you be interested in participating in a **brainstorm** workshop?

day00 day01

*prep /
homework*

*condensed and
accelerated ideation*



Contact Info.

Upali Nanda, PhD, Assoc. AIA, EDAC, ACHE
Director of Research, Principal
HKS
unanda@hksinc.com

Rebecca Soja, AIA, WELL AP, EDAC, Fitwel Amb, LFA
Architect
HKS
rsoja@hksinc.com



Download the full report:

<https://www.hksinc.com/how-we-think/research/enriched-environments-for-brain-health-that-foster-creativity-promote-positivity-and-reduce-stress-a-neurogenesis-hypothesis/>