Field evaluation of programmable thermostats: Does usability facilitate energy saving behavior?

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Thermostat usability

Findings from usability tests at LBNL (A.Meier et al.):

- Touchscreen interface performed better than button interface
- Best-performing thermostat requires internet (WiFi) and computer
- Second best is Honeywell VisionPro

Does usability facilitate energy saving behavior?

U.S. Department of Energy (DOE), Building America project

- Field Evaluation Study
- Research question:

Are people with a high-usability thermostat more likely to use energy-saving settings?

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- Multifamily affordable housing building in Revere, MA
- Weatherization in entire building
  - Furnace/AC replacement, insulation and air-sealing of the back wall in the utility closet
- Opt-out recruitment
- 83 out of 92 households participated in the study
- 63 valid datasets

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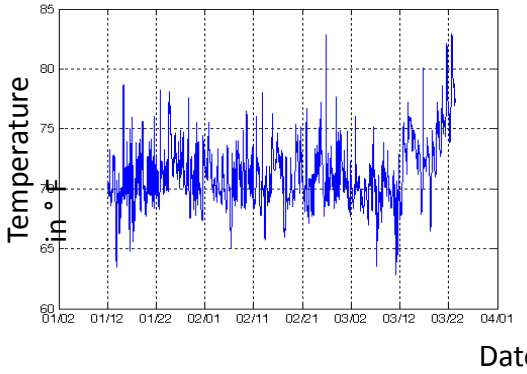
- Touch screen (high-usability) thermostats
- Button interface (low-usability thermostats)
- Non-intrusive sensors to measure
  - Temperature
  - Humidity
  - Furnace on/off state
- Questionnaire data
- Gas meter readings
- Weather data (Boston)



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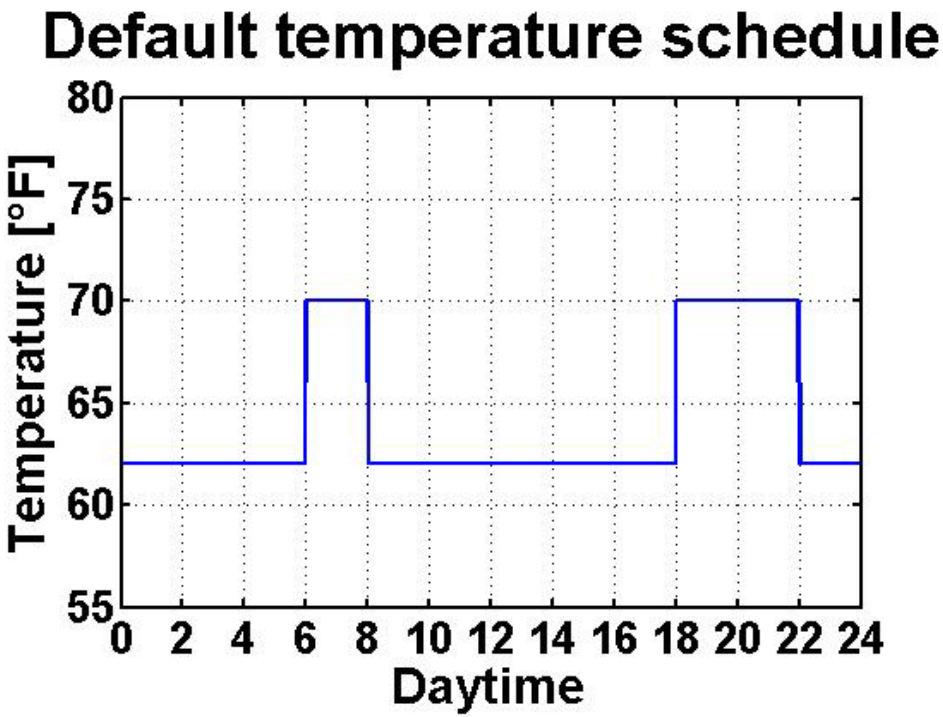
Two thermostat groups, same default settings

