

Emergence of Human-Centric Information Security and an Integrated Model

TREO Talk Paper

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Abstract

In this opinion paper, we first review the evolution of information security research, and summarize it as three waves of information security evolution (see Appendix A): the first wave is technology-centric, which aimed to create technical artifacts of information security, and the main contributors in the wave are the traditional STEM fields experts; the second wave is economics-centric, which aimed to design economic mechanisms to incentivize users' optimal information security behaviors, in this wave, the main contributors are the classic economist; and the emerging third wave is human-centric. In this wave, the focal point of interest is human decision making in information security scenarios, and a wide variety of factors that would influence human decision making in reality are incorporated in the study of information security. In this wave, the main goal is to develop information security technical tools that users will actually use in the real world and use properly, and to design information security regulations and policies that user will actually be able to follow in reality. This emerging trend in information security requires contributions from a wide spectrum of expertise: psychology, neuroscience, behavioral economics, sociology, etc.

Based on this understanding, we present an Integrated Model of Human-Centric Information Security (iMOHCIS), which systematically incorporates various factors that influence human brain functions, and illustrates how human brain activities result in actual information security behaviors (see Appendix B). In this model, information security artifacts refer to systems, interface, policies, practices pertaining to information security, and are created based on design science, engineering, and IT literature; brain activities refer primarily to psychophysiological, and neural activities of human brain, which are studied based on psychology and neuroscience literature; the human nature includes personal traits such as multitasking tendencies, age, gender etc, which are based on biology, psychology, and neuroscience literature; the environmental factors may include cognitive load of tasks, brain stimulation, cultural norms, societal influences etc, and are studied based on neuroscience, sociology literature; the antecedents of information security behaviors refer to elements such as emotions, attitudes, intentions, biases, etc, which are based on psychology, neuroscience literature; and finally the actual information security behaviors which can be observed as and measured by interaction time, clickstreams, decision making, etc.

This iMOHCIS focuses on human-centric information security at individual agent level. We extended it to incorporate multi-agent interactions in two significant dimensions: qualitative dimension and quantitative dimension (see Appendix C). In qualitative extension, we consider the decision makers to be either friendly or adversary to each other; in quantitative extension, we consider the decision maker's individual behavior versus group behavior. In the extended model, Quadrant 1 and 3 represent direct applications of iMOHCIS; Quadrant 2 and 4 are applications of iMOHCIS within the context of group decisions and group behavior. This extended model also shows the interactions in the two dimensions: A) Qualitative dimension: how friendly agent's behaviors and adversary agent's behaviors influence each other; and B) Quantitative dimension: how individual agent's behaviors and group's behaviors influence each other.

We are convinced that iMOHCIS and its extension capture the essence of the emerging human-centric information security, provide a comprehensive framework for understanding human-centric information security, and generate a systematic approach to identifying significant research opportunities related to information security. This framework also provides a foundation for human-centric information security education curriculum design.