Culture, Complexity, and Informing: How Shared Beliefs Can Enhance Our Search for Fitness

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Abstract

Where shared knowledge, beliefs, attitudes and artifacts exist within a group, we have a culture. Culture plays a central role in informing research with two key themes being dominant: 1) the challenges presented by communicating across cultures, and 2) the impact of shared attributes, such as receptiveness to novel ideas, on a culture's readiness to be informed.

Recent research in organizational behavior suggests another perspective: that having *a strong culture that is also adaptable* can significantly improve an organization's performance across a broad range of possible attributes. In other words, culture itself—independent of specifics—can exert a positive influence. The paper considers this proposition in the context of complex environments, finding considerable theoretical justification. Complex environments present major challenges to individuals seeking to improve their personal fitness; rules tend to be highly localized and fitness drops between states are often sharp. Using a combination of informing science models and simulations of complex landscapes, the paper demonstrates how imitating nearby neighbors proves to be a highly effective strategy as complexity grows. A strong culture fosters similarities across individuals or entities within a group, ensuring that participants have many self-similar neighbors to observe. The shared values can also serve to reduce the distortion we experience when we relate our own experiences and listen to the experiences of others.

Encouraging the development of strong culture is not without risk, however. It is already well established that certain cultural traits—such as the unwillingness to attend to individuals outside the cultural grouping—can impede informing. There is also the danger that the underlying processes that produce strong culture—such as homophily and social contagion—may succeed too well in static environments, leading to values that are over-constrained and therefore do not adapt well. By understanding the informing implications of culture, we may be able to better avoid such obstacles in the future.

Keywords: culture, informing, fitness, homophily, complexity, rugged landscapes, filters.

Introduction

Culture can be described as a system of knowledge, beliefs, procedures, attitudes, and artifacts that is shared within a group. That the cultures with which each of us connects exert a strong influence on our behaviors is beyond dispute. Recent research into the success of organizations has also shown that culture

can exert a major influence on organizational performance. Evidence also suggests that most individuals prefer to participate in strong cultures, as opposed to weak ones. This seems almost paradoxical because strong cultures naturally tend to limit what we think and do in relation to the shared elements of the culture. By participating in a strong culture we may therefore be constraining our personal freedom.

The present paper examines this paradox—that we seek shared values even at the cost of freedom—through the lens of informing. The core argument presented is that when we face highly complex environments, we must rely heavily upon observing others to increase our personal *fitness*, a term employed by evolutionary biologists to characterize an individual's relative ability to thrive in a particular environment. Unfortunately, environmental complexity also implies that we learn little from the actions and outcomes of others unless the individuals we observe happen to be similar to us in many ways. Culture serves as a mechanism for bringing together individuals with many shared traits. As a result, participating in one or more cultures provides us with the opportunity to make observations that are likely to be relevant to increasing our own fitness.

The paper proceeds as follows. The existing literature is presented in two parts. First, a quick introduction to the concept of culture is provided, including a review of how culture is presented within the informing science transdiscipline, considering how shared culture can reduce the distortion caused by the various filters that interfere with individual informing. That is followed by a discussion of recent investigations regarding the impact of culture on organizational performance. Finally, we identify key mechanisms—homophily and social contagion—that virtually ensure the emergence of culture within almost any long-standing group. The second portion of the review examines the nature of complexity, emphasizing the concept of fitness. The mapping between all possible traits and the resulting fitness value is referred to as a *fitness landscape.* Such landscapes range in their complexity from decomposable (each trait contributes to fitness independently of the state of other traits) to highly rugged (individual traits contribute to fitness only through interaction with other traits, such as the ingredients in a recipe). For individuals facing a rugged landscape, imitation proves to be a sensible approach for increasing fitness.

The main conceptual scheme of the paper is then presented: that a strong culture offers informing benefits that extend beyond the obvious contribution of shared attributes that directly support informing, such as a positive attitude towards education. The argument presented focuses on how culture can enhance search of a complex landscape through imitation. The paper then discusses practical issues relating to building a culture that facilitates informing. Although cultures tend to emerge, rather than being designed, ineffective or inconsistent leadership can undermine the development of a strong culture. Where a group perceives its environment to be static, the very processes that lead to a strong culture can produce a culture that becomes over-constrained, one in which individuals abandon the search for higher fitness. And, of course, there is the ever-present danger that a culture may adopt values antithetical to informing, particularly with respect to individuals outside of the group. In concluding, the paper proposes that a better understanding of the relationship between culture and complexity may help us avoid such barriers to informing in the future.

Nature and Impact of Culture

Terry Eagleton (2000, p. 1) begins his book *The Idea of Culture* with the statement:

> 'Culture' is said to be one of the two or three most complex words in the English language and the term which is sometimes considered to be its opposite—nature—is commonly awarded the accolade of being the most complex of all.

With thousands of books having been written on the subject of culture, and hundreds of thousands of articles referring to it, it is fair to assert that any comprehensive literature review attempting to

do justice to the concept as a whole is destined to fail, with little credit being awarded for the effort. The focus of the review that follows will be considerably more modest: providing a working definition for use in this paper, considering how culture is generally treated within the informing science transdiscipline, discussing some recent findings that relate culture to organizational effectiveness, and, finally, looking at specific human traits that lead to the emergence of culture.

Definitions of Culture and Its Impact

As illustrated in Table 1, culture has been defined in a number of different ways. As Smircich (1983) observes, anthropologists have been divided with respect to whether culture should be considered in terms of the purposes that it serves (e.g., functionalism, structural-functionalism) or with respect to its shared outcomes. Fortunately, for our purposes here, even functional definitions recognize the shared outcome consequences. We therefore focus on these in defining culture for the purposes of this paper:

> Culture is a system of shared knowledge, beliefs, procedures, attitudes and artifacts that exists among a group of humans.

Table 1: Selected Definitions of Culture

Definition	Source
the set of individual attributes that are subject to social influence	Axelrod (1997, p. 204)
those customary beliefs and values that ethnic, religious, and social groups transmit fairly unchanged from generation to generation	Guiso, Sapienza & Zingales (2006, p. 23)
complex rule-like structures that constitute resources that can be put to strategic use	DiMaggio (1997, p. 265)
Organizational culture is the pattern of basic assumptions that a given group has i*nvented, discovered,* or *developed* in learning to cope with its problems of *external adaptation* and *internal integration*, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to *perceive, think,* and *feel* in relation to those problems.	Schein (1984, p. 3)
a set of cognitions shared by members of a social unit	O'Reilly, Chatman, & Caldwell (1991, p. 491)
a system of shared values (defining what is important) and norms (defining appropriate attitudes and behaviors).	Chatman & Cha (2003, p. 21)
consists of symbolic vehicles of meaning, including beliefs, ritual practices, art forms, and ceremonies, as well as informal cultural practices such as language, gossip, stories, and rituals of daily life.	Swindler (1986, p. 273)
Conceptions of culture from anthropology: 1. Culture is an instrument serving human biological and culture needs, e.g., Malinowski's (1944) functionalism. 2. Culture functions as an adaptive-regulatory mechanism. It unites individuals into social structures, e.g., Radcliffe-Brown's (1952) structural-functionalism. 3. Culture is a system of shared cognitions. The human mind generates culture by means of a finite number of rules. E.g., Goodenough's (1971) ethnoscience. 4. Culture is a system of shared symbols and meanings. Symbolic action needs to be interpreted, read or deciphered in order to be understood, e.g., Geertz's (1973) symbolic anthropology. 5. Culture is a project of mind's universal unconscious infrastructure, e.g., Levi-Strauss' (1973) structuralism	As cited in Smircich (1983, p. 342)

From the outset, we need to recognize that an individual is inevitably going to participate in multiple cultures; cultures develop across nations, regions, religions, organizations, families, social

groups and so forth. Variations in individual group membership patterns will likely prevent a uniform "culture" from developing that is shared by *everyone* within a group. More than that, however, it is increasingly understood that individuals will vary even within a strongly shared culture (e.g., Tooby & Cosmonides, 1992).

For convenience of later analysis, it is useful to think of cultural sharing as having three aspects:

1. *Mental Models*: Knowledge, beliefs, and procedures that aid members of the group in dealing with the world. These models may reflect what is believed to be true (e.g., theories) or may be shared for their usefulness (e.g., conceptual schemes) (Gill, 2011). Included are reasoning systems such as mathematics and logic that allow models to be manipulated and extended.
2. *Preferences*: Attitudes and values surrounding what is right/good/valuable versus what is wrong/bad/worthless. Economists sometimes frame these as a utility function (Gill, 2008).
3. *Artifacts*: The manifestations of the culture that exists in the real world, such as languages, literature, tools, technologies, symbols, rituals, icons, and so forth. These cultural artifacts serve the role of communicating and re-affirming mental models and preferences that shape the members of the culture.

There is considerable evidence that culture can exert a significant impact on mental models and associated reasoning systems. This has been particularly well demonstrated with respect to regional cultures. Beliefs regarding causality, for example, have been shown to differ significantly between U.S. and Chinese students, the former explaining observed behaviors with reference to internal (dispositional) forces, that latter with reference to external (situational) forces (Morris & Peng, 1994). Western and Eastern cultures also appear to hold different views regarding the degree to which the individual is self-contained (Markus & Kitayama, 1991). In fact, subsequent studies have found even broader culture impacts. For example:

> the considerable social differences that exist among different cultures affect not only their beliefs about specific aspects of the world but also (a) their naive metaphysical systems at a deep level, (b) their tacit epistemologies, and (c) even the nature of their cognitive processes—the ways by which they know the world (Nisbett, Peng, Choi, & Norenzayan, 2001, p. 291)

The role of shaping shared preferences is also considered to be an element of culture. These preferences determine what we establish as goals and values. In the context of an organization, shared preferences/values have been described as acting in the following manner:

> they improve performance by energizing employees—appealing to their higher ideals and values and rallying them around a set of meaningful, unified goals. Such ideals excite employee commitment and effort because they are inherently engaging and fill voids in identity and meaning (Chatman & Cha, 2003, p. 21).

