A Self-Report Measure of End-User Security Attitudes (SA-6)

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Human-Computer Interaction Institute

NSF

Social Cybersecurity

Key takeaways

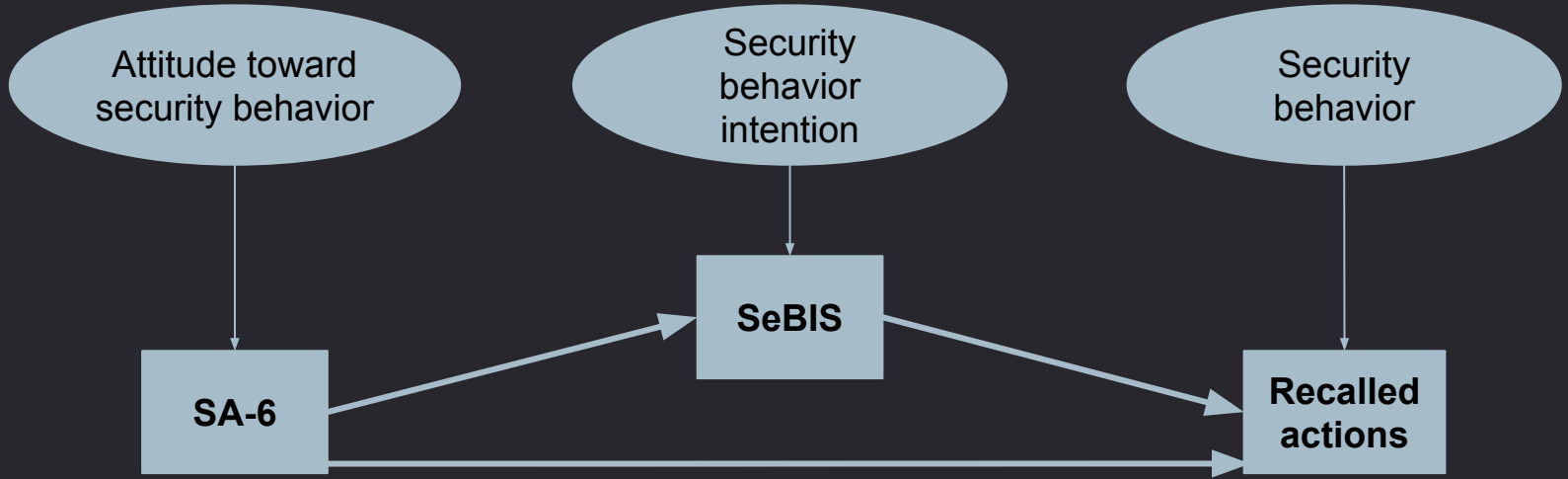
1. **SA-6 is a lightweight tool to quantify and compare people's attitudes** toward using recommended security tools and practices.
2. **SA-6 may help to improve predictive modeling** of who will adopt such behaviors.

SA-6 is a lightweight tool to quantify and compare security attitudes

On a scale of 1=Strongly Disagree to 5=Strongly Agree, rate your level of agreement with the following:

- Generally, I **diligently follow** a routine about security practices.
- I **always pay attention to experts' advice** about the steps I need to take to keep my online data and accounts safe.
- I am **extremely knowledgeable** about all the steps needed to keep my online data and accounts safe.
- I am **extremely motivated** to take all the steps needed to keep my online data and accounts safe.
- I **often am interested in articles** about security threats.
- I **seek out opportunities to learn** about security measures that are relevant to me.

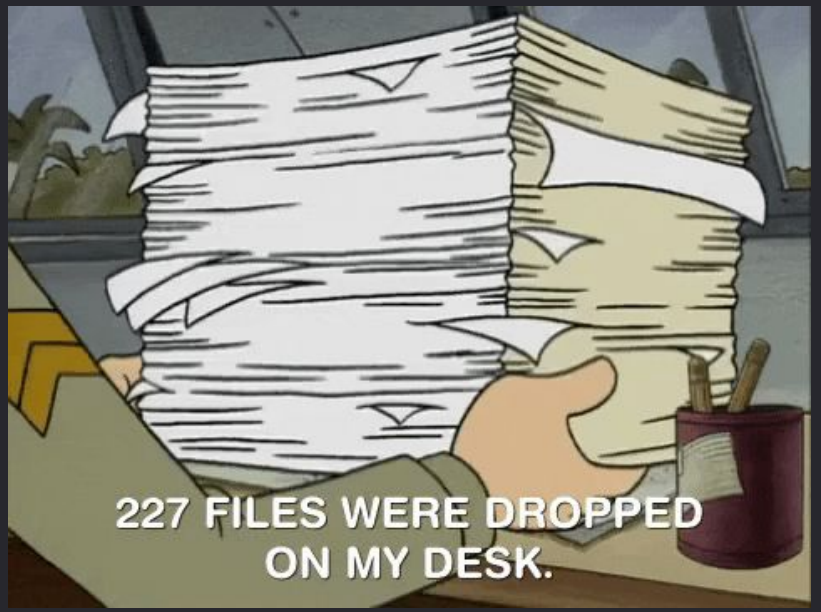
SA-6 may help to improve predictive modeling of security adoption



