

“Can Conversational Agents (Avatars) Help Older Adults Learn Health Information?”

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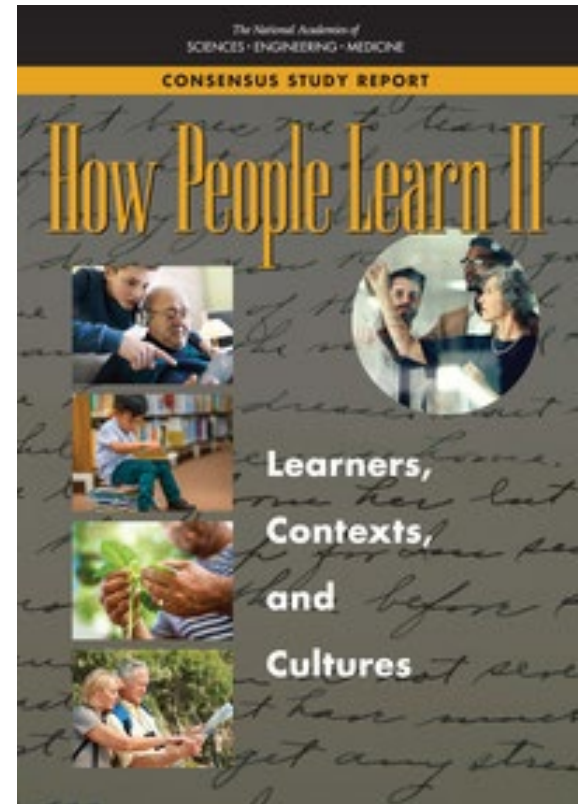


Overview

- Lifelong learning in the context of health and self-care
 - Learning for health and self-care
 - Technology and support for self-care: help or hindrance?
- Patient-centered design of technology
 - Framework for designing technology for older adults
 - Patient abilities needed for self-care
- Conversational Agents (CA) and Self-Care
 - CAs and accepting the need for self-care
 - CAs and establishing self-care behaviors
 - *CAs and COVID counselling*
- Wrap-up

Lifelong Learning and Health

- Learning is a lifelong enterprise that takes place at work, home, public spaces... as well as school (IOM, 2018)!
- Health (maintaining wellness and managing illness) is an increasingly important context for learning as we age
 - Interest in healthy lifestyles (healthy meals, exercise, sleep) and illness that increases health knowledge with age (Beier & Ackerman, 2005)
 - Need to manage the chronic illnesses that increase with age (medications, monitoring symptoms, ...)
 - Historical events that dramatically increase need for health and self-care across the lifespan (COVID-19)!



Learning in Health Care Systems

- Learning about health often takes place within health care systems
- With age, we tend to spend more time in health care systems
- Health systems encourage or require us to learn and make decisions about our health because responsibility has shifted to patients ('Patient-centered care')
 - Emphasis on shared decision-making
 - "The U.S. healthcare system increasingly assumes an active, aware, health-literate patient who is capable of making "informed choices" (TEDMED, 2012)



Learning in Health Care Systems: Patient/Provider Conversation and Collaboration

- We value learning from providers during face-to-face conversation. Older adults with lower health literacy especially prefer face-to-face communication (Medlock et al., 2015).
- Face-to-face communication helps us get “the gist” of key concepts (e.g., our “numbers”)
 - Verbal cues: Key words help us focus on relevant information and understand the ‘bottom line’ for health.
 - Nonverbal cues
 - Cognitive meaning (intonation/pitch, gesture)
 - Affective meaning (facial expression, posture)
 - Provider nonverbal cues are associated with patient satisfaction (Ambady et al., 2002)
- Face-to-face communication is critical for establishing ‘common ground’
 - Speakers (providers) monitor listeners (patients) to make sure they understand, for example by asking questions to ‘close the communication loop’ (‘teachback’; Schillinger et al. 2003).



Unfortunately.....

- Providers rarely have enough time to consistently use patient-centered communication techniques when talking to their patients (especially now during pandemic!!)
- As a result, older adults may go home unprepared for self-care. For example older adults forget 40-50% of information told by their providers (Kessel, 2003)



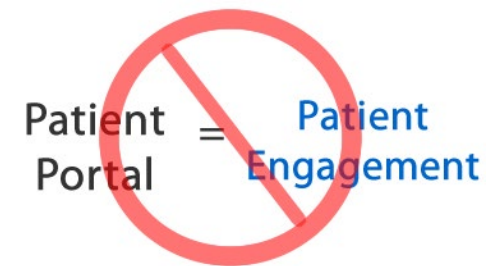
Learning in Health Care Systems: Technology to the Rescue?!?

- Pervasive technology in health care
 - Increasingly the standard of care (e.g., federal programs require technology such as electronic health records for educating patients in primary care; IOM, 2012; ONC, 2011)
 - Flood of mHealth technology (apps) for providers and consumers (Kreps & Neuhauser, 2014)
- Can technology step in for busy providers and help educate patients? Does it help or hinder our ability to learn about health and self-care?



Electronic Health Record Patient Portals

- Ideally, Portals to EHRs
 - Provide continuous access to information between provider visits to support home-based self-care (IOM, 2012)
 - Support coordinated care across multiple providers
- In reality, portals are too often:
 - Repositories of numeric information that challenge patients with limited literacy and numeracy.
 - Can sometimes reduce patient engagement with providers and their own health care.
 - Underutilized, especially by older adults with low health literacy (Sarker et al., 2010; 2011)!



Technology May Increase Access to Information but Not Understanding and Engagement



Talk to provider
(Prescribing)

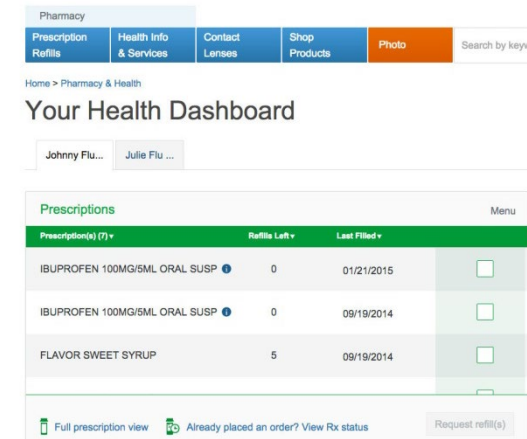
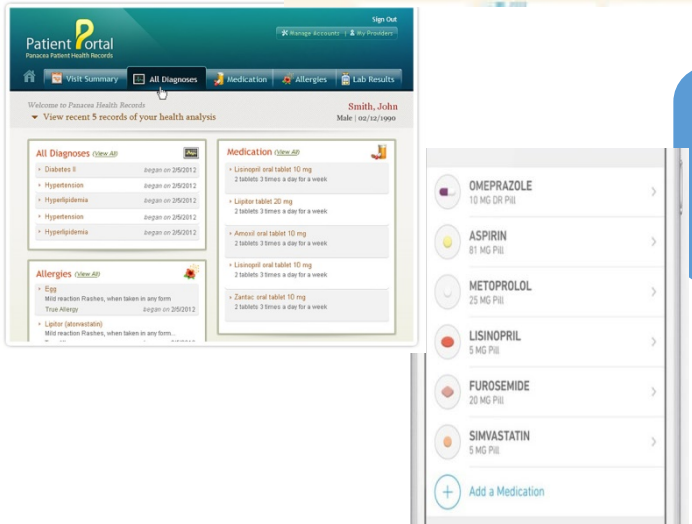


Talk to provider
(Pharmacy/Dispensing)



Take Medication at home

Pick-up Medication
(Pharmacy/Dispensing)
Read instructions



Dilemma for Patients?

- Older adults are often the typical patient in complex health systems that require them to manage their health care
- Technology intended to support self-care may not be designed with older adult needs and abilities in mind, increasing rather than reducing complexity of learning.

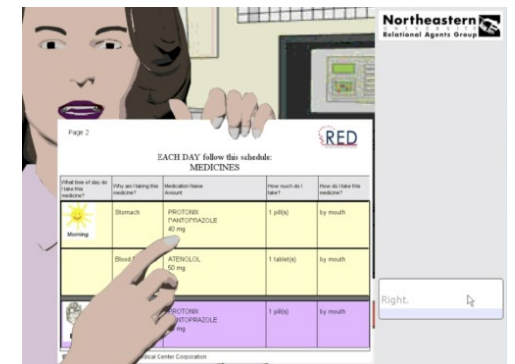
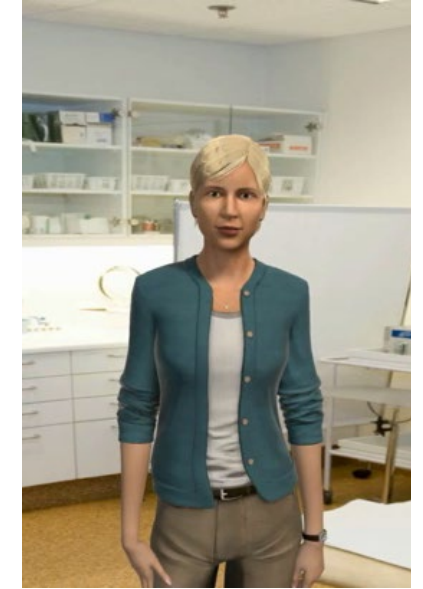


“Patient-Centered” Technology and Learning for Health

- Can we develop technology that supports learning for health by combining benefits of face-to-face provider/patient conversation with benefits of technology (ready access to information when and where needed)?

Conversational Agents

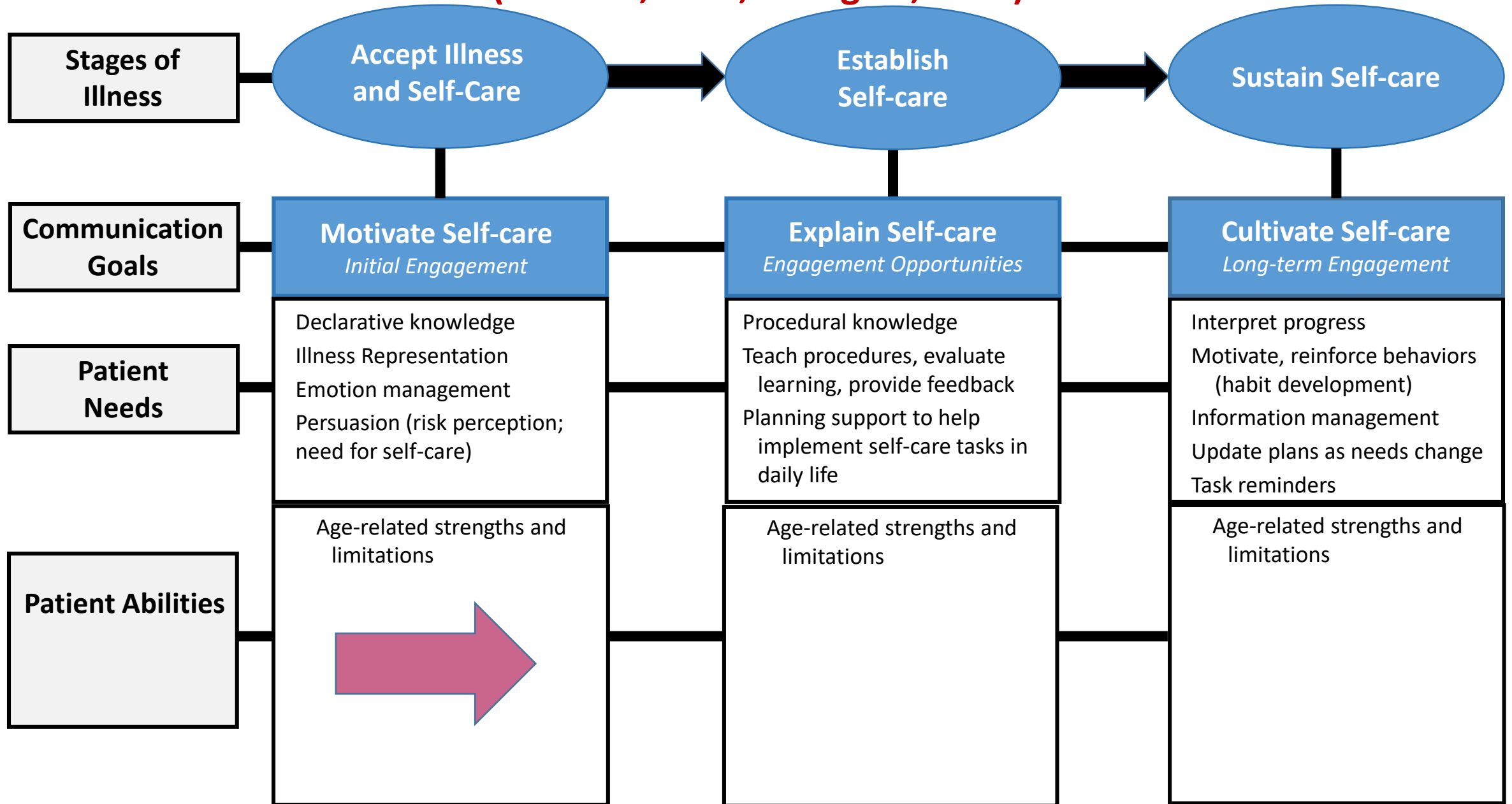
- “Virtual provider”: Embodied conversational agent (CA) that emulates face-face communication best practices.
- CAs may engage patients in self-care tasks and learning:
 - People respond to agents as if they are human (‘social stance’; Nass & Reeves, 1996)
 - More realistic (human-like) agents are perceived as more trustworthy (DeVisser et al., 2016; Pak et al. 2016)
 - Older adults are open to interacting with agents (Bickmore et al., 2010; Strassman & Kramer, 2016)
- Unlike people, CAs
 - Accessible whenever and wherever needed for learning
 - Repeat and clarify messages on demand, without being annoyed!
 - Tailor content and delivery to different audiences



