Chapter 23

Media naturalness theory: human evolution and behaviour towards electronic communication technologies

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Introduction

The advent of the Internet in the early 1990s, and of the World Wide Web in the mid 1990s, led to an explosion in the number of electronic business-to-consumer interactions. Empirical research on electronic communication (e-communication) behaviour also increased considerably and experienced a significant shift in focus from laboratory experiments to field studies (Kock 1999, 2008). Several theories informed this research, including technology-centric theories, of which the most prominent example is media richness theory (Daft and Lengel 1986). Many researchers have tested media richness theory (Carlson and Zmud 1999; Daft et al. 1987; Fulk et al. 1990; Kinney and Dennis 1994; Lengel and Daft 1988; Markus 1994a; Rice 1992; Trevino et al. 2000), and many others continue doing so, even though the theory was first proposed in the mid 1980s, well before the emergence of the Internet as we know it today.

Media richness theory was built around a central hypothesis, the media richness hypothesis, which states that different communication media possess different degrees of a trait called 'richness' (Carlson and Davis 1998; Daft and Lengel 1986; Lee 1994), that make them more or less effective conduits of information and knowledge. Several studies found general support for the media richness hypothesis (Daft et al. 1987; Rice 1993; Rice and Shook 1990; Sproull and Kiesler 1986; Walther 1996), other studies found weak support (Fulk et al. 1990; Markus 1990), and yet other studies found little or no support at all for the media richness hypothesis (Dennis et al. 1999; Kinney and Dennis 1994; Kinney and Watson 1992).

The main goal of this chapter is to extend prior research on human evolution and behaviour towards technology (Kock 2004, 2005, 2009), and offer a solid theoretical basis on which the mixed findings above can be understood. The chapter provides an alternative to the media richness hypothesis, referred to here as the media naturalness hypothesis. Like the media richness hypothesis, the media naturalness hypothesis has important implications for the selection, use, and deployment of e-communication tools in organizations. However, unlike the media richness hypothesis, it is argued here that the media naturalness hypothesis is compatible with social theories of behaviour towards e-communication tools. The 'e' in 'e-communication' stands for 'electronic', so the term 'e-communication' as used here refers to, essentially, any form of computer-mediated communication plus more traditional forms of electronic communication, such as telephone use.

The media richness hypothesis

The media richness hypothesis is used in this chapter to summarize the main idea proposed by media richness theory, originally proposed by Daft and Lengel (1986). According to that idea,

communication media can be classified along a continuum of 'richness', where richness is based on the ability of media to carry non-verbal cues, provide rapid feedback, convey personality traits, and support the use of natural language (Daft and Lengel 1986). Matching media to collaborative tasks is based on the need to reduce 'uncertainty', or the absence of information to perform a task, and 'equivocality', or the absence of a shared understanding of what information means in connection with the task being carried out.

The media richness hypothesis argues that the face-to-face medium is the richest and most effective medium for reducing equivocality, which is assumed to be high in, for example, knowledge-intensive tasks that involve different areas of an organization (Kock 1998; Lengel and Daft 1988; Rice and Shook 1990). Communication media created by e-communication tools are placed somewhere in between the face-to-face medium and paper-based written media, depending on their ability to carry non-verbal cues, and so on (Daft et al. 1987; Kock 1998; Lee 1994). According to the media richness hypothesis, rational and effective users choose media of appropriate richness for tasks that involve communication, and if due to accessibility constraints their choice of communication media is restricted to media of lower than appropriate richness, a decrease in task outcome quality will occur.

Evidence in support of the media richness hypothesis

Daft et al. (1987) found that managers who were media sensitive (i.e. who selected appropriately rich media for collaborative tasks) performed better than managers who were not. Later studies provided evidence that e-communication media are more task-oriented than the face-to-face medium, and that users perceived those e-communication media to be less suitable for personal interactions necessary in business communication as compared to richer media (Rice 1993; Rice and Shook 1990). Other studies suggested that use of e-mail and computer conferencing negatively affected group cohesiveness (Sproull and Kiesler 1986; Walther 1996), and argued that e-communication media reduced 'social context cues', making them impersonal and likely to be avoided for business tasks or, if adopted, likely to lead to lower quality task outcomes than the face-to-face medium (for reviews, see Lee 1994; Markus 1994b).