Better predictive modeling = better targeting of interventions

Our field needs reliable and validated psychometric scales

- Much usability research employs **in-depth interviews** and **observations.**
- But this is not always **feasible or desirable.**



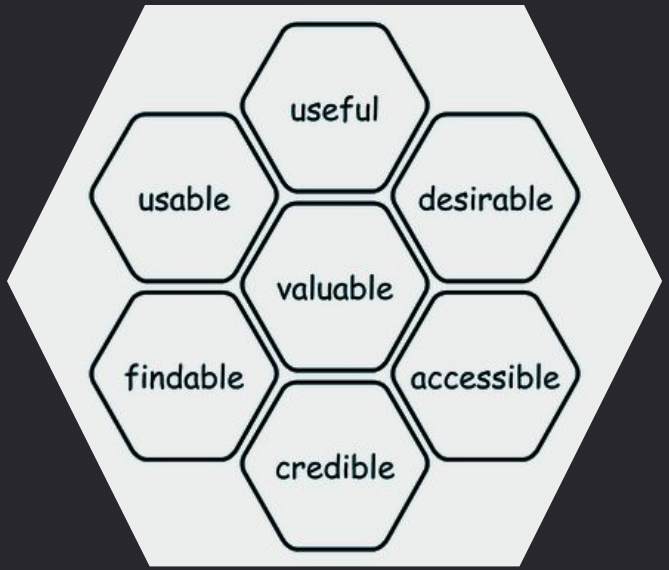
https://giphy.com/gifs/heyarnold-hey-arnold-nicksplat-xT1R9EbolF7trQnIyI

Our field needs reliable and validated psychometric scales

- **For large-scale, longitudinal or time-sensitive** research, we need an online survey form that can be given with other scales or questionnaires.

Our field needs reliable and validated psychometric scales

- Knowing users' **attitudes**, **intentions** and **behaviors** helps us craft security tools that are:
  - Useful
  - Easy to use
  - Satisfying to users



https://www.interaction-design.org/literature/topics/usability

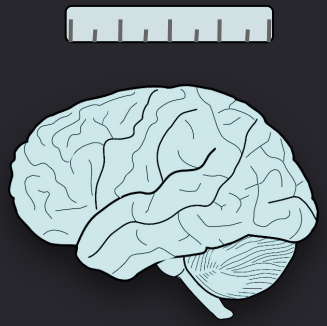
Our field needs reliable and validated psychometric scales

- **An attitude scale** helps answer research questions such as:
  - ***How attentive to security advice*** *is a certain user group likely to be?*
  - *Does a new tool* ***help or hurt a user's attitude*** *toward security compliance?*

The Security Behavior Intentions Scale (SeBIS) isn't enough

Current state of the art is SeBIS (Egelman & Peer 2015)

- 16-item self-report inventory in four areas:
  - Password generation
  - Proactive awareness
  - Software updates
  - Device securement

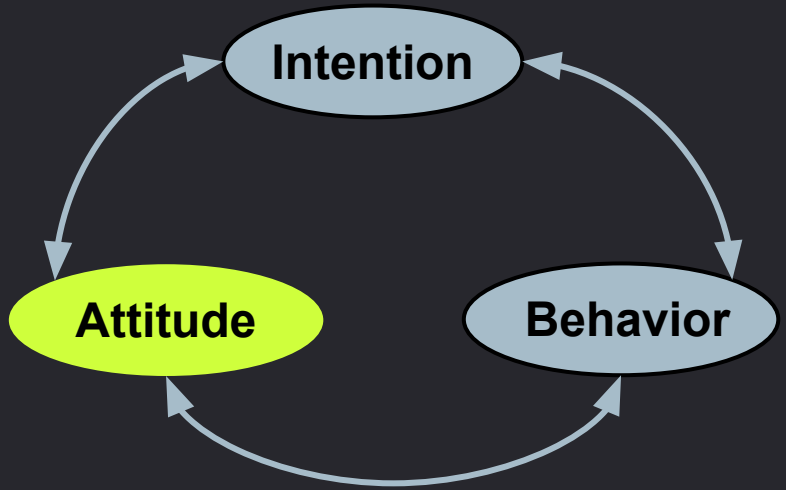


But it has limitations:

- Specific to behavior intentions, not to attitudes.
- Tech-specific wording may become outdated.

An additional scale is needed to conduct theory-motivated research

- **Theory of Reasoned Action**
  - *Technology Acceptance Model*
  - *Diffusion of Innovation Theory*
- Elaboration Likelihood Model
- Self-Determination Theory
- Protection Motivation Theory



Fishbein & Azjen 1967, 2010; Davis et al. 1989; Rogers 2010; Petty & Cacioppo 1980; Ryan & Deci 2000; Rogers 1975

Best practice: Generate candidate items from prior work (Das et al. 2017)

to engage in expert-recommended security practices

Best practice: Test many different item variations for SA-6 (60+ to start)

- A security breach, if one occurs, is not likely to cause significant harm to my online identity or accounts.
- Generally, I am aware of existing security threats.
- Generally, I am willing to spend money to use security measures that counteract the threats that are relevant to me.
- Generally, I care about security and privacy threats.
- Generally, I diligently follow a routine about security practices.
- Generally, I know how to figure out if an email was sent by a scam artist.
- Generally, I know how to use security measures to counteract the threats that are relevant to me.