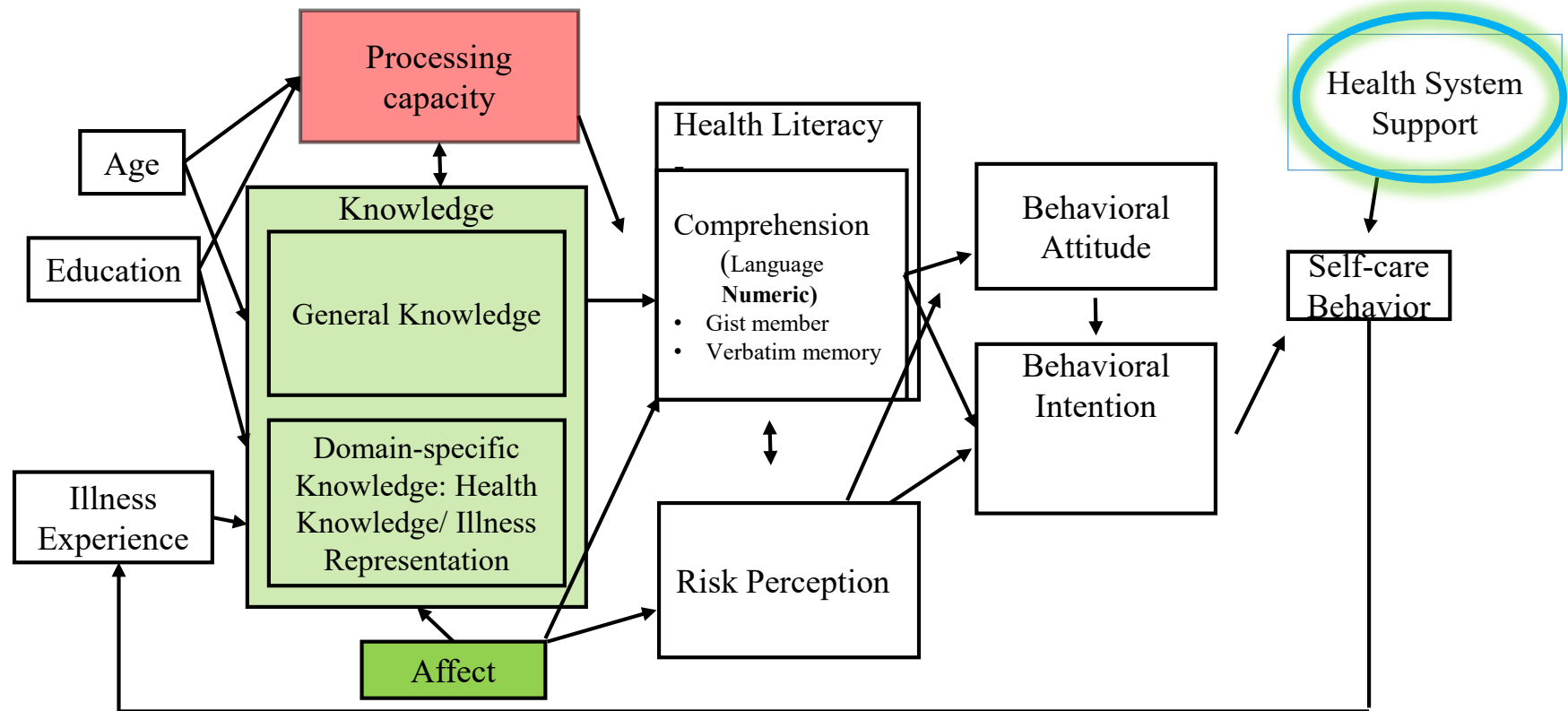
“Patient-Centered” Conversational Agents

- Designing effective CA technology requires a framework that
 - Articulates self-care learning needs at different stages of wellness and illness
 - Identifies our abilities related to communication, comprehension, decision-making (user-centered design)

Framework for Designing Technology to Support Self-Care Learning (Morrow, Lane, & Rogers, 2020)



Designing Technology in Terms of Age-related Strengths and Limitations



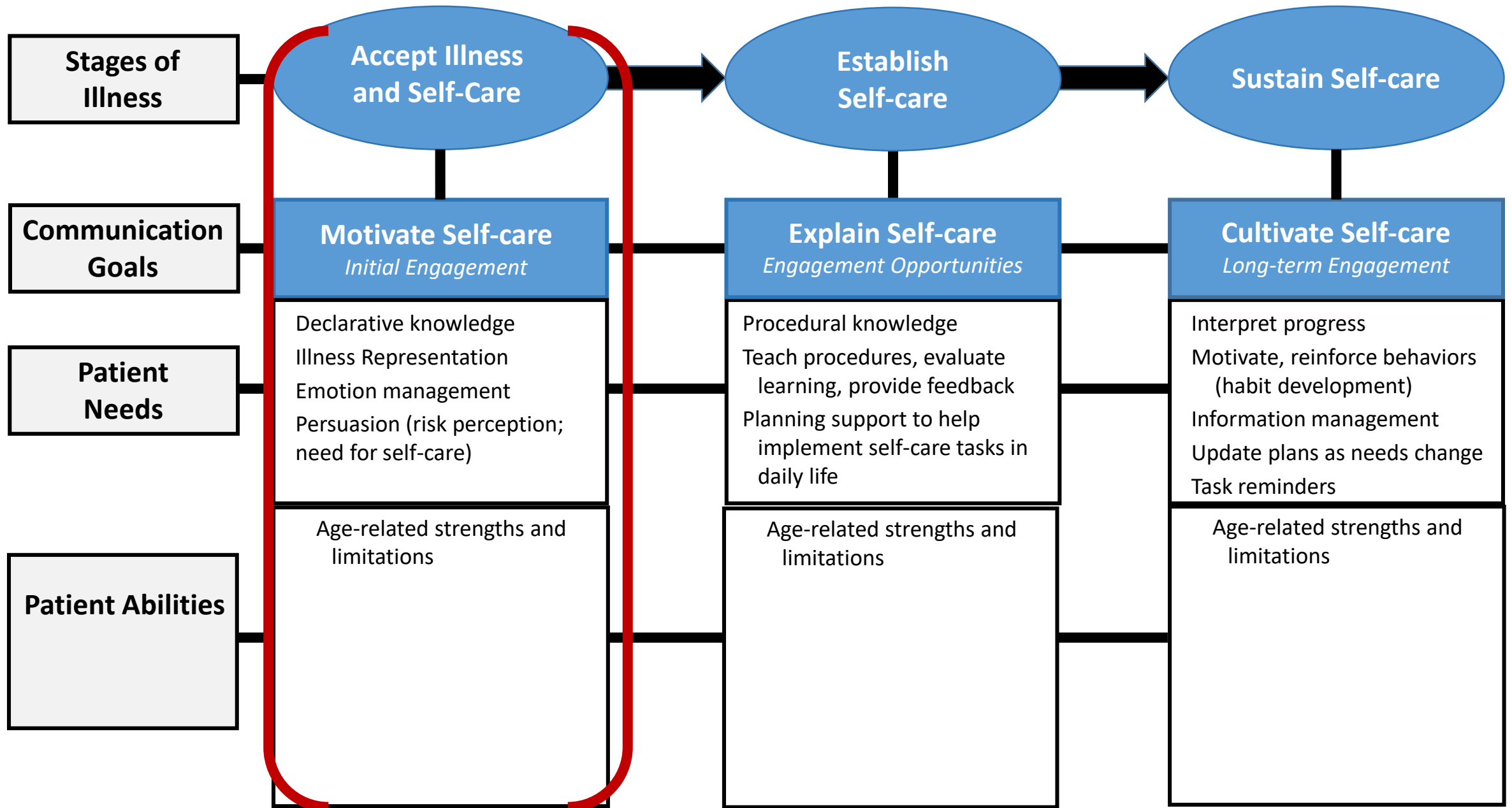
Morrow et al., 2017, *Journal of Biomedical Informatics*



Bottom-line for Patient-Centered Technology Design

- Learning about self-care is limited by processing capacity constraints, but supported by knowledge and affective/emotional responses.
- Design technology to reduce demands on processing capacity and build on knowledge and affect to support learning for health and self-care
- Exploring potential of CAs for learning information related to accepting need for self-care and establishing self-care behaviors.

Study 1: Can CAs Help Us Accept Need for Self-care?



Study 1: Can CAs Help Us Accept Need for Self-care?

- Accept illness and the need for self-care
 - Communication goals: Motivate self-care by understanding risks of illness and need for self-care to address these risks.
- Patient needs:
 - Information about health and illness provided in context that highlights implications for risk and what to do about it (e.g., lab test results)



Age-related Design of Communication: Comprehension of *Numeric* Health Information

- We interpret numbers in terms of our goals, knowledge, and affect to create gist as well as verbatim representations (Reyna, 2011)
 - “*Your LDL is 165*”
 - Verbatim: precise, exact information (*LDL is **165***)
 - Gist: ‘Bottom-line’ cognitive and affective significance of the numbers that is qualitative (*LDL is **high** or **increasing***) and evaluative (*High LDL is **threatening***)



Comprehension of Numeric Information: Patient Portals

- Typical formats for lab test results do not help convey seriousness of results in context of risk for our health.
 - Little clinical context (numbers without expert commentary to support bottom-line interpretation)

Component	Your Value	Standard Range	Units
Total Cholesterol	235	< 200 -	mg/dl
Triglycerides	224	< 150 -	mg/dl
HDL Cholesterol	34	40 - 60	mg/dl
LDL Cholesterol	160	< 100 -	mg/dl

Study 1a: Can CAs Help Us Accept Need for Self-care?

Responding to Clinical Test Results in Patient Portals

- Scenario-based study compared ‘enhanced formats’ for communicating test results that emphasize the meaning of the results for illness risk, compared to standard portal formats
- As a first step toward using CA as ‘virtual provider’, used video of actual provider
- Older adults read cholesterol scenarios with test results varying in risk for cardiovascular illness
- For each scenario (patient profile & test result message):
 1. Verbatim and gist questions (before and after summary)
 2. Affective response to test results
 3. Risk perception, behavior attitude, and behavior intent questions



Standard Message Format

Kathleen is a 43 year old woman with a family history of Coronary Artery Disease. She also smokes, but she has normal weight.

