eMBRACE

Establishing Mechanisms of Benefit to Reinforce the Alzheimer's Care Experience

Technology and Intervention Research in Dementia Care: Identifying and Understanding Measures and Mechanisms of Impact



WEBINAR FEATURING

SARA J. CZAJA, PHD

eMBRACE
Establishing Mechanisms of Benefit to Reinforce the Alzheimer's Care Experience

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Establishing Mechanisms of Benefit to Reinforce the Alzheimer's Care Experience

- Test **mechanisms of action** for interventions that target:
  - Individuals living with AD/ADRD
  - Living environment
  - Family/social network/provider
  - Neighborhood/community

- Evaluate **tailored** interventions
- **Home** and **community** settings

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Establishing Mechanisms of Benefit to Reinforce the Alzheimer's Care Experience

THANKS TO THOSE WHO SUBMITTED AN LOI FOR FUNDING JUNE 2027!

Stay tuned for updates on our next funding cycle: z.umn.edu/EMBRACEfunding

INTRODUCING
OUR INVESTIGATORS

Year 1



Manka Nkimbeng, PhD

University of Minnesota

Exploring an Adapted Active Caregiving: Empowering Skills (ACES) Intervention for High-Risk Care Partners

Enrolling

Year 2



Elizabeth Fauth, PhD

Utah State University

Online Self-Guided ACT for Dementia Caregivers: Evaluating Psychological Flexibility as the Mechanism to Improve Psychological Distress

Enrolling

Year 3



Darina Petrovsky, PhD



Katherine Ramos, PhD

Duke University

Examining a Mechanism of a Dyadic Music-Based Intervention in Persons Living with Dementia and their Care Partners

Approved



Eunjin Tracy, PhD

University of Missouri

Mechanisms of Action, Efficacy, and Feasibility of a Web-Based Cognitive Behavioral Therapy for Insomnia Intervention in Spousal Alzheimer's Disease and Related Dementias Caregivers (SHUTi-DC)

Approved

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Weill Cornell Medicine

Weill Cornell Medicine
Center on Aging
& Behavioral Research

Implementing Technology-Based Interventions:
Understanding Measures and Mechanisms of Impact

Sara J. Czaja PhD

Center on Aging and Behavioral Research
Division of Geriatrics and Palliative Medicine

EMBRACE Roybal Lectureship
November 10, 2026

Overview of Presentation

Begin with some definitions

Discuss the role of technology in behavioral intervention research:

- Intervention Delivery
- Data Collection and Trial Conduct
- Data Analysis

Benefits and Challenges

Examples of our research – focus on older adults

What we mean by technology

> *The application of scientific knowledge to the practical domains of human life.*
>
> The Britannica Dictionary (2023)

In practice: machines, tools, or applications used to perform or aid in the performance of activities

- Smartphone applications
- Sensing devices
- Artificial intelligence

As in everyday life, technology is becoming ubiquitous within behavioral intervention research.

Behavioral Intervention Research

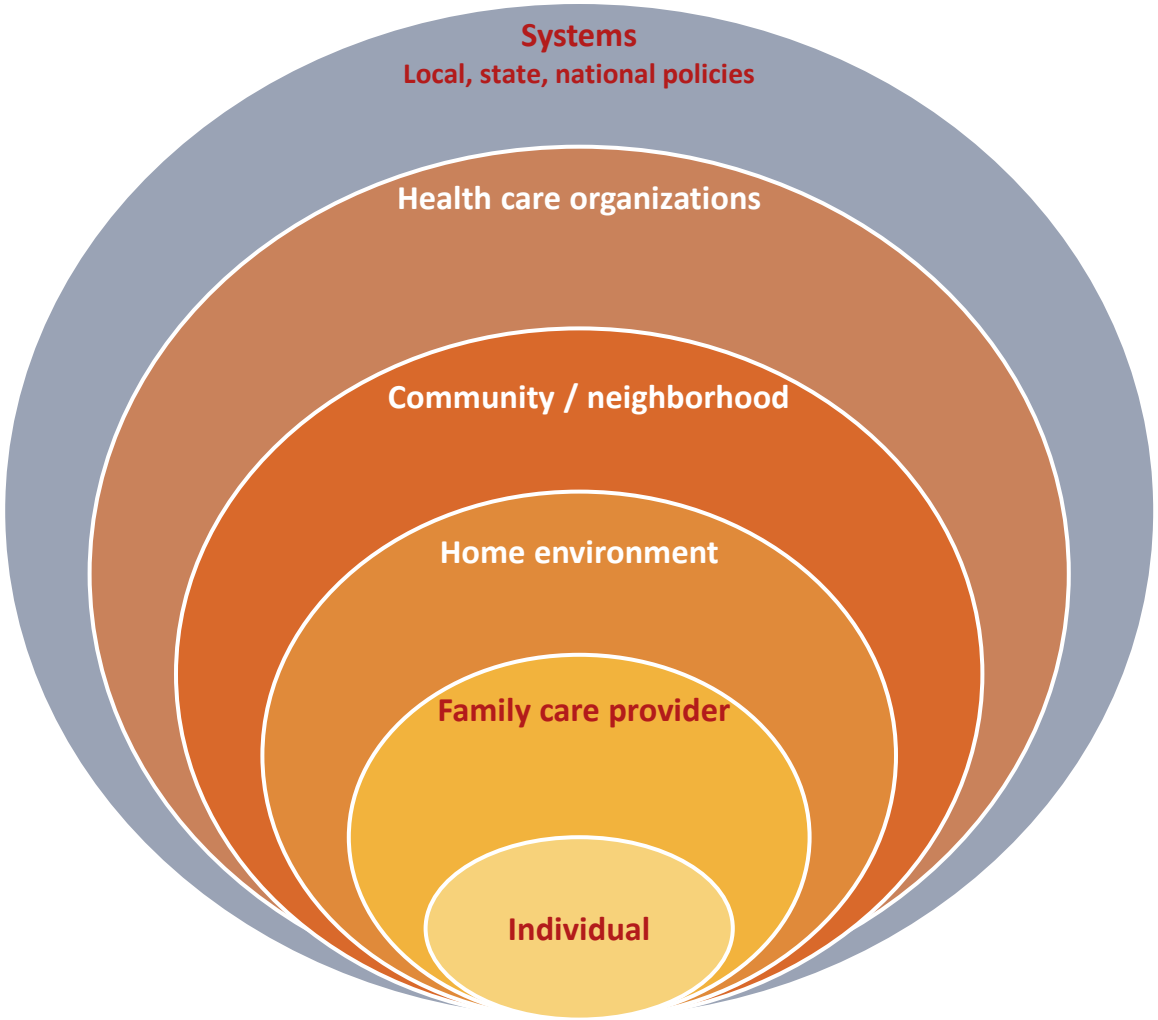
DEFINITION

Designing, evaluating, and implementing strategies to improve outcomes for a targeted population or community

Common intervention strategies

- Education and skill building
- Psychotherapeutic techniques (e.g., CBT)
- Goal setting
- Feedback and self-monitoring
- Problem solving
- Social support
- Motivational strategies

Six levels interventions can target



Macro level

Systems

Mezzo level

Health care organizations · Community / neighborhood

Micro level

Home environment · Family care provider · Individual

Dyadic: interventions can also target the caregiver–care recipient pair together.