Best practice: Collect measures theorized to relate with SA-6

- SeBIS scale, 16 items
- Internet Know-How, 9 items
- Technical Know-How, 9 items
- Internet Users Information Privacy Concerns scale, 10 items
- Frequency of falling victim to a security breach, 2 items
- Amount heard or seen about security breaches, 1 item
- Barratt Impulsiveness Scale, 30 items
- Privacy Concerns Scale, 16 items
- Ten-Item Personality Inventory, 10 items
- General Self-Efficacy scale, 11 items
- Social Self-Efficacy scale, 5 items

Best practice: Collect measures theorized to relate with SA-6

Test convergent validity

- **RQ1a:** Is SA-6 positively correlated with SeBIS?
- **RQ1b:** Do other measures thought to relate with security attitude correlate with SA-6?

Test discriminant validity

- **RQ2a:** Does SA-6 vary with respect to background social factors (*e.g.* age, gender)?
- **RQ2b:** Does SA-6 vary with past experiences of security breaches?

Best practice: Use a large, diverse sample for finalizing scale items

Amazon Mechanical Turk sample

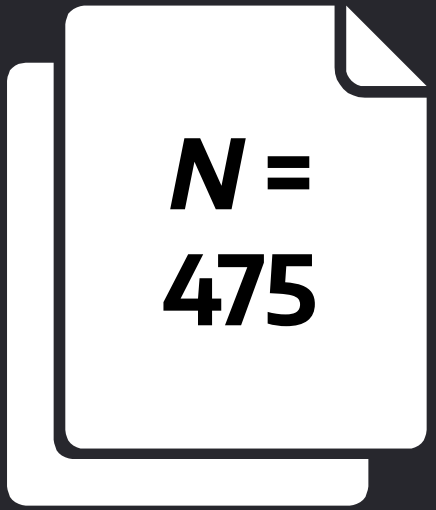
+

University-run study pool sample

Samples not significantly different by age [overall $X^2(4, N=475)=11.42$, p = n.s.]

=

or gender [$X^2(1, N = 475) = 2.95$, p = n.s.]



Meets recommended ratio (5:1 to 10:1) of responses to scale items

Best practice: Repeat study in a representative sample to validate scale

***N* = 209**

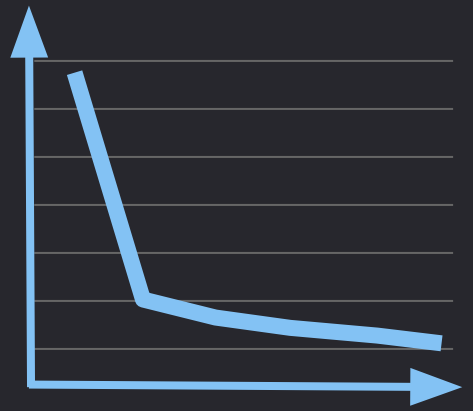
Qualtrics-filled panel with ***age*, *gender* & *income*** tailored to U.S. population

Best practice: Iterative analyses to zero in on the items for the scale

Factor tests → Model tests

- **Exploratory Factor Analysis** to check item correlations (SPSS)
- **Reliability Analysis (alpha)** to confirm internal consistency

- **Confirmatory Factor Analysis** to check goodness of fit (MPlus)
- **Run several CFA models** to make sure we specified the best model



SA-6 demonstrates desired consistency + fit for a psychometric scale

SA-6 scale items (SPSS Principal Components Analysis)	*Factor loading*
I seek out opportunities to learn about security measures that are relevant to me.	0.81
I am extremely motivated to take all the steps needed to keep my online data and accounts safe.	0.78
Generally, I diligently follow a routine about security practices.	0.77
I often am interested in articles about security threats.	0.72
I always pay attention to experts' advice about the steps I need to take to keep my online data and accounts safe.	0.71
I am extremely knowledgeable about all the steps needed to keep my online data and accounts safe.	0.71

α=.84

CFI=.91

SRMR =.05

SA-6 = attentiveness to and engagement with cybersecurity measures

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Best practice: Statistical testing of SA-6 as a valid attitude measure