- “high usability” touch screen

  VisionPro 8000 (VP)

- “low usability” button interface

  Basic Programmable (BA)



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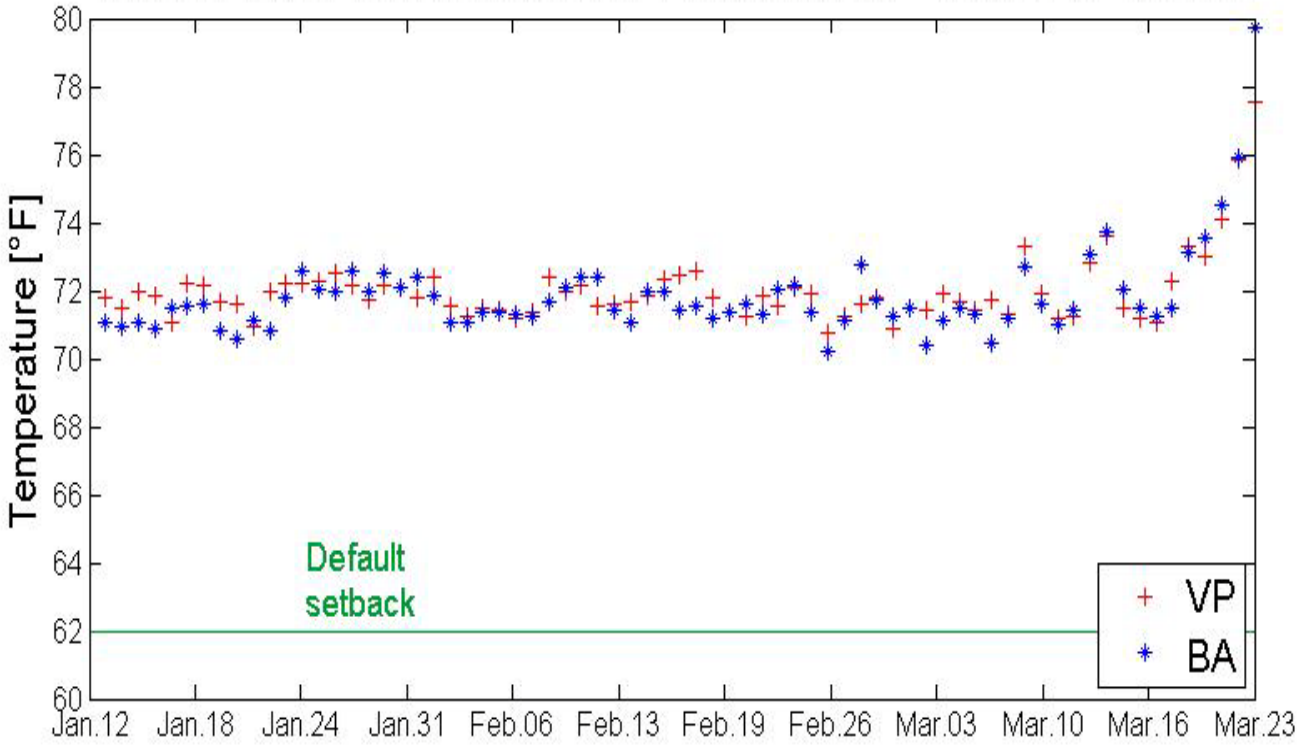
Behaviors analyzed

- Nighttime setbacks
- Daytime setbacks
- Permanent hold events

Mean Night temp – setback or not?