Here are her cholesterol test results:

1. Scores

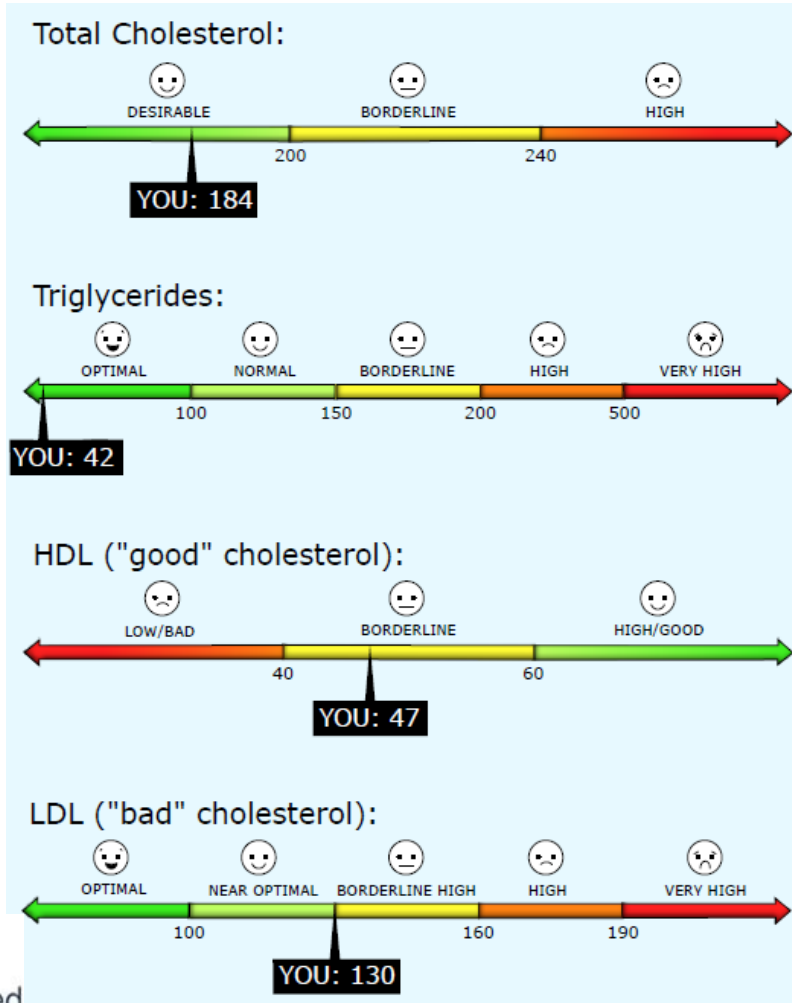
Component	Your Value	Standard Range	Units
Total Cholesterol	184	< 200 -	mg/dl
Triglycerides	42	< 150 -	mg/dl
HDL Cholesterol	47	40 - 60	mg/dl
LDL Cholesterol	130	< 100 -	mg/dl

2. Summary

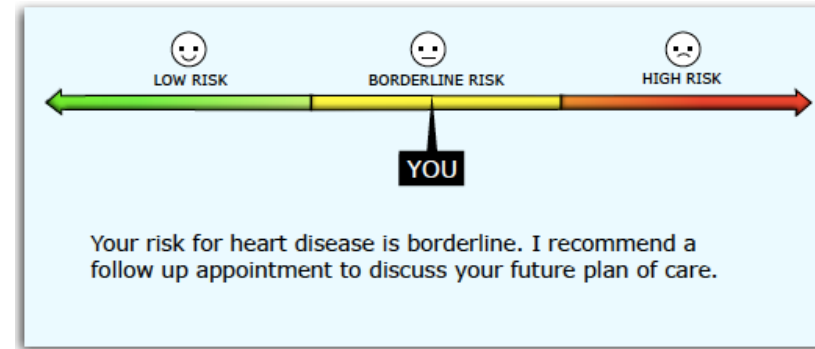
“Your test results require discussion to assess your future plan of care. A follow up appointment is recommended to discuss your results.”

Graphically Enhanced Message Format

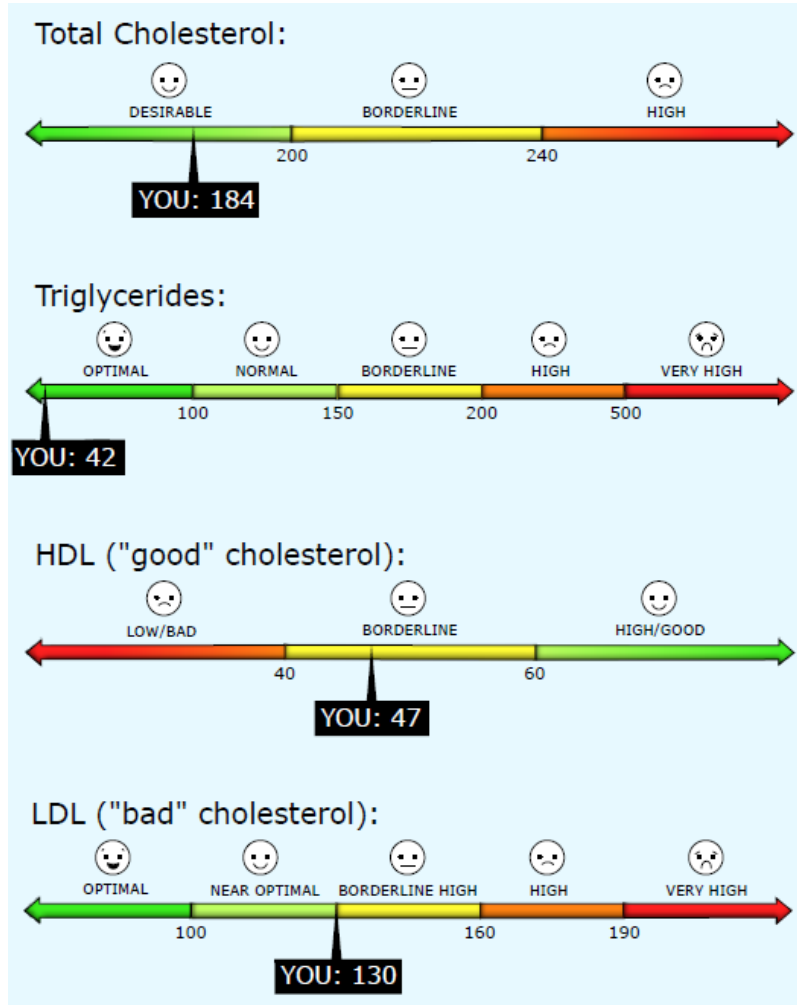
1. Scores



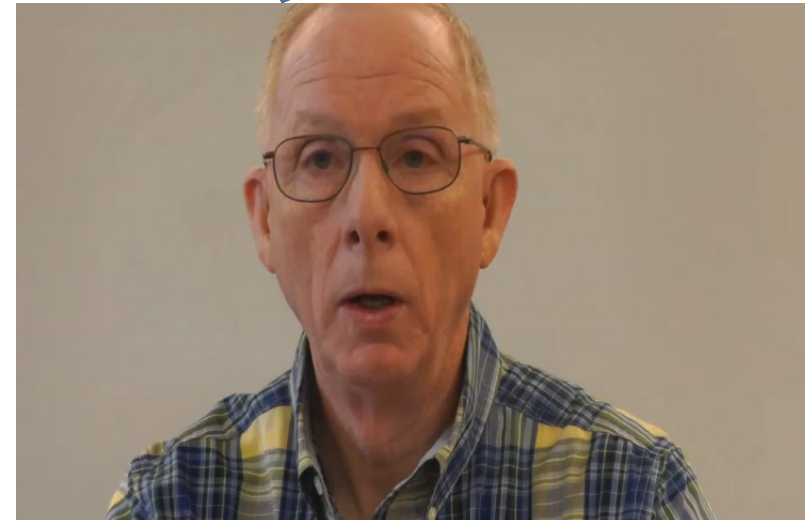
2. Summary



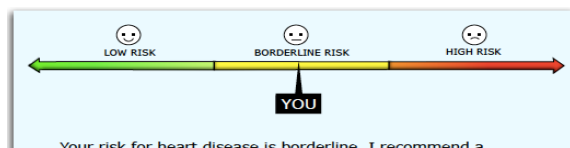
Video-Enhanced Message Format



"I'm going to tell you about the results of your cholesterol test. ... your *HDL* or good cholesterol is 47. This score is **borderline**. A **higher HDL score is desirable**, Also, your *LDL*, or bad cholesterol, score is 130. **This number is also borderline; a lower score is desirable.**



Physician Video



More Enhanced Messages will Improve...

Message Gist Memory

Level of risk (High/Borderline/Low)
associated with test values
in the message

Affective Response

Positive/negative feelings about
risk (Garcia-Retamero & Cokely, 2011)

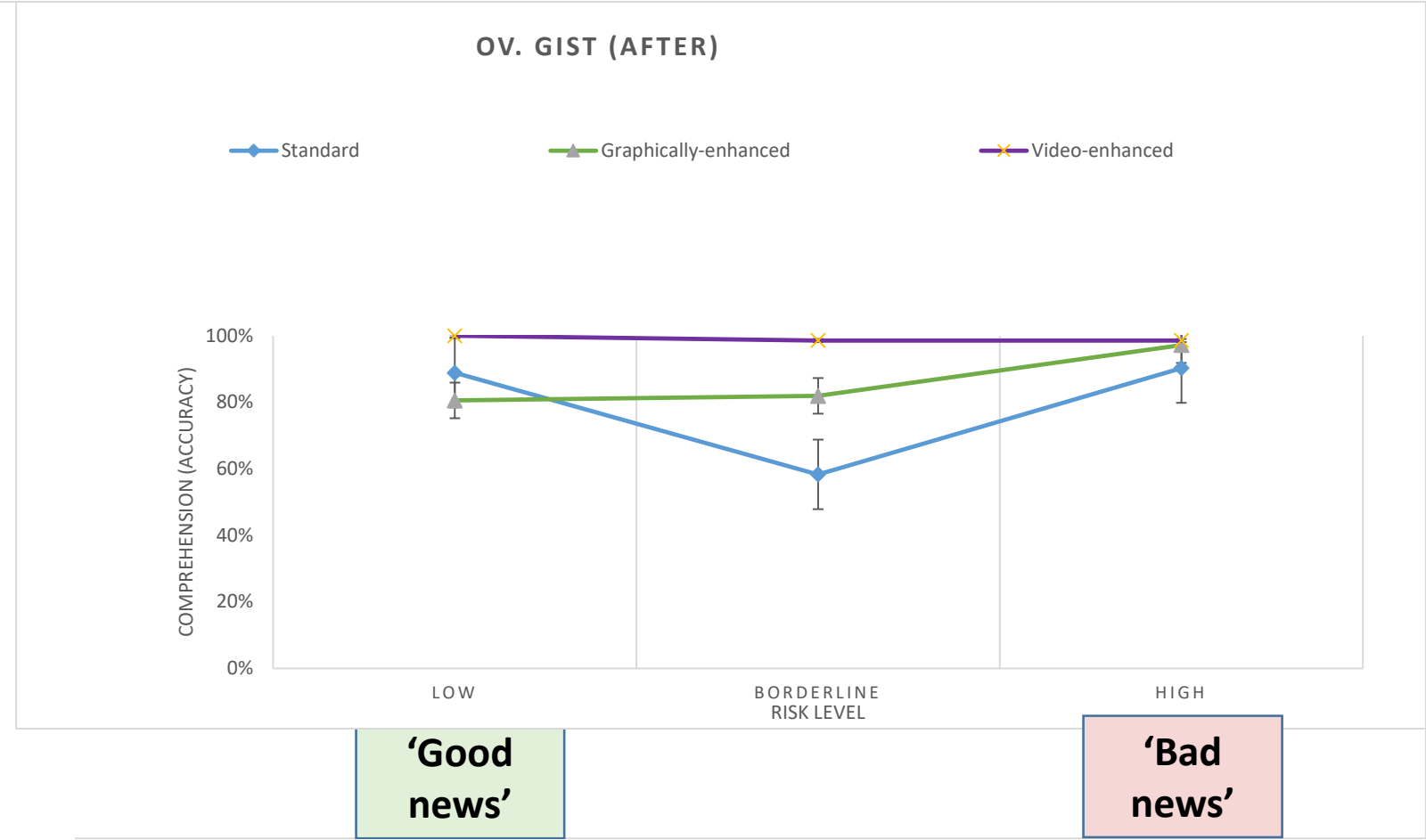
Risk Perception

Seriousness of/concern about risk
(Garcia-Retamero & Cokely, 2011)

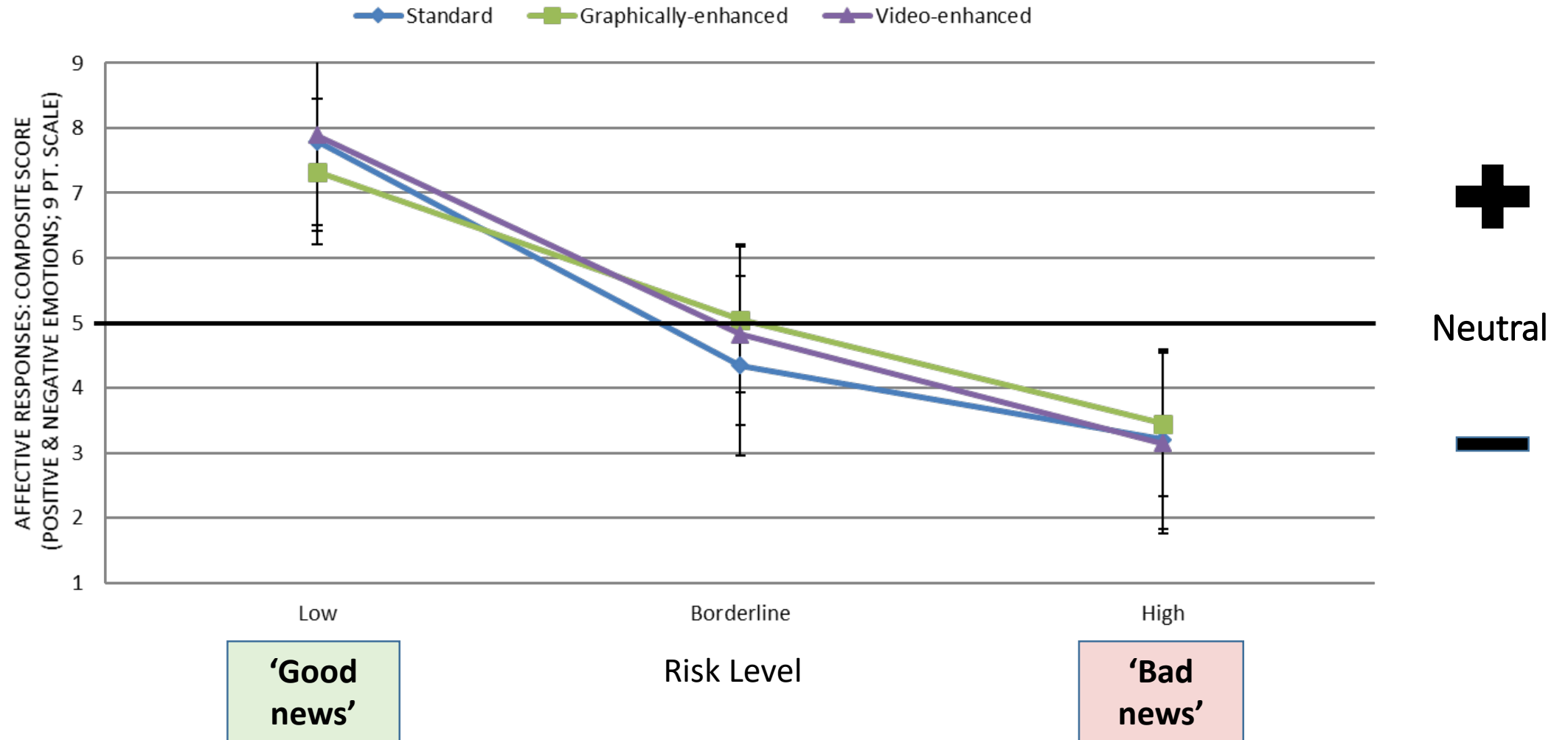
Behavioral Intention

How likely to perform behaviors to
mitigate risk (e.g., medication, diet;
Garcia-Retamero & Cokely, 2011)