Factor tests → Model tests → Validity tests

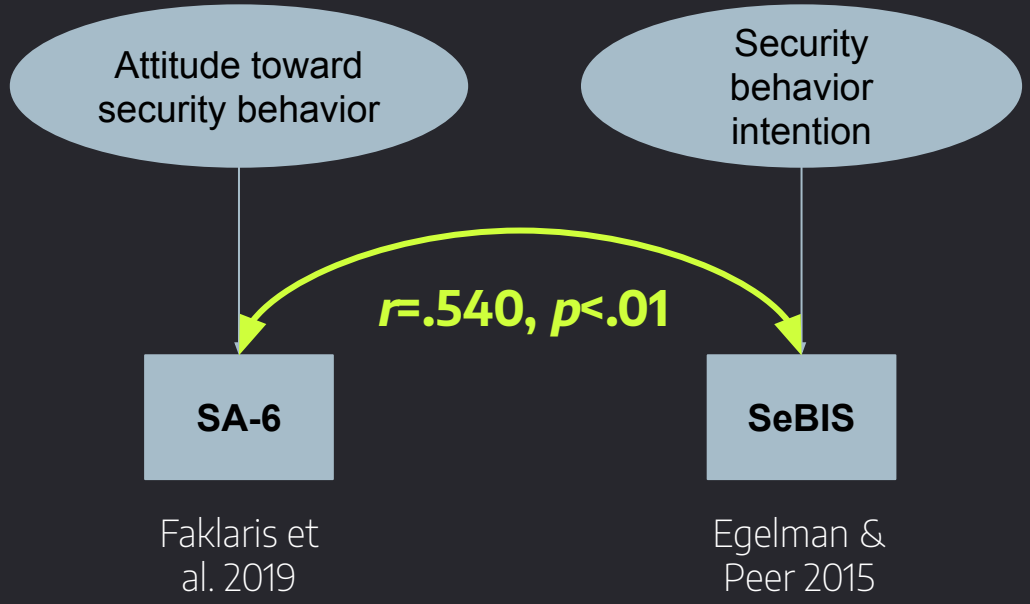
- **Exploratory Factor Analysis** to check item correlations (SPSS)
- **Reliability Analysis (alpha)** to confirm internal consistency

- **Confirmatory Factor Analysis** to check goodness of fit (MPlus)
- **Run several CFA models** to make sure we specified the best model

- **Test relationships + differences** with other variables (SPSS)
- **Also tested for ability to predict** participants' recalled security actions in past week

Best practice: Test for expected associations with SA-6

- **RQ1a:** Is SA-6 positively correlated with SeBIS?
- **Yes.**



Best practice: Test for expected associations with SA-6

- **RQ1a:** Is SA-6 positively correlated with SeBIS?
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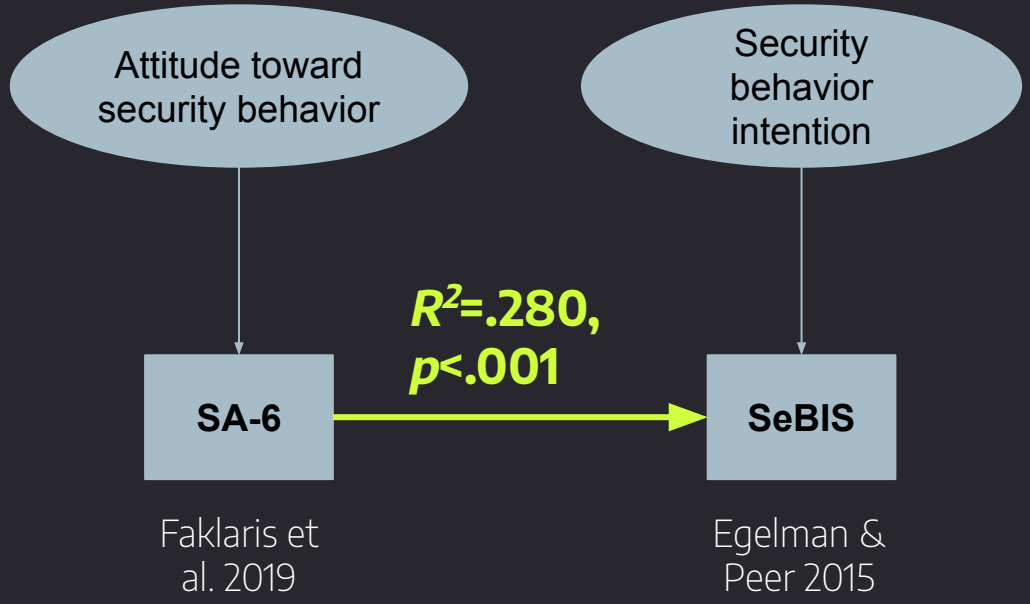


Best practice: Test for expected associations with SA-6

- **RQ1b:** Do other measures thought to relate with security attitude correlate with SA-6?
- **Yes.**

- With the Internet Users' Informational Privacy Concerns (IUIPC) scale

***r*=.390, *p*<.01** Malhotra et al. 2004

- With the Privacy Concerns Scale (PCS)

***r*=.382, *p*<.01** Buchanan et al. 2007

Best practice: Test for expected associations with SA-6

- **RQ1b:** Do other measures thought to relate with security attitude correlate with SA-6?
- **Yes.**

- With the Barratt Impulsiveness Scale	***r*=.180, *p*<.01**	Stanford et al. 2009 (update)
- With the General Self-Efficacy scale	***r*=.208, *p*<.01**	Zimmerman et al. 2000
- With the Social Self-Efficacy scale	***r*=.363, *p*<.01**	Zimmerman et al. 2000

Best practice: Test for expected associations with SA-6

- **RQ1b:** Do other measures thought to relate with security attitude correlate with SA-6?
- **Yes.**

- With the Kang Internet Know-How scale	***r*=.542, *p*<.01**	Kang et al. 2015
- w/Confidence in using computers	***r*=.280, *p*<.05**	Fogarty et al. 2001 (adapted)
- w/Web-oriented digital literacy	***r*=.503, *p*<.05**	Hargittai 2005