More recent studies continue to provide empirical support for the media richness hypothesis. Walther et al.'s (2001) study, for example, suggests that even the sharing of facial images of group members has a positive effect on group performance in 'zero-history' groups (i.e. groups whose members have no prior history of collaboration). A quote from another study, comparing face-to-face, teleconferencing, and electronic chat groups, is representative of the findings from the recent literature in connection with the media richness hypothesis:

> An analysis of the recorded group discussions revealed that, although most of the groups in the electronic chat condition selected an integrative tallying procedure, an effective strategy that would likely have resulted in the successful solution of the problem, they experienced difficulties coordinating member inputs and verifying information. This slowed their progress and heightened their level of frustration and mental effort. This supports the notion that electronic chat lacks certain characteristics, present in verbal communication, that are necessary for exchanging and structuring information in synchronous groups.
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> (Graetz et al. 1998, p. 741)

Evidence against the media richness hypothesis

In spite of the existence of supporting empirical evidence for the media richness hypothesis, research on communication media choice and use behaviour also led to results that contradicted the hypothesis. Fulk et al. (1990) and Markus (1990) discuss studies that found weak support for

the media richness hypothesis as well as evidence contradicting the hypothesis. Other studies attempting to test, replicate, or extend the media richness hypothesis found little or no support for it (Dennis et al. 1999; Kinney and Dennis 1994; Kinney and Watson 1992). Some found effects contrary to the notion that a lack of social presence and social context cues is necessarily 'bad' for collaborative tasks, as communication media users can compensate for the lack of richness of the media by adapting their communication behaviour (e.g. Carlson and Zmud 1999; Kock 1998; Weisband 1994; Weisband et al. 1995). Similarly, Markus (1994a) found that managers often used e-mail, a lean medium according to the media richness hypothesis, for complex communication in connection with managerial tasks. Others found evidence that users could have rewarding and perceptually rich interaction in computer-based and asynchronous newsgroups, or other on-line social communities, whose underlying communication media were relatively low in richness according to the media richness hypothesis (Rheingold 1993; Walther 1996).

In addition to the empirical evidence contradicting the media richness hypothesis, one main theoretical refutation has been proposed: the social influence refutation (Markus 1994b). This is based on Fulk et al.'s (1990) social influence model, which argues that social influences can strongly shape individual behaviour towards technology in ways that may be independent of technology features. Examples of social influences are patterns of technology use observed in individuals (Bandura 1986) that are consistent with formal and informal social norms of accepted behaviour within the group to which the individual belongs. Social influences on technology-related individual behaviour have been shown to be moderated by a number of factors, particularly an individual's personal attraction to a group (Fulk 1993). Markus (1994a,b) showed that social influences might shape individual behaviour towards communication media in ways that are inconsistent with the media richness hypothesis by focusing on media choices made by managers at a large risk management services provider. Specifically, Markus (1994a) questioned the accuracy of the media richness scale, which places e-mail behind face-to-face interaction, suggesting that social influences can change some of e-mail's attributes that are assumed under the media richness hypothesis to be static and dependent on media attributes. The key piece of evidence was that senior managers' pressure on other employees to reply quickly to e-mail increased the medium's feedback immediacy, and therefore shifted e-mail up from its relative position on the media richness scale. A plausible conclusion that follows from Markus' argument is that social influences, such as pressure from managers on their subordinates, can make a medium that is seen as 'lean' based on the media richness hypothesis to become 'richer' than face-to-face (e.g. if managers require their subordinates to use only e-mail for communication and to avoid face-to-face communication as much as possible).

