Research Highlights & Advances in Physical Activity Promotion and Health

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Right Care, Stanford, February 2020

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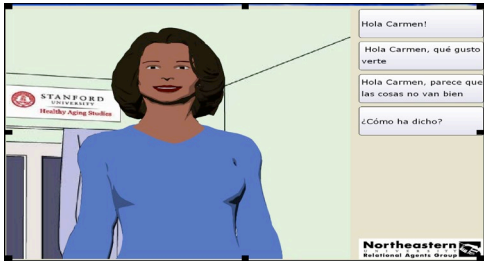
HARTS Lab: Our passions include . . .

- **Healthy Aging**
(maintaining independence, function, quality of life)

- **Borderless Health Promotion**
(customized *digital health* solutions regardless of education, language, locale)

- **Policy-engaged Citizen Science**
(residents document barriers to healthy living & activate environmental/policy level action)

- **Reducing Health Disparities worldwide**
(reaching underserved populations through innovative communication channels)



‘It Takes a (global) Village’ – Collaborating Organizations

U.S. Collaborators: (selected)

- Stanford University
- Arizona State U.
- City of Seattle, Human Services Dept. (Brent Butler)
- Cornell
- East San Jose, CA PEACE Partnership
- GirlTrek, USA
- LeadingAge, USA
- Place Labs, San Francisco, CA
- San Francisco State U., CA
- TransForm/Green Trip
- U Alaska, Anchorage
- U California, Irvine
- San Mateo Co. CA Public Health Dept.
- Santa Clara Co. CA Public Health Dept.
- Somos Mayfair
- Solano Co. CA Public Health Dept.
- Tulane U. School of Public Health
- Washington University at St. Louis, MO
- Youth Leadership Institute

International Collaborators: (selected)

- Aukland Univ of Tech, New Zealand
- FA Univ of Erlangen-Nuremberg, Germany
- Federal U. of Santa Maria, Brazil
- Glasgow Caledonian U, Scotland
- Hanze University of Applied Sciences, Netherlands
- Instituto Nacional de Salud Pública, Mexico
- ITRI-Taiwan; Kaohsiung Medical U., Taiwan
- JDC Israel Eshel • University of Haifa, Israel
- Mälardalen University, Västerås, Sweden
- Public Health Foundation of India
- Univ. de los Andes, Bogotá, Colombia
- Univ. of Birmingham, UK
- Univ. of Cape Town, S. Africa
- Universidad de la Frontera, Chile
- Univ. of Kwa-Zulu-Natal, S. Africa
- Univ. of Manitoba, Canada
- Université Nice Sophia Antipolis, France
- Univ. of Queensland, Australia

Funding: Robert Wood Johnson Foundation, NIH National Cancer Institute, Nutrilite Health Institute Wellness Fund, Stanford Discovery Innovation Fund, SHC grant, ITRI Taiwan, Silicon Valley Community Foundation, University of Queensland, Australia

Presentation Objectives

- Present highlights from ***2018 US Federal Physical Activity Guidelines for Health***
- Discuss some current trends in ***information & communication technologies*** *(ICT)* of particular promise for increasing physical activity
- Highlight some ***future directions*** in the field

Today, an **extensive evidence base** of **health benefits** related to moderate-to-vigorous physical activity (MVPA), *including--*

US 2018 Physical Activity Guidelines Advisory Committee Scientific Report
(portions published in King, Powell, Kraus, et al., *Med & Science in Sports & Exercise,* 2019)

For Children, include**:**

- Improved weight status & bone health (3-17 yrs.)
- Improved muscular fitness (6-17 yrs.)

For Adults of all ages, include**:**

- In addition to **CVD & type 2 diabetes prevention**, lower incidence of 8 cancers (breast, colon, bladder, endometrium, esophagus, kidney, stomach, & lung cancers)
- Reduced risk of excessive weight gain
- Prevents regain of wt. following initial wt. loss *with sufficient MVPA amount*
- Has additive effect on wt. loss when combined with mod. dietary restriction

US 2018 Physical Activity Guidelines Advisory Committee Scientific Report—

Strong Evidence that Regular MVPA:

- ***reduces blood pressure*** among adults with normal blood pressure & prehypertension
- helps to ***prevent people with normal blood pressure*** from becoming hypertensive
- ***reduces risk of dementia*** & improves other aspects of cognitive function
- For older adults, ***reduces risk of falls and fall-related injuries***
- *Improves physical function* ***in people with (& without) frailty, Parkinson's disease***

US 2018 Physical Activity Guidelines Advisory Committee Scientific Report—

Latest Evidence for People with **Type 2 Diabetes**

- Strong evidence shows that more PA is associated with ***reduced risk of cardiovascular mortality***

- Strong evidence shows that more PA is associated with ***lower risk of diabetes progression*** (assessed by hemoglobin A1C, BP, BMI, lipids)

  - True for aerobic activity, muscle-strengthening activity, or combination

Latest evidence of health benefits related to moderate-to-vigorous physical activity, ***for Other Medical Conditions***

(US 2018 Physical Activity Guidelines Advisory Committee Scientific Report)

For Individuals *with Pre-Existing Medical Conditions*:

- Breast cancer: Reduced risk of all-cause & breast cancer mortality
- Colorectal cancer: Reduced risk of all-cause & colorectal cancer mortality
- Prostate cancer: Reduced risk of prostate cancer mortality
- Osteoarthritis: Decreased pain; improved function & quality of life
- Hypertension: Reduced progression of CVD & BP increases over time
- Type 2 diabetes: Reduced CVD mortality risk; reduced progression of disease indicators (e.g., hemoglobin A1c, BP, blood lipids, BMI)
- Multiple sclerosis: Improved walking; improved physical fitness
- Dementia & other conditions with impaired cognition: Improved cognition (e.g., ADHD, schizophrenia, Parkinson's disease, stroke, multiple sclerosis)

Latest evidence of health benefits related to moderate-to-vigorous physical activity (MVPA), continued

(US 2018 Physical Activity Guidelines Advisory Committee Scientific Report)

For Women who are Pregnant or Postpartum:

- Reduced risk of excessive weight gain during pregnancy
- Reduced risk of gestational diabetes [with no risk to fetus from MVPA]
- Reduced risk of postpartum depression

PA Benefits can be achieved *in a* ***variety of ways***

- A ***single bout*** (episode) of MVPA can reduce anxiety symptoms & blood pressure and can improve sleep, insulin sensitivity, & cognition <u>on that day</u>
- Substantial health benefits can occur for many people even if the weekly MVPA target of 150-300 mins is not reached; ***small increases matter!***
- For people who perform little to no MVPA, replacing sedentary activities with ***light-intensity PA*** reduces all-cause mortality, type 2 diabetes risk
- Physical activity of ***any duration*** counts (not just those lasting 10+ mins.)
- The ***more steps per day*** the better