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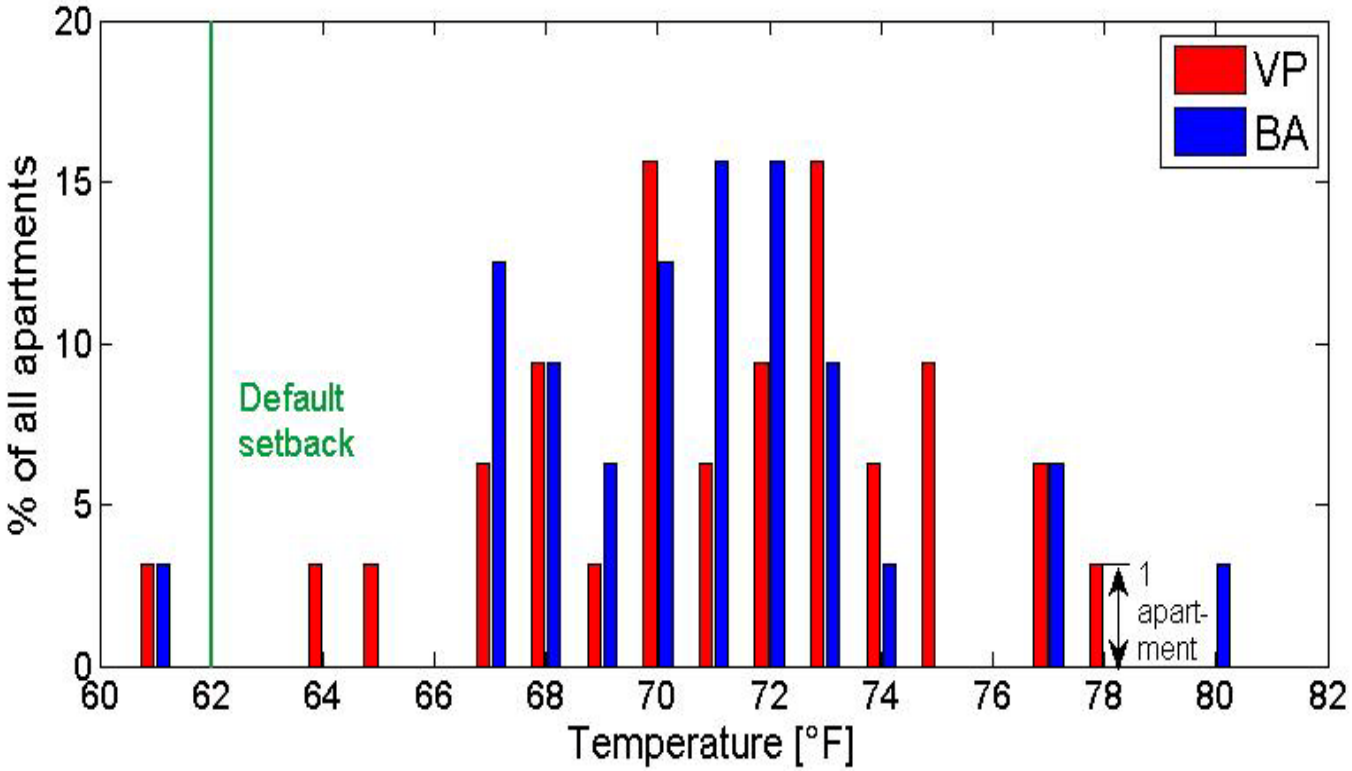
Coldest nights

- Only nights when temperature fell below freezing 32°F (22 nights after January 12)
- Calculated average temperature for each apartment between midnight and 4AM
- Averaged for 22 cold nights