Results: Video Improves Gist Memory

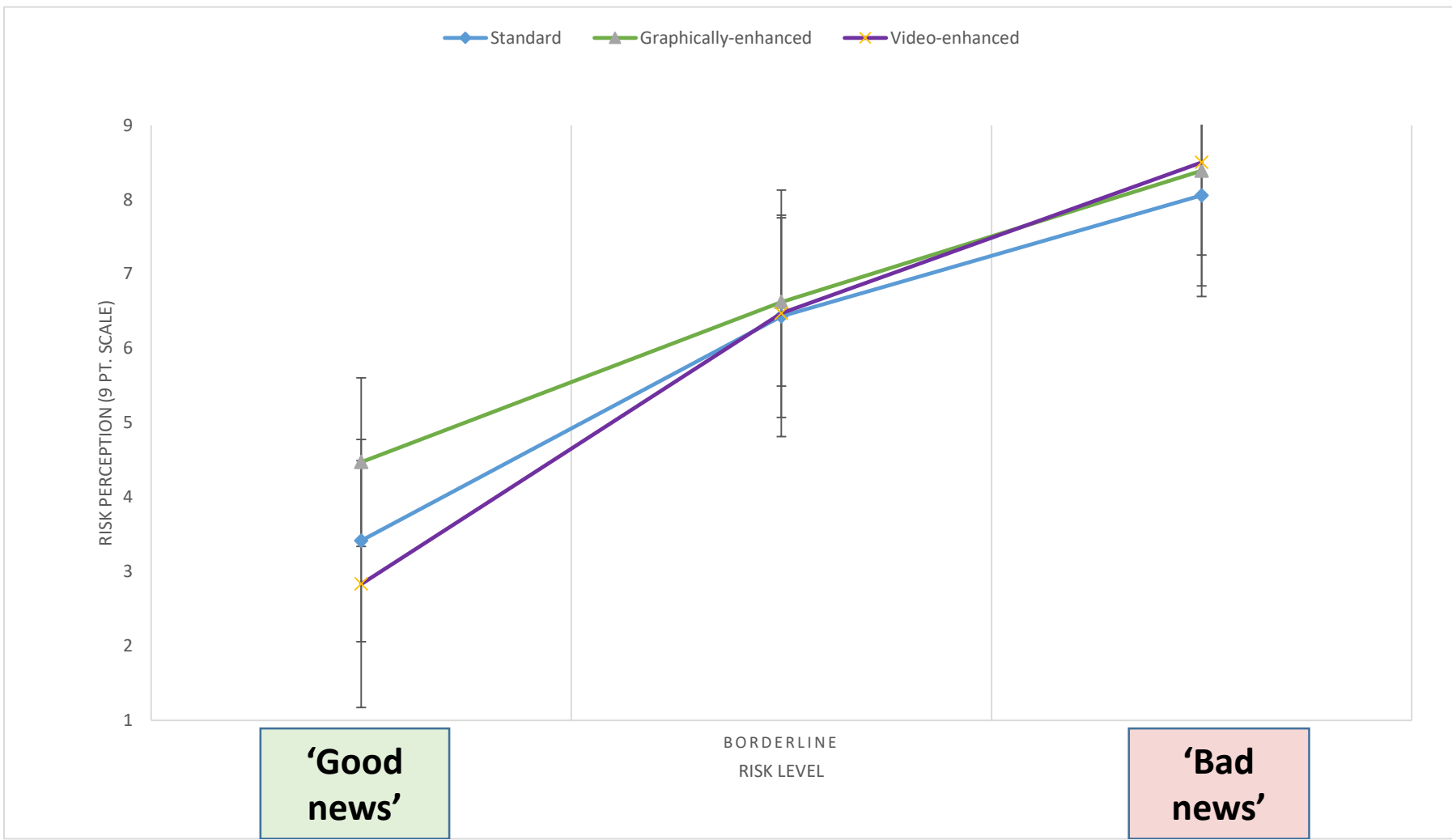


Affective Response

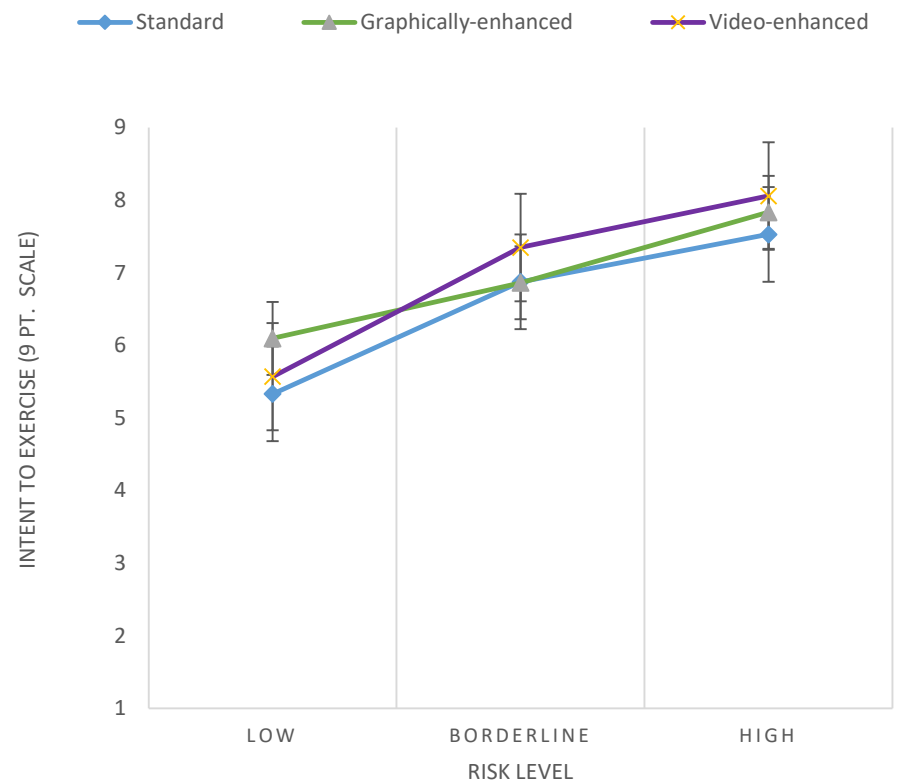




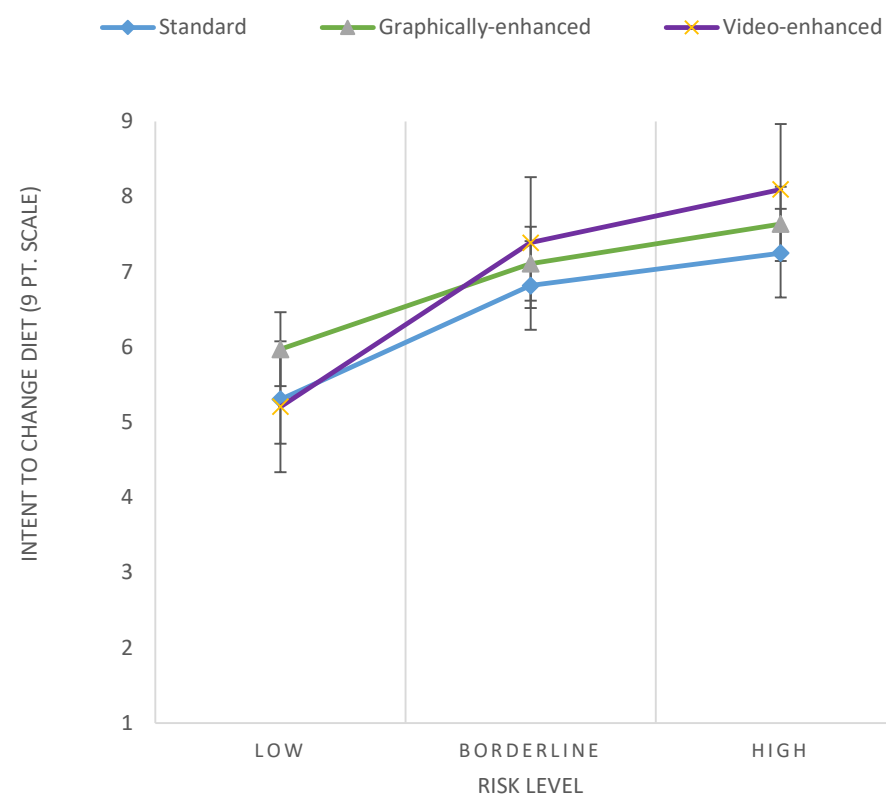
Risk Perception



BEHAVIORAL INTENTION - EXERCISE



BEHAVIORAL INTENTION - DIET

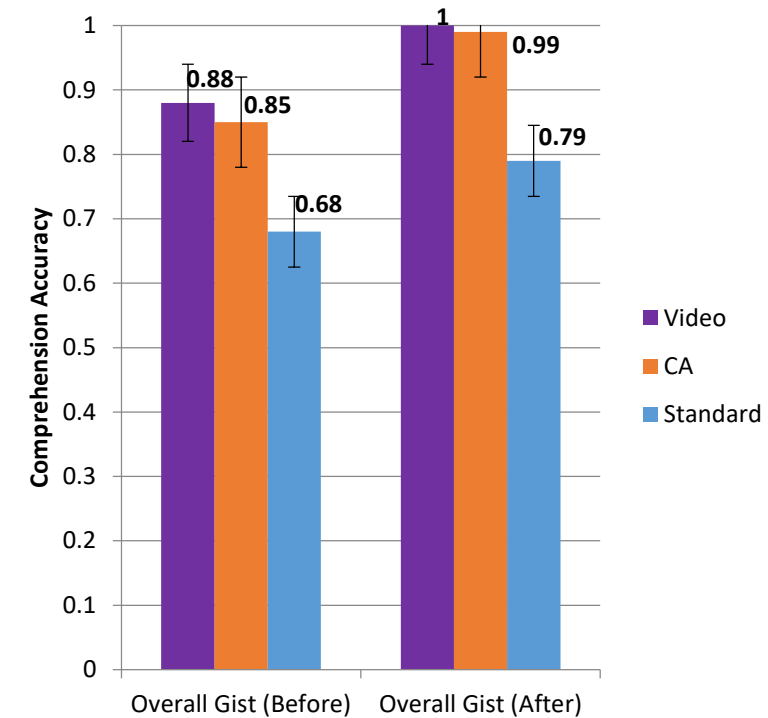
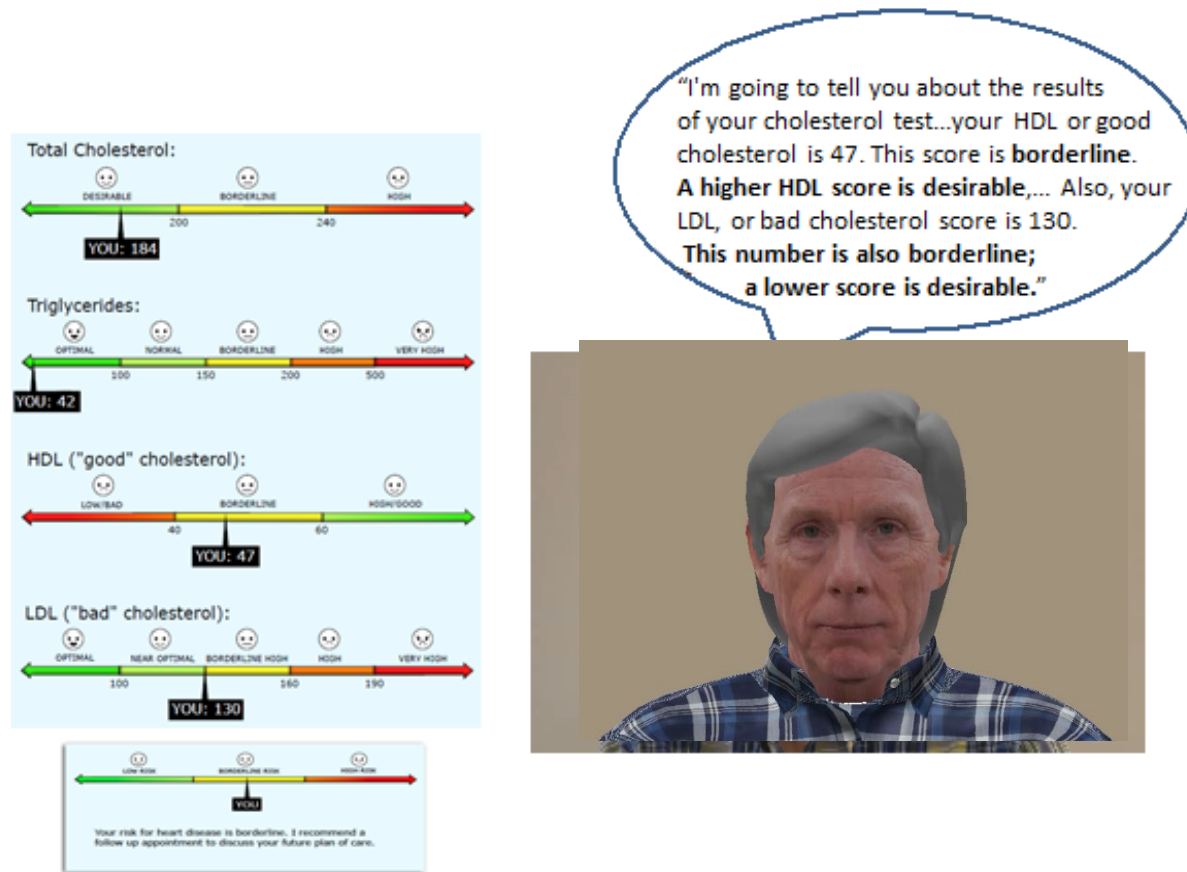