Latest evidence of health impacts related to **Sedentary Behavior**

(waking behaviors involving ≤ 1.5 METS of energy while in sitting, reclining, or lying postures)

US 2018 Physical Activity Guidelines Advisory Committee Scientific Report (and *MSSE,* 2019)

- Strong evidence that high amounts of SED behavior (>8 hrs./day sitting) increase risk for *all-cause and CVD mortality, & incident CVD and type 2 diabetes*
- Moderate evidence that SED behavior is associated with *incident colon, endometrial, & lung cancer*
- Strong evidence that hazardous effects of sedentary behavior **more pronounced** in physically inactive people
- For Youth: Consistent support for multi-component **school-based SED interventions** targeting reductions in TV viewing & screen time

(but currently unclear whether reductions are sufficiently large to produce health effects)

*So, with all this Evidence of Benefits, why are **~80%** of American adults & teens insufficiently active?*

Piercy K, Troiano R, Ballard RM, et al., 2018, *JAMA*

It's time to think differently about

"MOTIVATION"

TRAIT view:

- Due to personal abilities, ***in-born*** characteristics (e.g., "willpower")
- **Result:**
  - interventions focused on individual only
  - blamed if no change
  - Relieves others of responsibility

More Useful view:

- Due to ***complex*** set of factors
  - e.g., **personal *and* environmental/contextual factors**
- **Result:**
  - Multi-factorial interventions
  - Empowerment
  - Shared responsibility

For instance,

Local Built Environments & Walkability matter!

"High Walkable":

Higher density, with connected streets & mixed land use

"Lower Walkable":
Not dense, unconnected streets, & residential only

*Although older adults & some other groups may prefer this for recreational walking & biking

Commercial smartphone data (Azumio's Argus app) also confirm that

Daily Physical Activity Differences across U.S. cities are related to **how Walkable a Location Is**

For example: **Walkability** is associated with smartphone-based differences in ***Daily Steps*** **& patterns in U.S.**

(69 U.S. cities with at least 200 Argus app users)

- **Higher Walkability score** associated with more daily steps *across Age, Sex, & BMI groups* (R^2 = 0.61)

- Compared ***Top 10 Walkable US cities with Bottom 10 Walkable cities*** and found:

  - Differences between higher & lower walkable cities = **~2,000+ step difference/day** (~ a mile, for average person)

  - Walkability associations sig. larger for **Women** (across age groups)

"Walkability": "Walk Score" (from 1-100) from https://www.walkscore.com/cities/

Althoff, Sosic, Hicks, King, Delp, Leskovec, *Nature, 2017*

#2: *Social Environments Matter!*

e.g., The ***Power of Peers*** **to Promote PA**

- Extensive history of using ***trained, in-person volunteers*** to advise & support others in increasing their PA

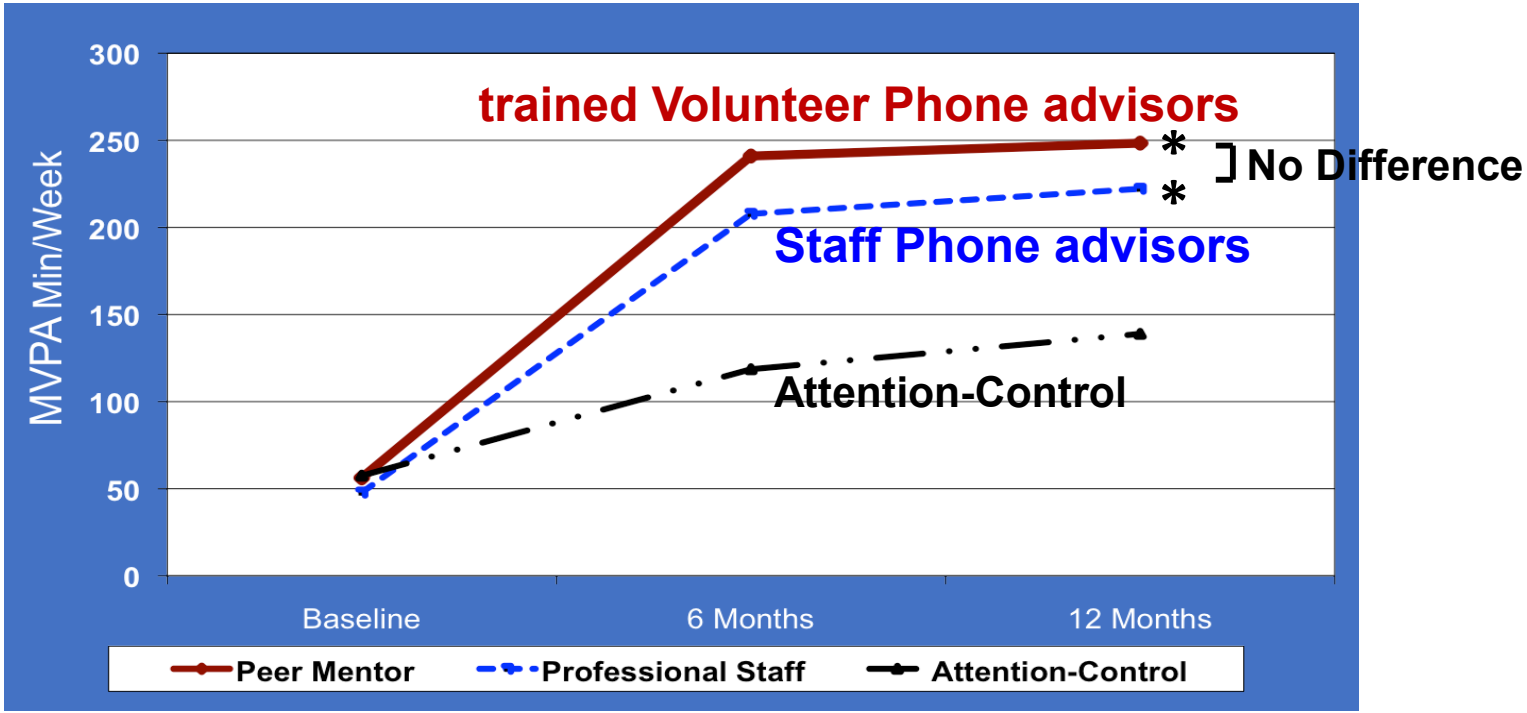
e.g., trained **Latino peer mentors** successfully increased 12-month walking levels in inactive older Latino adults by *average of* ***~130*** *mins/week over initial baseline levels*