© All rights reserved, Gitlin & Czaja. 2025, Handbook on Intervention Science. Not for duplication.

The Roles for Technology in Intervention Research

01



Intervention delivery

- Health apps
- Videoconference support groups
- Online asynchronous training
- Conversational agents

PRIMARY FOCUS TODAY

02



Data collection & trial conduct

- Sensors, wearables, home monitoring
- Ecological momentary assessment
- Remote consent and electronic data capture
- Adherence tracking

03



Data analysis

- Predictive modeling
- Language processing codes transcripts, qualitative data
- Machine learning

AI across the research cycle

Personalization

Delivery

Machine learning can tailor content, timing, and intensity, with adaptive learning and feedback.

Prediction & targeting

Trial conduct

Predictive models flag who is at risk, likely to drop out, or likely to benefit.

Conversational agents

Delivery

Chatbots and language models deliver coaching, education, or CBT — on schedule or on demand, at scale.

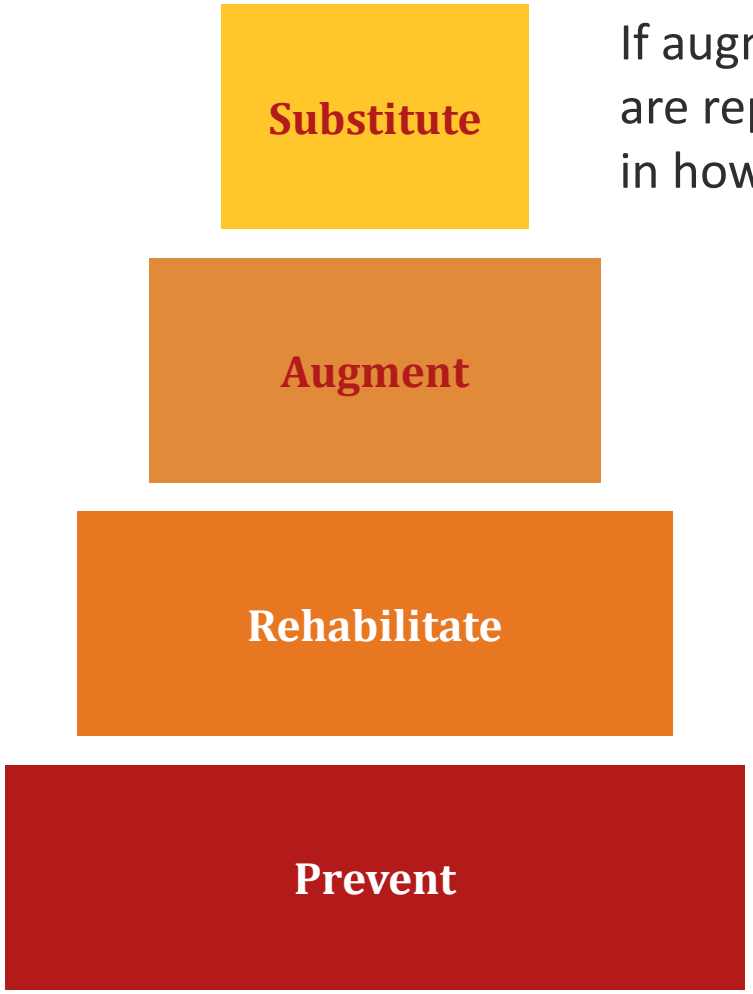
Unstructured data

Analysis

Language processing codes transcripts, open-ended responses, and clinical notes far faster than hand coding.

Each application still needs testing in trials — prediction is not causal evidence.

The PRAS framework: what technology can do



If augmentation fails, lost bodily or mental functions are replaced by an assistive device or a major change in how one interacts with the environment.

e.g., Robotics, smart-home automation

If rehabilitation fails, augmentation compensates for impairment so people can use the faculties they still have.

e.g., Reminders, hearing and navigation aids

If prevention fails, rehabilitation aims to restore normal, healthy functioning.

e.g., Telerehabilitation, VR-based therapy

Stay functional for as long as possible by maintaining good health and cognition.

e.g., Exercise and brain-health apps, coaching

Charness, N. (2020). A framework for choosing technology interventions to promote successful longevity: PRAS. Gerontology.

Technology across the NIH Stage Model



Basic research

Technology example

Sensors that measure reactions to an event help identify target mechanisms that lead to an outcome.

Intervention generation & refinement

Technology example

Computer-based simulation of an intervention evaluates how design changes affect outcomes.

Efficacy and effectiveness

Technology example

Technology-delivered exercise intervention maximizes reach and fidelity and tracks impact.

Implementation & dissemination

Technology example

Websites share information about an intervention's availability and educate users.

Stages are iterative: findings at any stage can send development back to an earlier one.

Based on Onken & Shoham (2015), NIH Stage Model for Behavioral Intervention Development.

Why technology matters for research with older adults



Older adults are diverse

Technology affords personalization to accommodate differences in health, function, cognition, and preferences.



Access barriers

Mobility limits, rural distance, and caregiving demands keep many older adults from attending in-person programs.



Measurement burden

Frequent clinic visits and long surveys are fatiguing; passive and remote tools capture objective measures of activity, mood, and more.

Technology can address all three — if it is designed with older adults in mind.

01

Intervention delivery



Medicine

Technologies used to deliver interventions

- Mobile health apps
- Web-based programs
- Sensors
- Videoconferencing
- Conversational agents
- Wearables
- Virtual reality & avatars
- Robotics
- Telehealth

Examples from aging intervention research

Domain	Example technologies
Falls and mobility	Wearable and home sensors to detect gait change and fall risk
Cognitive health	Digital cognitive tests and everyday-behavior markers of early change
Loneliness	Conversational agents, video visits, and social robots
Dementia caregiving	Online support, tele-coaching, and monitoring tools for family caregivers
Aging in place	Smart-home sensing, medication reminders, and remote check-ins

Key Caveat

Technology is the vehicle — not the mechanism of behavior change!