Framed in another way, cultural preferences provide the individual with an estimate of the fitness of different behaviors and outcomes. Such estimates can prove to be critical in directing an individual's actions and choices (Gill, 2010).

Artifacts represent the most visible manifestations of culture, particularly to outsiders. For this reason, some researchers argue that they should be the means by which culture is defined (Swindler, 1986). Regardless of definition, they represent the key channel through which mental models and values are communicated. A particularly important artifact is the story, which has been found to be an unusually effective form of communication (e.g., Heath & Heath, 2007; Weick, 1987). One explanation that has been proposed for this resonance is the fact that stories commu-

nicate knowledge and values in context, allowing the individual to assess their specific relevance to a particular situation, rather than presenting these as general rules that must either be believed or disbelieved (Gill, 2010).

As already noted, cultures can vary considerably in their impact upon individuals within a group. Two dimensions of cultural sharing prove to be particularly relevant to the present paper:

- *Comprehensiveness*: The degree to which the elements of culture are expected to impact all aspects of individual behaviors. Some cultures, such as those shared by certain religious groups (such as the Amish), are so comprehensive that they are expected to impact virtually everything the member does and thinks. Other cultures (such as might develop around a Wednesday night bowling league) have far fewer shared elements (e.g., the importance of showing up on time, what discussion topics are off-limits, and expected level of sobriety at the commencement and completion of a match).
- *Strength*: The degree to which elements of a culture are shared uniformly by all members of a group. In a strong culture, we would expect that key values would be held nearly universally, shared artifacts would be respected by all, and beliefs incorporated into the culture would not be subject to routine questioning. In a weak culture, on the other hand, we would expect high levels of variation in adherence to shared elements among members. Groups constructed around a particular set of ideas or beliefs will often devolve into subgroups to accommodate different levels of strength of culture. Judaism and Catholicism, for example, both have their own orthodox (relatively high strength) and secular (relatively low strength) subgroups.

Culture and Informing Science

Culture is assumed to play an important role both in informing processes and in the development and evolution of informing systems. Despite that fact, it has not appeared to be a major research focus in the informing science literature. Only eight articles featuring culture as a central theme could be identified based on a search of *Informing Science Institute* journals. These articles are summarized in Table 2.

Table 2: Significant references to culture within informing science publications

Finding or topic	Source
A cross-culture comparison of Japan and the U.S. found that hypothesized influences on knowledge sharing showed similar patterns of significance across the two cultures.	Ryan, Windsor, Ibragimova, & Prybutok (2010)
A study to demonstrate how aspects of Maori culture could be acquired from Maori websites.	Kovacic (2001)
Proposed an adaptive learning design that could accommodate the sensibilities of different cultures.	Reiners & Dreher (2009)
Explored the common aspects of IT culture across 26 IT professionals from 3 organizations.	Chase (2008)
Examined the change in culture that took place in a Canadian folk arts festival and the role played by the politics of information.	Travica (2005)
Social networking sites could enable types of knowledge exchange that would facilitate adaptation to U.S. culture by international students.	Ryan, Magro, & Sharp (2011)
National culture had a moderate impact on readiness for eGovernment.	Kovacic (2005)
Cultural differences between U.S. and Norway that were reported by Hofstede did not appear in a study of ICT workers.	Sørnes, Stephens, Sætre & Browning (2004)

In attempting to expand the role culture plays within the informing science transdiscipline, a potentially useful way of viewing how culture may impact our ability to inform can be found in the

bias filter model (Gill, 2008, 2010; Jamieson & Hyland, 2006). According to this model, for effective informing to take place—which is to say informing that produces intended changes in the mental schema of the client—it must pass through a series of client mental filters without undue loss or distortion. This conceptual scheme is illustrated in Figure 1.

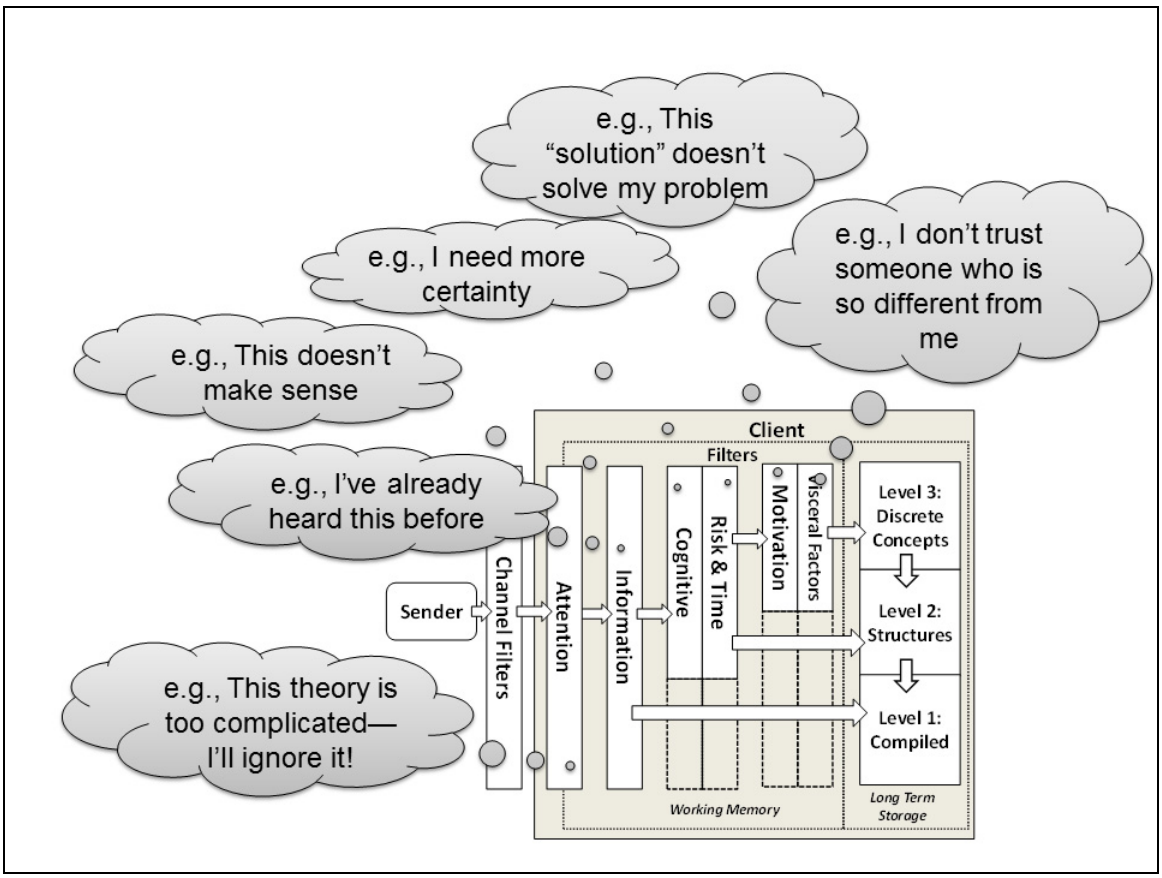


Figure 1: Bias filter model of individual informing (adapted from Gill, 2010)

Within this model, it is immediately evident that culture can exert an influence on every filter that would otherwise block or distort incoming communications. For example:

- *Attention*: Culture can shape an individual's attitude towards what is, or what is not, interesting. For example, the media seems to devote an inordinate amount of time reporting upon the private activities of celebrities of the popular culture. More generally, what we find most interesting is usually items that depart slightly from existing mental models, but not too much (Davis, 1971). Culture can play a strong role in establishing these pre-existing mental models.
- *Information*: We tend to interpret new information in a manner that confirms what we already know. When we see symbols, we use these as a cue to retrieve information beyond what has been communicated, often intermixing the two. Generally speaking, the mental models and artifacts that are associated with a particular culture allow for more efficient communication since tacit knowledge does not need to be transmitted. They can also distort communications, however, both by causing us to ignore relevant details and by causing us to imagine that information has been conveyed that was not actually communicated.

- *Cognitive*: We tend to reject information that conflicts with our existing mental models and beliefs. Since such models and beliefs are essential parts of a strong and comprehensive culture, their presence can seriously impair communications. Individuals belonging to the same culture are more likely to take into account such models in framing their message.
- *Risk and Time*: Attitudes towards risk and time are frequently incorporated in the preferences of a culture. U.S. public companies, for example, are often accused of promoting a culture that favors quarter-to-quarter profits over long term performance. Communications that fall outside the individual's preferred time-frame or risk tolerance are likely to be ignored or discounted. Cultures frequently share risk/time preferences, as noted in Hofstede's cultural dimensions (Hofstede & Bond, 1984).
- *Motivation*: Individuals are rarely impacted by information if they are not motivated to do so; such motivation can be either extrinsic (a function of a reward system) or intrinsic (a consequence of the individuals internal desire to improve). A formal system of rewards and punishment is an important artifact of many cultures. As noted earlier, however, one of the most important aspects of many cultures is establishing a system for identifying what is right/good/valuable versus what is wrong/bad/worthless. Such a system is a critical contributor to intrinsic motivation.
- *Visceral Factors*: These are the aspects of a communication that impact us at an emotional level. The artifacts that accompany many strong, comprehensive cultures—such as the rites and rituals, stories, symbols, art, and literature—can all exert a powerful influence at this level, increasing or decreasing our willingness to accept the communication. In addition, self-similarity is an important aspect of culture (to be discussed later) that can influence both our receptiveness to a message and how we interpret certain elements of the communication, such as body language.

In identifying these mechanisms through which culture can impact informing, it is critical to note that they can serve either a *negative* or *positive* role. When communicating between cultures, they often act as a barrier. When communicating within cultures, on the other hand, the mutual understanding that exists across the membership of a strong, comprehensive culture can dramatically reduce the difficulty of communicating ideas. Indeed, some researchers argue that the ability to share and understand intentions is a central evolutionary benefit of culture (e.g., Tomasello, Carpenter, Call, Behne, & Moll, 2005). Understanding the mental models of the client is an important element of making informing more structured and routine (Gill, 2010, p. 230).