[COMPASS2 Trial; NIH R01HL11644802]

*Peer Advising also can Occur by **PHONE**: Team Trial*

Moderate-Vigorous Physical Activity

(CHAMPS questionnaire; n= 180 inactive midlife & older adults)

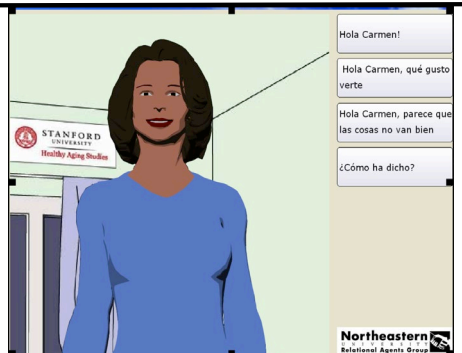


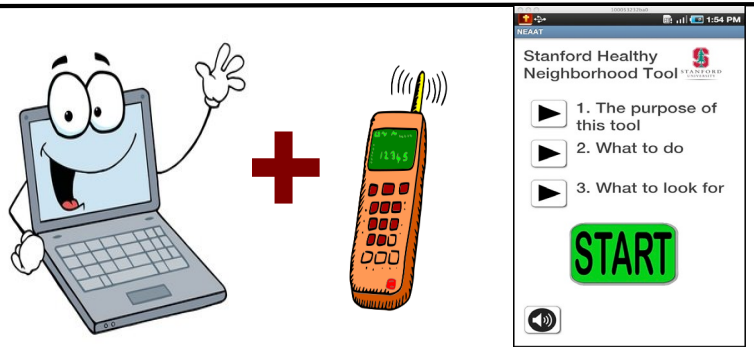
*Volunteer & Professional Staff > Attention Control, p <.05

Castro, King, et al., *Health Psychol,* 2011

#3: **Communication Environments** matter!

- Involve leveraging a wide array of **information & communication technologies** (ICT) in **languages** & at **literacy levels** appropriate for different populations





ICT Domains include:

- **Me**

- **We**

"ME" domain

In addition to quantification & assessment,

- **Personalized "IT Advisors" for *health promotion*** (intervention)

Effective Communication Channels for Physical Activity Promotion (based on current literature)

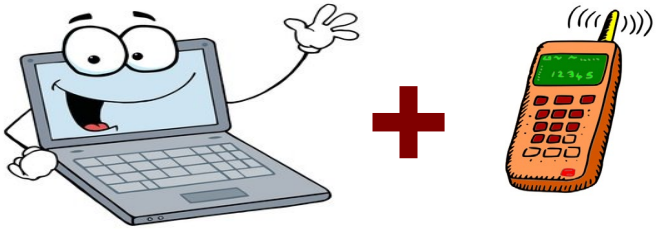
US 2018 Physical Activity Guidelines Advisory Committee Scientific Report (King et al., MSSE, 2019)

- Phone-based Advising
- Web-based or Internet-delivered interventions
- Computer-tailored Print
- Wearable Activity Monitors (with goal-setting & other behavioral strategies)
- Smartphone Apps for children & teens, and
- Texting programs for Adults

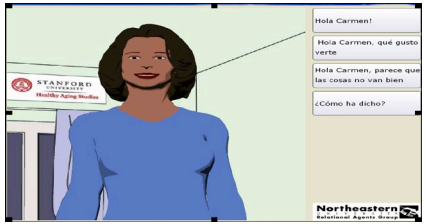
Individually-Adapted IT Interventions:

EXAMPLES

- ***Tele-health***



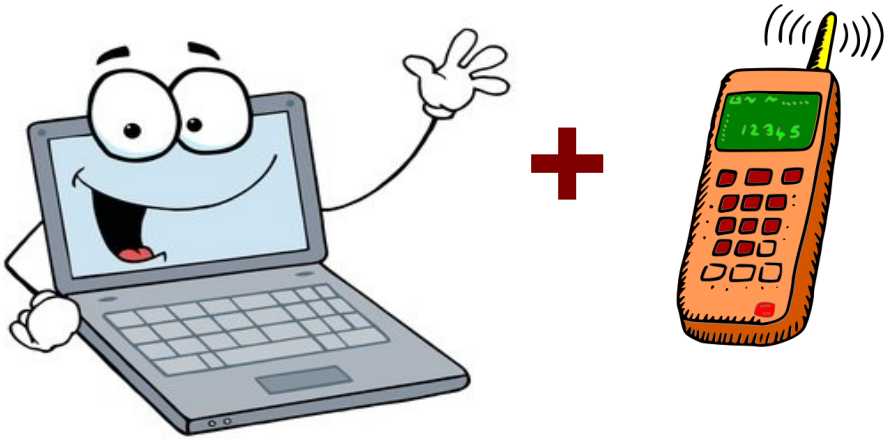
- ***'Virtual' Advisors***



- ***Smartphone App platforms***

Tele-Health by Computer

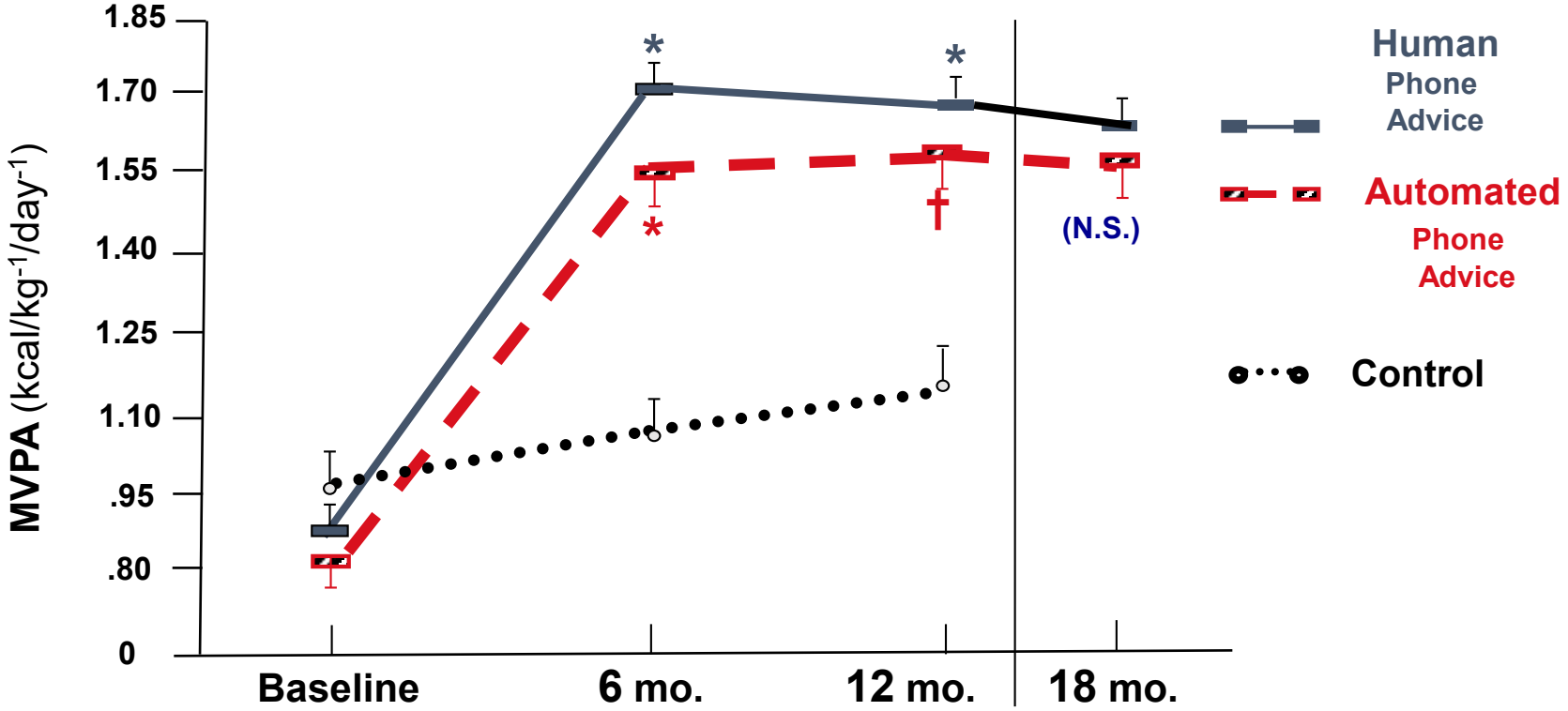
Can ***Automated systems*** replace Human instructors in promoting regular physical activity?



(think phone-based pharmacy or clinic reminders)

(CHAT Trial)

Estimated Energy Expenditure in MVPA (7-day PAR)



*Intervention > control, $p \leq .01$; †Intervention > control, $p = .05$

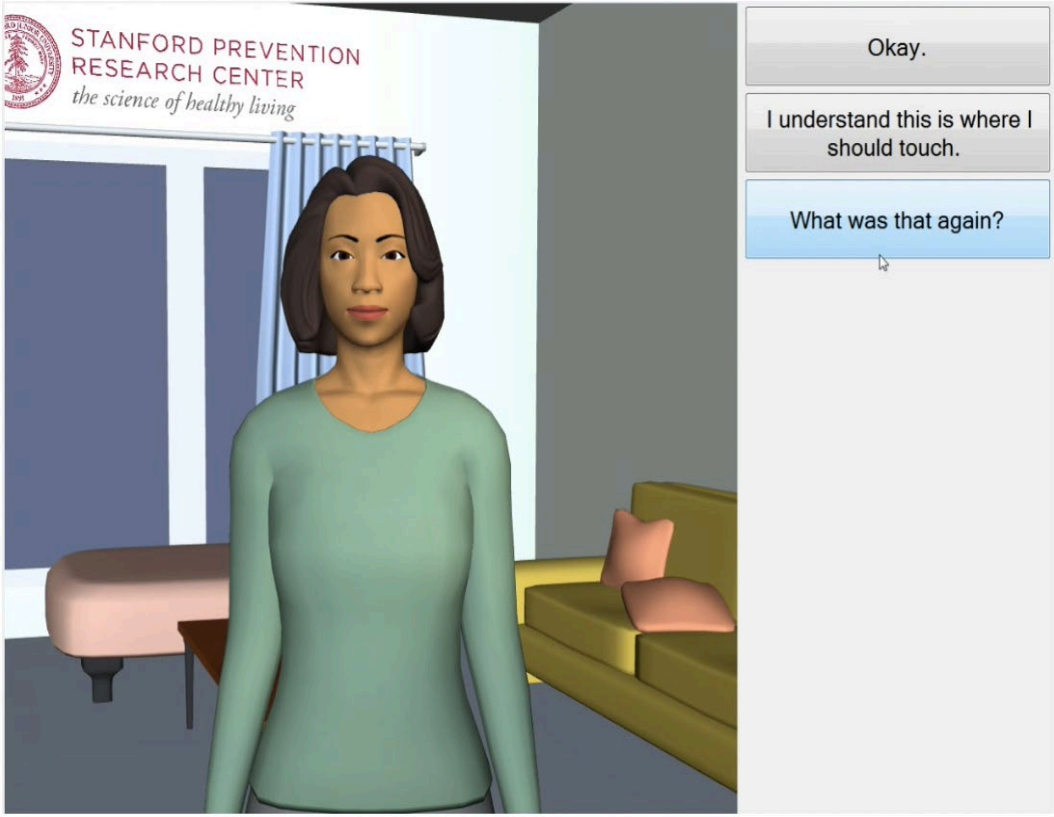
King AC et al., *Health Psychol, 2007;* 218 inactive adults 55 yrs+

Another side to Personalized Technology:
Preventing Widening of *Health Disparities Gap*
("digital divide")

- Language issues
- Reading levels
- Computer access/skills/comfort levels
- & Health literacy
- ***'Virtual Advisors'***
  – Provide *tailored interactions* via both simple **verbal & nonverbal communication**