Coldest nights: mean apartment temperature



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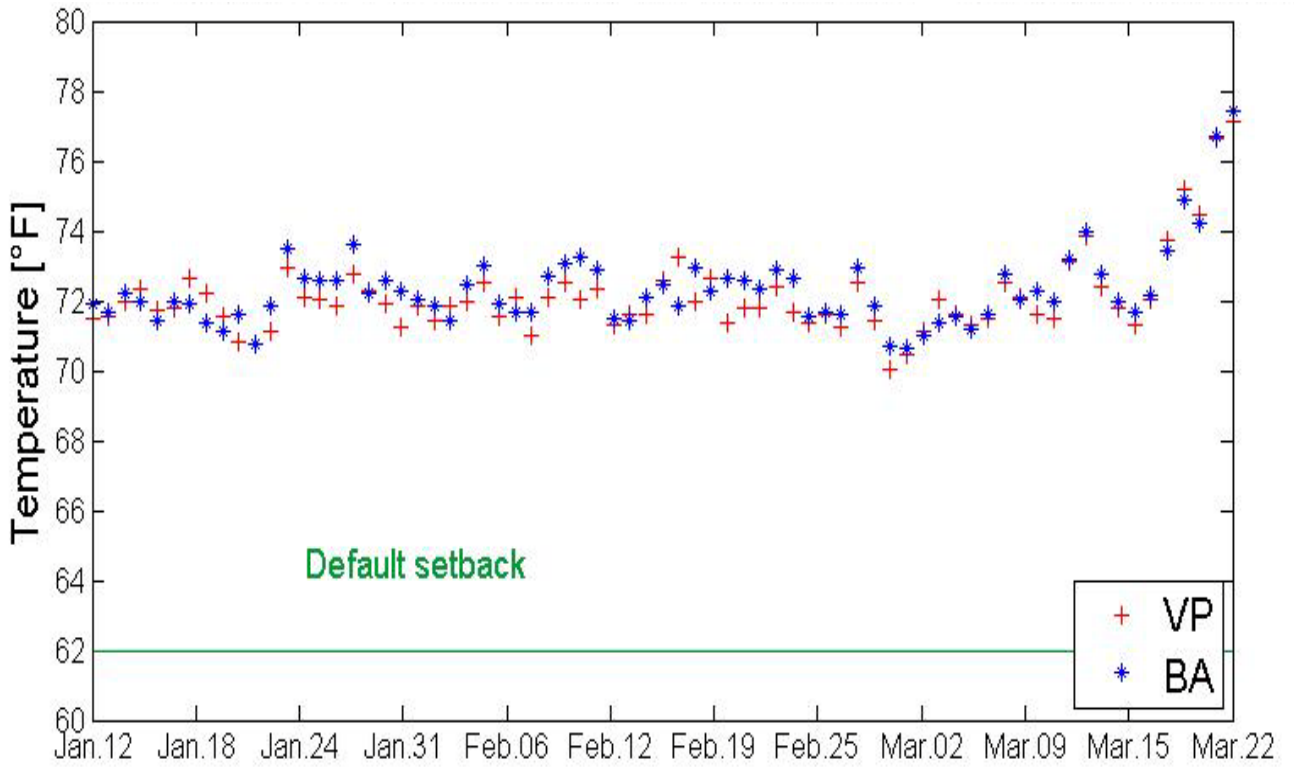
Mean daytime (10am-2pm) temp – setback or not?