The models and artifacts of a culture can also impact an informer's ability to frame particular types of problems and, accordingly, structure a communication. This particular cultural impact can work either to clarify or obscure—even within a particular culture. In the book *Outliers* (Gladwell, 2008) examples of both are provided. In the case of a Korean Airliner, the unwillingness of a co-pilot to contradict a pilot caused a jet to crash into a mountain. In the case of Chinese rice paddy farmers, it has been proposed that the highly precise nature of the work has produced a particular aptitude for mathematical problem solving.

The impacts of culture on shared models and framing ideas is illustrated in Figure 2, adapted from an earlier model (Gill, 2010). Informing tends to become routine once the knowledge to be conveyed is well defined and the pre-existing mental models of the clients are well understood. Typically, the greater the complexity of the models and the greater the diversity of the clients, the less structured the informing process. Culture is presumed to impact this model in two ways (the arrows outside the box). Whereas knowing the values of other members is nearly always expected to make informing more routine (the horizontal axis), existing cultural elements can either facilitate or present a barrier to models being conveyed (the vertical axis). For example, a culture that

has not developed the habit of framing logical problems in terms of syllogisms will be at a distinct disadvantage when information is conveyed in that manner (Lee & Johnson-Laird, 2006).

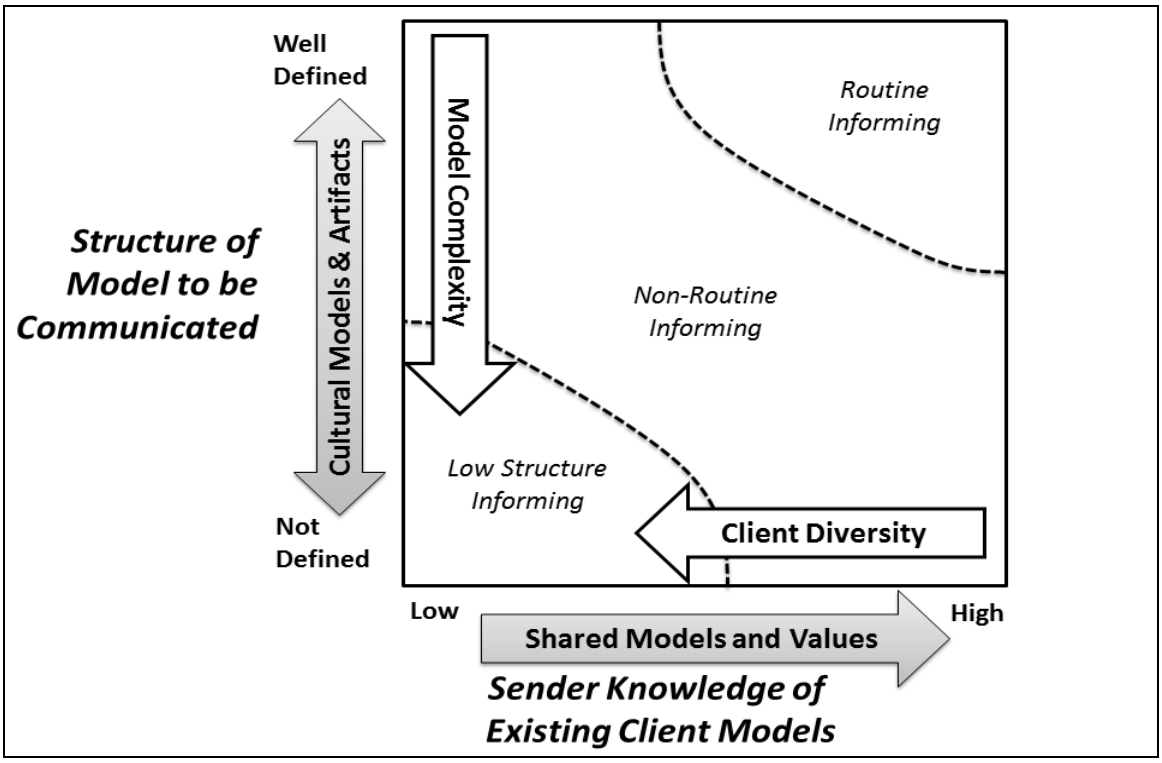


Figure 2: Impact of culture on the structure of informing processes

Impact of Culture on Organizational Performance

The development of a culture is virtually inevitable wherever there is a permanent or long-standing group of individuals. Some researchers propose that the evolution of an organization's culture represents an important aspect of "organizational learning" (Cook & Yanow, 1993). Others have argued that "a system which values stories, storytellers, and storytelling will be more reliable than a system that derogates these substitutes for trial and error" (Weick, 1987, p. 113). Culture has also been characterized as an alternative to formal policies that can be employed as a leadership tool (Chatman & Cha, 2003).

A particularly intriguing set of research findings has emerged regarding the impact of culture on overall organizational performance (e.g., Heskett, 2011) and on individual performance within the organization (Groysberg, 2010). What makes these findings particularly interesting is that they deal with overall culture and its strength as opposed to treating specific elements of a culture as being either "good" or "bad". For the moment, these findings are summarized. Later in the paper, we consider their specific implications with respect to informing.

The culture cycle

Some managers in large organizations have long ascribed almost mystical properties to organizational culture. In *The Culture Cycle* (Heskett, 2011) some of the quotes from managers include:

> With the right culture, the problems of commitment, alignment and motivation go away and hierarchy becomes irrelevant… --Akardi Kuhlmann, CEO of *ING Direct*

> …our belief is that if you get the culture right, most of the other stuff—like great customer service or building a great long-term brand, or passionate employees and customers—will happen naturally on its own. –Tony Hseih, CEO of *Zappos.com*
>
> Until I came to IBM, I probably would have told you that culture was just one among several important elements in any organization's makeup and success— along with vision, strategy, marketing, financials, and the like ... I came to see, in my time at IBM, that culture isn't just one aspect of the game— it is the game. –Lou Gerstner, CEO of *IBM*
>
> At the beginning, we said "stop wasting time on five- or ten-year plans. We want to start an airline. Culture comes first…" --Herb Kelleher, Cofounder, *Southwest Airlines*

Expressed beliefs such as these led to a systematic research program, described in Heskett (2011), that was originally expected to demonstrate that strong culture (as estimated by competitors within an industry) leads to enhanced organizational performance. Surprisingly, what the researchers found instead was little direct relationship between strength of culture and performance. Instead, they observed a much more complicated relationship.

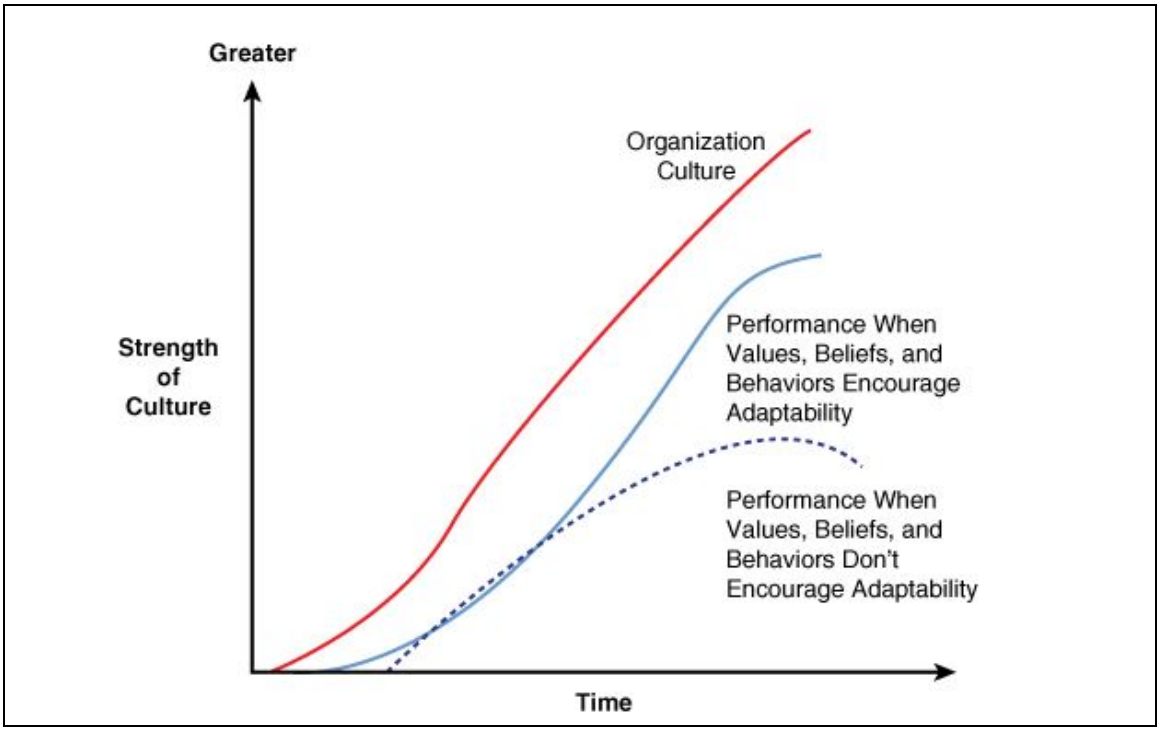


Figure 3: Culture, performance and adaptability over time (from Heskett, 2011, Figure 3.1)

As illustrated in Figure 3, the strength of an organization's culture typically tends to grow over time. The impact that culture exerts on the organization's performance, however, can either be positive or negative. The key moderator on performance appears to be adaptability. Where a culture is strong and promotes adaptability, performance continues to improve even as the culture grows in strength. Where adaptability is not encouraged, however, performance actually drops as culture became stronger.

Portability of performance

Another recent study emphasized the importance of the individual's fit with culture. Described in *Chasing Stars: The Myth of Talent and Portability of Performance* (Groysberg, 2010), over 200

high-performing investment analysts that changed firms were interviewed. What the researchers found was two significant results:

- Star performers in one firm rarely achieved similar results after they moved.
- These drop-offs in performance were much more pronounced for male analysts than for female analysts.