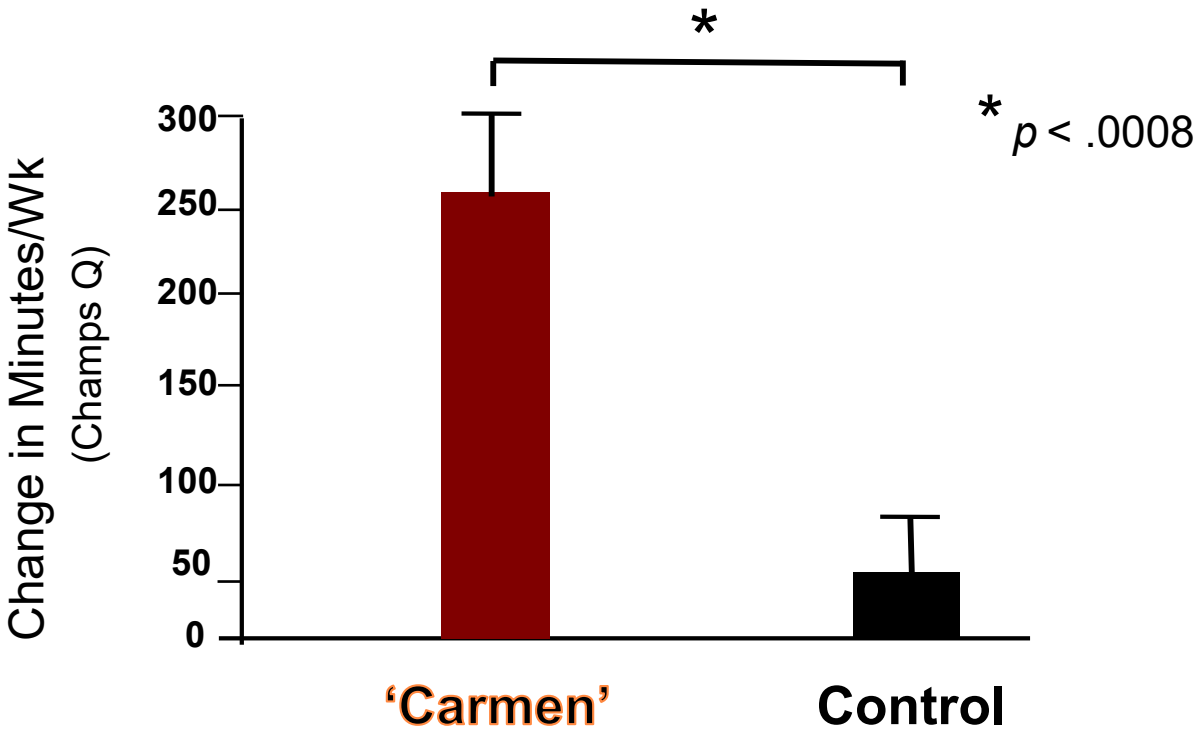
Virtual Advisors: Meet **Carmen** (with Northeastern Univ.; embodied conversational agent)

She speaks English & Spanish, using a simple touch-screen interface only



4-month Change in Minutes of Walking/Week

(N = 40; low-income Latino Older Adults with low computer literacy)



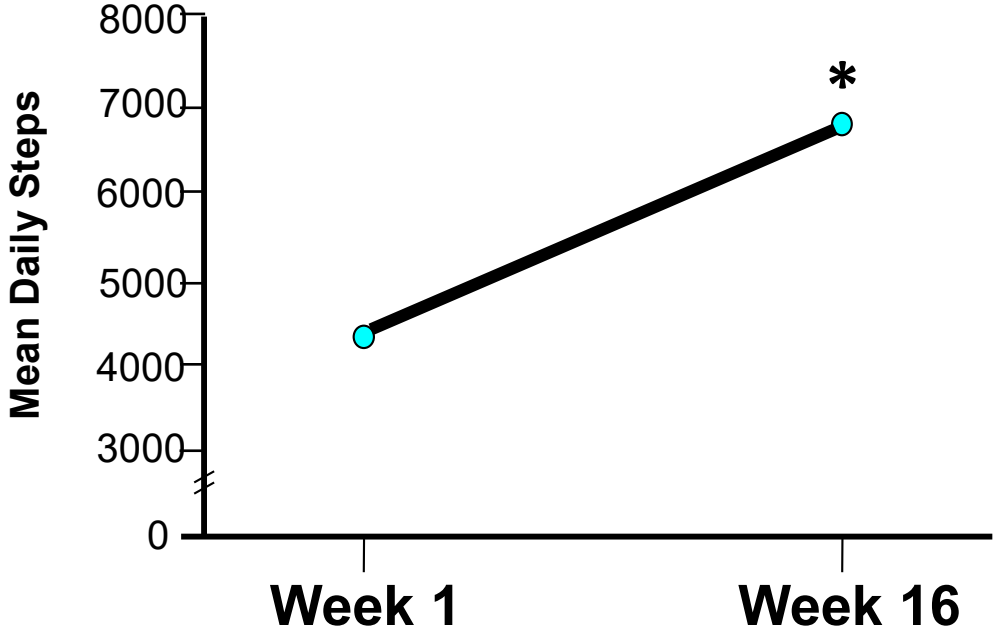
King, Bickmore et al., *J Health Communication,* 2013

COMPASS1 Study

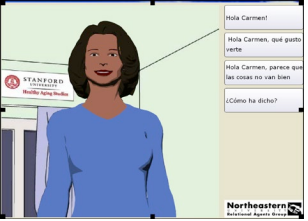
4-month Change in Daily Steps

(Omron Pedometer)

Intervention Participants (n = 20)



* Slope analysis: p = .002, King et al., 2013



At 4-month Post-test, ***Intervention participants indicated that . . .***

- 'Carmen' *cared* about them (mean rating = 6.2 out of 7)
- *Felt close* to 'Carmen' (mean= 6 out of 7)
- *Trusted* 'Carmen' (mean= 6 out of 7)
- Were interested in *continuing to work with* 'Carmen'

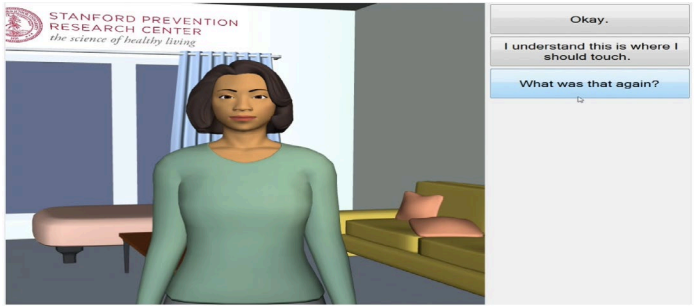
(& did so **over next 5 months** after research ended)

(from Working Alliance Inventory)

King, Bickmore et al., *J Health Communication,* 2013

Next Step: Virtual vs. Human Advisor 'Challenge'

- Recently tested 1-yr effectiveness of **Carmen vs. trained peer advisors** in inactive, Latino aging adults (delivered in community centers in low-income neighborhoods using cluster-randomized design) [NIH R01HL11644802]



vs.