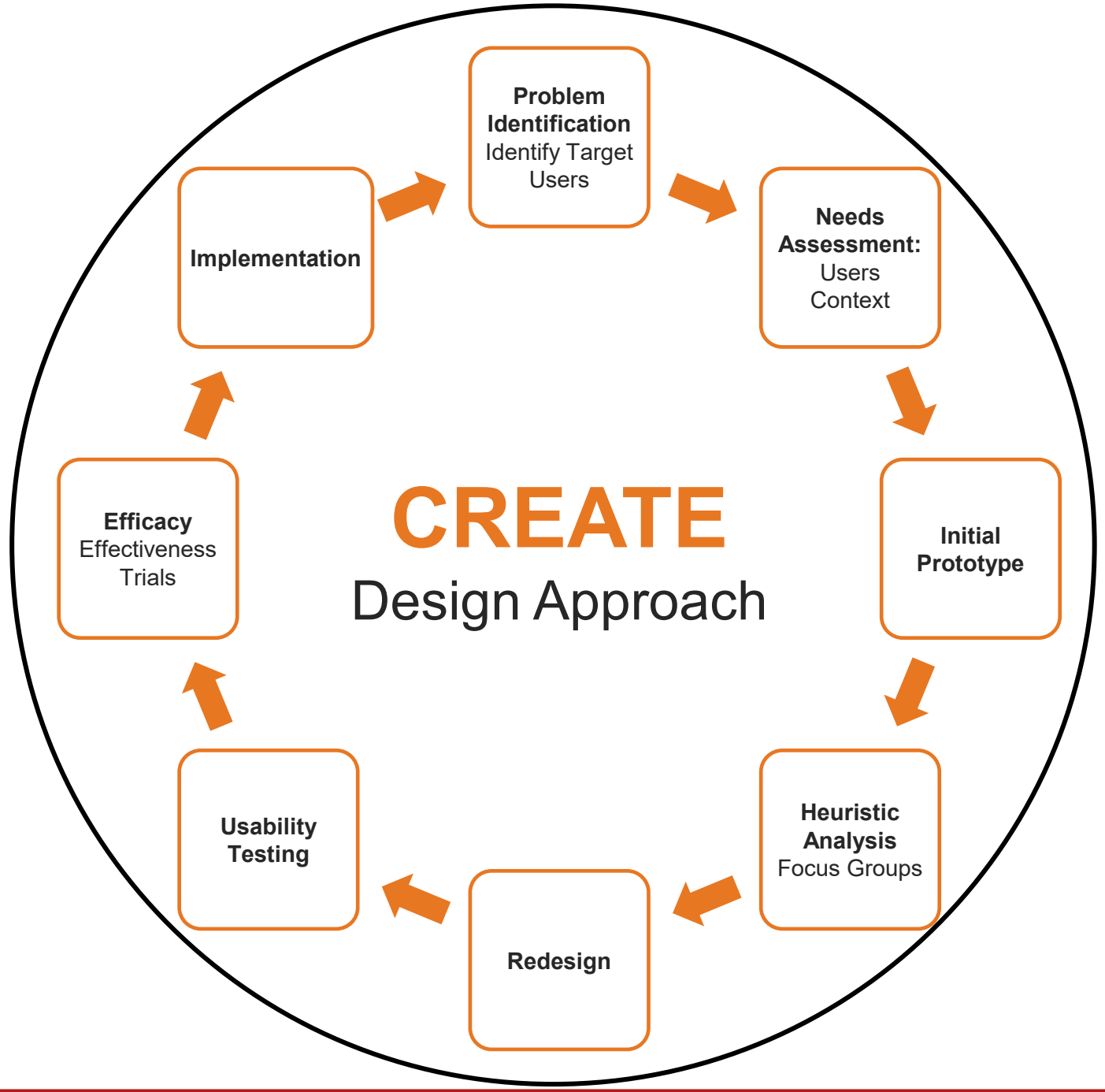
Interventions should be theory-driven, e.g., behavior change theories such as:

- Social cognitive theory
- Theory of planned behavior
- Stress Process Model

Examples from our research

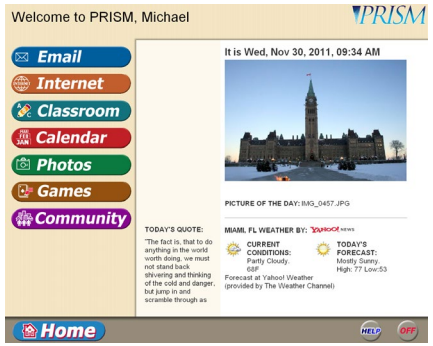
Older adults with CIs, their care partners, & clinicians are involved throughout the design cycle

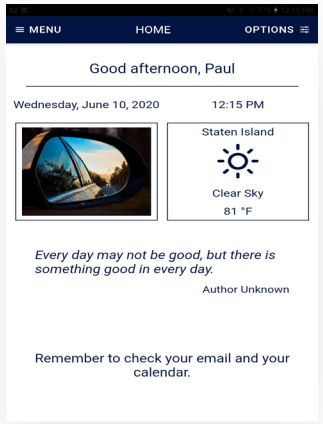
EAB provides input from community stakeholders, industry/business and the research community



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PRISM: Prevent Loneliness and Enhance Social Connectivity







Populations:

Ethnically diverse older adults

Age: 65 -98 yrs.
Varied technology proficiency
With and without cognitive impairments