The difference in organizational culture between the different firms—all of which were in the same industry—was deemed to be the most significant contributor to the drop-off after the move. It was also used to account for the male-female disparity. From the interviews they discovered:

> Female star analysts, aware that many investment banks are not advantageous places for women, tended to be very cautious when approaching new offers and investigated the culture of a research department thoroughly before deciding… (Groysberg, 2010, p. 140)

This study confirms the widely held belief among researchers that culture is an important factor in determining how an individual fits an organizational context (e.g., O'Reilly, et al., 1991). This idea of the importance of "fit", rather than the attributes themselves, is closely related to the concepts of landscape complexity (to be introduced shortly). Analogous to the role played by the ingredients of a recipe, under conditions of high complexity the impact of a particular attribute can only be considered in conjunction with how well it fits with other attributes.

Emergence of Culture

It has been observed that "Cultures form with or without leadership, structure, or clear intent" (Heskett, 2011). This raises an interesting set of issues. At least at the organizational level, we have already seen that a strong culture's direct impact on performance is ambiguous. For every organization whose strong culture led to great success, we can cite an equally compelling example where a strong culture led to decline, at least in the long run. Why, then, should it be that the development of culture seems to be inevitable?

At one level, the question of why cultures emerge is relatively easy to answer. From a psychological standpoint, two nearly universal traits appear to be embedded in the human psyche:

1. *Homophily*: The tendency of individuals to seek out and join groups of individuals with similar characteristics.
2. *Social Influence/Social Contagion*: The tendency of members of a group to become more alike one another as time progresses.

According to a seminal review of homophily (McPherson, Smith-Lovin & Cook, 2001) the dimensions across which phenomenon has been observed include:

1. Race and ethnicity
2. Sex and gender
3. Age
4. Religion
5. Education, occupation and social class
6. Network position (e.g., near the center or at the periphery)
7. Behavior
8. Attitudes, abilities, beliefs and aspirations

Recent studies have extended the set of characteristics (see review in Gill, 2012). Furthermore, the phenomenon of social contagion means that those differences existing between us and the group norm at the time we join a group will grow smaller as time passes. This applies even to

traits that we would not necessarily want to emulate, such as being overweight (Christakis & Fowler, 2009).

Given the manner in which culture is usually defined—in terms of shared knowledge, attitudes, etc.—it is hard to imagine how groups of individuals imbued with homophily and subject to social influence could fail to develop a culture over time. This answer, however, is unsatisfying. It does little but push the question of why culture emerges down a level, mutating it to the question: What benefits are offered by homophily and social contagion that cause them to become so widespread?

One recent attempt (Gill, 2012) to explain the existence of homophily/social contagion involves understanding the role that they can play in improving fitness under conditions of complexity. We now turn to this model.

Complexity, Fitness, and Ruggedness

The principle thesis of this paper is that culture plays a powerful role in helping the individual perform effectively under conditions of complexity. Somewhat regrettably, this requires defining complexity, which turns out to be yet another one of the trickier terms in widespread use. We begin by introducing the alternative meanings of complexity as it applies to task performance. We then specifically turn our focus to fitness and ruggedness.

Task Complexity

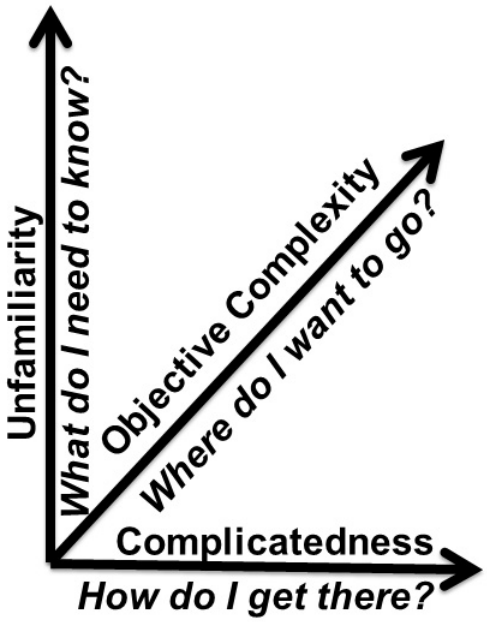
Task complexity is a term widely used in management and related disciplines. That usage is frequently ambiguous, however. Indeed, one study of the construct found 13 alternative definitions that fell into 5 distinct classes that could not be mixed without producing serious logical inconsistencies (Gill & Hicks, 2006). Subsequent investigations (e.g., Gill, 2010) suggested that *ruggedness*, a sixth class, was needed for the sake of completeness but that these classes could then be collapsed into three dimensions: *unfamiliarity*, *complicatedness*, and *objective complexity* (Gill & Murphy, 2011) based upon whether they were antecedents or consequences of the construct. These dimensions are illustrated in Figure 4 and can be described as follows.

Unfamiliarity represents the complexity as we experience it, normally when our pre-existing task-specific knowledge is insufficient to complete the task. If present, for example when performing a non-routine task, we experience mental states that may include perceived difficulty, uncertainty, and ambiguity. Unfamiliarity is, of course, a highly performer-specific manifestation of task complexity.

Complicatedness refers to quantity and structure of knowledge used to perform the task. It is most closely related to Campbell's (1988) definition of task complexity and is presumed to be somewhat less performer specific than unfamiliarity, in that two performers applying the same knowledge structures would be expected to achieve the same outcomes, analogous to running the same program on different hardware/OS combinations. The consequences of this form of complexity include values such as information processing (IP) requirements, number of possible paths, and may also be related to expected error rates and to the typical time required for learning to perform the task.

Objective complexity is the dimension of complexity that is independent of the performer and complicatedness of the program used to perform a task. It is presumed to be a function of the number of task attributes/elements, the degree to which they are interrelated, and the degree to which they change over time. Although these are the same sources of objective complexity as defined by Wood (1986), he appeared to view their presence leading to an outcome similar to that of complicatedness. In the three dimensional model, however, the consequences of objective

complexity principally relate to the fitness of the task end states, the mapping between all possible end-states and their respective fitness being referred to as a *fitness landscape*.



Antecedents	Consequences
Unfamiliarity	
Lack of specific knowledge required to perform task	Difficulty, uncertainty, ambiguity
Complicatedness	
Amount and depth of knowledge needed to perform task	IP requirements, path entropy, time to learn
Objective Complexity	
Number of attributes, degree of inter-relationship, dynamics of relationships	Ruggedness, number of local peaks, variability between states, turbulence

Figure 4: Three dimensions of task complexity, their antecedents and their consequences

In considering the informing implications of culture upon the first two complexity dimensions, unfamiliarity and complicatedness, the previously described bias-filter model has a relatively straightforward interpretation. Both of these dimensions relate to the acquisition and organization of knowledge. Individuals within the same culture, better knowing what mental models and preferences already exist, should therefore be better able to inform each other. Indeed, this is a finding already well supported by the diffusion of innovation literature (e.g., Rogers, 2003), where most informing appears to take place between self-similar peers. Further development of these ideas is presented elsewhere (e.g., Gill, 2010).

Much less well understood is the impact of culture on objective complexity. In experimental studies of task complexity (e.g., Payne, 1976), the task presented to subjects is often unfamiliar and complicatedness is varied as an experimental manipulation, changing the task in ways that increase its IP requirements or the number of possible paths the subject may take. Far less common, however, are studies where the task involves ambiguous or unspecified end-states. The concept of a fitness landscape can help us to better analyze these tasks.

Fitness Landscapes and Ruggedness

A fitness landscape maps a set of attributes to an associated desirability value, referred to as fitness. The concept was introduced in evolutionary biology, where fitness represents the relative ability of an entity (e.g., gene, species) to thrive in a particular environment and survive from

generation to generation. Fitness landscapes have been most thoroughly explored in the field of complex adaptive systems (e.g., Kauffman, 1993).

Briefly summarized, suppose that as series of N attributes, $x_1,\ldots,x_N$, jointly determine the desired fitness of an outcome. This relationship can then be expressed as a function:

$$\text{Fitness} = f(x_1,\ldots,x_N)$$

The manner in which the attributes contribute can vary considerably, however. When the relationship is fully decomposable, each attribute contributes independently of other attribute values, meaning the relationship could be expressed as:

$$\text{Fitness} = f_1(x_1)+f_2(x_2)+\ldots+f_N(x_N)$$

An example of this might be the way weighted scores on the individual questions (attributes) of a test are totaled to produce a final score (fitness). At the opposite extreme, sometimes referred to as a *chaotic* landscape (Kauffman, 1993), the fitness relationship cannot be meaningfully broken into subparts. In this type of relationship, every combination has its own fitness value and similar combinations have fitness values that are unrelated. The intermediate case, the *complex* or *rugged* landscape, is a mix of the two, with both main effects and interaction effects, i.e.:

$$\text{Fitness} = f_1(x_1)+f_2(x2)+\ldots+f_N(x_N) + f_{\text{INTERACTION}}(x_1,\ldots,x_N)$$

Think, for example, how ingredients and preparation techniques (attributes) map to the quality (fitness) of a dish being prepared by a chef.

The interesting thing about fitness landscapes is how they behave when moving from decomposability to chaos. As complexity/ruggedness grows, two important changes generally occur:

1. The number of local peaks—i.e., specific attribute combinations where any incremental change leads to a loss of fitness—grows.
2. The amount of information that the fitness of a particular state provides about adjacent states declines. In other words, the expected changes in fitness from one state to its nearby neighbors grow larger and more unpredictable.

In fitness landscapes where entities can adapt, either through evolutionary processes or through conscious decision-making, we generally are more interested in peaks than in the landscape as a whole. A good example is the recipes in a cookbook. As noted earlier, each recipe effectively describes a mapping between ingredients/preparation and a resultant dish. We may assume, however, that each recipe in a cookbook describes a perceived fitness peak—at least in the mind of its author—since it would make little sense to publish a recipe that you believed could be improved with a simple incremental change. We may also assume that the cookbook landscape is likely to be quite rugged, since questions about individual ingredients (e.g., "Does adding garlic improve a recipe?") will invariably lead to the answer: "It depends…" Furthermore, we often encounter ingredients—e.g., baking powder in a cake—whose presence is essentially undetectable to taste but whose absence is disastrous.