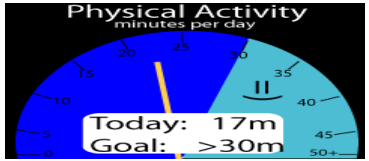
<u>Results</u>: *Similarly effective in promoting recommended levels of* ***weekly walking;*** *Similar benefits for* ***12-month weight loss*** *(~5 lbs), and lowered* ***resting blood pressure*** *levels*

Smartphone applications –

Increasingly popular & ubiquitous channel

- Have paradigm-shifting capabilities: can provide ***just-in-time feedback*** for behavior change

- But few apps employ <u>other</u> theoretically- or empirically-based strategies to systematically enhance motivation & behavior over time



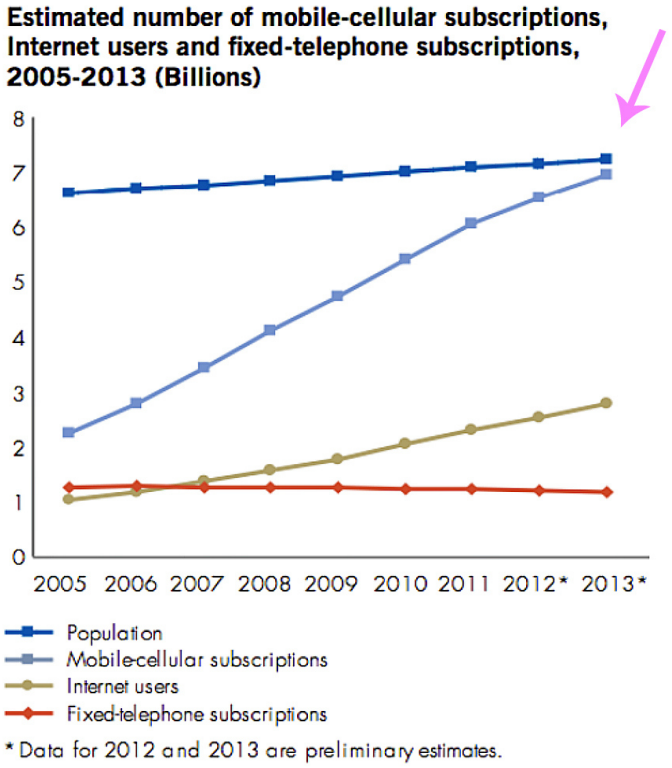
King AC, Hekler EB, Grieco LA, et al. PloS One. 2013; 8, e62613

An array of evidence-based Behavioral Strategies that work ***across Communication Channels***

- Realistic **outcome expectations** (benefits to expect)
- **Reinforcement** schedules, types of rewards
- Increased **awareness** (mindfulness); positive mindsets
- Exploring personal **benefits & costs**
- Personal **goal-setting**
- **Self-monitoring**
- Regular **feedback**
- **Social & other environmental supports**

EXPLOSION of Mobile phones around the world

- About as many mobile phone subscriptions as *people* in the world
- **Smartphones** now the *dominant* mobile device
- In developed countries, **69%** of adults own *smartphones*
- and **46%** in developing economies & rapidly growing
- Many spend >3 hrs./day on them



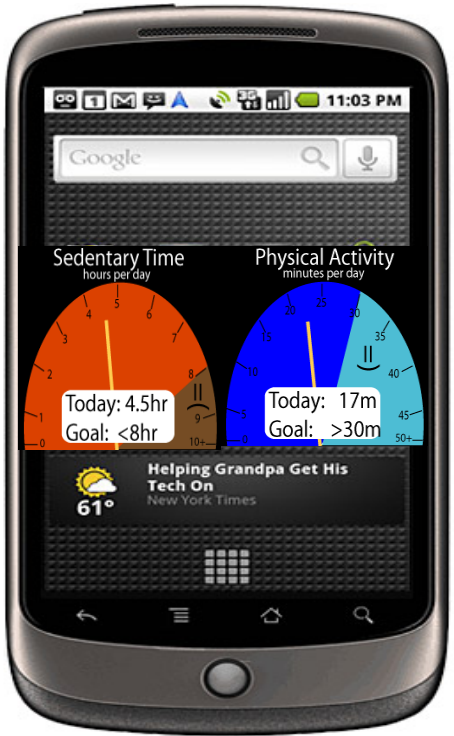
United Nations Millennium Develop. Goals Report, 2013; Ericsson Mobility Report, 2017

Smartphone Apps for *walking more & sitting less*

(using different motivational frames)