Best practice: Test for expected differences in SA-6 by subgroup

- **RQ2a:** Does SA-6 vary with background factors? **Yes.**

	SA-6 Mean (SD)		*t(df), p*
Age group	*18-39* 3.40 (.81)	***40 +*** **3.69 (.76)**	*t*(207)= -2.172, *p*<.05
Gender	***Male*** **3.77 (.71)**	*Female* 3.53 (.81)	*t*(198.38)= 2.19, *p*<.05

Best practice: Test for expected differences in SA-6 by subgroup

- **RQ2a:** Does SA-6 vary with background factors? **Yes.**

	SA-6 Mean (SD)		*t(df), p*
College attendance	*No college* 3.42 (.79)	***Attended college*** **3.73 (.76)**	*t*(207)=-2.76, *p*<.01
Income level	*Below $25K* 3.30 (.71)	***Above $25K*** **3.73 (.77)**	*t*(207)=-3.42, *p*<.005

Best practice: Test for expected differences in SA-6 by subgroup

- **RQ2b:** Does SA-6 vary with past breach experiences? **Yes.**

	SA-6 Mean (SD)		*t(df), p*
	Low	***High***	
Themselves falling victim to a security breach	3.56 (.78)	**4.13 (.58)**	$t(41.46) = -4.54$, $p<.001$
Close friends or relatives falling victim	3.57 (.76)	**4.10 (.74)**	$t(207)= -3.40$, $p<.005$
Heard about security breaches in the past year	3.35 (.80)	**3.77 (.74)**	$t(207)=-3.77$, $p<.001$

Best practice: Collect measures theorized to relate with SA-6

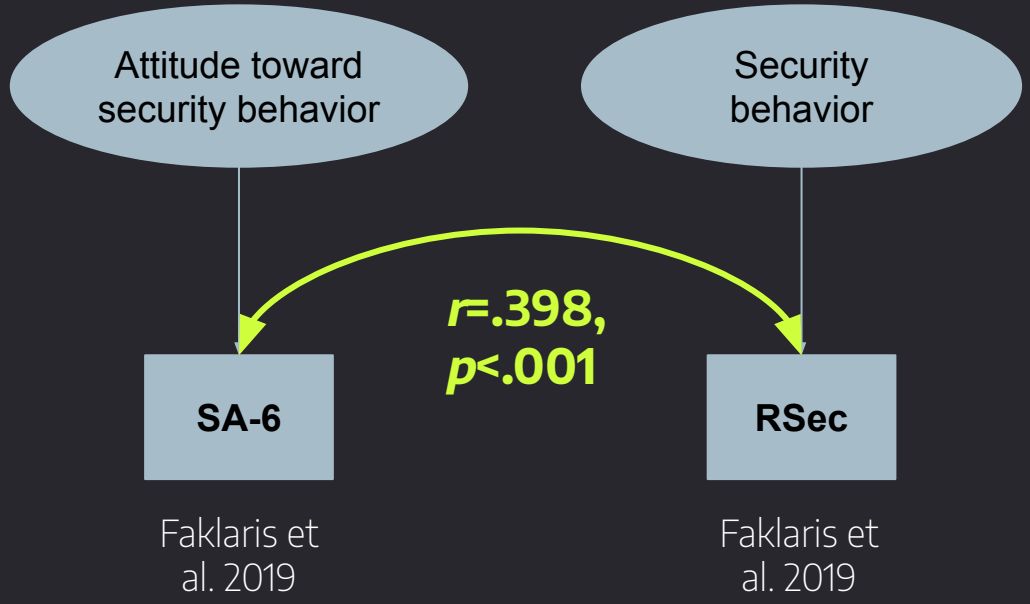
Test support for predictive validity

- **RQ3:** Does a person's SA-6 score positively associate with a measure of self-reported security behaviors within the past week?
- **Collected 10 items** based on SeBIS, 5-level agreement scale (RSec)