There are many examples where the quest for fitness can be treated as an informing activity. Consider, for example, how we might model the problem of choosing an undergraduate college to attend. Each choice can be described in terms of numerous attributes: setting, available majors, facilities, sports, extra-curricular activities, academic ratings, etc. The landscape is also incomplete, meaning that some combinations of attributes do not exist, e.g., the extremely small private college with a top 10 football team. In addition, there may be considerable uncertainty regarding the impact of specific interactions, e.g., how a high "party school" rating is likely to impact the academic experience of a particular student. Thus, faced with a choice of school decision, or any other decision exhibiting that type of ruggedness, we are likely to want to become better in-

formed. The relevant question for this paper then becomes: What, if any, role will culture play in informing our decisions?

Culture and Fitness Maximization

In considering how culture and ruggedness might interact, we need to ask ourselves: Is it better to be informed by someone who is very different from us or by someone who is very much like us? If the former, culture should act as a barrier to informing, since it tends to make us more alike. If the latter, a strong and comprehensive culture should help us become better informed.

It is highly unlikely that the question posed has a straightforward answer. In fact, any simple answer is bound to conflict with empirical findings that we already know, such as those suggesting that strong culture can improve organizational effectiveness unless it hampers adaptability, in which case it has the opposite effect (Heskett, 2011).

The Extreme Cases

Intuitively, we might expect that ruggedness *should* exhibit some interaction with culture. Imagine that we have two entities on a fitness landscape with the characteristics:

Agent X: $x_1,x_2,\ldots,x_N$

Agent Y: $y_1,y_2,\ldots,y_N$

Since culture tends to make entities more similar, we would expect two entities sharing the same culture should have more values of i where $x_i=y_i$ than two otherwise similar entities who did not happen to share the same culture. Now consider the following two extreme landscapes:

1. *No ruggedness*: For the completely decomposable landscape, we would expect the greatest opportunity for agent X to improve its fitness by learning from agent Y would be where the two are least similar. This would be particularly true if there were a lot of different Y agents and we had tools—such as multiple regression—that would allow us to estimate the individual impact on fitness of each variable i. So in this condition, culture would provide a barrier and we would be better off heeding the advice of experts who have analyzed the population across the entire environment.
2. *Maximal ruggedness*: In the chaotic landscape, the fitness of a particular state provides no information about the fitness of adjacent states; that is a matter of definition. Assuming that (i) we try to attain fitness by imitating other agents (as opposed to randomly exploring states) and (ii) culture in some way limits our observations to close-by agents, culture would tend to place unnecessary limits on our potential fitness as contrasted with being able to observe the fitness of all possible agents. Thus, once again, culture would appear to work against informing processes that rely upon observing others. This finding comes with an important additional caveat, however. If two agents are not allowed to occupy the same state, then observing other agents on a chaotic landscape offers no value.

Given that the two extreme cases both seem to suggest that culture is likely to be a barrier to informing (if it has any impact at all), it is tempting to conclude that this would be the case across the entire range of landscape ruggedness. Such a conclusion would be premature, however. Both the decomposable and chaotic landscapes have properties that make them seem atypical when contrasted with the real world. For the decomposable landscape, it is the extreme order and the ease with which the single peak can be achieved through incremental search. For the chaotic landscape, it is the underlying assumption that fitness is random—such landscapes conflict with any notion of rational decision-making. Thus, it makes sense to look more closely at the impact that culture might exert where intermediate levels of ruggedness are present.

Culture on a Rugged Landscape

In fact, evolutionary models of culture development propose that culture can develop as a consequence of the need for *local* knowledge sharing, which implies individuals operating around a local peak. For example:

> Because of combinatorial explosion, knowledge of successful local techniques is precious and hard to discover, but relatively cheap to share (once again, ignoring the cost of the psychological mechanisms that facilitate or perform such sequential reconstruction). Within limits, this creates economies of scale: The greater the number of individuals who participate in the system of knowledge sharing, (1) the larger the available pool of knowledge will be, (2) the more each individual can derive from the pool, (3) the more advantageous reconstructive adaptations will be, and (4) the more it would pay to evolve knowledge-dependent mechanisms that could exploit this set of local representations to improvise solutions to local problems. (Tooby & Cosmonides, 1992, p. 119)

Modeling the impact of culture on rugged landscapes is not a trivial task, however. First: it requires that we design a model of a fitness landscape that allows us to tune its ruggedness. Second: it requires that we establish a mechanism of causing agents on that landscape to prefer to look to self-similar agents, as opposed to dissimilar agents, for information about fitness. Fortunately, simulation results already exist that incorporate:

1. The tunable *NK landscape* proposed by Kauffman (1993)
2. Agents with a tunable "visibility" parameter that allows the researcher to specify how far agents can look in attempting to improve fitness by observing other agents (Gill, 2012).

Thus, we begin by interpreting these results in the context of understanding how culture and ruggedness might interact.

Simulation results

The simulation model, fully described in Gill (2012), was based upon Kauffman's (1993) NK landscape. This model assumes a fitness function that is constructed using two parameters:

- N: the number of attributes that impact fitness, and
- K: the number of other attributes whose value must be known in order to determine that attribute's impact on fitness. K can vary from 0, implying a completely decomposable landscape, to N-1, in which case every attribute interacts with every other attribute to determine fitness, implying that fitness is randomly assigned to each attribute combination.

Agents are placed on the landscape, where they would seek to achieve higher fitness. In judging the efficacy of a strategy, three dependent variables were used: number of steps to reach a peak (lower is better), average fitness achieved across all agents when peaks are achieved (higher is better), and cumulative fitness over the course of the simulation (higher is better).

Four different types of agents were used for the simulation:

- *Random*: Agents try out adjacent states, returning to their original state if the adjacent fitness was lower.
- *Expert*: Agents try out adjacent states, prioritizing their choices based upon "expert" advice, obtained by performing a multiple regression of all agent states against the fitness dependent variable. Once again, if a tested state proves to have lower fitness than the original state, the agent returns.

- *Imitating*: Similar to expert agents, except these agents prioritize their choices based on looking at the fitness of other agents, limited by a visibility parameter. If no nearby agents of higher fitness happen to be present, they behave like random agents.
- *Goal Setting*: Similar to imitating agents, except that these agents will a) recall a high fitness state exists even if the nearby agent that occupied that position leaves it in search of even greater fitness, and b) accept lower fitness states while in transit to a known higher fitness state.

The visibility parameter (V) that could be set for the last two agent types can range from 0 (no adjacent agents can be seen—making these agents the same as random agents) to N-1 (where a particular agent can observe the fitness of all other agents, regardless of how different they are). Low visibilities, where agents can only see nearby agents, effectively mimic the assumed impact of culture; we pay attention only to those who share most of our knowledge and values.

Because the simulation stops when all agents are on local peaks, and—particularly for lower levels of complexity—the number of peaks is likely to be far lower than the number of agents. As a result, the fact that agents eventually cluster is entirely uninteresting as a finding. It is guaranteed by design. What is somewhat more interesting is that at very low visibility levels (e.g., V=2), the imitating and goal setting agents substantially outperformed the remaining types of agents on steps to fitness and cumulative fitness as soon as landscape ruggedness became significant (Gill, 2012, p. 63).

Most interesting is the sensitivity to the visibility parameter on complex landscapes. There would seem to be two possible outcomes of interest:

1. If sensitivity is high, meaning that there is a large advantage to mimicking dissimilar agents, this would work against the hypothesis that culture has a positive impact on informing. Rather than clustering with individuals sharing your values in looking for higher fitness, it would make sense to hang out with a group that is as diverse as possible.
2. If sensitivity is low, particularly at the high end of the visibility range, it would argue that looking at nearby agents confers all, or nearly all, the benefits of looking at more distant agents without the difficulties associated with non-routine informing (Figure 2).

Figure 5 illustrates the outcomes of different agent types on an intermediate complexity environment as visibility changes. In this simulation, there were essentially no benefits to increased visibility $V > 2$ for imitating agents and for $V > 3$ for goal setting agents at the intermediate complexity level ($K=6$) used the base case for the simulation. Random and expert-guided agents were, of course, unaffected by changes to visibility since neither used observations of adjacent agents in deciding where to move.

Framing these findings in terms of the central theme of this paper, according to this simulation model we would expect participating in a strong culture to enhance our search for fitness on rugged landscapes if we seek to improve our fitness by imitating others. In fact, doing so increases the rate at which we achieve fitness and the cumulative fitness we experience over the course of our search. What it does not necessarily improve is the average fitness of our end-state. Imitating agents—agents that are driven only by the current states of nearby agents and will not take any step that reduces their fitness—do no better at achieving high average fitness than random or expert-guided agents. In this scenario, "culture" does nothing to alleviate the danger of becoming trapped on a low-fitness peak. Goal setting agents, on the other hand, are willing to accept drops in fitness in pursuit of known goals, and continue to benefit from slightly higher visibility. These agents are basically followers, but are willing to step outside of short-term adherence to culture when there appear to be fitness benefits from doing so.