Findings: (*Czaja et al., 2018, 2023, 2024):*

Able to successfully train all participants on PRISM

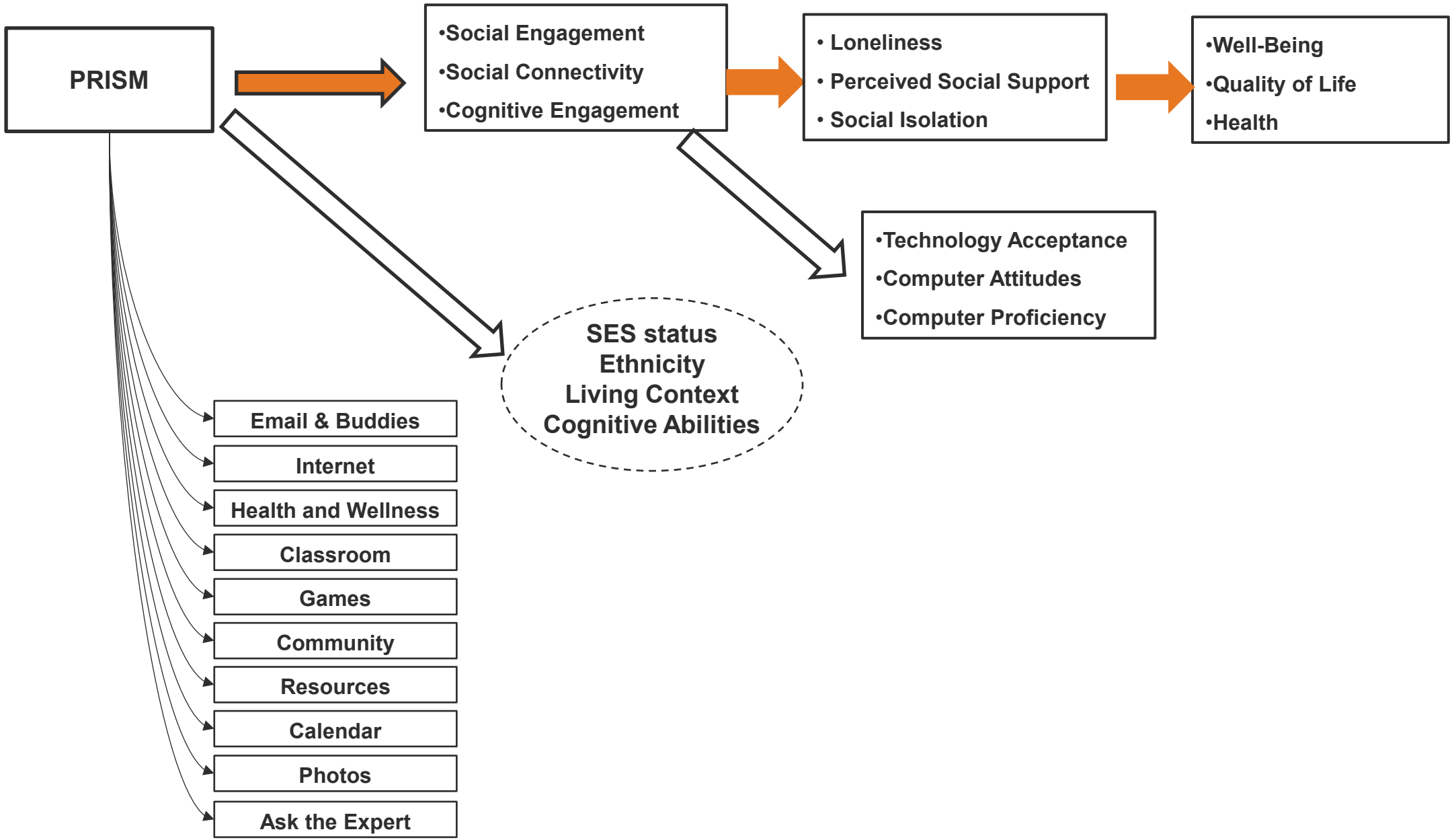
Increase in:

Social Support
Emotional Well-Being
Tech proficiency & efficacy

Decrease in:

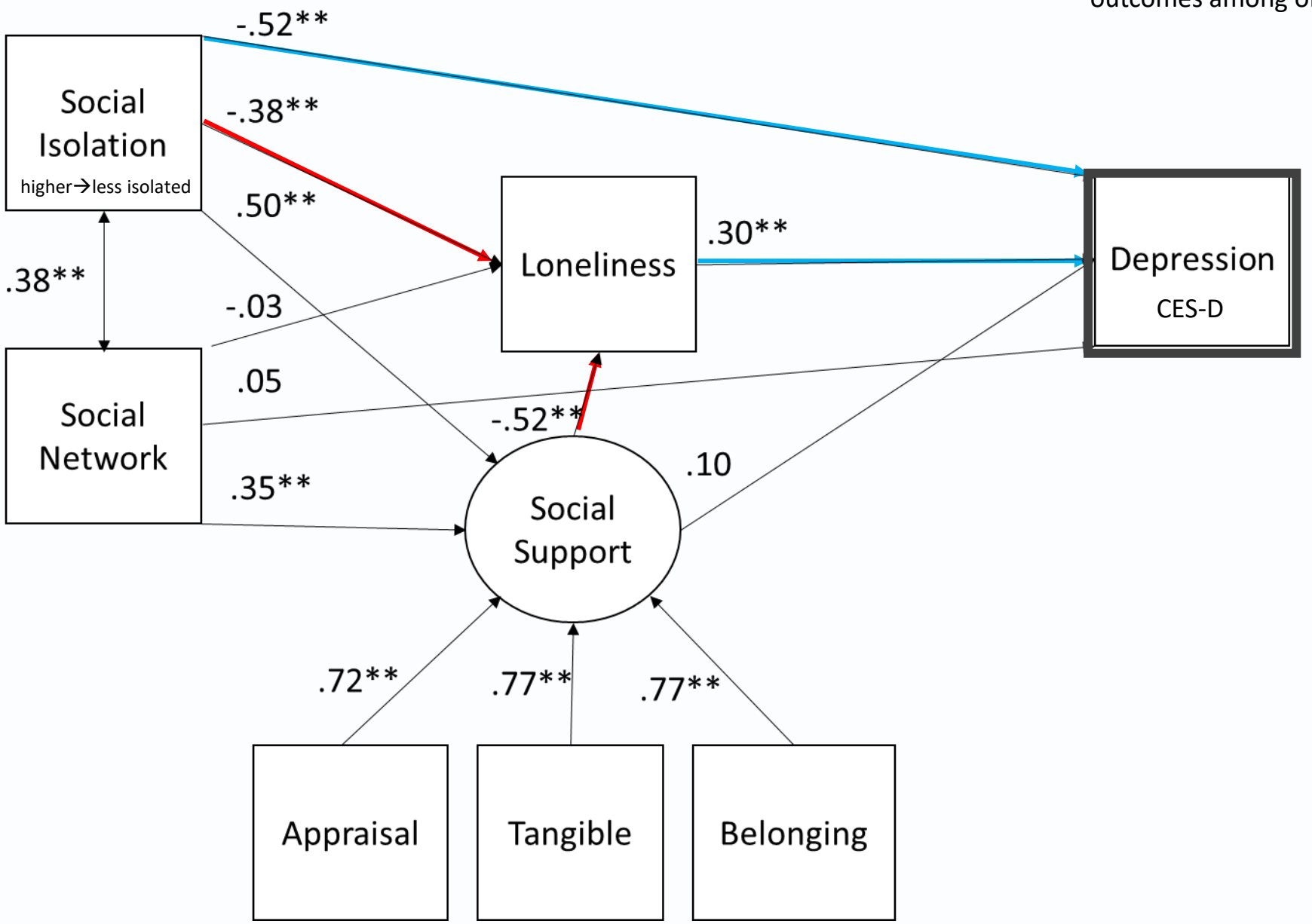
Loneliness

Conceptual Model

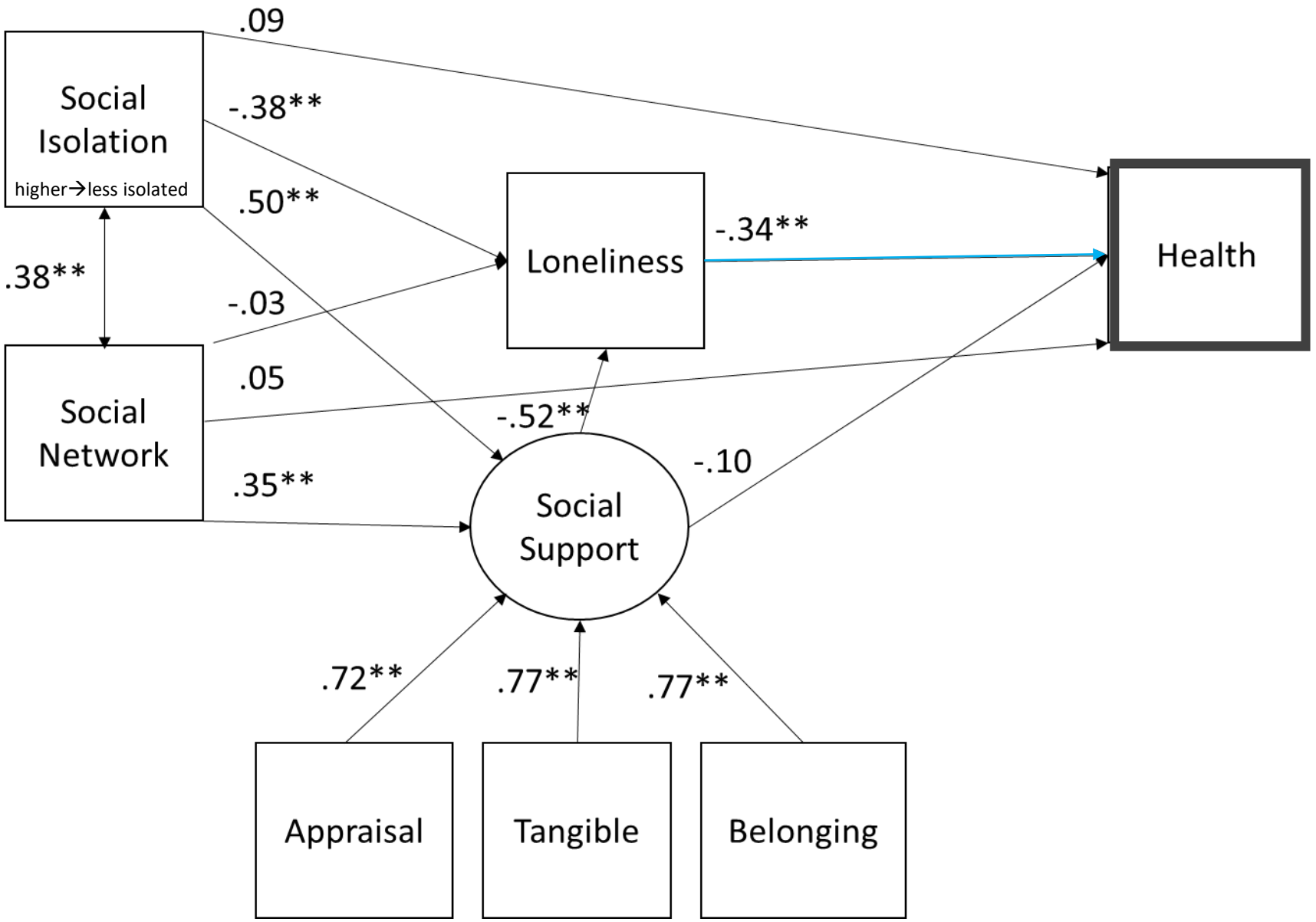


Predicting Depression

Czaja, S. J., **Moxley**, J. H., & Rogers, W. A. (2021). The relationships among social support, isolation, loneliness and health outcomes among older adults.



Predicting Health Self-Rating



CAST Study

- Design and evaluate an immersive VR intervention:
  - Cognitive Activity Social Technology (CAST)
  - that provides aging adults a suite of virtual cognitive, social, and activity engagement applications.

- The CAST program will provide:
  - virtual interactions (one-on-one or groups)
  - cultural, creativity, and educational opportunities
  - cognitive engagement opportunities (e.g., gaming)