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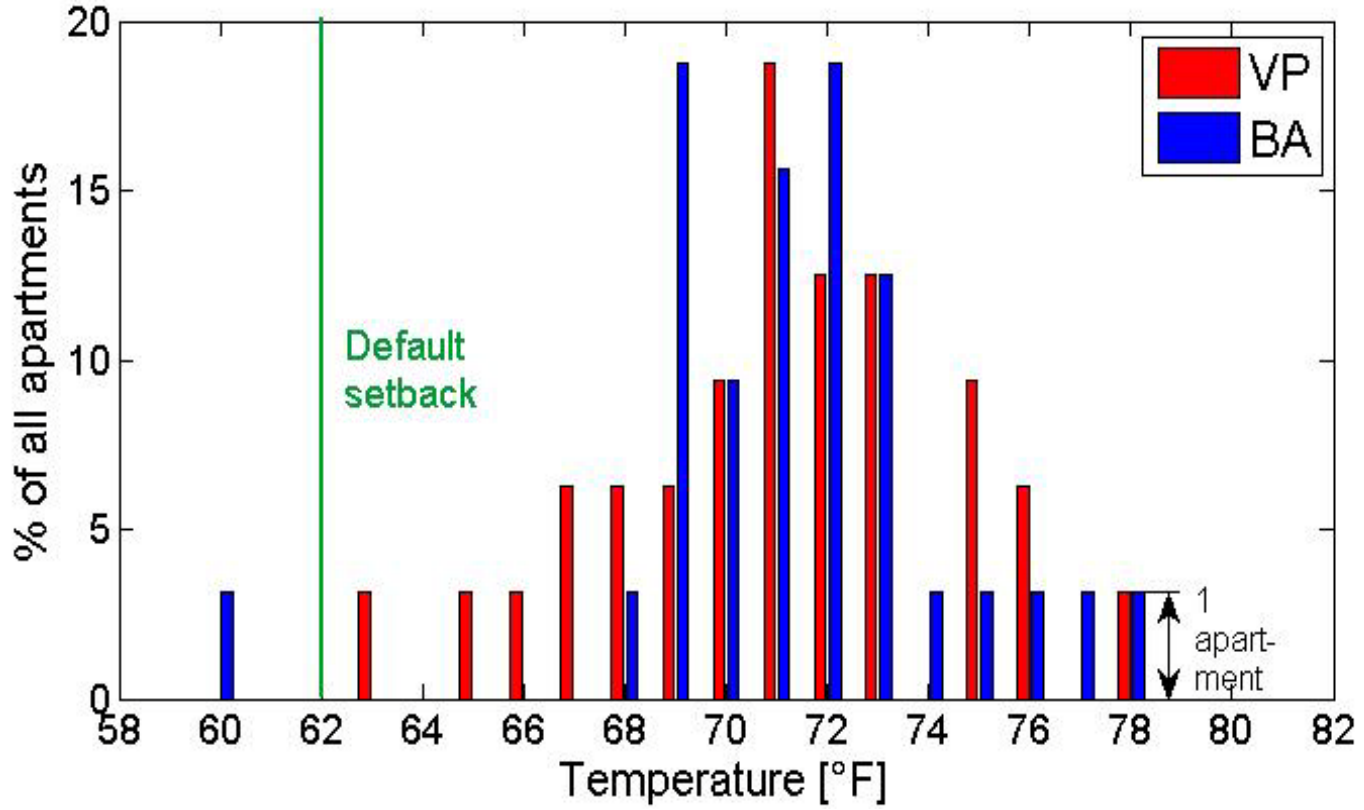
Days below freezing point: mean apartment temperature