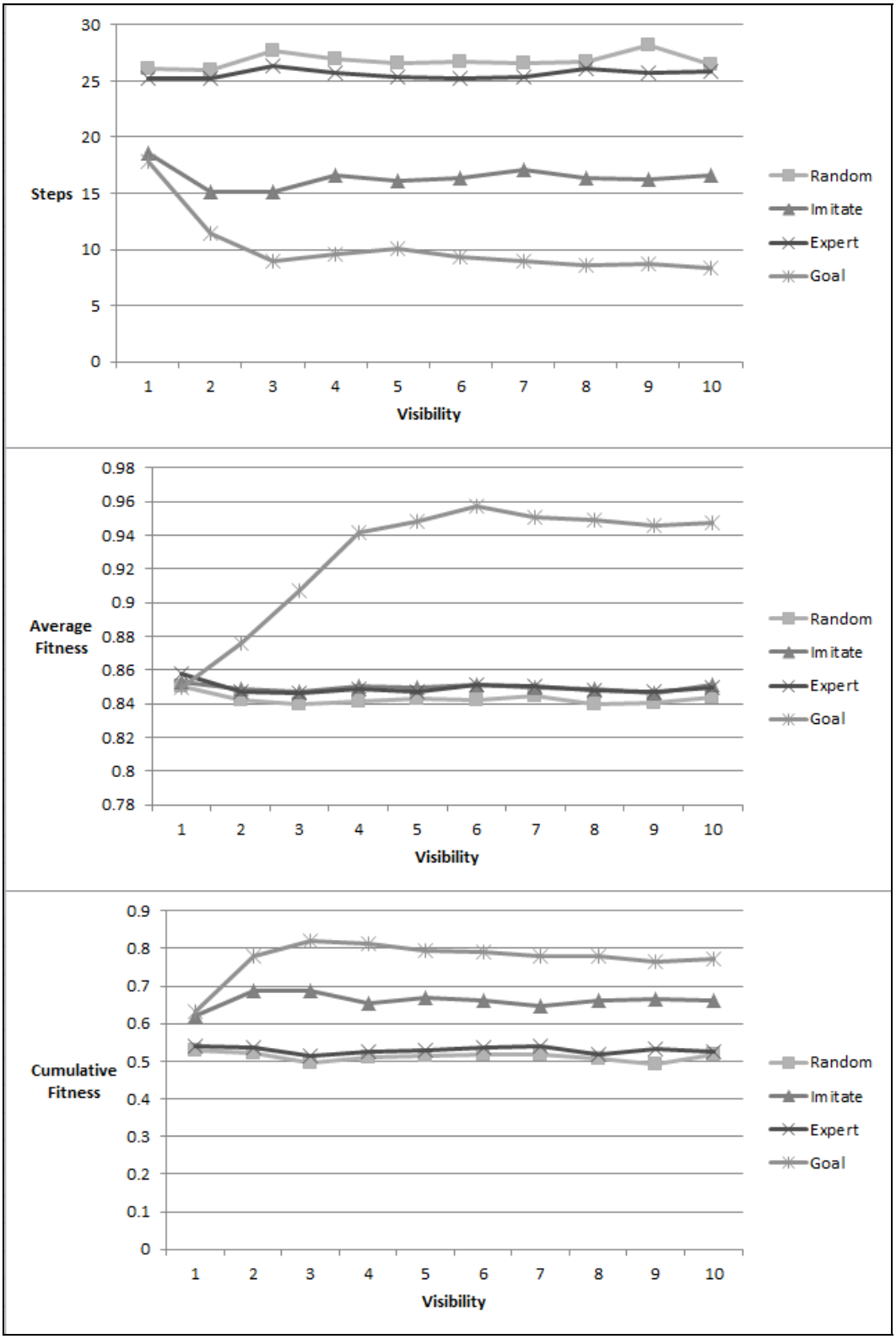


Figure 5: Agent performance as visibility increases (from Gill, 2012, p. 65)

Caveats

Before taking the simulation findings too seriously, it is important to note some significant assumptions embedded in the model. For example:

1. It assumes the landscape is static
2. It assumes the search for fitness ceases once an agent is assured of having reached a peak
3. It assumes that agents are homogeneous in their behavior
4. It assumes that agents can determine the fitness of other agents by observing them
5. It assumes that all attributes pertaining to fitness can be modified by the agent. What happens, for example, if an attribute such as current age is part of the fitness equation?
6. It assumes the attributes of an agent do not impact the search strategy employed for increasing fitness.

Such assumptions are necessary if the number of simulation parameters is to be kept at a manageable level. Given that many of these assumptions seem highly unrealistic, however, it would be easy to dismiss the entire exercise, along with its preliminary conclusion that strong culture enhances our search for fitness. To consider whether the proposed model is of any value as a conceptual scheme, we must therefore retreat from simulation and move towards discussion. First, however, the essence of the model is summarized through a series of propositions.

Propositions

The value of a conceptual scheme is not that it is true in *all* situations but, instead, that it is useful for thinking about *some* situations (Gill, 2011). The conceptual scheme suggested by the model includes the following propositions, many of which could be framed as testable hypotheses. The first three specifically deal with properties implied by rugged landscapes:

1) Many of our most significant activities can be characterized as a search to increase our fitness on a landscape with many peaks and valleys. *Implications*:
   a) Once we know we have reached a peak, our motivation for further search will decline significantly
   b) *Caveat*: Attachment to peaks should be most pronounced for static landscapes.
2) The ruggedness of a landscape is indicated by the number of peaks and the amount of variability between adjacent states. *Implications*:
   a) As ruggedness grows, the risk associated with random search increases.
   b) As ruggedness grows, the diversity of peaks available to agents grows correspondingly.
3) The fitness of a particular state is nearly always unknown and is often unknowable. *Implications:*
   a) Agent behaviors will be guided by individual estimates of fitness
   b) If these estimates diverge, then agents will often migrate towards different peaks, particularly as ruggedness grows.

The next three propositions specifically relate to the impact of culture on rugged landscapes and are the focus of the discussion that follows:

4) Having self-similar people around us will typically increase the efficiency of our search for a fitness peak more than having "random" people around us. *Implications*:
    a) Cultural comprehensiveness and strength should grow with time as the search narrows to a particular peak.
    b) There is not necessarily a guarantee that a strong culture will lead to a high fitness peak. Since the very strength of the culture will tend to encourage search at the margins making it prone to being captured by any local peak, not just the high ones.
    c) Groups sharing a strong culture should reach peaks more rapidly than groups whose culture is weak.
    d) *Caveat*: Strong cultures are likely to be prone to entrapment on local peaks, particularly where the fitness landscape is perceived to be stable,
5) Strong culture emergence resulting from imitation of fitness will depend upon the ability of individuals to ascertain the fitness of others. *Implications*:
    a) Strong cultures will only develop where a consistent means for estimating fitness is included in the culture.
    b) *Caveat*: There is no similar requirement that the culturally accepted estimate of fitness actually reflects the underlying fitness of a state, meaning that strong cultures can migrate to states that are either high or low in actual fitness.
6) The potential benefits of self-similarity will tend to grow with landscape ruggedness. *Implications*:
    a) Because greater ruggedness means more attributes interact to determine fitness, the comprehensiveness of a culture—the number of shared attributes—will tend to contribute to the search for fitness.
    b) As ruggedness grows, the forces that tend to splinter a culture will grow correspondingly as local peaks proliferate. It will therefore require an increasingly strong and comprehensive culture to ensure that individuals migrate towards the same peak.
    c) *Caveat*: Because ruggedness also implies greater attachment to peaks, if a cultural consensus is reached that a peak has been attained, a taboo prohibiting further search is likely to emerge.

Discussion

We now consider some examples of areas where the proposed conceptual scheme may be useful in interpreting and understanding observed phenomena, showing both areas of agreement with existing models and areas where the landscape model might offer different predictions or could extend the existing model. We begin with the two earlier examples from the literature review then consider some additional applications.

Culture Cycles

Heskett's (2011) evolution of culture/performance, illustrated earlier in Figure 3, maps well to the hill-climbing metaphor presented in the fitness landscape informing model. The process begins with individuals within the organization becoming more alike in their attributes, and the strength and comprehensiveness of the resulting culture grows accordingly. With that growing culture, informing grows more efficient and performance improves. At some point, however, there are

two possible factors—according to the fitness landscape model—that could undermine performance:

- A perceived fitness peak could be achieved, at which point the incentive for further search would be greatly reduced. This could produce two effects. First, remaining upon the same peak for an extended period of time could cause the comprehensiveness and strength of the culture to increase to a point where insufficient degrees of freedom exist for experimentation, as per proposition 4d. Effectively, the culture becomes *over-constraining*. In addition, such stability could encourage the adoption of values leading to the second factor...
- As more and more attributes are shared, attitudes that tend to discourage search may become shared values, as per proposition 6c.

Based upon the model, we would expect the challenge of becoming stuck on a fitness peak to be much more likely in situations where the fitness landscape is perceived to be static (see proposition 1b). This could be the case in an industry where growth is slow and technological innovation is limited. It might also occur where organizations are insulated from volatility by long term agreements with customers, regulatory barriers, or intellectual property assets (e.g., patents).

Heskett (2011) lists the eight enemies of effective culture as follows:

1. inconsistent leadership behavior,
2. arrogance born of pride and success,
3. too-rapid growth,
4. too little growth,
5. nonorganic growth,
6. failure to maintain a small-company feel,
7. "outsider" leadership, and
8. ineffective measurement and action.

For at least a couple of these "enemies" (i.e., 2 and 4), the danger is not that a strong culture will fail to develop. Rather, it is that the culture will become over-constrained and non-adaptable. In turbulent competitive environments, the dictates of survival would likely preclude such complacency, although they can lead to other problems, as described later.

There are many examples of cultural attributes that could contribute to lack of adaptability. In cataloging the cultures of nations (Hofstede & Bond, 1984), for example Hofstede identified at least three dimensions that could potentially reduce search:

- *Uncertainty avoidance*: a dimension reflecting risk tolerance. Since searching a rugged landscape requires willingness to experience major temporary fitness drop-offs, high uncertainty avoidance would necessarily reduce the rate of search.
- *Power distance*: a dimension describing the degree to which individuals accept uneven distributions of power. Where power distance is high, leaders would be perceived as being very different from subordinates, and therefore we would expect information to flow less readily between the two groups.
- *Individualism*: Collectivist cultures would be expected to come together more quickly within an organization. On the other hand, they might be less likely to encourage the individual experimentation.

Heskett (2011) also points to examples of specific cultural attitudes that would tend to encourage search, such as the highly positive attitude towards innovation and the long time horizons of companies such as *3M*. Time horizon has also been proposed as an extension to Hofstede's original four factors. Where immediate returns to search are not demanded, attachment to peaks will likely be reduced as it becomes possible to explore more distant states in search of higher fitness; this is consistent with the difference between imitating and goal-setting agents described earlier.

The importance of leadership emphasized in the culture cycle model can also be reconciled with the fitness landscape conceptual scheme. According to proposition 6b, it should be increasingly difficult to maintain strong culture among large groups on highly rugged landscapes because many different peaks will be attractive, tending to fragment the culture. We would expect this to be a particular problem in highly turbulent, high growth environments, since these are most likely to produce rugged and dynamic fitness landscapes. In fact, *too-rapid growth* is seen to be an enemy of effective culture (Heskett, 2011); here the problem is likely to be an undermining of the development of strong culture rather than one of over-constraint.