Study 1a Summary

- Video format may be effective for portal communication because it retains some aspects of face-to-face communication that support
 - gist memory for risk
 - affective response to risk
 - risk perception and behavior intentions

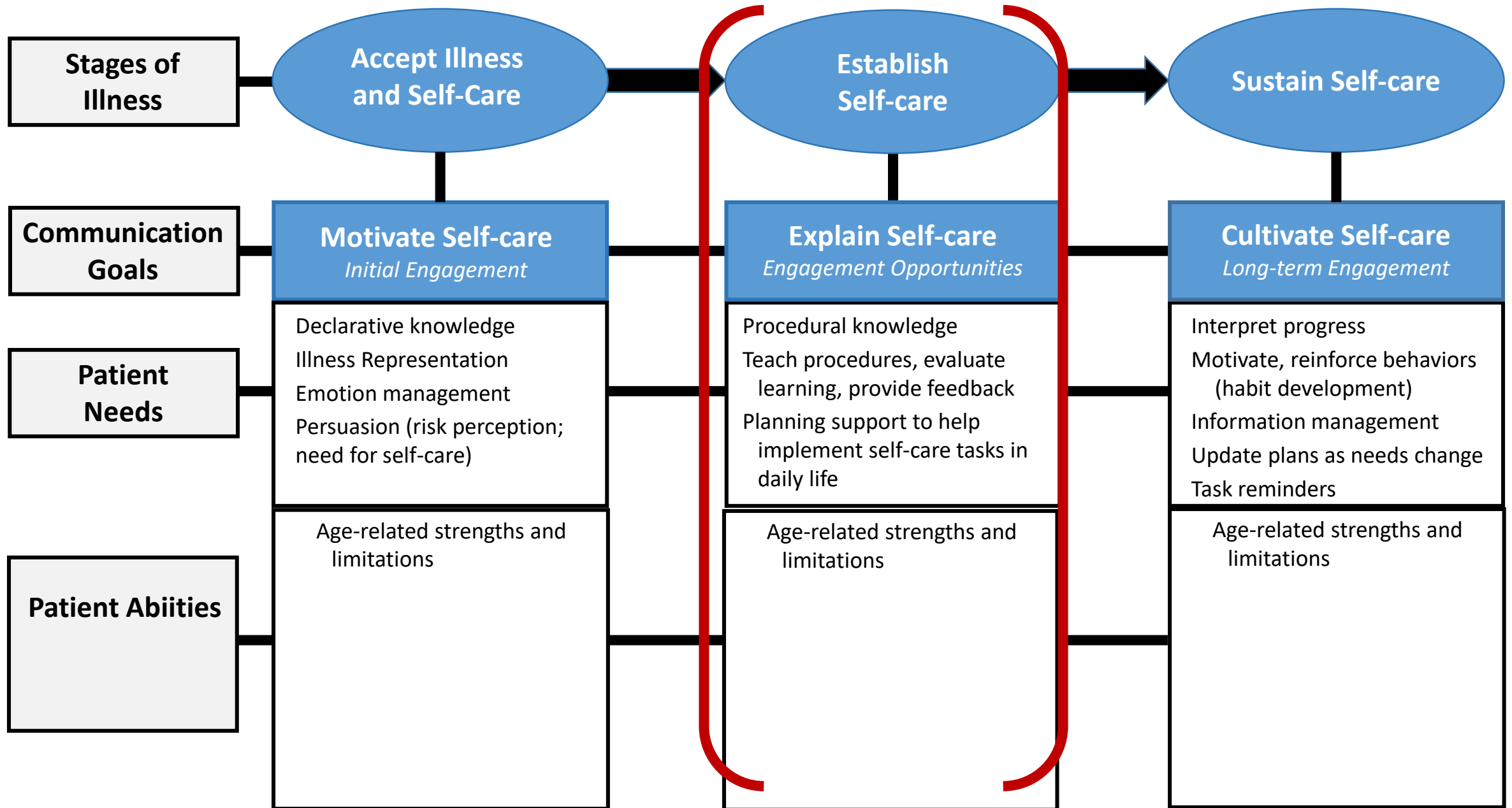
- **But, large-scale implementation of *videos* in portals is not feasible!!!**

Study 1B: 'Virtual physician' in Patient Portal



But there is certainly room for improvement!!!!

Study 2: Can CAs Help Us *Establish* Self-care?



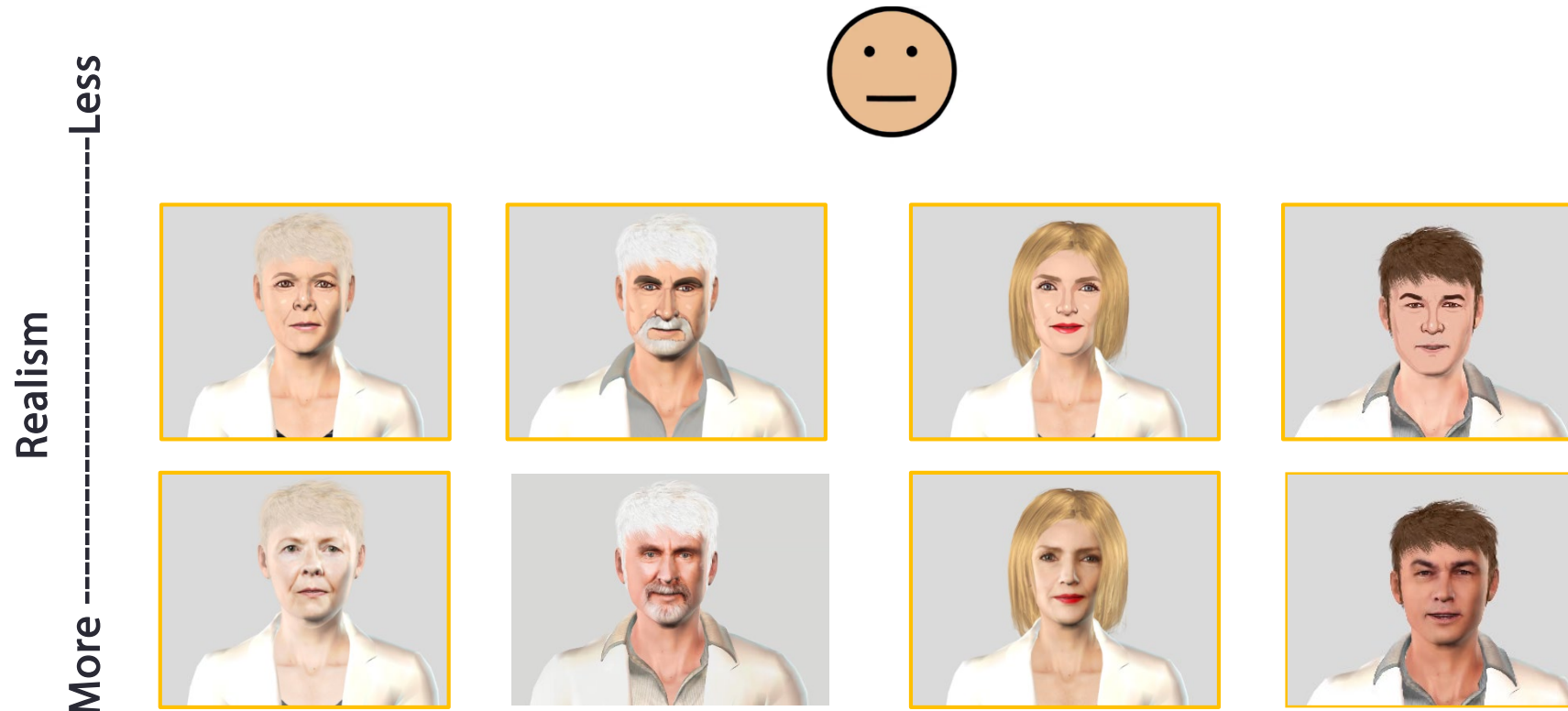
Study 2: Can CAs Help Us *Establish* Self-care?

- Can CAs help older adults establish self-care once the need for self-care is accepted?
 - Communication goals: Explain self-care; help people understand how to take medication or other tasks.
 - Patient needs: Procedural knowledge about tasks; receive instruction and feedback about performing tasks

Azevedo et al (2018) *American Medical Informatics Association*

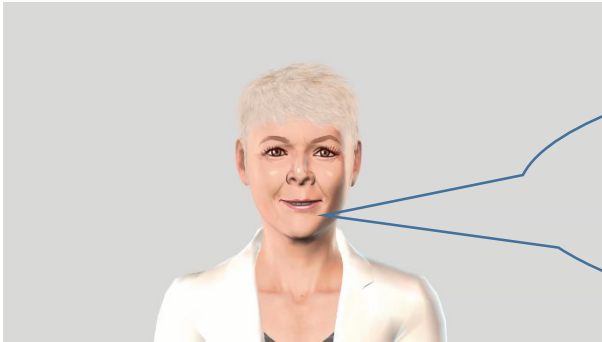
Study 2a: 'Talking head' CAs As Teachers

- Next step toward using CA as 'virtual provider': Compared 'talking head' CAs varying in age, gender, and realism/abstraction in terms of ability to teach about taking medication

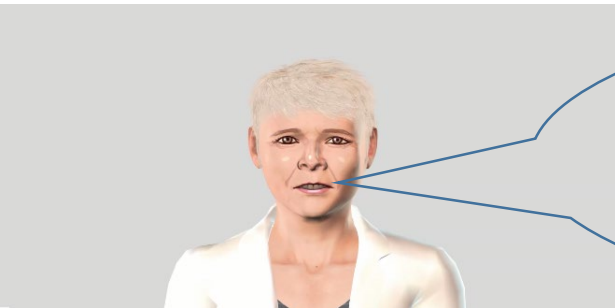


Study 2a: 'Talking head' CA Teachers

- In online study, CAs described medication information (benefits or risks of taking medication) with appropriate nonverbal and verbal delivery (e.g., facial expressions, tone of voice).
 - Memory for the messages and attitudes about the CAs were measured