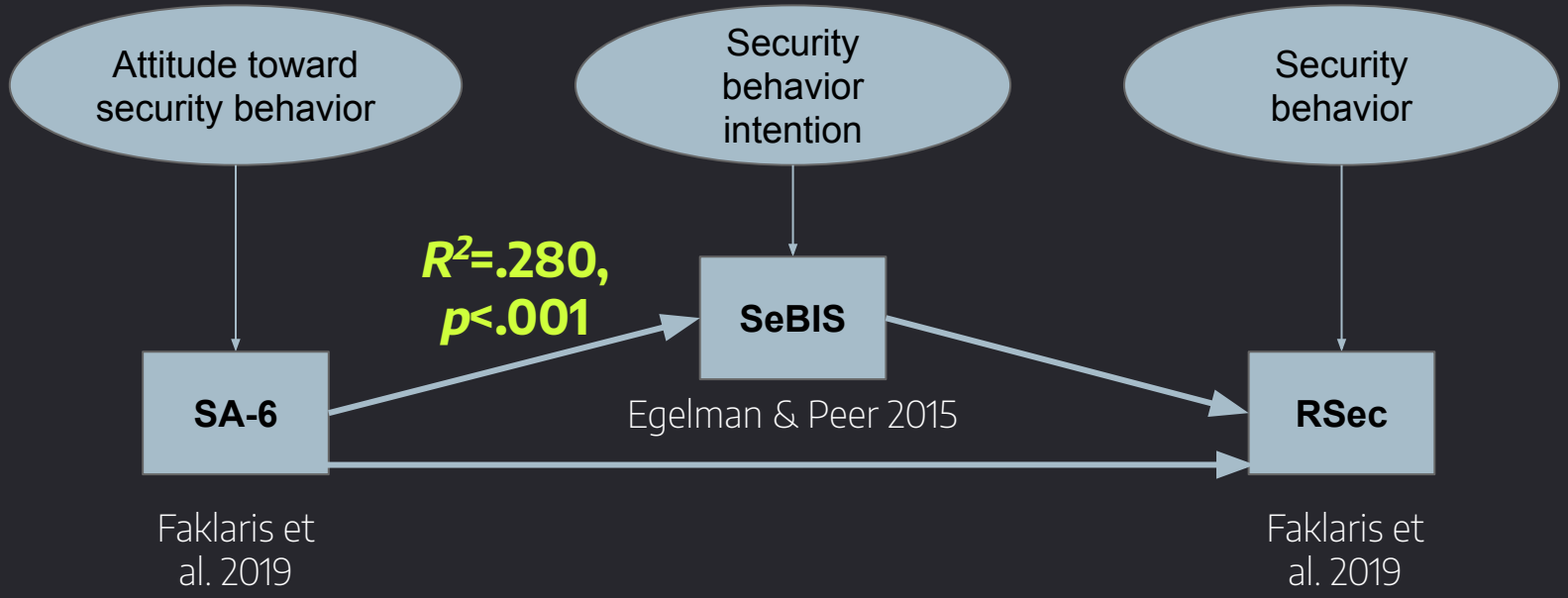
Ex: **"In the past week, I have verified at least once that my antivirus software is up to date."**

Best practice: Test for SA-6's influence on outcome variables

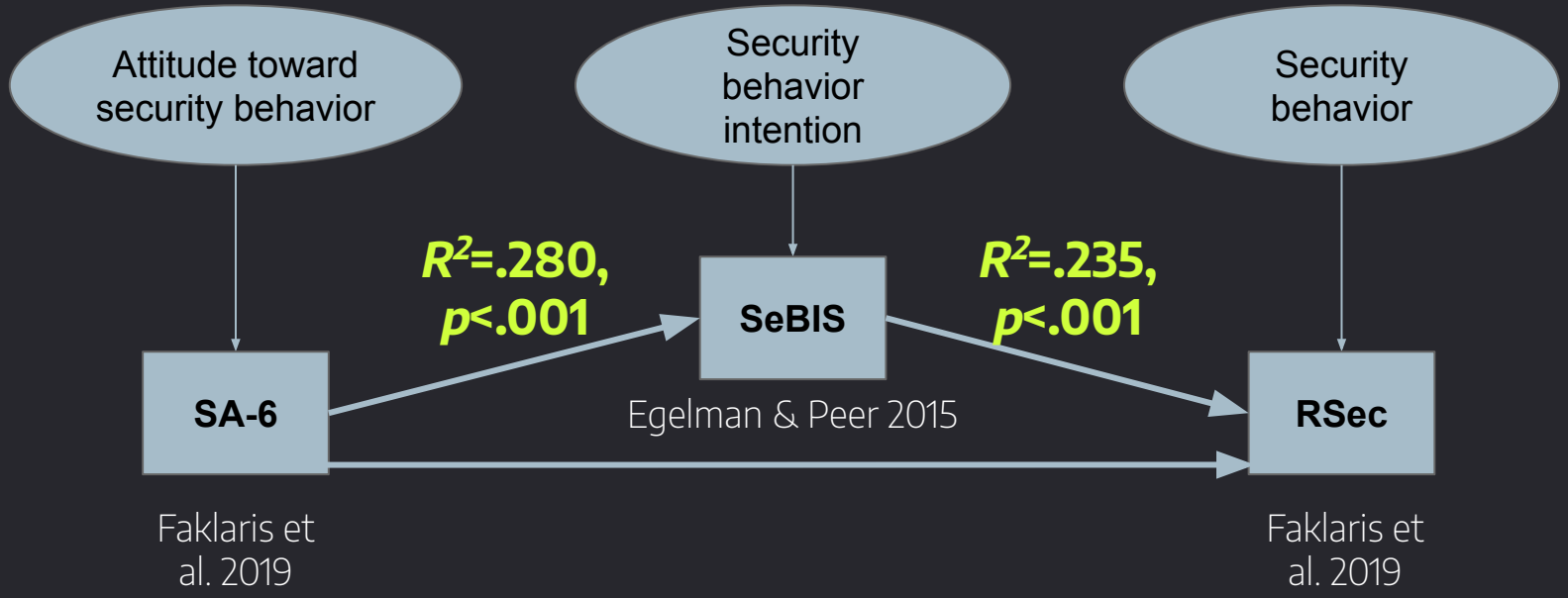
- **RQ3:** Does SA-6 positively associate with a measure of self-reported security behaviors within the past week (RSec)?
- **Yes.**