This phenomenon could be offset if certain agents—the leaders—are presumed to exert greater attractive force than the average agent. This would involve relaxing one of the (unrealistic) assumptions made in the simulation model, that agents are homogeneous. For this to be successful, it would be critical that the leader's behavior be perfectly in tune with the culture to be created. In fact, Heskett (2011) specifically mentions *inconsistent leadership behavior* as yet another one of the eight enemies of effective culture.

A particularly important consistency between the culture cycle and landscape models of culture involves estimating fitness. The last of the eight enemies of effective culture specified is *ineffective measurement and action*. The measurement aspect is critical to estimating fitness. Ineffective measurement would have two important implications in the rugged landscape model, as per propositions 5a and 5b. If the measurement is ineffective because it is inconsistent, it would present a major barrier to the formation of culture. If the measurement is ineffective because it is does not do a good job of reflecting underlying fitness, then any culture that forms is likely to migrate to a low fitness state and, quite possibly, remain there.

Performance Portability

The problem of weak performance portability (Groysberg, 2010) is readily explained using the fitness landscape model. Star performers at one firm can be viewed as existing at or near a fitness peak at their original firm. The job performance fitness function, however, is likely to include cultural elements that are set by the original firm, including different views of how to estimate fitness, as per proposition 5a. Upon changing firms, these attributes change. If the fitness landscape for job performance is rugged, we would expect that such changes—even if they do not appear major—would produce significant changes to the performance (since sensitivity to small changes is a characteristic trait of ruggedness). Moreover, if the cultures of the original and subsequent organizations are quite different, we would expect that:

- The cultural communications barriers discussed in Figure 2 would make understanding the problem difficult.
- The individual's perception of being on a peak at the prior organization would inhibit motivation to engage in the type of search necessary to achieve high fitness in the subsequent organization. This situation would be particularly acute if the organizational cultures strongly differed in how fitness was estimated.

As previously noted, Groysberg (2010) found some anecdotal evidence that women paid much greater attention to the cultural aspects of the subsequent organization prior to accepting a posi-

tion. This might help explain why the decline in performance was much less pronounced for women. It is also possible that women proved more adaptable and attuned to the new culture, thereby making it easier for them to search for fitness in the subsequent organization. This would be consistent with Hofstede's masculinity cultural dimension, where the femininity pole is described as one emphasizing "caring for others and quality of life" (Hofstede & Bond, 1984, p. 420). Unlike some of his other dimensions, this dimension was named because it not only could be assessed for a national culture as a whole, but was also found to be significantly different for individuals of different genders within a nation.

The portability of performance issue can also impact the strength of existing culture within a firm. Returning to Heskett's (2011) eight enemies, both *non-organic growth* and *"outsider" leadership* fit in this category. Both represent collisions between agents who are likely focused on different peaks (proposition 6b) and who are also likely to hold to different estimates of fitness (proposition 5a).

Innovation Networks

An interesting model--one that is highly consistent with the fitness landscape model described here—has been proposed in anthropology. The model proposes that we seek out and imitate successful individuals, essentially the union of propositions 4 and 5. Specifically:

> This evidence, from both field and laboratory studies, shows that humans possess a psychological propensity to pay attention to, and attempt to imitate, particularly skillful, successful and/or prestigious individuals. A tendency to orient one's social learning attention toward particularly skillful individuals ("cultural models") creates a selective force in cultural transmission that may, under some circumstances generate cumulative adaptation. (Henrich, 2004, p. 200)

It further argues that imperfect imitation—i.e., mistakes—may be an important source of innovation, as the mistake sometimes proves better than the original. Essentially, this would tend to converge to the same model as the one proposed here, provided "mistakes" were relabeled "search". The research further suggests that there may be a critical mass of individuals necessary to sustain the process, using the loss of technology that occurred in Tasmania as an example of what could occur where sufficient numbers were not present. This is also consistent with the finding that as the number of agents on a landscape increases, fitness indicators for the two homophilic agent types improve, albeit slightly (Gill, 2012, p. 67).

The same argument is made today with respect to communities embracing a common culture of innovation, such as the Silicon Valley (e.g., Ridley, 2010). This is an example of what futurist Steven Johnson (2010, p. 58) describes as "liquid networks", stating:

> When the first market towns emerged in Italy, they didn't magically create some higher-level group consciousness. They simply widened the pool of minds that could come up with and share good ideas. This is not the wisdom of the crowd, but the wisdom of someone in the crowds. It's not that the network itself is smart; it's that individuals get smarter because they are connected to the network.

Anecdotal evidence suggests that, at a minimum, physical proximity and a substantial set of shared beliefs (i.e., culture) help to make such networks effective. That may explain why, in a world of global telecommunications and airlines, we still see the communities such as the Silicon Valley responsible for a disproportionate share of innovation within specific domains.

As per proposition 6b, the rugged landscape model suggests that there may be practical limits on group size beyond which cultures that are purely self-organizing tend to splinter as a consequence of the proximity of many distinct peaks. For such mass cultures to exist—as we know they do—

additional mechanisms for ensuring cohesion, such as institutions, leaders and mass communications are likely to be required as a supplement to undirected individual search. Interestingly, Gladwell (2000, p. 179) assigns a specific number to the maximum size of social circles: 150, commonly referred to as the "Dunbar Number" (Bennett, 2013). While the model proposed in this paper would agree that such practical limits could well exist, the number in a specific context would likely be affected by factors such as level of ruggedness, quality of available estimates of fitness, and pre-existing similarities between the agents involved. All of these would impact the level of difficulty likely to be encountered in the mutual informing process.

Innovator's Dilemma

Christensen's (1997) well known innovator's dilemma presents another interesting opportunity to consider the potential application of the fitness landscape model. To summarize the dilemma briefly, it typically begins with an organization that has established a leadership position in a particular industry, normally built around a particular technology—such as integrated steel mills, mini-computers or magnetic disk drives. As industry leader, the firm develops a collection of loyal customers and suppliers, all of whom it seeks to please by refining and enhancing its approach.

The situation evolves when a competing technology emerges—particularly one that is radically different from the approach used by the market leader, in which case it can be described as a *disruptive technology*. Actual examples of such technologies include steel mini-mills, personal computers, and solid state primary storage. When they are introduced, these technologies are explored by the market leader and are found to be intrinsically unsuitable for the firm's existing customers. For example, they may be lacking in quality (e.g., mini-mills), capacity (e.g., personal computers), or may be too expensive for widespread use (e.g., solid state drives). Encouraged by its customers and suppliers—both of whom are satisfied with the trajectory of existing technologies—the leader continues to focus on business as usual. Over time, this may require ceding small or unprofitable customers to the new technology; even this may not be perceived as a bad thing since it appears to increase focus on the firm's most valued customers.

Meanwhile, the new technology advances at a rate that far surpasses the existing technology, as novel technologies tend to do in their early stages. The result is that over a period of years or decades, the new technology reaches the point where it equals or surpasses the existing technology on all three dimensions: quality, capacity, and cost. At that point, the leader's existing customers rethink their relationship and—often quite abruptly—switch to the new technology, in many cases leading to the demise of the former leader.

The innovator's dilemma represents a near-perfect example of how the fitness landscape model could be applied. As the original company establishes industry leadership, it achieves a fitness peak. Not only will this tend to confirm the assumptions of the culture leading to that peak, it will also tend to lead to a period during which these assumptions are reinforced. Christensen (1997, p. 194) writes eloquently on this score:

> As successful companies mature, employees gradually come to assume that the priorities they have learned to accept, and the ways of doing things that they have employed so successfully, are the right way to work. Once members of the organization begin to adopt ways of working and criteria for making decisions by assumption, rather than by conscious decision, then those processes and values come to constitute the organization's *culture*. As companies grow from a few employees to hundreds and thousands, the challenge of getting all employees to agree on what needs to be done and how it should be done so that the right jobs are done repeatedly and consistently can be daunting for even

> the best managers. Culture is a powerful management tool in these situations. Culture enables employees to act autonomously and act consistently.

Framed in terms of the rugged landscape model, and consistent with culture cycle model presented in Figure 3, the formation of strong culture is likely to begin well before the fitness peak is achieved and will aid the original company in reaching that peak before its competitors (i.e., propositions 4a, b & c). This will be particularly true in the turbulent environments frequently experienced in technology-related industries (propositions 6a & 6b). Upon reaching that peak, however, the same culture—particularly the strengthening consensus on estimates of fitness reflecting current practices (e.g., sales, gross margins, customer satisfaction, product quality)—may actually discourage recognition of impending changes to the fitness landscape (e.g., proposition 5b) and may become so comprehensive and unquestioned that they actually discourage innovation (i.e., propositions 4d & 6c).

Conclusions

Culture is often viewed as a source of stability in a dynamic world. For this reason, claims to being "a culture of change" or "a culture of innovation" can provoke suspicion. How can a set of shared values, processes and artifacts that change slowly—if at all—promote out of the box thinking and exploration?

A similar paradox exists with respect to the role of culture in informing. Culture is widely perceived to be a barrier to informing, e.g.,

> Cultural knowledge is conceptualized to be like a contact lens that affects the individual's perceptions of visual stimuli all of the time (Hong, Morris, Chiu, & Benet-Martinez, 2000, p. 209)

When we study international business, we are frequently cautioned about how the clash of cultures can lead to misunderstanding through mechanisms such as stereotyping and prejudice (e.g., Fiske, 2000). Rarely are we encouraged to recognize the role culture plays in promoting understanding.

Despite these paradoxes, the fact remains that culture can contribute both to innovation and to understanding. The evidence from studies such as those described in *The Culture Cycle* (Heskett, 2011) are compelling on this score, as are the mechanisms described through which culture contributes to performance.

The present paper has focused on exploring a particular aspect of culture from an abstract point of view. Specifically, it has considered the impact of culture on the individual's search for fitness in complex environments. In doing so, it has highlighted two key aspects of culture from an informing perspective:

1. The ability of common values and models to reduce the distortion and loss of information during communications between members sharing the same culture.
2. The degree to which common values improve the effectiveness of imitation as a strategy for improving fitness in those complex environments where fitness is difficult to achieve.

