CHAPTER 3

The Role and Contribution of Theory in HCI

"Ernest Hilgard used to grumble about psychology that if you develop a theory it's like your toothbrush, fine for you to use but no one else is very interested in using it." (Jonathan Grudin, 2002).

Theory is very powerful for advancing knowledge in a field. It is the bedrock of many disciplines driving research programs, resulting in insights and enabling new discoveries. A theory can be defined strictly in terms of an explanation of scientific data that follows the scientific method. Predictions are made in terms of hypotheses about an assumed phenomenon, which are then tested, allowing them to be supported because the data cannot be falsified. If the data does not support a hypothesis, it is rejected and the theory is modified and new predictions made.

3.1 INTRODUCTION

Within HCI, the scientific method to theory development was initially adopted as a way of advancing the body of knowledge. However, increasingly other interpretations of theory, drawing from the natural sciences, social sciences, arts and philosophy, have started to be used. These are much broader in scope, where theory is viewed as beginning from description, and then moving onto identification of patterns, and only hundreds of years later, does it become useful theory (Grudin, 2008). Critical theory as viewed in sociology (e.g., Adorno, Habermas), the arts and humanities (e.g., literary theory) and philosophy (e.g., the extended mind theory, Clark, 2004) is not quantifiably measureable, in any scientific sense, but provides conceptual tools and a cogent set of arguments or propositions that can explain or articulate phenomena. Within HCI, a broad church of theory, including those originating in the arts and humanities, is increasingly accepted. A key challenge is finding ways of communicating between the different kinds and levels of theory.

3.2 IMPORTING THEORY

Since the 1980s, HCI has imported numerous kinds of theories, providing the means to analyze and predict the performance of users carrying out tasks for specific kinds of computer interfaces and systems. The theories have been diverse ranging from over-arching theories that attempt to cover the science of HCI — such as Barnard et al.'s (2000) "systems of interactors" intended to bind together contributions from different disciplines — to micro-theories that address a specific phenomenon

that can make predictions about certain behaviors — such as dual-task performance — leading to testable hypotheses.

The kinds of theories that have been imported have been primarily cognitive, social and organizational in origin; for example, cognitive theories about human memory have informed the design of interface elements, such as icons, command names and the location of menu items, to make them easy to remember; social psychology theories have informed the design of social experiments which investigate how people communicate and work together in groups when using computer-based collaborative tools and social media; and organizational theories have been developed in CSCW to systematically conceptualize how people interact and process information, make decisions, behave towards others and operate in their work and other social settings (Barley et al., 2004).

One of the main benefits of applying specific theories from other fields about human behavior is they help identify factors (e.g., cognitive, social and organizational) relevant to the design and evaluation of interactive products. In particular, they can help narrow down an area into concerns and research questions that can then be operationalized in terms of a problem or design space. The rationale for selecting a variable or set of variables can be backed up by a proposed cause-effect. For example, the type of words and the syntax that people are likely to remember most with least error may be based on the findings of prior cognitive studies of how subjects learn and recall sets of word-pairings, based on psycholinguistic theory.

3.3 DIFFERENT ROLES AND EXPECTATIONS

Theory works at an abstract level, enabling understandings and generalizations to be made about specific phenomena. Within HCI, a number of vehicles for disseminating these have been proposed, ranging from qualitative and descriptive concepts, themes, patterns, ideas, frameworks, to more formally and predictive, taxonomies, models and principles. They usually are based on assumptions and, at the highest level, aim to provide general laws, rules and formulas, which can be applied in a variety of contexts. The most well known in HCI is Fitt's Law that has been widely used to predict the best placement of buttons and keys on mobile devices and elements on a GUI, to reduce error rate based on the observation of how users aim for targets using their fingers or pointing devices.

An early example of using theory in the scientific tradition was the application of information processing theory to make predictions about how long it would take someone to complete a set of tasks when comparing two or more kinds of interfaces, that varied along one dimension in a controlled way, such as how information was presented (e.g., the efficacy of selecting from 4 menus, each presenting 4 options versus 2 menus, each presenting 8 options). However, as HCI moved from its early roots in engineering through its aspirations to be a scientific discipline to its current mix of science, engineering, art and design, others have argued that the role of theory should be more. Bederson and Shneiderman (2003), for example, suggest that there at least five kinds of theories we should be *aiming* for using in HCI. These are:

- **descriptive** - in the sense of providing concepts, clarifying terminology and guiding further inquiry;

- **explanatory** – in the sense of explicating relationships and processes;
- **predictive** – enabling predictions to be made about user performance;
- **prescriptive** – providing guidance for design;
- **generative** – in the sense of enabling practitioners to create or invent or discover something new.

They suggest that each serves a particular role in the HCI community: *describing* "objects and actions in a consistent and clear manner to enable cooperation" among researchers; *explaining* "processes to support education and training," predicting performance "so as to increase the chances of success;" *prescribing* "guidelines, recommending best practices and cautioning about dangers" to practitioners, and *generating* novel ideas to improve research and practice.