However, the social influence refutation focused on showing a fatal flaw in the media richness hypothesis, and did not aim to address one striking fact about many of the empirical studies that contradicted the media richness hypothesis. Even though those studies found evidence against the hypothesized positive link between media richness and media choice or quality of task outcomes, they also often found evidence that pointed to the perceived inadequacy of media of low richness by their users, a perception that was aligned with the media richness hypothesis (Carlson and Zmud 1999; Kock 1998; Markus 1994a,b; Rheingold 1993; Walther 1996). This is true in Markus' (1994a) study as well, where managers and employees also perceived e-mail as a poor medium for communication, in spite of the managers' decision to promote the use of e-mail because of some of its advantageous features, such as the ability to enable distributed and asynchronous interaction. That is, those studies successfully questioned the existence of a link between low media richness and two patterns, namely media avoidance and lower quality of task outcomes than in richer media, but not the perception by users that media that veered too far away from the face-to-face medium were somehow less appropriate than the face-to-face medium to

support communication concerning business tasks. This chapter tries to explain this phenomenon by introducing the concept of media naturalness and proposing a new hypothesis, called the media naturalness hypothesis. In addition to explaining the phenomenon, as well as explaining evidence in support of the media richness hypothesis, the media naturalness hypothesis is shown to be compatible with Fulk et al.'s (1990) social influence model. The new hypothesis builds on the modern version of Darwin's theory of evolution by natural selection, which allows us to understand how we developed our current biological communication apparatus.

Human evolution and media naturalness

The relevance of understanding the process that led to the evolution of our biological communication apparatus and the effect that this has on e-communication behaviour, comes from one important principle, which is that humans have been 'engineered' by evolutionary forces to communicate primarily in a co-located and synchronous manner, as well as through facial expressions, body language, and speech.

According to the modern version of Darwin's (1859) theory of evolution, the human species evolved through natural selection, a process in which random mutations are introduced in the genetic makeup of offspring, leading to traits that are selected for based on their usefulness for survival and mating (Darwin 1859; Dawkins 1989; Mayr and Provine 1998). The evolutionary pace set by natural selection is usually very slow (Boaz and Almquist 1997; Dobzhansky 1971; Lorenz 1983). Genetic mutations that enhance an individual's chances of survival and mating, in many cases only slightly (Dobzhansky 1971), slowly accumulate and spread through the members of a species, leading to the development of species-wide physical, behavioural and cognitive traits over long periods of time. These may span thousands or millions of years, and are contingent on breeding speed and mortality rates.

Evidence suggests that during much of our evolutionary past we relied on co-located and synchronous forms of communication through facial expressions, body language, and sounds (including speech, which uses a large variety of sound combinations) to exchange information and knowledge among ourselves (Boaz and Almquist 1997; Cartwright 2000). Humans have developed a complex web of facial muscles (22 on each side of the face; more than any other animal) that allow us to generate over 6000 communicative expressions; very few of these muscles are used for other purposes, such as chewing (Bates and Cleese 2001; McNeill 1998). There is a noticeable evolutionary direction towards the development of a biological communication apparatus that supported ever more sophisticated forms of speech, or increased communication complexity, culminating in the development of complex speech by *Homo sapiens*. The advent of complex speech was enabled by the development of the larynx, located relatively low in the neck, and an enlarged vocal tract—key morphological traits that differentiate modern humans from their early ancestors and that allow modern humans to generate the large variety of sounds required to speak most modern languages (Laitman 1984; Lieberman 1998). The morphology of the human ear also suggests a specialized design to decode speech (Lieberman 1998; Pinker 1994).

Since our biological communication apparatus has been used for co-located and synchronous communication using facial expressions, body language, and sounds over such a long period of time, it stands to reason that it should have been designed for communication interaction modes that present those characteristics. A plausible corollary would be that other communication interaction modes, including e-communication in general, would be matched to different degrees to our biological communication apparatus, depending on the degree to which they approximate face-to-face communication.