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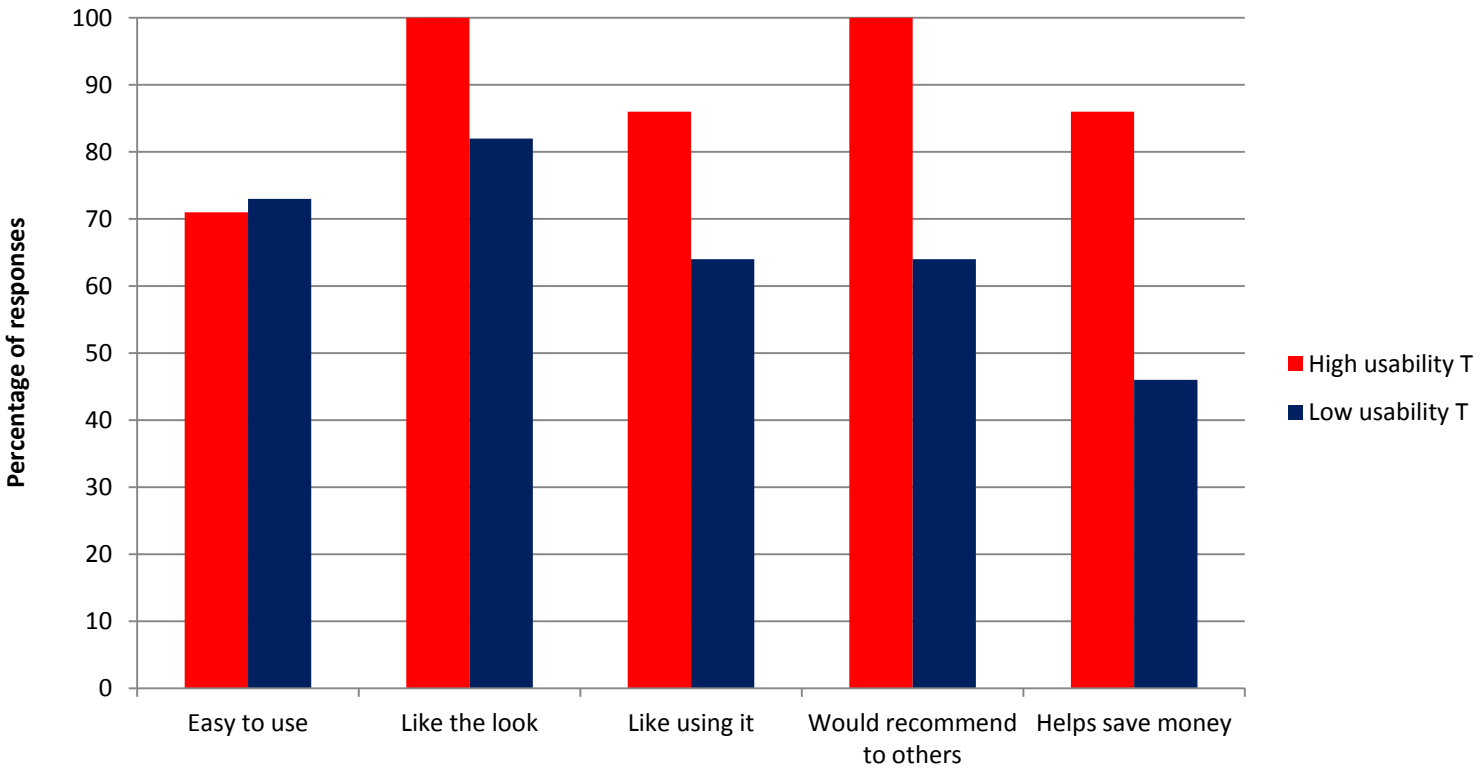
Permanent hold events

	Low Usability (BA)	High Usability (VP)
% of apartments using hold feature	49%	25%
Average hold Temperature (°F)	75.3	74.4
Average duration per hold event	1.8 days	1.9 days
Mean of maximum hold event duration*	2.1 days	2.9 days
*Among all apartment who used the hold functionality in each group		

Satisfaction with thermostats



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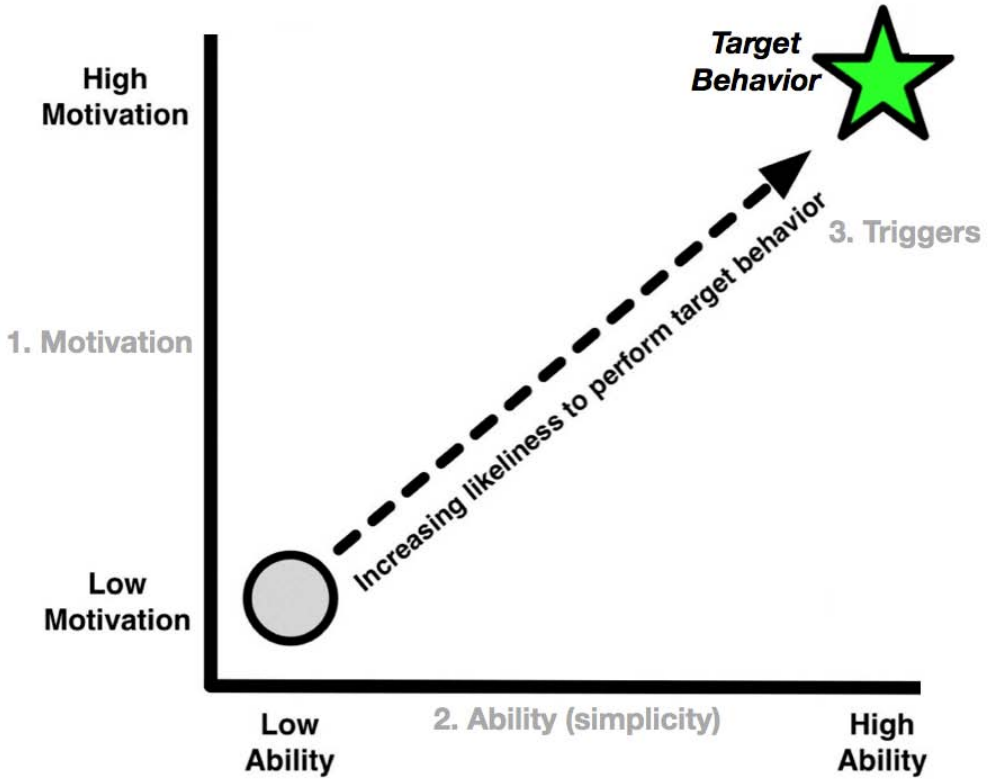
Summary