King, Hekler, Grieco, Winter, Buman, et al., *PLoS ONE,* 2013; 2016

Analytic

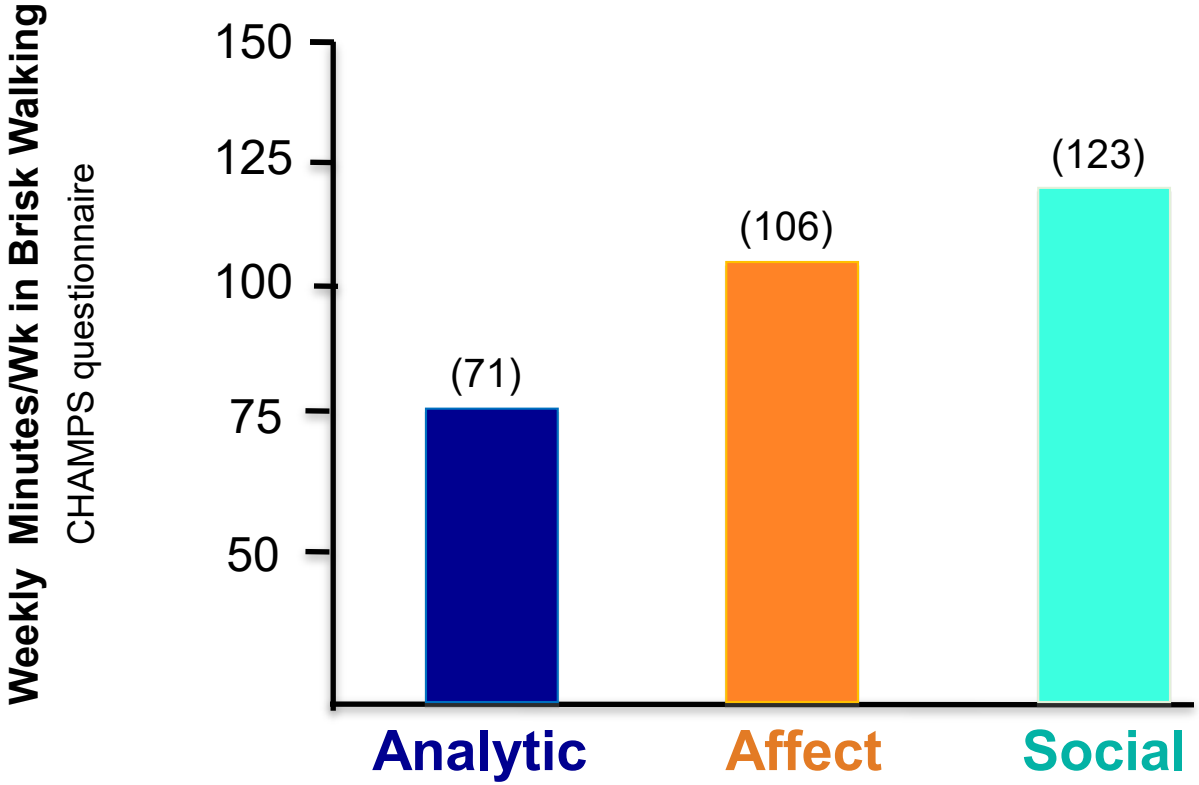


Affect/Play

Social

MILES pilot – ***Increase in Daily Walking* (2 months)**

(n = 68 adults ≥ 45 yrs, inactive, 1st contact with Smartphones)



King, Hekler, Grieco, et al., *PLOS One,* 2013

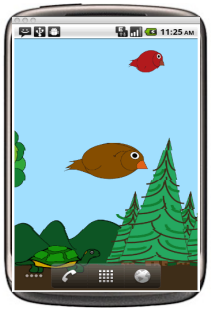
MILES apps: When tested in an Experiment

(2 months; with Calorific control app; N=95 inactive adults ages 45+)

Using smartphone's ***built-in accelerometer:***

- **MVPA: Social** app did best (p<.05)
  - Other 2 apps = More variability in R; ***(which app for whom?)***

- **Sedentary time: Social** app= lower accel-derived daily sedentary time, &
  - **Social & Affect** apps decreased daily reported **sitting time** relative to Control & Analytic apps (p values<.05)



King, Hekler et al., PLoS One, 2016

What does the Future hold?

Technology that informs/motivates but *"gets out of the way"* of **Active/Healthy Living**

Experiencing the World through a *Screen*

Going up a level:

"WE" domain

- Empowering patients & residents as ***'Citizen scientists'*** to assess & *advocate* for healthier neighborhoods & communities

What is **"Citizen Science"**?

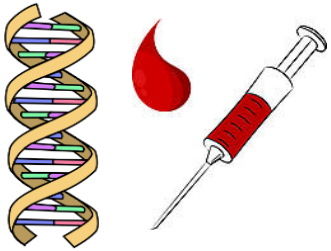
- A centuries old American tradition of engagement

(e.g., Thomas Jefferson recruited volunteer weather observers in 6 states)

Today, at least 3 general types:

***For* the people:**

- Donation of biological specimens, information



***With* the people:**

- Active data collection

  (natural or built environments)

***By* the people:**

- Participate in setting objectives;
- Collect & help interpret data;
- Solution building

An Example: *The "**OUR VOICE**" Citizen Science Research Initiative*

Empowers residents to assess & advocate for healthier neighborhoods & communities (with local decision-makers)

***Facilitators** of this process can be researchers, community & clinical organizations, govt. groups, or local opinion leaders or residents themselves*

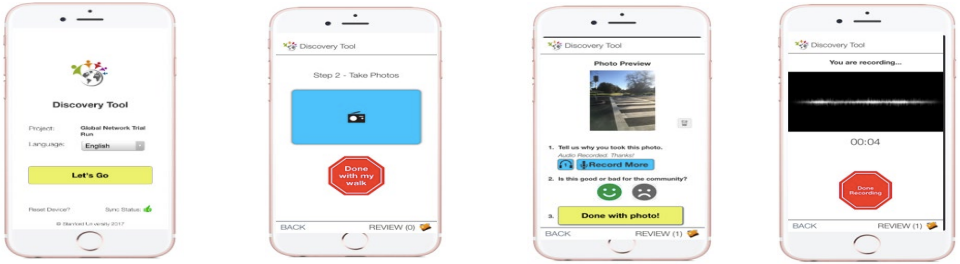
Buman et al. *Translat Behav Med*, 2012; *AJPM,* 2013; Winter et al., *Translat Behav Med,* 2014; King et al., *TJACSM,* 2016; Goldman et al., *J Urban Health,* 2016; Sheats et al., *J Urban Health,* 2017; King et al, 2019

It starts with an easy-to-use mobile app:

Stanford Healthy Neighborhood Discovery Tool

Buman et al. *Am J Prev Med*, 2013

- Used by residents, ***irrespective of 'tech literacy' or language,*** to assess community features that *promote or hinder* healthy living or daily well-being
- Tool used to collect neighborhood info via **GPS Route tracking/ Geo-coded Photos & Audio narratives**; as few as 8-10 residents needed to get convergence around top barriers & enablers of healthy or active living in a specific locale



Next, in a facilitated process, Residents:

- ***share*** their photos & “stories” collected on their walks with other residents

- ***build consensus*** around high-priority yet realistic areas for change
- share their data with ***key decision makers*** & develop possible solutions

- ***formulate action steps*** to activate local changes

  (e.g., a safe, age-friendly walking route for Israeli seniors, with support of local businesses)

Developed & tested initially with **low-income, ethnically diverse older adults** in San Francisco Bay area

© Stanford University

Among **Citizen Science Activities** in East Palo Alto, CA:

- Older low-income Residents were able to use Discovery tool to identify neighborhood barriers to PA/food choices & advocate for changes

- In response, City planning committee & City Council made a number of changes & investments to enhance community infrastructure for active living . . .

Buman et al. *Translat Behav Med,* 2012; Winter S, et al. *Translat Behav Med,* 2014

Successes in E. Palo Alto, CA included:

- City appropriated $400,000 for **environmental analysis**
- Created a **safer walking environment** through revising/repairing streets, sidewalks
- Improved **access** to senior center
- Helped seniors develop a senior **community garden**
- Local orgs. taught seniors how **to grow & cook vegetables**
- Resident reports of enhanced **social cohesion**

Winter, King, et al., Translat Behav Med, 2015

Other IMPACTS of Global *Our Voice* projects include:

- Safer, more user-friendly ***city-wide 'open streets' recreational*** *programs* (Colombia)
- Increased ***age-friendly walking routes*** to destinations (Israel, USA)
- Residents identified ***under-utilized spaces*** for recreational use by seniors (Taiwan)
- Created safer ways to ***walk/bike to school*** (USA) & *healthier* ***school envir.*** (Colombia, South Africa)
- Developed strategies for ***improving control of stray/roaming dogs*** (Mexico)
- Identified strategies for ***healthier food access*** in urban & rural areas (USA, Colombia)
- Enacted ***park improvements*** to increase community physical activity & greater park utilization (USA, Colombia)
- Improved ***indoor environments in a geriatric rehabilitation unit*** to promote mobility among patients (Australia)