It is important to note here that optimal biological design rarely occurs in nature because evolution is a slow process that takes time to catch up with environmental change. As a result, changes in the environment often make previous biological designs sub-optimal. A leading evolutionary psychologist has made this point rather eloquently in the past:

> One constraint on optimal design are evolutionary time lags … evolution refers to change over time … Because evolutionary changes occur slowly, requiring thousands of generations of recurrent selection pressure, existing humans are necessarily designed for the previous environments of which they are a product. Stated differently, we carry around a stone-aged brain in a modern environment. A strong desire for fat, adaptive in a past environment of scarce food resources, now leads to clogged arteries and heart attacks.
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> (Buss 1999, p. 20)

Buss's (1999) conclusion is a general one; of which the main hypothesis proposed in this chapter (i.e. the media naturalness hypothesis) can be seen as a corollary. Essentially, what is argued here is that modern humans' brains are not optimally adapted for current e-communication technologies because these technologies often suppress too many of the elements found in face-to-face communication. That is, our brain has likely been to a large extent 'hardwired' for co-located and synchronous communication employing facial expressions, body language, and speech; or, in other words, our brain is genetically programmed to excel in communication interactions that incorporate those elements. This provides the basis on which the concept of *media naturalness* can be defined—the ability of communication media to support co-located and synchronous communication employing facial expressions, body language, and speech. It follows that using modes of communication that veer away from 'natural' communication is likely to put 'extra burden' on the brain, as our brain has been designed for that type of communication. Essentially, natural communication is equated with face-to-face communication.

A simple analogy can help highlight the importance of the above conclusion. Since we evolved two hands, not only one or as many as three hands, we also evolved brain functions designed for the use of two hands (as well as other connected elements, such as arms) to accomplish a number of basic tasks, such as climbing a tree by holding onto its branches. Therefore, trying to climb a tree using only one hand is likely to be more difficult and frustrating for a human than if both hands were used. That is, the lack of 'naturalness' of the act causes a mismatch between the biological makeup of the individual and the task being accomplished. It is argued here that communicating in ways that are not 'natural' is analogous to this, in that it also leads to a mismatch and related consequences. This mismatch refers to our biological communication apparatus, which comprises the brain functions associated with communication, and the various communication instincts (Pinker 1994, 1997) that have been programmed into our brain by evolutionary forces. This conclusion provides the basis for the development of the media naturalness hypothesis.

However, before we go any further, it is important to stress that e-communication tools exist for a reason, which is that they solve key communication problems that exist today (and that did not exist in our prehistoric past). For example, communication through e-mail, with all its limitations, can take place regardless of time and physical location—that is, it can take place in an asynchronous and distributed manner—making it a convenient alternative to face-to-face communication in a variety of business situations. Moreover, e-mail, with all its limitations, generates a record, and thus can be re-processed by its recipient as many times as needed (as long as proper filing takes place); something that is not possible with face-to-face communication. Therefore, the argument put forth in this chapter should not be interpreted as a call for the use of face-to-face communication only in business, but an alternative explanation as to why we often should

make e-communication media as face-to-face-like as possible, while at the same time preserving the advantages that led to the widespread use of communication systems such as e-mail.

The effects of media naturalness on communication attributes

The media naturalness hypothesis is an attempt to derive a general predictive statement linking a few dependent communication-related constructs with one main independent construct, namely the mismatch between our biological communication apparatus and communication media characteristics. The inverse of this mismatch is defined as the 'naturalness' of a communication medium—that is, the higher the mismatch, the lower the naturalness of a communication medium. In this section, I define media naturalness and key constructs affected by it, following that with the formal enunciation of the media naturalness hypothesis.

Media naturalness

As discussed in the previous section, there is strong evidence that human beings have been 'engineered' by evolutionary forces to communicate primarily in a co-located and synchronous manner, as well as through facial expressions, body language, and speech. Thus, it is reasonable to assume that natural communication involves at least five key elements: 1) a high degree of co-location, allowing individuals engaged in an interaction to see and hear each other; 2) a high degree of synchronicity, which would allow the individuals engaged in a communication interaction to quickly exchange communicative stimuli; 3) the ability to convey and observe facial expressions; 4) the ability to convey and observe body language; and 5) the ability to convey and listen to speech.