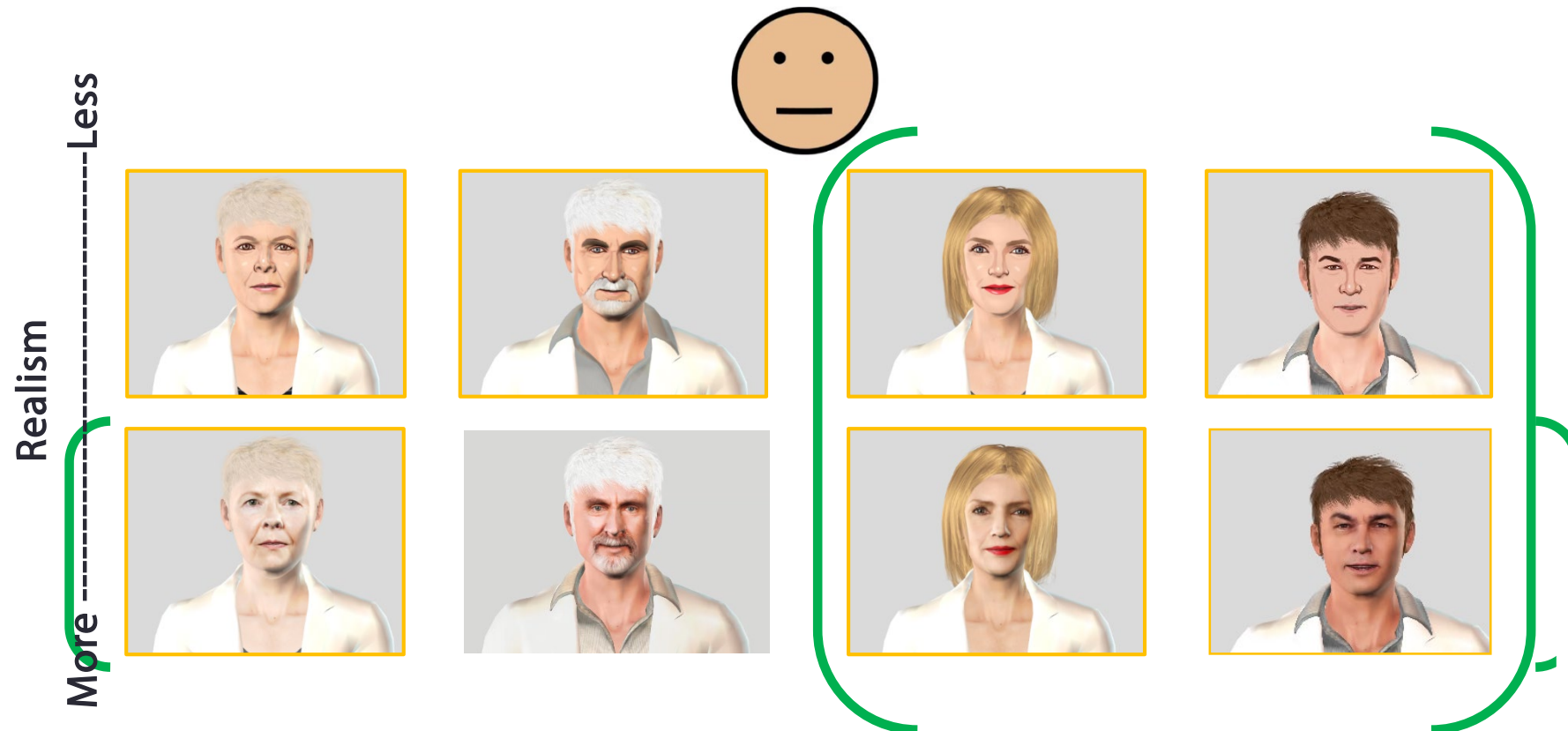
This prescription is for a medicine called **Amiodarone**. If you **take Amiodarone** as directed by your doctor, your **heart rhythm** will be **steady and regular**. You will also have a **heartbeat** that is **strong and steady**. ...
[Gain Frame]



This prescription is for a medicine called **Amiodarone**... If you **don't take Amiodarone** as directed by your doctor, your **heart rhythm** will be **unsteady and irregular**. You will also have a **heartbeat** that is **weak and unsteady**....
[Loss Frame]

Study 2a: 'Talking head' CA Teachers Some Findings

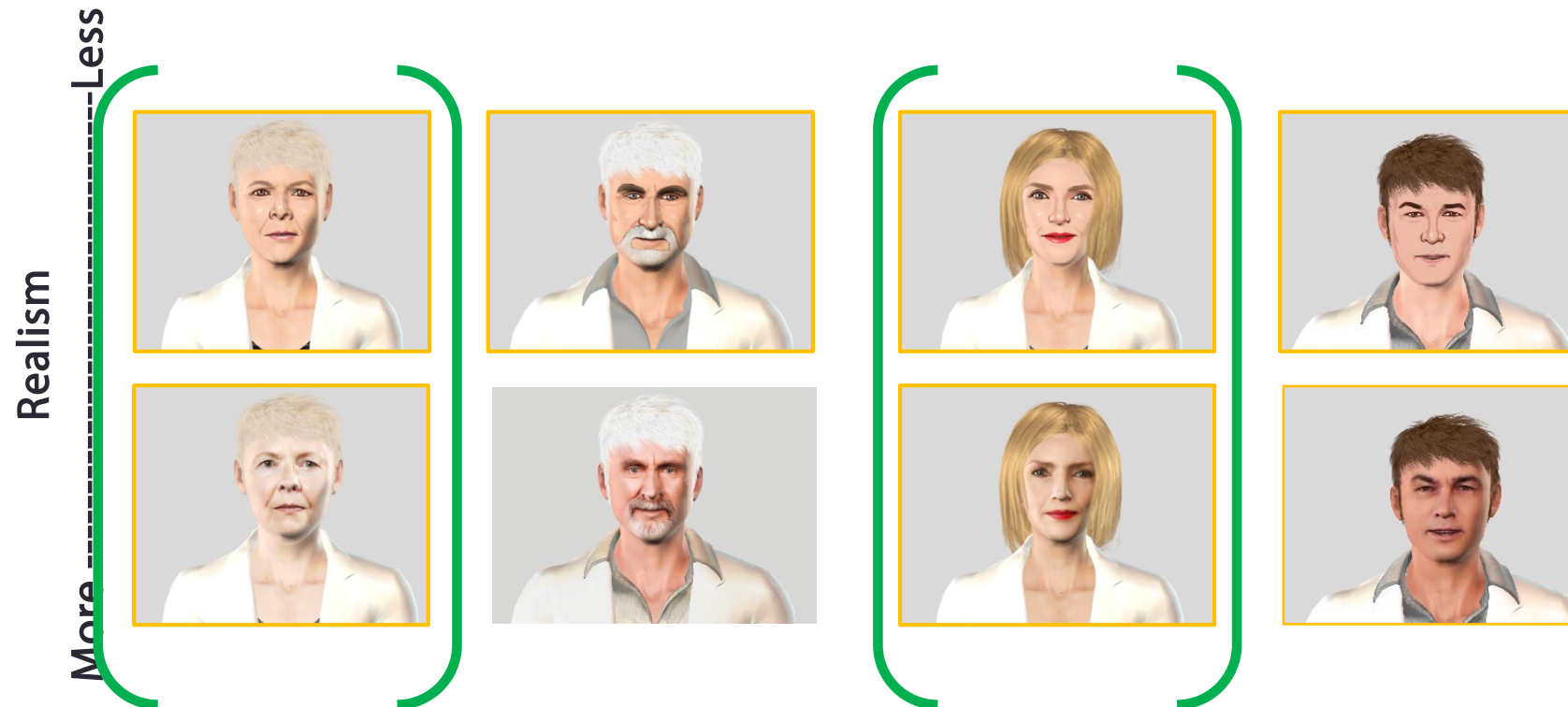
- “The agent lead me to think more deeply about the information”
 - **Younger CA > Older CA**
 - **More realistic > less realistic CA**