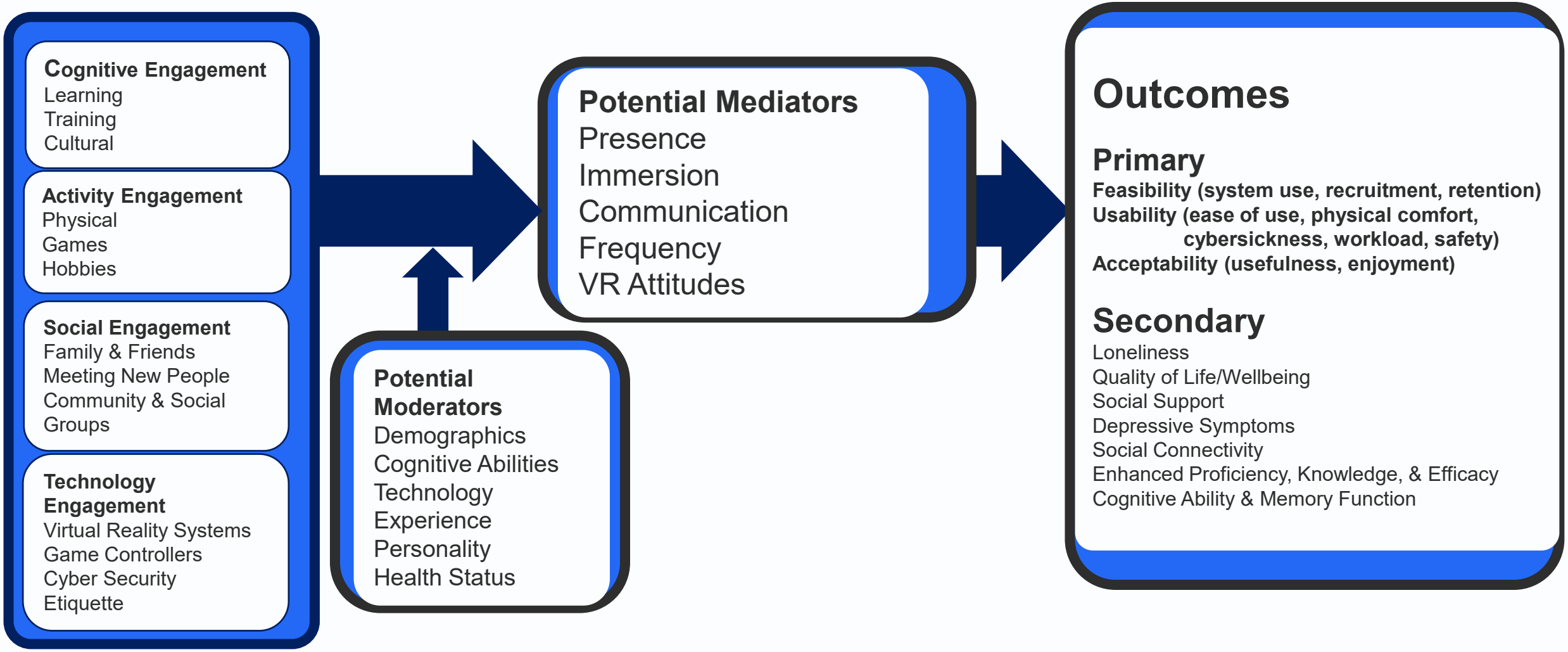




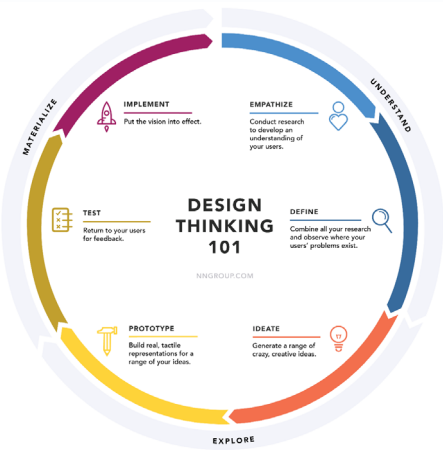


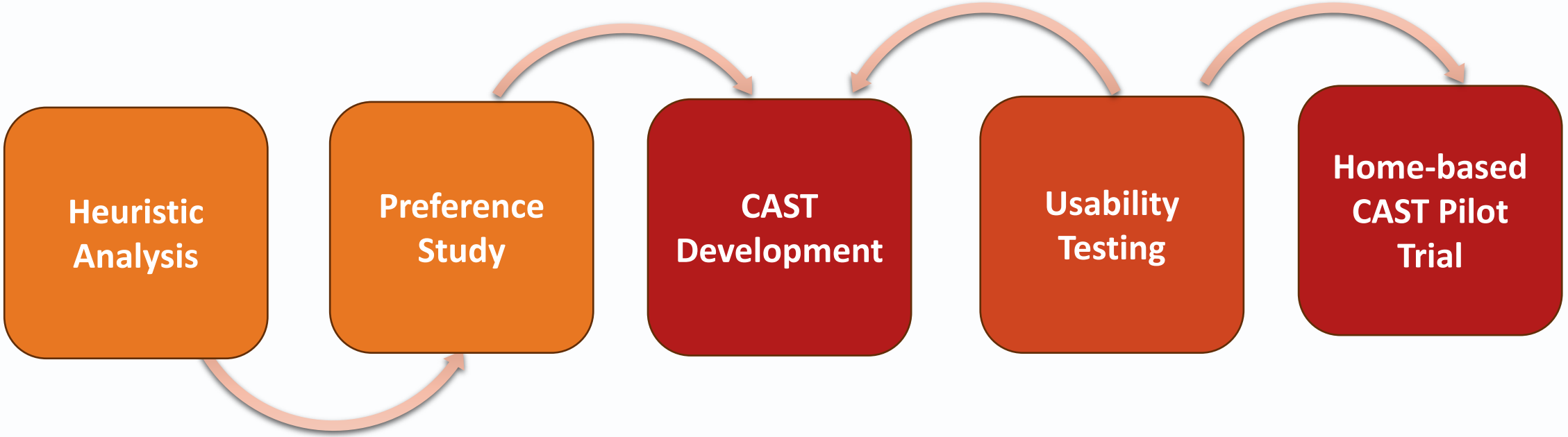
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CAST VR PROGRAM