The principal intended contribution of this paper has been to propose that culture can be a powerful tool for increasing fitness on rugged (complex) landscapes. It also provides a basis for explaining why culture is frequently a double-edged sword in such circumstances. A strong culture will help you get to a fitness peak faster, but it will not always be the best peak and, once you are there, it may be hard to leave even as the environment changes.

The end product of the paper is a conceptual scheme that complements, rather than contradicts, existing research. The relationship between culture and environmental complexity does not appear to have been explored extensively. It is hoped that this paper will encourage further research in this area.

References

Axelrod, R. (1997). The dissemination of culture. *Journal of Conflict Resolution, 41(2)*, 203-226.

Bennett, D. (2013). How a technophobic Oxford primatologist became Silicon Valley's social networking guru. *The Economist, 406*(8819), 52-56.

Campbell, D. J. (1988). Task complexity: A review and analysis. *Academy of Management Review, 13*(1), 40-52.

Chase, N. (2008). An exploration of the culture of information technology: Focus on unrelenting change. *Journal of Information, Information Technology, and Organizations, 3*, 135-150. Retrieved from http://www.informingscience.org/jiito/articles/JIITOv3p135-150Chase128.pdf

Chatman, J., & Cha, S. (2003). Leading by leveraging culture. *California Management Review, 45*(4), 20-34.

Christakis, N. A., & Fowler, J. H. (2009). *Connected: The surprising power of social networks and how they shape our lives.* New York, NY: Little Brown.

Christensen, C. (1997). *The innovator's dilemma*. New York, NY: HarperCollins.

Cook, S., & Yanow, D. (1993). Culture and organizational learning. *Journal of Management Inquiry, 2*(4), 373-390.

Davis, M. (1971). That's interesting! Towards a phenomenology of sociology and a sociology of phenomenology. *Philosophy of the Social Sciences, 1*, 309-344.

DiMaggio, P. (1997). Culture and cognition. *Annual Review of Sociology, 23*, 263-287.

Eagleton, T. (2000). *The idea of culture*. Malden, MA: Blackwell.

Fiske, S. (2000). Stereotyping, prejudice and discrimination at the seam between the centuries: Evolution, culture, mind, and brain. *European Journal of Social Psychology, 30*, 299-322.

Geertz, C. (1973). *The interpretation of cultures.* New York, NY: Basic Books.

Gill, T. G. (2008). A psychologically plausible goal-based utility function. *Informing Science: The International Journal of an Emerging Transdiscipline, 11*, 227-252. Retrieved from http://inform.nu/Articles/Vol11/ISJv11p227-252Gill220.pdf

Gill, T.G. (2010). *Informing business: Research and education on a rugged landscape*. Santa Rosa, CA: Informing Science Press.

Gill, T. G. (2011). When what is useful is not necessarily true: The underappreciated conceptual scheme. *Informing Science: The International Journal of an Emerging Transdiscipline, 14*, 1-32. Retrieved from http://www.inform.nu/Articles/Vol14/ISJv14p001-032Gill589.pdf

Gill, T. G. (2012). Informing on a rugged landscape: Homophily versus expertise. *Informing Science: The International Journal of an Emerging Transdiscipline, 15*, 49-91. Retrieved from http://www.inform.nu/Articles/Vol15/ISJv15p049-091Gill616.pdf

Gill, T. G., & Hicks, R. (2006). Task complexity and informing science: A synthesis. *Informing Science: the International Journal of an Emerging Transdiscipline, 9*, 1-30. Retrieved from http://inform.nu/Articles/Vol9/v9p001-030Gill46.pdf

Gill, T. G., & Murphy, W. (2011). Task complexity and design science. *9th International Conference on Education and Information Systems, Technologies and Applications: EISTA 2011, Orlando, FL, July 19th-22nd.*

Gladwell, M. (2000). *The tipping point*. New York, NY: Back Bay Books.

Gladwell, M. (2008). *Outliers*. New York, NY: Little, Brown & Co.

Goodenough, W. (1971). *Culture, language and society*. Reading, MA: Addison-Wesley.

Groysberg, B. (2010). *Chasing stars: The myth of talent and portability of performance*. Princeton, NJ: Princeton University Press.

Guiso, L., Sapienza, P., & Zingales, L. (2006). Does culture affect economic outcomes? *Journal of Economic Perspectives, 20*(2), 23-48.

Heath, C., & Heath, D. (2007). *Made to stick*. New York, NY: Random House.

Henrich, J. (2004). Demography and cultural evolution: How adaptive cultural processes can produce maladaptive losses: The Tasmanian case. *American Antiquity, 69*(2), 197-214.

Heskett, J. (2011). *The culture cycle: How to shape the unseen force that transforms performance*. Upper Saddle River, NJ: FT Press.

Hofstede, G., & Bond, M. (1984). Hofstede's culture dimensions: An independent validation using Rokeach's value survey. *Journal of Cross-Cultural Psychology, 15*(4), 417-433.

Hong, Y., Morris, M., Chiu, C., & Benet-Martinez, V. (2000). Multicultural minds: A dynamic, constructivist approach to culture and cognition. *American Psychologist, 55*(7), 709-720.

Jamieson, K., & Hyland, P. (2006). Good intuition or fear and uncertainty: The effects of bias on information systems selection decisions. *Informing Science: the International Journal of an Emerging Transdiscipline, 9*, 49-69. Retrieved from http://inform.nu/Articles/Vol9/v9p049-069Jamieson60.pdf

Johnson, S. (2010). *Where good ideas come from: The natural history of innovation*. New York, NY: Riverhead Books.

Kauffman, S.A. (1993). *The origins of order.* Oxford, UK: Oxford University Press.

Kovacic, Z. (2001). Communicating culture: An exploratory study of the key concepts in Maori culture on Maori web sites. *Informing Science: The International Journal of an Emerging Transdiscipline, 4*(2), 53-59. Retrieved from http://www.inform.nu/Articles/Vol4/v4n2p053-059.pdf

Kovacic, Z. (2005). The impact of national culture on worldwide eGovernment readiness. *Informing Science: The International Journal of an Emerging Transdiscipline, 8*, 143-158. Retrieved from http://www.inform.nu/Articles/Vol8/v8p143-158Kova.pdf

Lee, N. L., & Johson-Laird, P. N. (2006). Are there cross-cultural differences in reasoning? In R. Sun (Ed.), *28 Annual Conference of the Cognitive Science Society*. New Jersey: Erlbaum.

Levi-Strauss, C. (1973). Structuralism and ecology. *Social Science Information, 12*(1), 7-23.

Malinowski, B. (1944). *A scientific theory of culture and others essays*. Chapel Hill, N. Carolina: The University of North Carolina Press.

Markus, H., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*(2), 224-253.

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks, *Annual Review of Sociology, 27*, 415-444.

Morris, M., & Peng, K. (1994). Culture and cause: American and Chinese attributions for social and physical events. *Journal of Personality and Social Psychology, 67*(6), 949-971.

Nisbett, R., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems: Holistic versus analytic cognition. *Psychological Review, 108*(2), 291-310.

O'Reilly, C., Chatman, J., & Caldwell, D. (1991). People and organizational culture: A profile comparison approach to assessing person-organization fit. *Academy of Management Journal, 34*(3), 487-516.

Payne, J.W. (1976). Task complexity and contingent processing in decision making. *Organizational Behavior and Human Performance, 16*, 366-387.

Radcliffe-Brown, A. (1952). *Structure and function in primitive society: Essays and addresses*. Glencoe, IL: Free Press.

Reiners, T., & Dreher, H. (2009). Culturally-based adaptive learning and concept analytics to guide educational website content integration. *Journal of Information Technology Education, 8*, 125-139. Retrieved from http://www.jite.org/documents/Vol8/JITEv8p125-139Reiners436.pdf

Ridley, M. (2010). *The rational optimist: How prosperity evolves*. New York, NY: HarperCollins.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Ryan, S., Windsor, J., Ibragimova, B., & Prybutok, V. (2010). Organizational practices that foster knowledge sharing: Validation across distinct national cultures. *Informing Science: The International Journal of an Emerging Transdiscipline, 13*, 139-164. Retrieved from http://www.inform.nu/Articles/Vol13/ISJv13p139-164Ryan540.pdf

Ryan, S., Magro, M., & Sharp, J. (2011). Exploring educational and cultural adaptation through social networking sites. *Journal of Information Technology Education: Innovations in Practice, 10*, IIP 1-16. Retrieved from http://www.jite.org/documents/Vol10/JITEv10IIPp001-016Ryan883.pdf

Schein, E. (1984). Coming to a new awareness of organizational culture. *Sloan Management Review, 25*(2), 3-16.

Smircich, L. (1983). Concepts of culture an organizational analysis. *Administrative Science Quarterly, 28*(3), 339-358.

Sørnes, J., Stephens, K., Sætre, A., & Browning, L. (2004). The reflexivity between ICTs and business culture: Applying Hofstede's theory to compare Norway and the United States. *Informing Science: The International Journal of an Emerging Transdiscipline, 7*, 1-30. Retrieved from http://www.inform.nu/Articles/Vol7/v7p001-030-211.pdf

Swindler, A. (1986). Culture in action: Symbols and strategies. *American Sociological Review, 51*, 273-286.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences, 28*, 675–735.

Tooby, J., & Cosmonides, L. (1992). The psychological foundations of culture. In J. Barkow, L. Cosmonides, & J. Tooby, *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19-136). Oxford, UK: Oxford University Press.

Travica, B. (2005). Information politics and information culture: A case study. *Informing Science: The International Journal of an Emerging Transdiscipline, 8*, 211-244. Retrieved from http://www.inform.nu/Articles/Vol8/v8p211-244Travica.pdf

Weick, K. (1987). Organizational culture as a source of high reliability. *California Management Review, 29*(2), 112-127.

Wood, R. (1986). Task complexity: Definition of the construct. *Organizational Behavior and Human Decision Processes, 37*, 60-82.

Biography

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