- Are people with a high-usability thermostat more likely to use energy-saving settings?
  - Not for nighttime setbacks
  - Not for daytime setbacks
  - Not for low-temperature vacation holds
- Why?

Behavior change requires more than USE-ability

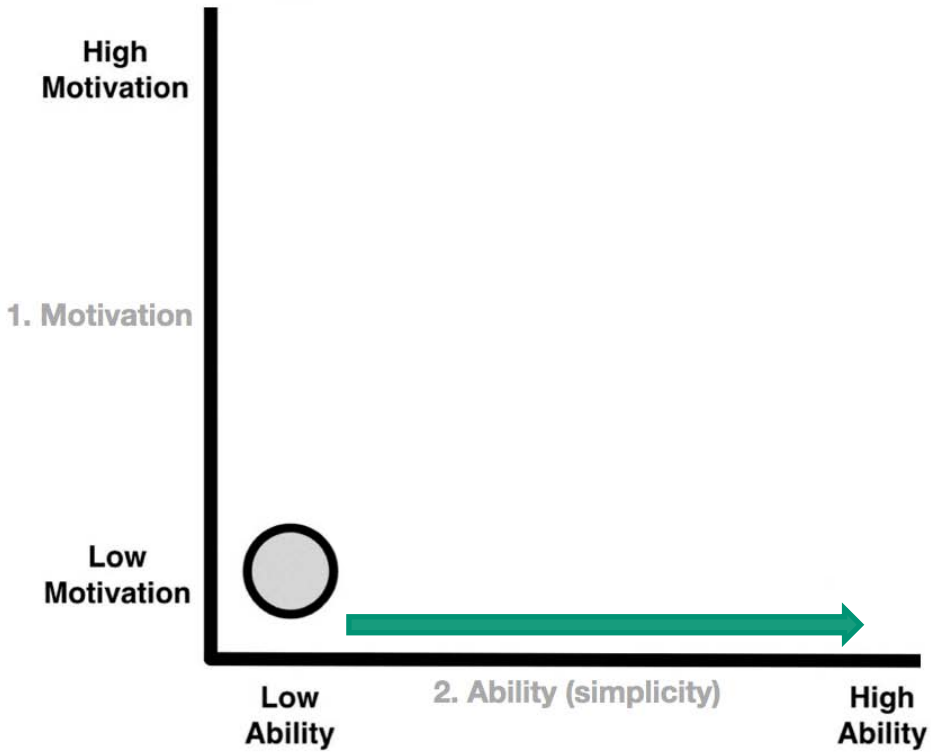
- Factors underlying Behavior Change:
  - Ability
  - Trigger
  - Motivation



Persuasive'09, April 26-29, Claremont, California, USA.

Thermostat behavior change: ability is not enough…

- Three main factors:
  - Ability
  - ~~Trigger~~
  - ~~Motivation~~



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Limitations

- Population sample: affordable housing residents
- Thermostat models used
- Data collection and analysis methodology

Follow-up research

- Summer cooling data collection and analysis
- More realistic setback temp
- Integration of behavioral data into building performance models