Study 2a: 'Talking head' CAs as Teacher

Some Findings

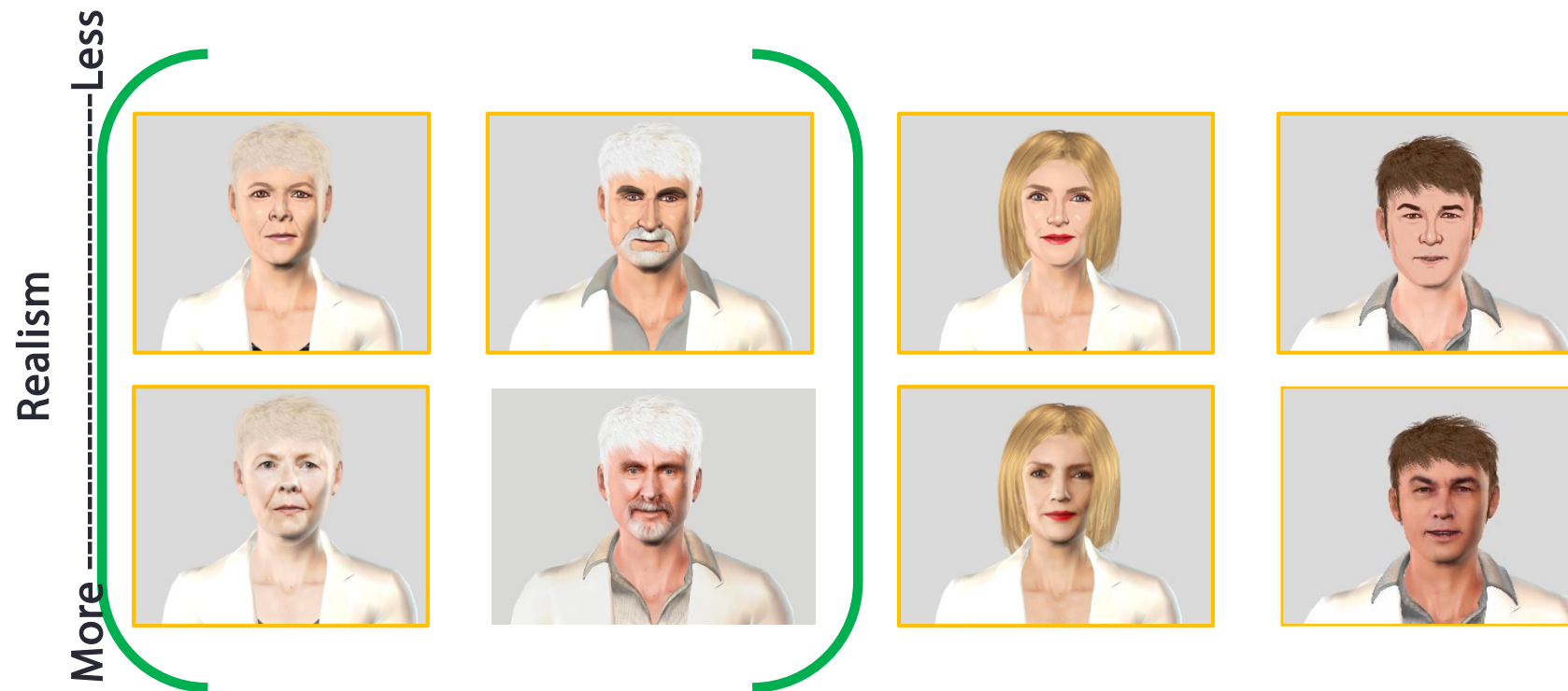
- **General Preference for female CA**



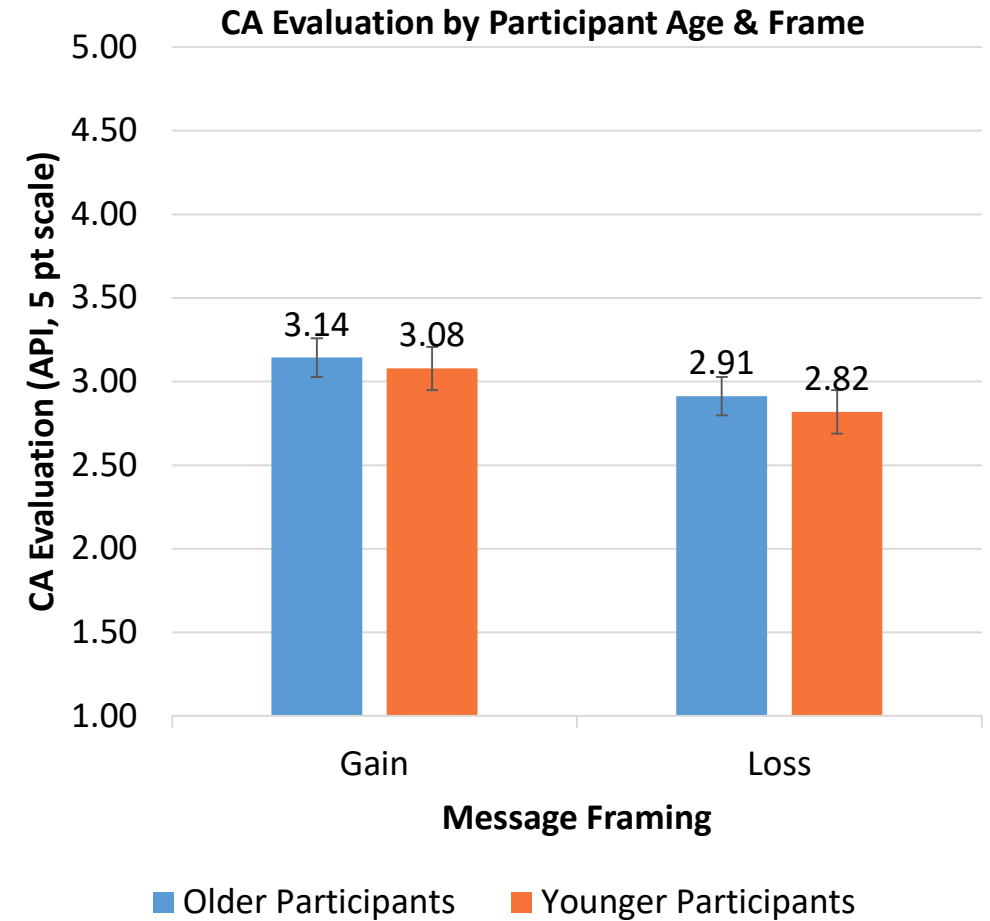
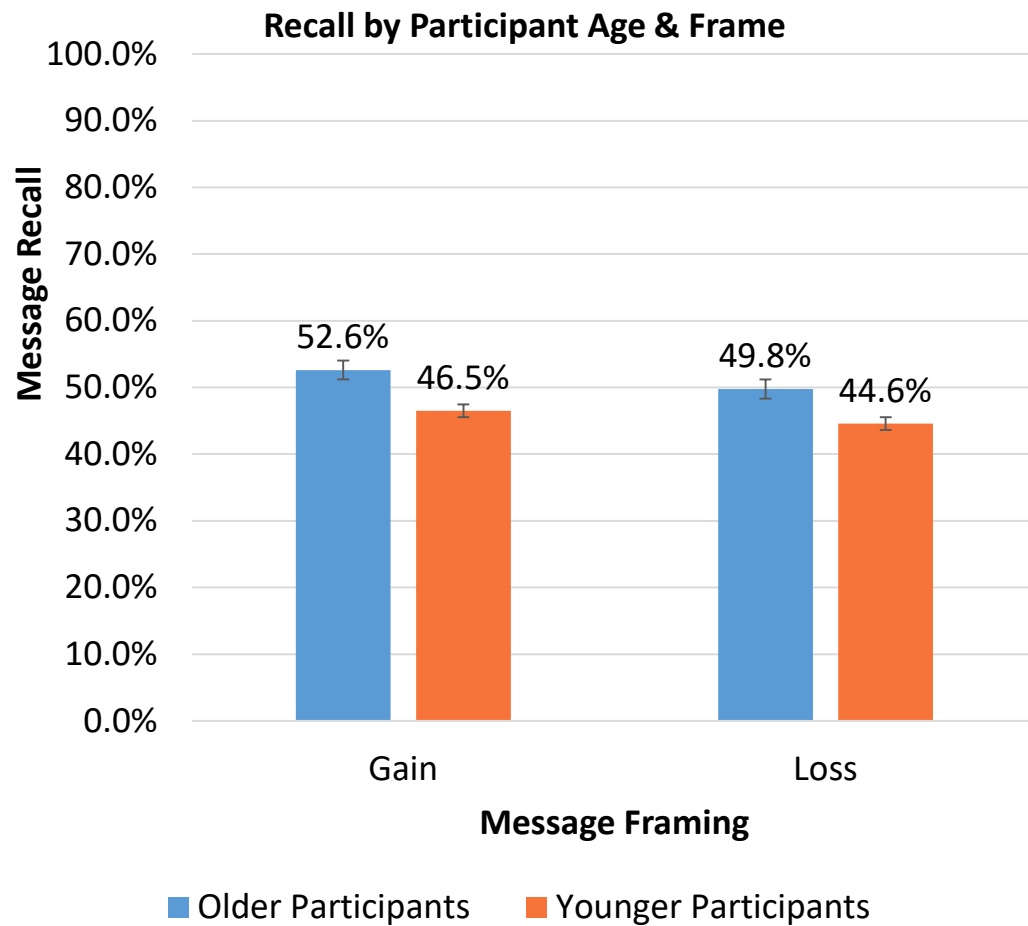
Study 2a: 'Talking head' CAs as Teacher

Some Findings

- **Older adults responded positively to CAs**
 - Better remembered the medication information than younger adults did
 - Rated the older CAs more positively than younger CAs



The Power of Framing Health Messages as Gains



Study 2b: Embodied CAs as Teachers

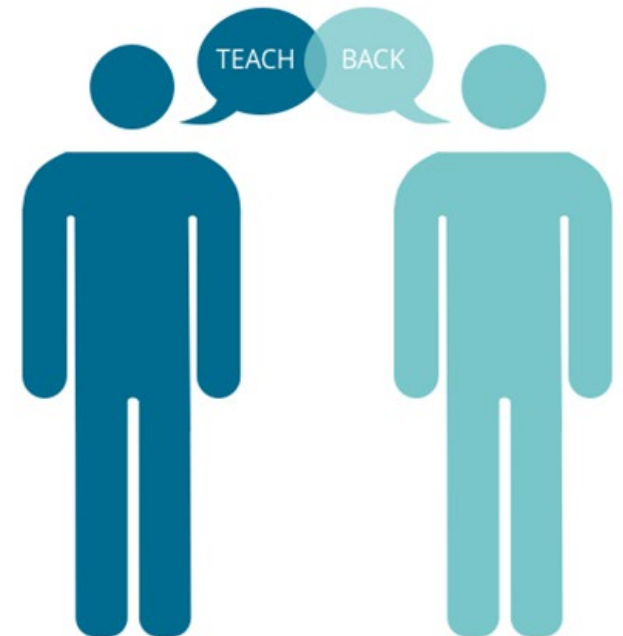
- Embodied, interactive CAs may be more effective teachers than talking heads
 - More likely to engage and motivate learners to do self-care
 - More effectively support learners by providing feedback
- Examined benefits of interaction in the context of using ‘teachback’ technique.



(Morrow et al., 2020, Proceedings of Human Factors & Ergonomics Society).

Teachback and Patient-Centered Communication

- Recommended best practice for educating patients
- Health providers ask questions about key concepts to ensure patients understand them, thus ‘closing the communication loop’ (Schillinger et al. 2003). For example “How many times a day do you take Insulin Lispro?” when providing medication instructions
- Although teachback can improve patient comprehension, it is not routinely used by providers (AHRQ, 2019)



Study 2b: Embodied CAs as Teachers

- Potential of CA for emulating teachback technique when teaching about medication
 - Investigated older adult responses to a prototype CA functioning as ‘virtual provider’ that either used teachback or not when presenting medication instructions.
- Predictions
 - Older adults are open to interacting with virtual provider
 - CA perceived as more useful when interactive (teachback).
 - More effective teacher, but not be more relational, when using teachback (same CA in both conditions)

Study 2b: Embodied CAs as Teachers

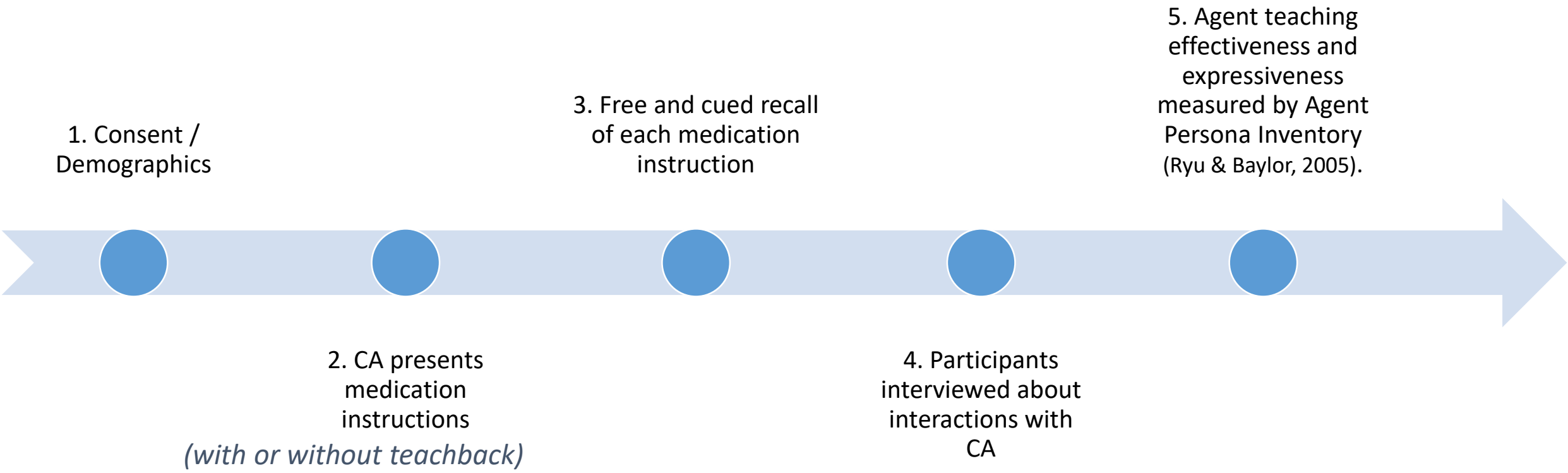
- CA was female because older and younger adults preferred receiving medication instructions from female CAs in Study 2a.
- CA told older adults how to take diabetic medications. In the teachback condition, questions were interleaved with the instructions. In the non-teachback condition, instructions were presented uninterrupted.



CA developed using the Virtual Human Toolkit (<https://vhToolkit.ict.usc.edu/>; Hartholt et al., 2013)

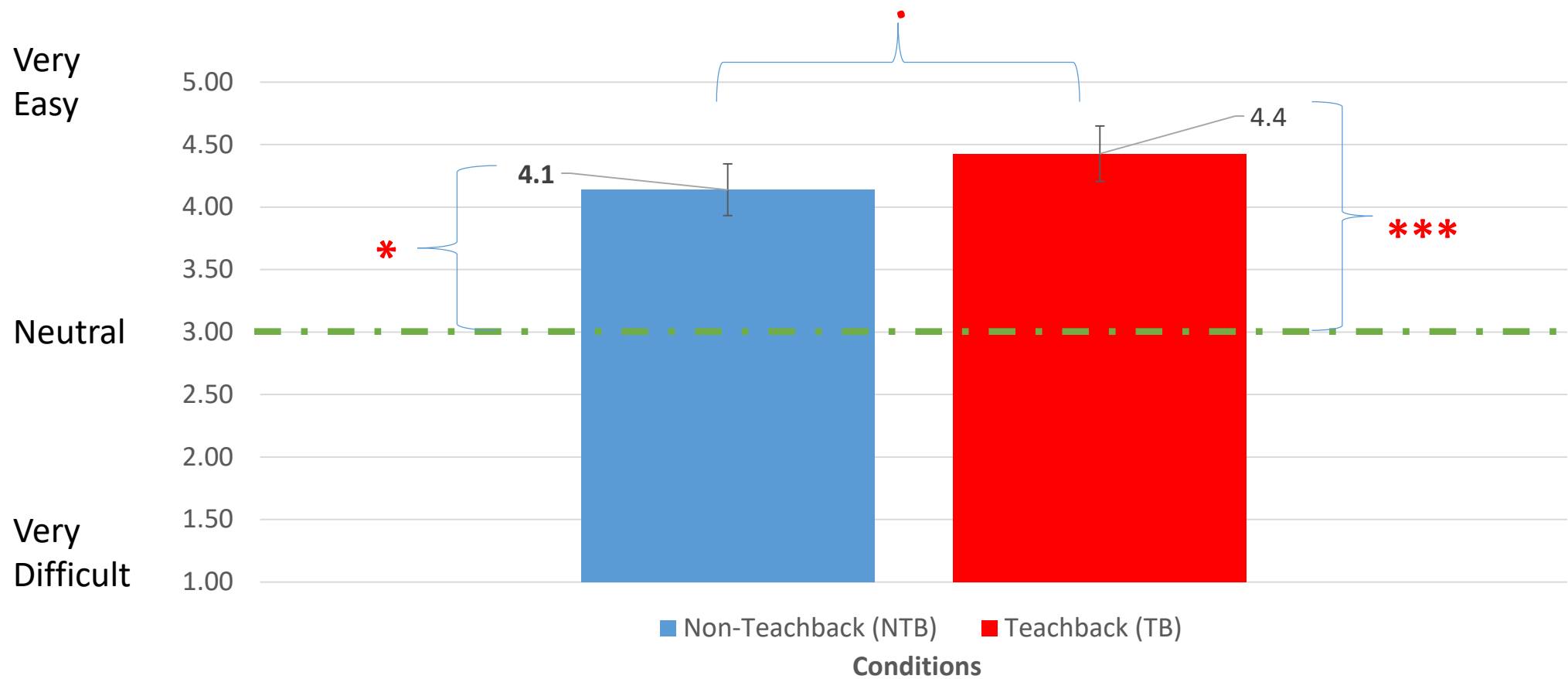


Study Procedure



Results: How easy was it to understand the CA?