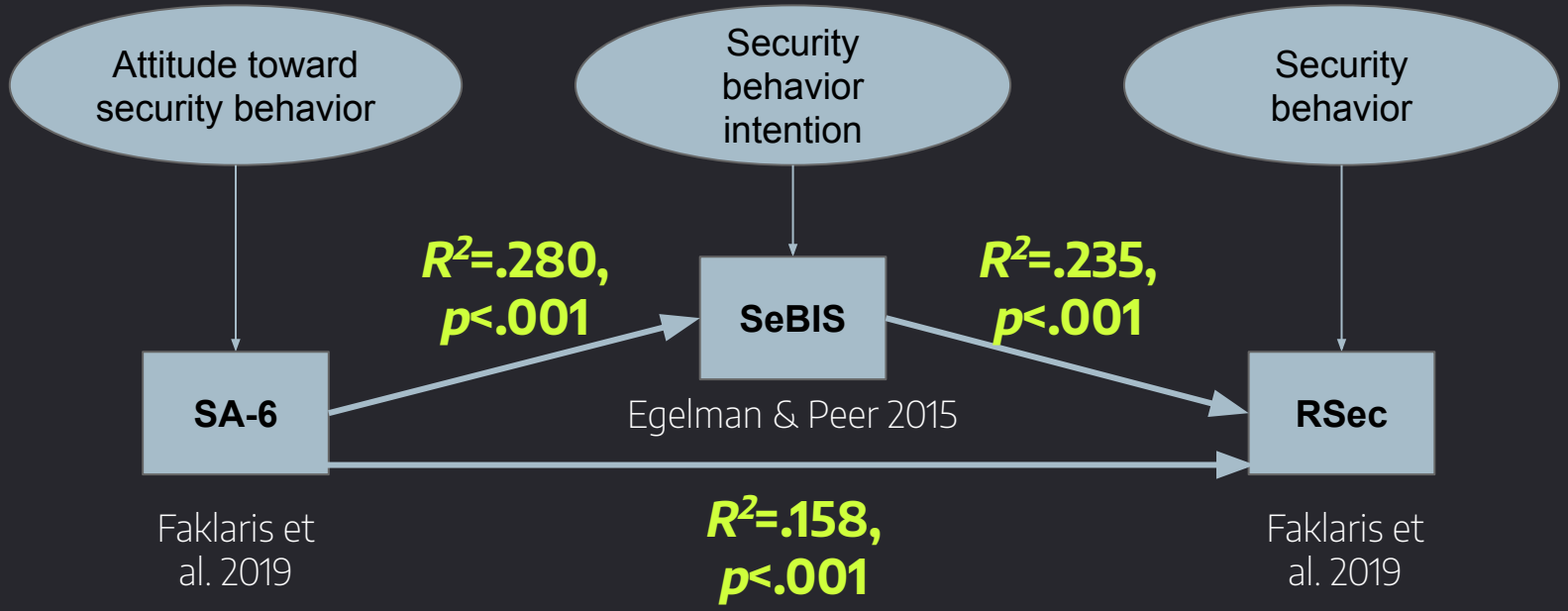
Best practice: Test for SA-6's influence on outcome variables



