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

Cori Faklaris, Laura Dabbish and Jason I. Hong

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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.
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?
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)

- **Awareness**
- **Motivation**
- **Knowledge**

**Security Sensitivity**

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 $X^2(4, N=475)=11.42$, $p = \text{n.s.}$]

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

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

$N = 475$
Best practice: Repeat study in a representative sample to validate scale

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

$N = 209$
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

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<tr>
<th>SA-6 scale items (SPSS Principal Components Analysis)</th>
<th>Factor loading</th>
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<tbody>
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<td>I seek out opportunities to learn about security measures that are relevant to me.</td>
<td>0.81</td>
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<td>I always pay attention to experts' advice about the steps I need to take to keep my online data and accounts safe.</td>
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\( \alpha = .84 \)

CFI = .91

SRMR = .05
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Best practice: Statistical testing of SA-6 as a valid attitude measure

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

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

Validity tests
- 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.

**Scale Validation**

- **Faklaris et al. 2019**
- **Egelman & Peer 2015**
Best practice: Test for expected associations with SA-6

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

$R^2 = .280, \ p < .001$

- **Attitude toward security behavior**
- **Security behavior intention**

**SA-6**

Faklaris et al. 2019

**SeBIS**

Egelman & Peer 2015

Introduction | Study Motivation | Scale Development | Scale Validation | Conclusion
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
    
    \[ r = 0.390, \quad p < 0.01 \]
    
    Malhotra et al. 2004

  - With the Privacy Concerns Scale (PCS)
    
    \[ r = 0.382, \quad p < 0.01 \]
    
    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.**

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<th>Scale Validation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- With the Barratt Impulsiveness Scale</td>
<td>( r = .180, p &lt; .01 )</td>
</tr>
<tr>
<td>- With the General Self-Efficacy scale</td>
<td>( r = .208, p &lt; .01 )</td>
</tr>
<tr>
<td>- With the Social Self-Efficacy scale</td>
<td>( r = .363, p &lt; .01 )</td>
</tr>
</tbody>
</table>
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
  - $r = .542, p < .01$

- w/Confidence in using computers
  - $r = .280, p < .05$

- w/Web-oriented digital literacy
  - $r = .503, p < .05$

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- Kang et al. 2015
- Fogarty et al. 2001 (adapted)
- Hargittai 2005
**Best practice: Test for expected differences in SA-6 by subgroup**

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

<table>
<thead>
<tr>
<th>Age group</th>
<th>SA-6 Mean (SD)</th>
<th>t(df), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-39</td>
<td>3.40 (.81)</td>
<td>t(207) = -2.172, p &lt; .05</td>
</tr>
<tr>
<td>40 +</td>
<td>3.69 (.76)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>SA-6 Mean (SD)</th>
<th>t(df), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>3.77 (.71)</td>
<td>t(198.38) = 2.19, p &lt; .05</td>
</tr>
<tr>
<td>Female</td>
<td>3.53 (.81)</td>
<td></td>
</tr>
</tbody>
</table>
Best practice: Test for expected differences in SA-6 by subgroup

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

<table>
<thead>
<tr>
<th>College attendance</th>
<th>SA-6 Mean (SD)</th>
<th>t(df), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No college</td>
<td><strong>3.42 (.79)</strong></td>
<td></td>
</tr>
<tr>
<td>Attended college</td>
<td><strong>3.73 (.76)</strong></td>
<td>t(207) = -2.76, p &lt; .01</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Income level</th>
<th>SA-6 Mean (SD)</th>
<th>t(df), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below $25K</td>
<td><strong>3.30 (.71)</strong></td>
<td></td>
</tr>
<tr>
<td>Above $25K</td>
<td><strong>3.73 (.77)</strong></td>
<td>t(207) = -3.42, p &lt; .005</td>
</tr>
</tbody>
</table>
**RQ2b:** Does SA-6 vary with past breach experiences? **Yes.**

<table>
<thead>
<tr>
<th>Event</th>
<th>Low Mean (SD)</th>
<th>High Mean (SD)</th>
<th>t(df), p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themselves falling victim to a security breach</td>
<td>3.56 (.78)</td>
<td>4.13 (.58)</td>
<td>t(41.46) = -4.54, p&lt;.001</td>
</tr>
<tr>
<td>Close friends or relatives falling victim</td>
<td>3.57 (.76)</td>
<td>4.10 (.74)</td>
<td>t(207) = -3.40, p&lt;.005</td>
</tr>
<tr>
<td>Heard about security breaches in the past year</td>
<td>3.35 (.80)</td>
<td>3.77 (.74)</td>
<td>t(207) = -3.77, p&lt;.001</td>
</tr>
</tbody>
</table>
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.**

Faklaris et al. 2019

\[ r = 0.398, \quad p < 0.001 \]
Best practice: Test for SA-6’s influence on outcome variables

Attitude toward security behavior

Security behavior intention

Security behavior

SA-6

SeBIS

Egelman & Peer 2015

R²=.280, p<.001

SeBIS

RSec

Faklaris et al. 2019

Faklaris et al. 2019

Introduction | Study Motivation | Scale Development | Scale Validation | Conclusion
Best practice: Test for SA-6’s influence on outcome variables

- Attitude toward security behavior
- Security behavior intention
- Security behavior

**SA-6**
- $R^2=.280, p<.001$
- Faklaris et al. 2019

**SeBIS**
- $R^2=.235, p<.001$
- Egelman & Peer 2015

**RSec**
- Faklaris et al. 2019
Best practice: Test for SA-6’s influence on outcome variables

- **Attitude toward security behavior**
  - $R^2 = 0.280$, $p < 0.001$
  - Faklaris et al. 2019

- **Security behavior intention**
  - $R^2 = 0.235$, $p < 0.001$
  - Egelman & Peer 2015

- **Security behavior**
  - $R^2 = 0.158$, $p < 0.001$
  - Faklaris et al. 2019
SA-6 can improve predictive modeling + targeting of interventions

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

- Attitude toward security behavior
- Security behavior intention
- Security behavior

SA-6 → SeBIS → RSec

Egelman & Peer 2015

$R^2 = .280, \ p < .001$
$R^2 = .235, \ p < .001$
$R^2 = .158, \ p < .001$

Faklaris et al. 2019

Faklaris et al. 2019
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

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