The Role of Emotion in Risk Communication and Warning: Application to Risks of Failures to Update Software (CNS-1343766)

PIs: Mohammad Maifi Hasan Khan (PI)*, Ross Buck (CoPI)¥

*Department of Computer Science and Engineering, ¥Department of Communication

University of Connecticut

This project identifies that ignoring and failing to address the role of emotion in the decision making process in response to pop-up warning messages contribute to the design of ineffective warning mechanisms and resulting noncompliance. To address this shortcoming, this project (i) operationalizes the role of emotion in user experience in the context of pop-up warnings, and (ii) leverages the anticipated and anticipatory emotions to design effective software update and security warning communication mechanisms. Successful completion of this project will change the way software vendors communicate the risks of running buggy and vulnerable software, and warn users about security risks, and has broader implications regarding conceptualizing and measuring user experience (UX) in general.

Approach

Investigate the current designs and delivery mechanisms of pop-up warning messages, and leverage the Communication-Human Information Processing (C-HIP) framework as an investigative tool to identify their limitations from an affective-cognitive perspective.

- Develop User Affective Experience (UAX) scale to measure discrete emotions involved in computer use, and specifically relating to decisions involving pop-up warnings.
- Develop a rational decision framework to identify differences in perceptions between users' who follow advice to those who do not.

•Investigate design of emotion-aware communication and delivery mechanisms to change users' behavior.

Communication-Human Information Processing (C-HIP) Model§
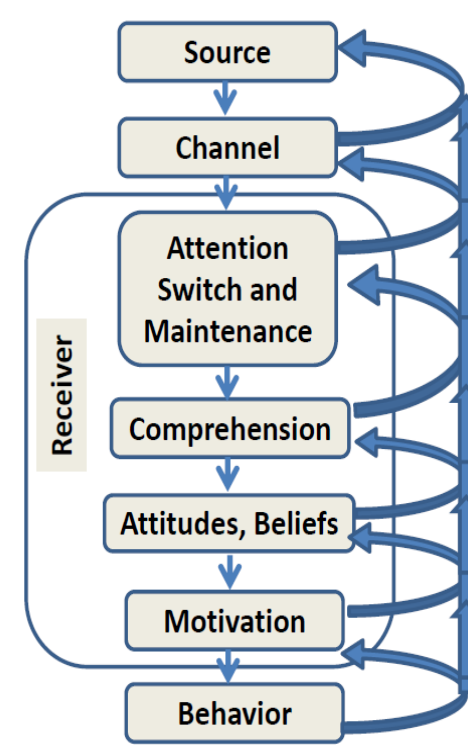
C-HIP model is used to determine where, if at all, the failure in persuasion occurs when trying to convince a user to perform a behavior.

1. **Attention Switch and Maintenance** - Is the message noticeable?
2. **Comprehension** - Is the message understandable?
3. **Attitudes/Beliefs** - Does the message agree with the existing opinions of the receiver?
4. **Motivation** - Does the message provide necessary motivation for the receiver to act?

§ The figure is reproduced from *A Communication–Human Information Processing (C–HIP) approach to warning effectiveness in the workplace, Vincent C. Conzola and Michael S. Wogalter, Journal of Risk Research 4 (4), 309–322, 2001.*

The User Affective Experience Scale (UAX): A measure of emotions reported in response to pop-up computer warnings (Study - I)

- We examined discrete emotions reported when pop-up warnings appear, including specific positive, negative, individualist, and prosocial emotions based upon affective neuroscience.
- Forty-five emotions associated with receiving warnings associated with failing to update software, both in relaxed online sessions and sessions involving time and attention pressures, were assessed for underlying measurement structure.
- 400 participants were recruited via Mechanical Turk, and reported about specific emotions presented in random order.
- Exploratory Structural Equation Modeling (ESEM) analyses revealed four reliable latent factors for relaxed (R) and pressured (P)conditions: Positive Affect, Anxiety, Hostility, and Loneliness.
- P conditions were higher in reported Anxiety, Hostility, and Loneliness; and lower in reported Positive Affect.
- Men reported higher feelings of Hostility and Loneliness.
- Women reported higher Anxiety.

Why Do They Do What They Do?: A Study of What Motivates Users to (Not) Follow Computer Security Advice (Study - II)

- Compare those who follow advice to those who don't
  - Use a rational decision framework to identify differences in perceptions
    - Add risk and social variables to the basic framework
  - Ask participants, "why?"
- Initial sample gathered from Mechanical Turk (N = 764)
  - Groups of 50 formed for 8 groups
    - One group only had 47 eligible participants
- Groups contacted with full survey
- Common Security Advice
  1. Keeping your software up to date
  2. Using a password manager
  3. Using two-factor authentication
  4. Changing passwords frequently

Why Do They Do What They Do?: A Study of What Motivates Users to (Not) Follow Computer Security Advice (Study - II)

- **Decision Model**
  - 12 total variables
    1. *Individual Benefit of Following*
    2. *Social Benefit of Following*
    3. *Individual Risk of Following*
    4. *Social Risk of Following*
    5. *Individual Cost of Following*
    6. *Social Cost of Following*
    7. *Individual Benefit of Not Following*
    8. *Social Benefit of Not Following*
    9. *Individual Risk of Not Following*
    10. *Social Risk of Not Following*
    11. *Individual Cost of Not Following*
    12. *Social Cost of Not Following*
  - 3 components
    - Benefit, risk, and cost
  - 2 behavior contexts
    - Following (the advice), and not following (the advice)