I also discussed the various roles that theory has played in HCI (Rogers, 2004). Some of these overlap with Bederson and Shneiderman's classification, but, in addition, include the following:

- **informative** –selected knowledge and generalizations from another field that provide relevant research findings for HCI to couch understandings and designs;
- **ethnographic**–rich descriptions of a real-world phenomenon interpreted and grounded within a disciplinary tradition, such as anthropology, cognitive science or sociology;
- **conceptual** – the development of high-level frameworks and dimensions for informing and articulating the design and evaluation of prototypes, user interactions and user studies;
- **critical** – critiquing and reasoning about interaction design based on cultural and aesthetic concerns.

Within CSCW, Halverson (2002) also suggested that the role of theory is to provide a conceptual framework that helps the researcher make sense of and describe the world, which can be **descriptive**, **rhetorical**, **inferential** or **application-based**. By descriptive, she refers to how a theory can account for a work setting as well as critiquing an implementation of technology in that setting. By rhetorical, she refers to how theory can label important aspects of the conceptual structure that enables researchers to describe things to themselves as well as communicating this to others. By inferential, she refers to engaging in arguments about whether theories are true, or only falsifiable, where sometimes the inferences may be about phenomena that are not fully understood to know where or how to look. By application, she refers to applying theory to the real world for pragmatic reasons, such as informing and guiding system design.

Hence, the role of theory in HCI has been stretched, from how it was originally used as part of the scientific method to being interpreted broadly at different levels to describe, explain, predict and argue with. Whereas in other disciplines, such as chemistry and neuroscience, adhering to the scientific method provides the necessary rigor and criteria to advance knowledge, the widening of theory in HCI has provided many ways of conceptualizing phenomena, in terms of framing,

explaining, prescribing and informing — which appears to allow for more transferability. Ultimately, it is an applied field, which means it does not have to be constrained by the restrictions and criteria of a natural science. The downside of such eclectism, however, is a weakening of its theoretical adequacy, i.e., being certain that an account is representative of the state of affairs.

Many of the early theoretical approaches in HCI followed the scientific tradition, whereby particular theories were used to make predictions about user behavior resulting in prescriptive advice. But as will be discussed in the next chapter their limitations soon became apparent. The emergence of ethnographic approaches in the 1990s was partially as a reaction to this. As an alternative, they offered more expansive ways of accounting for user behavior that was grounded in a particular theoretical or epistemological perspective, including cognitive, social and anthropological ones. A corpus of case studies of the intricate goings on in workplace and other settings appeared (Plowman et al., 1995; Suchman, 1987). They highlighted the importance of considering the social context, the external environment, the artifacts and the interaction and coordination between these during human-computer interactions.

The new kinds of fine-grained, discursive writings were in stark contrast to the concise quantitative results that came out of the predictive and prescriptive approaches to HCI. The accounts of situated human-computer interactions were revelatory, opening many computer scientists' eyes to seeing the world of technology use differently (Dourish, 2001). In turn, it led to thinking about the design and redesign of technologies from very different perspectives. Generative theories then came to the fore that provided design dimensions and constructs to inform the design and selection of new user experiences. More recently, critical theories have provided different ways of understanding, conceptualizing and constructing arguments about aspects of the user experience, interaction design and practice.

3.4 A TAXONOMY OF HCI THEORY: CLASSICAL, MODERN AND CONTEMPORARY

As mentioned in Chapter 1, I have chosen to describe the various theoretical developments in HCI in terms of three periods: Classical, Modern and Contemporary. To reiterate, Classical (Chapter 4) refers to the 1980s, when classical cognitive theories were first imported from cognitive psychology, primarily for modeling and analytic purposes; Modern (Chapter 5) refers to the 1990s and early 2000s when a wide body of theories and frameworks were brought to the field from quite diverse disciplines to address the burgeoning challenges; and Contemporary (Chapter 6) refers to everything that has happened since, including postmodernist, philosophical and in-the-wild approaches.

Classicism in the arts was about setting standards, by being formal and restrained, with a high regard for taste in antiquities. There are parallels in classical HCI, in so far, as rigor and quality of theory were considered central. Similar to the developments in Modern Art, developments in Modern HCI theory were not as prescriptive as in Classical HCI theory. Contemporary HCI is more socially conscious than the previous movements. Theories have been imported and developed

with the goal of making an impact on life and a difference to society: including behavioral change, climate change, feminism, multiculturalism, globalization and poverty.

The parallels to art history are meant only as a heuristic, helping to see patterns and commonalities in the scoping and framing of different theories throughout its relatively short history. Others have chosen to link theoretical developments. more closely to the technology eras that have been identified. For example, the turn to the social was not a shift in intellectual thinking but more a recognition that technology and design problems were changing at that time. Similarly, "theories today that focus on place, movement, and ubiquity would still be coffee-time discussions at PARC if we did not have smartphones and other mobile devices" (Carroll, personal communication). If technology development has a strong influence on the choice of theoretical approach, it raises the question of what is in store, post contemporary theories? What theories will we use when computers become increasingly embedded in our bodies, managing our vital organs? But before contemplating where future theories will come from and what role they will play, in the next three chapters, I introduce and discuss the context and theoretical approaches developed in each of the three loosely coined periods.