Best practice: Test for SA-6's influence on outcome variables

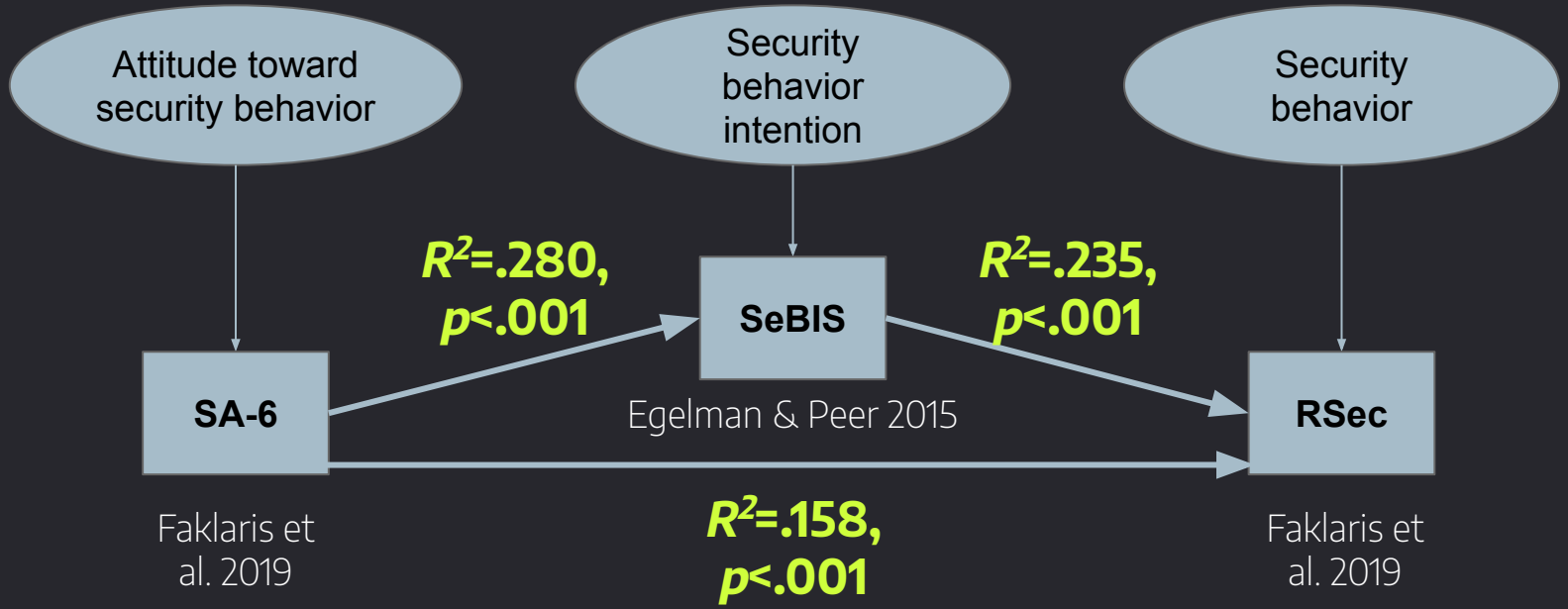


Best practice: Test for SA-6's influence on outcome variables



SA-6 can improve predictive modeling + targeting of interventions

Low SA-6 → boost awareness/motivation; High SA-6 → boost skill/ability



SA-6 can be helpful in your own usable security research

- **Easily administer SA-6** via online survey form with other scales or questionnaires.
- **Answer research questions** such as
  - *How attentive to security advice is a certain user group likely to be?*
  - *Does a new tool help or hurt a user's attitude toward security compliance?*

https://socialcybersecurity.org/sa6.html

SA-6 can be helpful in your own usable security research

- **Test hypotheses & models** motivated by:
  - *Theory of Reasoned Action*,
  - *Elaboration Likelihood Model*,
  - *Self-Determination Theory*,
  - *Protection Motivation Theory*,
  - Other theories and frameworks.

https://socialcybersecurity.org/sa6.html

Take the Security Attitude quiz at SocialCybersecurity.org/sa6quiz

Research Thrusts + Current Projects

Mini-Games

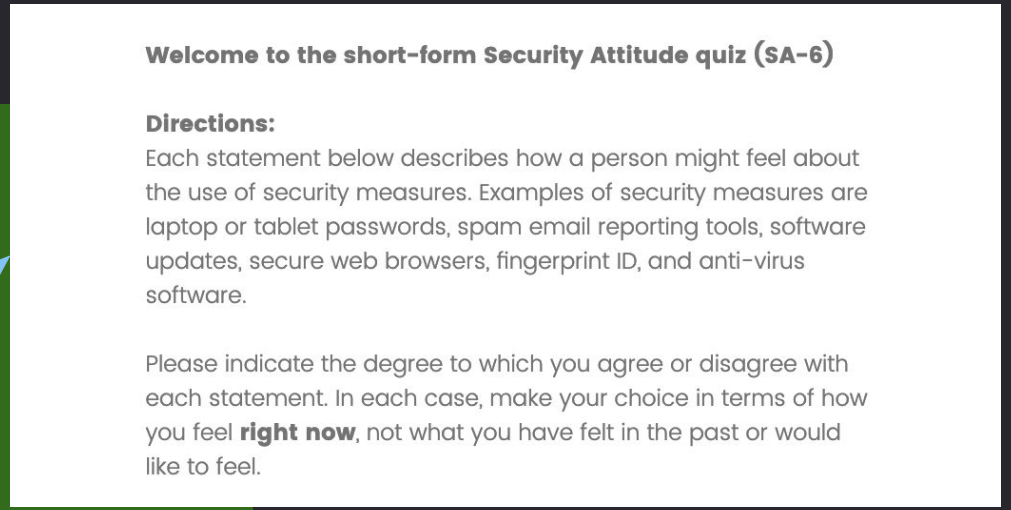
- "Apps vs. Hackers" web-hosted game [Poster] [Play the G
- "Hacked Time" desktop-based game

Everyday Interventions

- Safesea plugin for Google Chrome browser [Poster]

Adoption Strategies

- Psychometric scales and models [SA-6] [SA-13] [Take the Security Attitude quiz]
- Security Score for end users
- Behavior change models



Welcome to the short-form Security Attitude quiz (SA-6)

Directions:
Each statement below describes how a person might feel about the use of security measures. Examples of security measures are laptop or tablet passwords, spam email reporting tools, software updates, secure web browsers, fingerprint ID, and anti-virus software.

Please indicate the degree to which you agree or disagree with each statement. In each case, make your choice in terms of how you feel **right now**, not what you have felt in the past or would like to feel.

Key takeaways

1. SA-6 is a lightweight tool **to quantify and compare** people's attitudes toward using recommended security tools and practices.
2. SA-6 may help to improve **predictive modeling** of who will adopt such behaviors.

Get the SA-6 scale & follow our work:

- Twitter: **@heycori** | Email: **heycori @cmu.edu**
- **https://socialcybersecurity.org/sa6.html**

Thank you to

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