Individual Benefit of Following

	A(M)	A(M)	U	p	d
Update	3.77(4)	2.97(3)	274.5	<0.001	0.51
Pass.Man.	3.78(4)	2.5(2.5)	154.5	<0.001	0.73
2FA	3.71(4)	2.90(3)	243.5	<0.001	0.49
Chg.Pass.	3.47(4)	2.53(3)	256	<0.001	0.57

Individual Benefit of Not Following

	A(M)	A(M)	U	p	d
Update	1.51(1)	2.13(2)	347.5	0.002	0.38
Pass.Man.	1.68(1)	2.70(3)	302	<0.001	0.49
2FA	1.6(1.5)	2.62(3)	161.5	<0.001	0.61
Chg.Pass.	1.70(2)	3.03(3)	176	<0.001	0.66

Cost of Following

		A(M)	A(M)	U	p	d
Individual	Update	2.03(2)	2.10(2)	527.5	0.444	0.09
	Pass.Man.	1.73(2)	2.18(2)	533	0.011	0.28
	2FA	2.00(2)	2.39(2)	405.5	0.036	0.26
	Chg.Pass.	2.35(2)	2.97(3)	449.5	0.005	0.33
Social	Update	1.22(1)	1.29(1)	431	0.781	0.04
	Pass.Man.	1.28(1)	1.52(1)	565.5	0.213	0.15
	2FA	1.52(1)	1.44(1)	403.5	0.786	0.04
	Chg.Pass.	1.28(1)	1.64(1)	491	0.073	0.21

Risk of Following

		A(M)	A(M)	U	p	d
Individual	Update	1.56(2)	1.75(2)	496.5	0.335	0.12
	Pass.Man.	1.83(2)	2.53(2)	342.5	<0.001	0.49
	2FA	1.56(1)	1.62(1)	498.5	0.729	0.04
	Chg.Pass.	1.35(1)	1.71(2)	498.5	0.014	0.28
Social	Update	1.13(1)	1.38(1)	369.5	0.047	0.25
	Pass.Man.	1.41(1)	1.53(1)	628	0.707	0.04
	2FA	1.31(1)	1.48(1)	433.5	0.47	0.09
	Chg.Pass.	1.19(1)	1.17(1)	628.5	0.709	0.04

Risk of Not Following

		A(M)	A(M)	U	p	d
Individual	Update	3.42(4)	2.77(3)	336.5	0.002	0.37
	Pass.Man.	2.88(3)	1.80(2)	302.5	<0.001	0.52
	2FA	3.42(3)	2.61(3)	243.5	<0.001	0.53
	Chg.Pass.	3.14(3)	2.63(3)	440.5	0.003	0.34
Social	Update	2.67(3)	1.76(1)	262.5	<0.001	0.44
	Pass.Man.	1.92(2)	1.29(1)	409	0.002	0.37
	2FA	2.48(3)	1.79(2)	289	0.013	0.32
	Chg.Pass.	1.70(1)	1.29(1)	483	0.044	0.24

Cost of Not Following

		A(M)	A(M)	U	p	d
Individual	Update	2.95(3)	2.00(2)	247.5	<0.001	0.48
	Pass.Man.	3.15(3)	1.75(1)	244.5	<0.001	0.60
	2FA	1.76(1)	1.57(1)	446.5	0.451	0.09
	Chg.Pass.	2.28(3)	1.61(1)	425.5	0.003	0.35
Social	Update	2.32(2)	1.59(1)	248	0.001	0.41
	Pass.Man.	1.84(1)	1.03(1)	354	<0.001	0.49
	2FA	1.69(1)	1.41(1)	343	0.356	0.12
	Chg.Pass.	1.50(1)	1.24(1)	525.5	0.174	0.16

Publications

[1] Why Do They Do What They Do? A Study of What Motivates Users to (Not) Follow Computer Security Advice. Michael Fagan and Mohammad Maifi Hasan Khan. In Proceedings of Symposium on Usable Privacy and Security (SOUPS), 2016.
[2] A study of users' experiences and beliefs about software update messages. Michael Fagan, Mohammad Maifi Hasan Khan, and Ross Buck. *Computers in Human Behavior* 51 (2015): 504-519. Elsevier.
[3] How does this message make you feel? A study of user perspectives on software update/warning message design. Michael Fagan, Mohammad Maifi Hasan Khan, and Nhan Nguyen. *Human-centric Computing and Information Sciences* 5.1 (2015): 1.
[4] The User Affective Experience Scale (UAX): A measure of emotions reported in response to pop-up computer warnings. Ross Buck, Mohammad Maifi Hasan Khan, Michael Fagan, and Emil Coman. (Under Review)
[5] An Investigation into Users' Considerations Towards Using Password Managers. Michael Fagan, Yusuf Albayram, Mohammad Maifi Hasan Khan, and Ross Buck. (Under Review)
[6] To Follow or Not to Follow: A Study of User Motivations Around Cybersecurity Advice. Michael Fagan and Mohammad Maifi Hasan Khan. (Under Review)

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