Given this, we can define the naturalness of the communication medium created by an e-communication technology based on the degree to which the technology selectively incorporates (or suppresses) those five elements. That is, it can be stated that, other things being equal, the degree of 'virtual' incorporation of one of the media naturalness elements correlates the degree of naturalness of an e-communication medium. The term 'virtual' means that none of the five media naturalness elements will be incorporated to the e-communication medium to the same extent to which it is available in actual face-to-face communication. For example, flat representations of facial expressions, such as those provided by desktop video conferencing, are a virtual approximation of the actual three-dimensional experience of seeing live facial expressions (Bryson 1996; Mass and Herzberg 1999).

With the main independent construct of the media naturalness hypothesis defined, we can now focus on the identification of key dependent constructs that are relevant from a business perspective. This is done here as a first step, since identifying a comprehensive set of dependent constructs that are directly affected by media naturalness will require extensive empirical research. Nevertheless, the set of dependent constructs identified below can be seen as sufficient to justify the media naturalness hypothesis as a viable alternative for the media richness hypothesis. The dependent constructs discussed here are *cognitive effort*, *communication ambiguity*, and *physiological arousal*.

Cognitive effort

There is a large body of evidence pointing at our ability to employ the media naturalness elements rather effortlessly in communication interactions. For example, it has been shown that human beings possess specialized brain circuits that are designed for the recognition of faces and the generation and recognition of facial expressions (Bates and Cleese 2001; Le Grand et al. 2001;

McNeill 1998), which artificial intelligence research suggests require complex computations that are difficult to replicate even in powerful computers (Kurzweil 1999; Russel and Norvig 1995). The same situation is found in connection with speech generation and recognition (Kurzweil 1999; Lieberman 1991, 2000; Russel and Norvig 1995).

Since our brain's circuitry has been configured by evolution to excel in communication employing the five media naturalness elements discussed above, one can reasonably conclude that selectively suppressing those elements in communication media will require the development and use of specialized brain circuits to make up for the absence of those elements and enable effective communication. Those brain circuits are not hardwired into our brain but learned over time, primarily through changes in the brain's neocortex, its outer layer, where most learned circuits are concentrated. Lieberman (1991, 1998, 2000) has shown that, as far as human communication is concerned, learned circuits are unlikely to be as efficient as the hardwired circuits endowed on us by evolution; the former usually relying on more convoluted paths than the latter. As pointed out by Pinker and Bloom (1992, p. 477), the latter, genetically coded circuits are a result of the gradual evolution of '. . . neural mechanisms [that make communication] become increasingly automatic, unconscious, and undistracted by irrelevant aspects of world knowledge'.

Moreover, most learned brain circuits used in communication have to be 'refreshed' (or partially re-learned) from time to time, otherwise they are 'erased' (Pinker 1997; Schacter 2001). Those learned circuits usually differ from individual to individual, which can lead to inefficiencies associated with differences in sender/receiver communication brain circuitry (Kotulak 1997). Thus, it is plausible to conclude that since the use of more convoluted paths requires increased neural activity, decreases in media naturalness will generally lead to increased mental effort, or what we refer here to as *cognitive effort*, in connection with communication interactions.

Cognitive effort is defined here as the amount of 'mental activity', or, from a biological perspective, the 'amount of brain activity' involved in a communication interaction. It can be assessed directly, with the use of techniques such as magnetic resonance imaging. Cognitive effort can also be assessed indirectly, based on perceptions of levels of difficulty associated with communicative tasks (Schacter 2001; Todd and Benbasat 1999), as well as through indirect measures such as that of 'fluency', proposed by Kock (1998). The 'fluency' measure builds on the assumption, previously made in many empirical studies (see, e.g. Leganchuk et al. 1998), that the amount of cognitive effort associated with an intellective task correlates with the amount of time required to complete the task. As such, 'fluency' is defined as the amount of time taken to convey a certain number of words through different communication media, which is assumed to correlate (and serve as a surrogate measure of) the amount of time taken to convey a certain number of ideas through different media (Kock 1998).