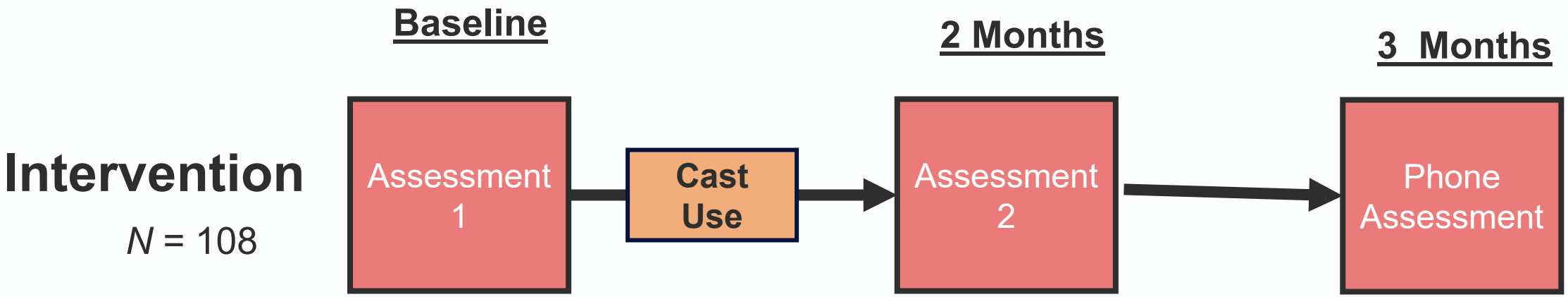
Project Steps





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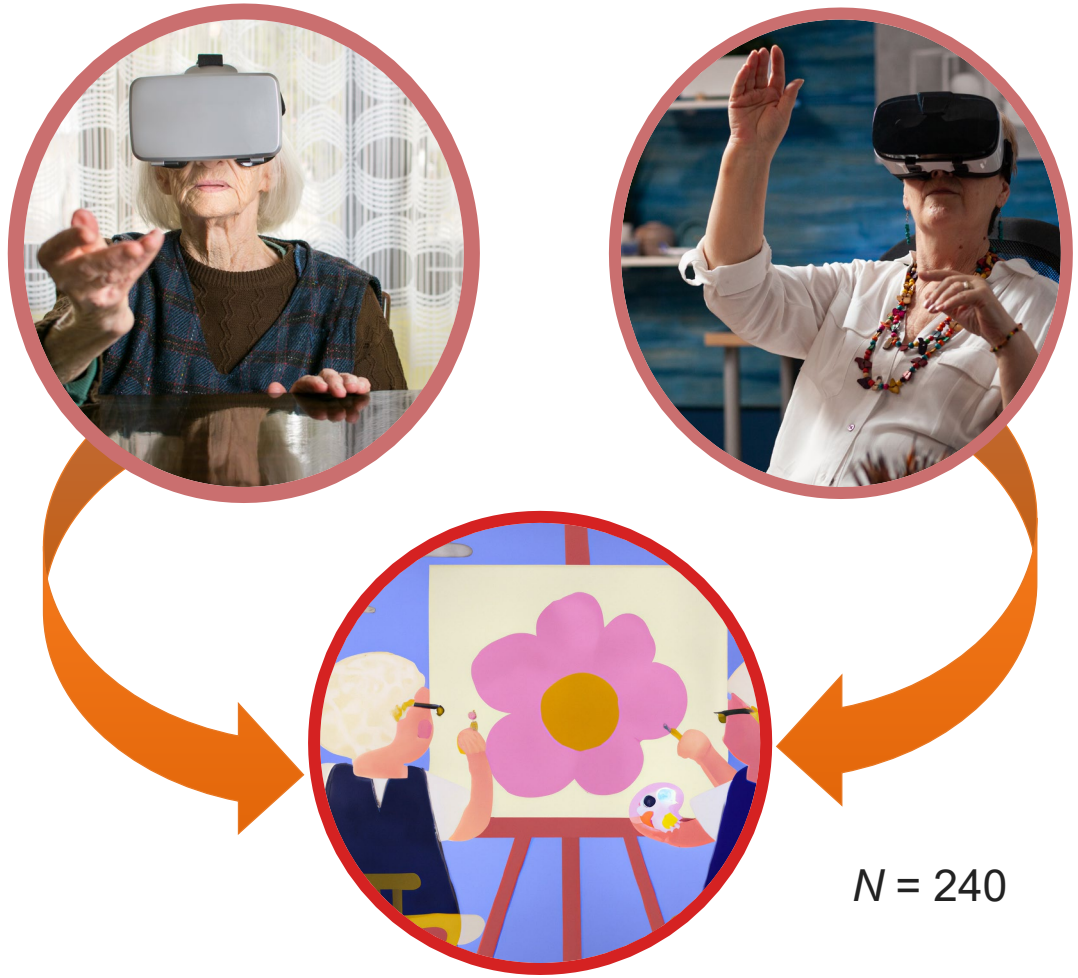
Trial Study Design



SERVE Virtual Volunteer Intervention: Connecting Cognitively Impaired Older Adults with Older Remote Volunteers

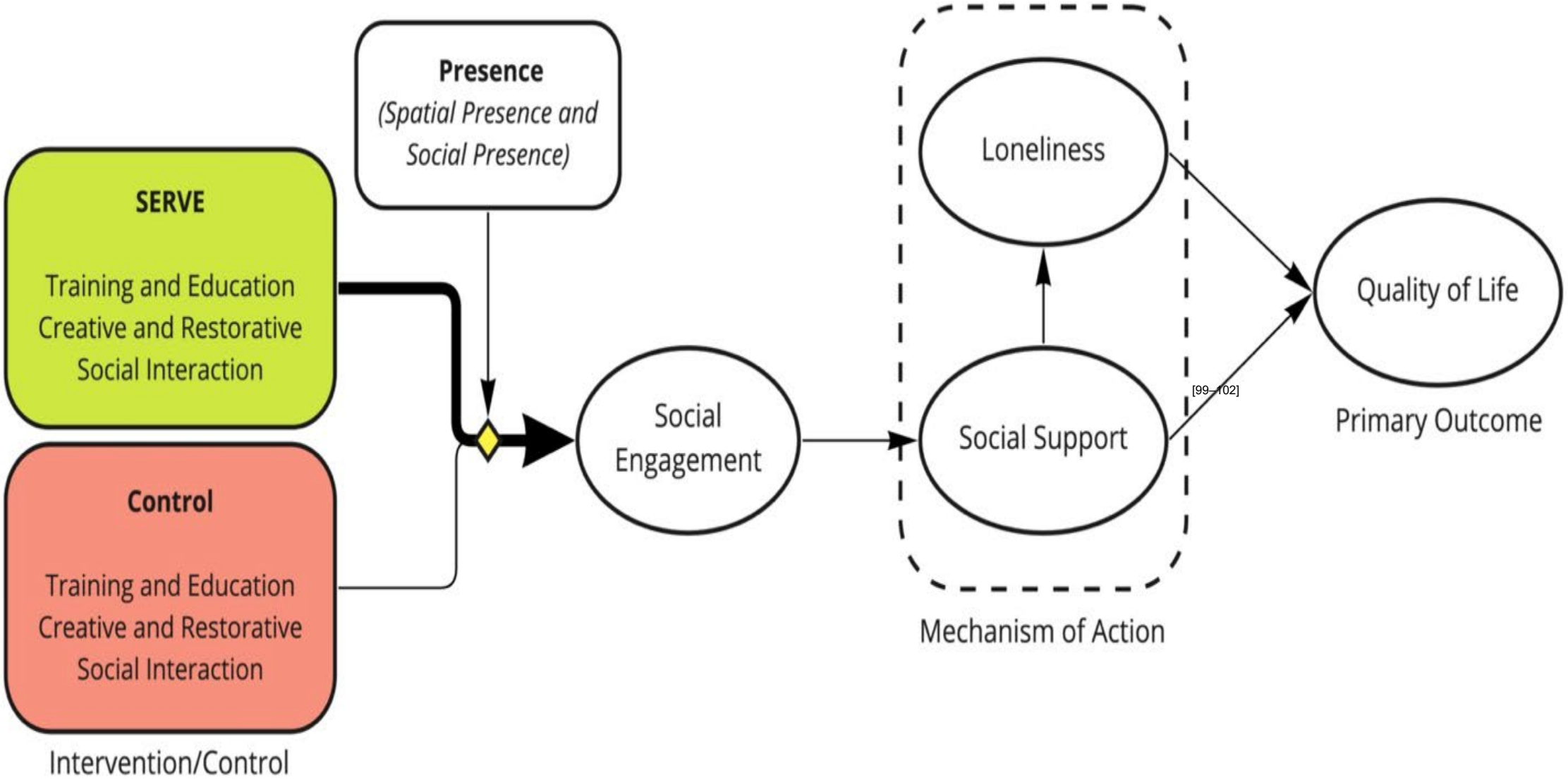
Innovation:
Harnessing VR and the human capital of older volunteers to engage in meaningful social and cognitive engagement with older adults with MCI.