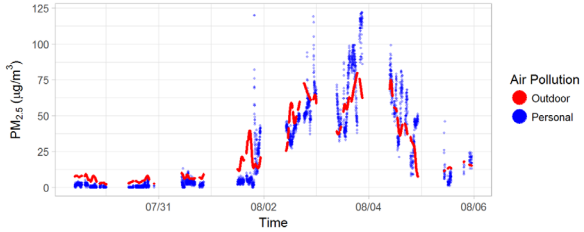
King A, *TJACSM,* 2016; Rosas LG, *J Urban Health,* 2016; Moran M, *J Aging Phys Act,* 2017; Sheats J, *J Urban Health,* 2017; Zieff S, *J Urban Health,* 2018; Hua, *Ann Behav Med,* 2018, Chrisinger, *Frontier Pub Health*, 2018; Rodriguez, *BMJ Pub Health,* 2019; King, *Prev Med,* 2019

Combining Discovery Tool with ***Sensors*** to expand understanding **of effects of environment on health**

➢ Example: **Environmental Sensors of Air Quality**

Community Air Quality Monitor
(neighborhood-level)

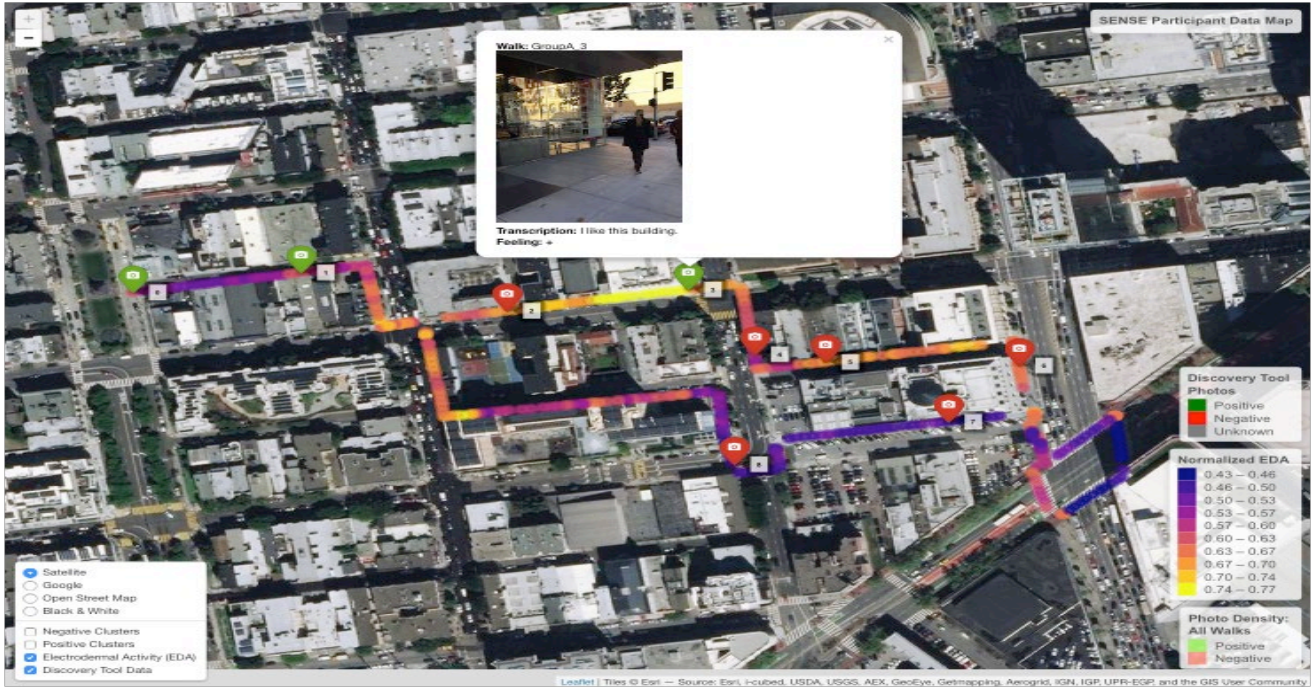
Portable Air Particle Monitor (Univ. of Washington)
(person-level)



Another Example:

- Use of wrist-worn sensor of electro-dermal & heart rate activity

- ***Identifies locations along walking routes linked with increased arousal/stress***



Chrisinger B & AC King (International J Health Geography, 2018). Stress Experiences in Neighborhood and Social Environments (SENSE). (with Place Labs, SF [Empatica])

20+ countries, 6 continents

Major Goal:
Dynamic exchange of data, measures, & learnings to advance global health equity

Finally, **Some *Future Directions*** include:

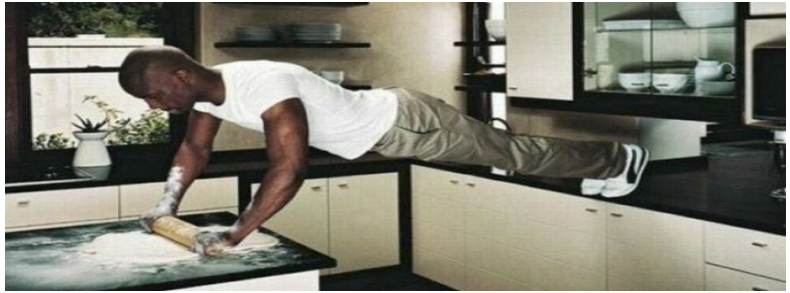
- Harness power of ***Intergenerational*** groups, ***Social networks,*** & ***Technology*** to better address ***health disparities, and patient & community health***

- Explore opportunities to partner with the ***private sector*** as well as ***community organizations*** to reach more people where they live, work, & play

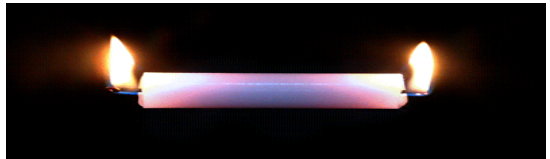
- Develop ***multi-level*** strategies that <u>combine</u> different interventions (e.g., personal + environmental levels)

Some Future Directions - *continued*

- Combine health behaviors (e.g., physical activity & diet) as *complementary & synergistic targets* to promote population-wide behavioral health



- Tackle local & global environment challenges to health both from top down (e.g., policies) and from *bottom up* through ***citizen science engagement***



Thank you!