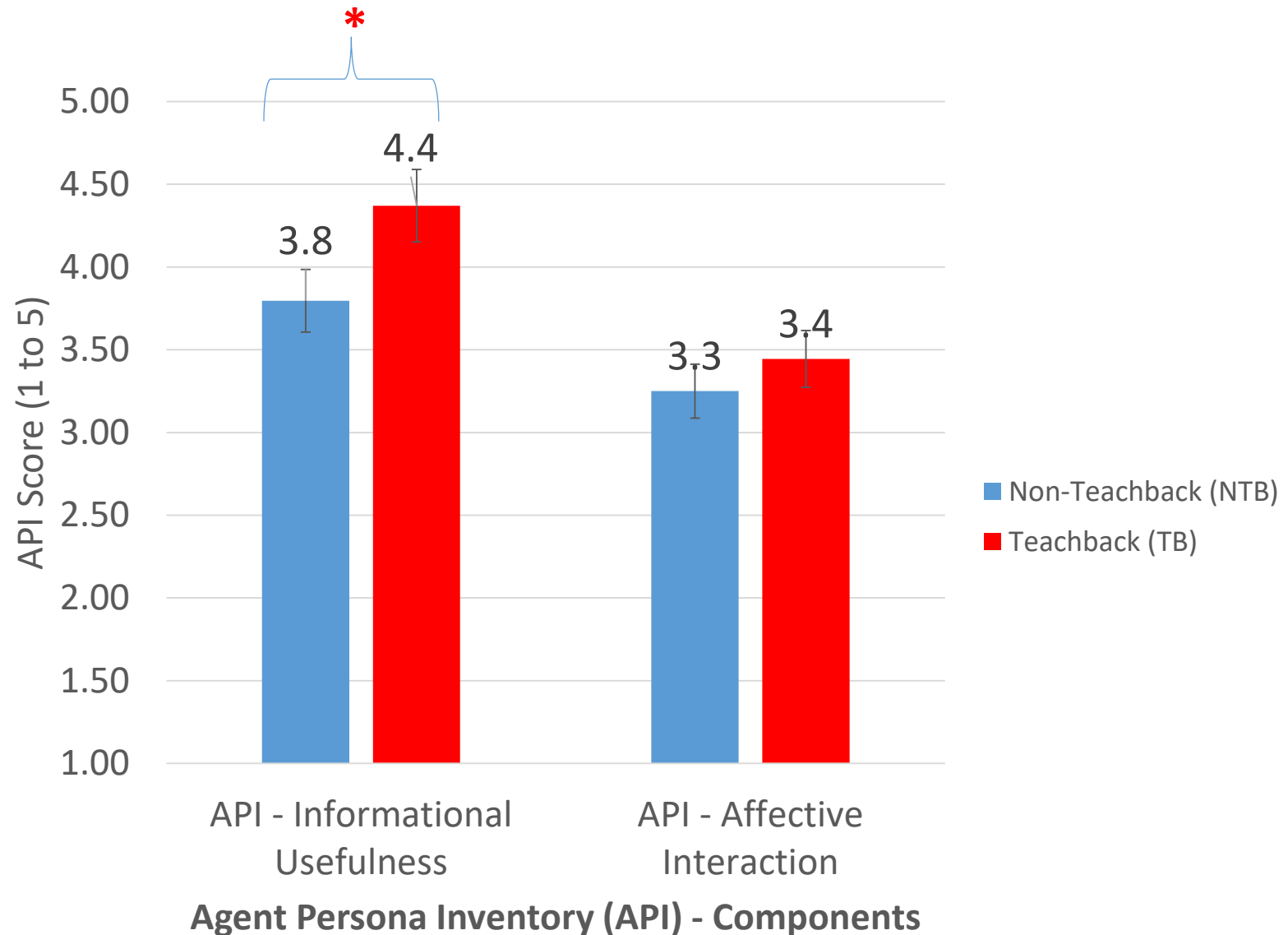
- Older adults thought the CA-presented instructions were easy to understand



Wilcoxon test, *** $p < .001$, * $p < .05$; . $p < .10$

Results: CA Evaluation

- Participants thought the CA was a more effective teacher when CA used teachback.
- Groups did not differ in how they perceived the CA affective/relational properties





Results: Interview Questions

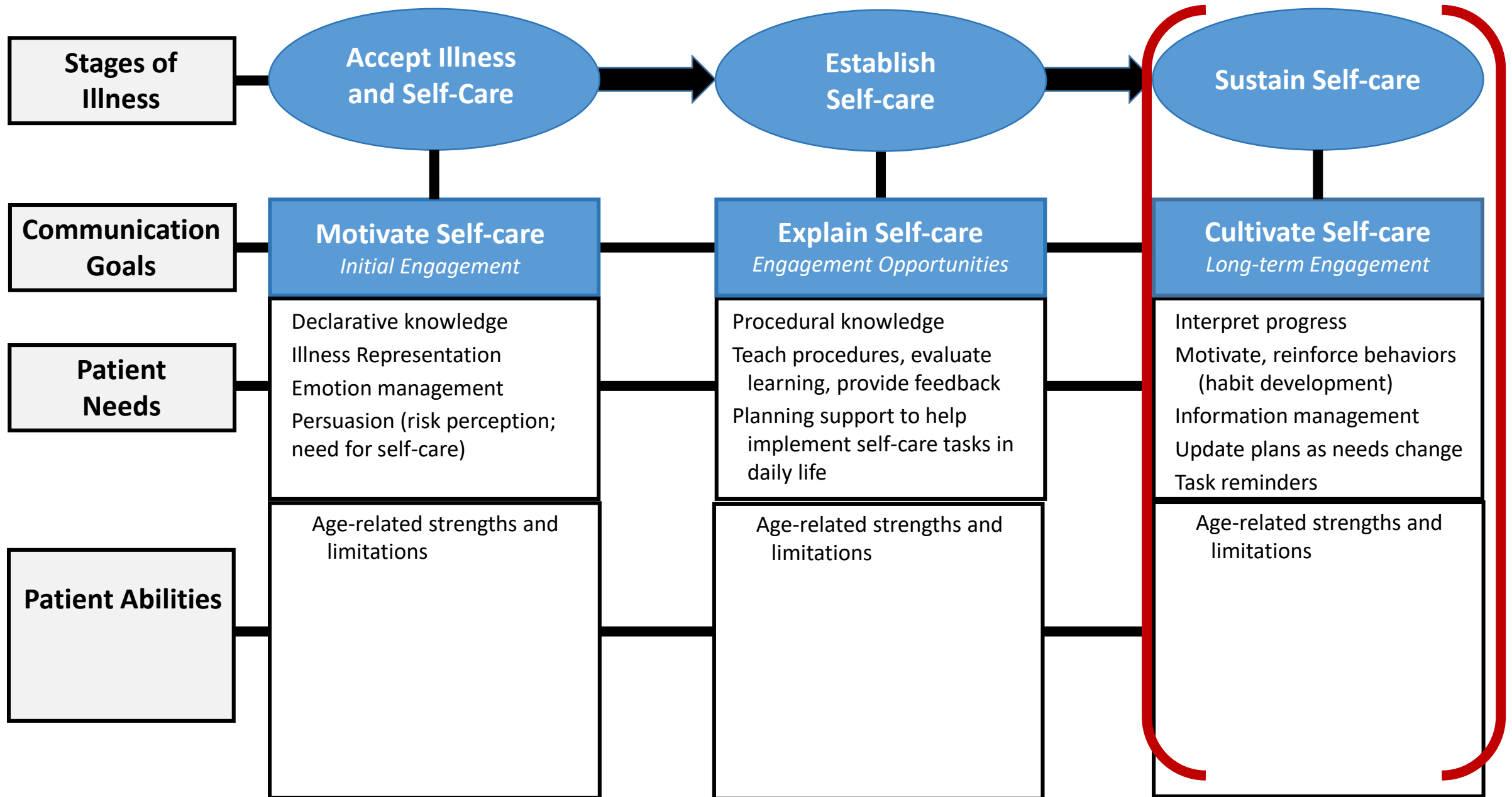
- Answers to the interview questions were coded, drawing on existing taxonomies in the literature
- Each comment was coded for negative and positive valence related to the CA
- Comments about the CA were overall more positive in the teachback group, with a trend for more negative comments in the non-teachback group ($p = 0.02$)
- These comments suggested participants thought the CA using teachback helped them learn and remember the medication instructions, in part by reducing cognitive load and reinforcing key concepts.



Study 2 Summary

- Older adults are open to interacting with CAs, suggesting self-care can be supported by CA technology. Participants in both groups felt the CA was generally personable and useful, although they thought its appearance and behavior could be improved.
- Most important, older adults thought teachback was helpful and the CA was a better teacher when using this interactive strategy, as found for patients interacting with human providers (Samuels-Kalow et al., 2016).
- Thus, CAs may provide an important resource for reinforcing and augmenting provider communication about self-care and other topics, which should promote continuity of care.

CAs and Sustaining Self-care



CAs and Sustaining Self-care

- CAs may be especially helpful for sustaining self-care in daily life, probably the most challenging part of self-care.
 - Communication goals: Cultivate self-care by maintaining motivation, reminding us to do self-care, providing feedback about progress toward goals, and updating learning as self-care needs change.
- CA potential for sustaining self-care is little investigated, but work by Bickmore and colleagues suggests it is challenging to maintain engagement with CAs over time, even when CAs are easy to access and use variable language.
- Ubiquity of smart speakers suggest voice only more effective than embodied CA for sustaining self-care?



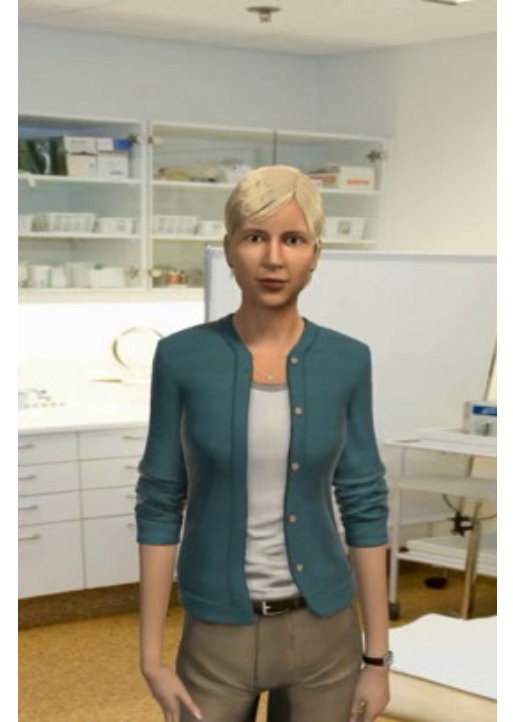
CAs in the Time of COVID-19?

- Can CAs help us navigate the challenges of daily life during the pandemic?
- COVID-19 interactive counselor to help people understand and accept the risks of the C-19, and establish safe behaviors
 1. User describes a risky situation (e.g., shopping, work, social engagements).
 2. CA asks follow up questions about the situation (inside/outside, number participants and their spacing & activities, do participants comply with recommended strategies such as social distancing and masking)
 3. Based on user answers and access to current scientific evaluation of risk, counselor provides feedback about risk level associated with the situation and suggests strategies.



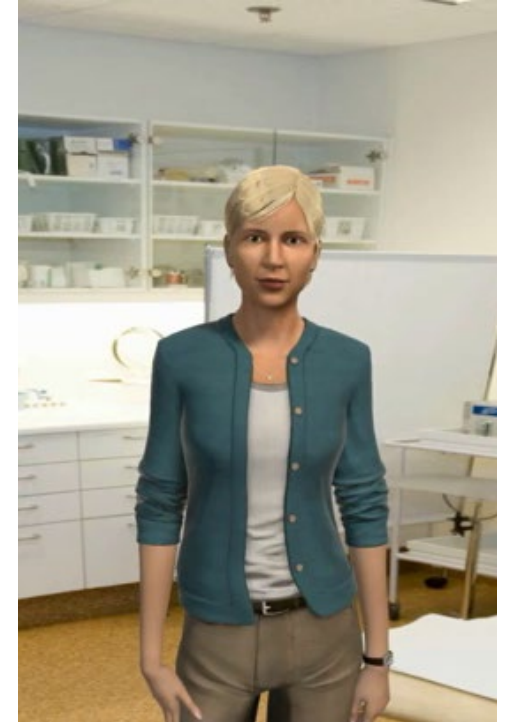
Wrap-up

- Learning for health is an lifelong enterprise
- This learning often takes place in health care systems
- We often prefer to learn about our health in conversation with our providers, who have limited time for this critical responsibility.
- Technology has the potential support our learning by augmenting provider education, but often not designed with our needs and abilities in mind.



Wrap-up

- Conversational agents have the potential to combine benefits of face-to-face communication (engagement, support for gist learning) and technology (ready access to large amounts of information as needed) to support learning for health.
- First steps in investigating this potential for helping us accept the need for self-care, establishing self-care by learning key tasks, and sustaining self-care over time.
 - Talking head CA → embodied CA → interactive CA



We are Grateful for Support from:



National Institutes
of Health

National Institutes of Health

National Institute on Aging

National Institute of Nursing Research



Agency for Healthcare Research and Quality (**AHRQ**)



Jump Applied Research for Community Health through Engineering and Simulation (**ARCHES**) program, UIUC/OSF Hospital, Peoria IL.



Technology Innovation in Educational Research & Design, UI College of Education

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Science & Technology



Questions?