Predicted benefits for both recipient (MCI) and volunteer (non-MCI).



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- **Conceptual Model**



Lessons Learned



Delivery: advantages and challenges

Advantages

- Extends reach, especially to underserved populations
- Tailor treatment to situational contexts (e.g., supportive feedback)
- Flexible delivery formats
- Asynchronous and anonymous access
- Adaptable as needs change
- Enables new forms of intervention (e.g., avatars)

Challenges

- Lack of meaningful access
- Usability issues and system complexity
- Adherence
- Constant change in technology
- Less personal connection
- Cybersecurity
- Cost
- Lack of interoperability across systems

Access: the digital divide persists among older adults

78%
of adults 65+ own a smartphone

70%
of adults 65+ subscribe to home broadband

54% vs. 94%
home broadband among adults with incomes under $30K vs. $100K+

Meaningful access is more than a device

Technology moves faster than trials

Obsolescence

Devices, operating systems, or platforms may change or disappear

Fidelity & versions

Software updates mid-trial can change the intervention participants receive

Evolving Technologies

Video Care



PRISM 2.0
Wellness
COPHeR



PRISM 1.0



CREATEMATE



CAST
SERVE



Usability Issues: designing for the full range of older users



Perceptual changes

Small text, low contrast, and audio-only cues



Motor changes

Small targets, complex gestures, and handheld controllers



Cognitive demands

Memory load, complex navigation, and cognitive impairment



Experience & attitudes

Low proficiency, technology anxiety

Czaja, S. J., Boot, W. R., Charness, N., & Rogers, W. A. (2019). Designing for Older Adults (3rd ed.). CRC Press.

Measurement challenges in tech-based interventions

Technology vs. intervention

- Delivery channel vs. active ingredient
- Novelty effects fade over time
- Platform updates during the trial

Engagement & dose

- No shared definition of engagement
- Usage is not attention or comprehension
- Effective dose rarely specified

Sensor & passive data

- Consumer device accuracy varies
- Wear-time and non-wear rules
- Proprietary, changing algorithms

Digital self-report

- Mode effects vs. paper or interview
- EMA burden and reactivity
- Vision, dexterity, cognitive load

Equity & representation

- Samples skew toward confident tech users
- Digital literacy confounds outcomes
- Measurement non-invariance

Older adults & cognition

- Proxy vs. self-report divergence
- Learning curve vs. true ability
- Practice effects; ongoing assent

Analytic challenges

- Intensive longitudinal data
- Many metrics risk selective reporting
- Linking proximal to distal outcomes

Implementation outcomes

- Ad hoc usability measures
- Trial efficacy vs. real-world use
- Privacy and data governance

Examples of measures

Feasibility

Can the intervention and study be delivered as planned?

Sample metrics

- Recruitment and enrollment rates
- Retention and attrition
- Adherence and session completion
- Data completeness

Acceptability

Do users and other interest holders find it suitable and satisfying?

Sample criteria

- Satisfaction
- Perceived appropriateness
- Intention to use
- Willingness to recommend

Usability

Can users reach their goals effectively, efficiently and with satisfaction?

Sample criteria

- Task performance
- Perceived usability
- Workload

Safety

How much risk of harm does the intervention carry?

Sample criteria

- Adverse event frequency and severity
- Perceived safety
- Risk management

Adapted from Table 1, Shore J, Hwang AS, Wang RH. *JMIR Rehabil Assist Technol* 2026;13:e79026 (CC BY 4.0).

Examples of measures

Impact

Does it show promise for positive change in the target population?

Sample criteria

- Change in clinical measures
- Maintenance of change
- Perceived benefit
- Caregiver burden

Implementation

Can it be delivered and used as intended across settings?

Sample criteria

- Adherence and fidelity
- Contexts of use
- Barriers and facilitators

Technical performance

Does the technology meet its requirements and goals over time in its setting?

Sample criteria

- Accuracy and reliability
- Responsiveness
- Error handling
- Maintenance and repair

Privacy, security, and ethics, amplified by AI

Data & privacy

- Passive sensing collects continuous, sensitive data
- Third-party apps and cloud platforms
- Data ownership, storage, and retention

Autonomy & consent

- Consent with cognitive impairment
- Monitoring vs. independence and dignity
- Family and caregiver access to data

AI-specific risks

- Inaccurate or "hallucinated" answers
- Bias in training data and algorithms
- Transparency and over-reliance

Other Issues

Adherence

- Use often declines once novelty fades
- Usage is not the same as engagement
- "Dose" is hard to measure

Cost & Technical Expertise

- Access costs
- Data costs
- Availability of technical expertise

Active ingredients

Hard to separate effects of content, delivery mode, and human support

Control conditions

Choosing attention controls, usual care, or digital "placebo" conditions

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SUMMARY



Start with theory

Technology is not the mechanism of behavior change.



Design with older adults

Involve users early and test iteratively, including people with cognitive impairment.



Remove access barriers

Provide devices, connectivity, training, and help-desk support.



Plan for engagement

Build in tailoring, nudging and social features.



Expect technology to change

Choose adaptable platforms, track versions, and use flexible designs.



Protect participants

Address privacy, security, and responsible AI.



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Thank you



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Q & A

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https://embraceroybal.wisc.edu

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Thanks for joining us!