Empirical studies conducted by Kock (1998, 1999) of process improvement groups interacting through different communication media are particularly well aligned with the notion that a decrease in media naturalness will generally lead to an increase in cognitive effort. Those studies showed that 'fluency' is, on average, 18 times higher face-to-face than over e-mail in complex group tasks. Even in the case of proficient typists, who can usually type half as fast as they can speak or faster, Kock's (2001a, b, c) research suggests fluency in complex collaborative tasks conducted face-to-face to be about 10 times higher than over e-mail, regardless of other factors such as cultural background and familiarity with collaborators. According to this estimate, if exchanging 600 words face-to-face required about 6 minutes, exchanging the same number of words over e-mail would take approximately 1 hour—these figures are comparable to those found in Kock's (2001a, b, c) studies.

Communication ambiguity

Individuals brought up in different cultural environments usually possess different information processing schemas that they have learned over their lifetimes. Different schemas make individuals interpret information in different ways, particularly when information is expected but not actually provided. Bartlett (1932) has unequivocally demonstrated this phenomenon, perhaps for the first time, in his famous experiments involving the American Indian folk tale 'The War of The Ghosts'.

Essentially, the experiments showed that subjects who held different information processing schemas would interpret the tale, which is filled with strange gaps and bizarre causal sequences, in substantially different ways. In Bartlett's (1932) experiments, individuals were expecting certain pieces of information to be provided to them. When they did not get the information that they were expecting, they 'filled in the gaps' based on their existing information processing schemas and the information that they were given (see also Gardner 1985). This led to significant differences in the way individuals interpreted the tale.

The human brain has a series of hardwired information processing schemas that are designed to solve problems that have occurred recurrently during the millions of years that led to the evolution of the human species (Cosmides and Tooby 1992; Tooby and Cosmides 1992). Several of these problems addressed by evolutionary adaptations are related to the communication process (Pinker and Bloom 1992). Our hardwired schemas involved in the communication process make us search for stimuli that will enable us to obtain enough information to effectively interpret the message being communicated, and several of the stimuli we automatically search for are those present in actual face-to-face communication (Lieberman 2000), such as contextual cues (available in co-located communication), immediate feedback (available in synchronous communication) in the form of facial expressions and body language, and voice intonations. When several of these stimuli are not present, by being selectively suppressed by e-communication technologies, individuals 'fill in the gaps' much like the subjects in Bartlett's (1932) experiments.

The problem is that in the absence of information-giving stimuli, 'filling in the gaps' is likely to lead to a higher proportion of misinterpretations, and thus ambiguity, than if the stimuli were not suppressed—as Bartlett's (1932) and other studies (see, e.g. Gardner 1985; and Pinker 1997) show. While different individuals are likely to look for the same types of communicative stimuli, their interpretation of the message being communicated in the absence of those stimuli will be largely based on their learned schemas, which are likely to differ from those held by other individuals (no two individuals, not even identical twins raised together, live through the exact same experiences during their lives). That is, a decrease in medium naturalness, caused by the selective suppression of media naturalness elements in a communication medium, is likely to lead to an increase in the probability of misinterpretations of communicative cues, and thus an increase in *communication ambiguity*.

The above conclusion is consistent with the empirical observation that certain feedback comments, especially those involving constructive criticism, which are often used effectively in face-to-face interaction together with other non-verbal cues that 'soften' their tone, are interpreted in different (and often negative) ways when provided via e-mail in business-related discussions—sometimes as very critical and blunt, sometimes as implying indifference (Kock 1999). Indeed, e-communication in general is perceived as more 'ambiguous' than face-to-face communication (Carlson and Zmud 1999; Graetz et al. 1998; Kock 1998, 2001b; Rheingold 1993; Walther 1996).

While there are studies that show that individuals can voluntarily or involuntarily compensate for this increase in communication ambiguity by means of constructing better thought-out

messages (Kock 1998, 2001b), and by becoming familiar with the medium and their partners (Carlson and Zmud 1999; Walther 1996), to the best of my knowledge there have been no studies suggesting that the suppression of media naturalness elements causes a reduction in communication ambiguity (i.e. the opposite effect to what we hypothesize here). That is, even though there is evidence suggesting that the effects of greater communication ambiguity can be moderated by compensatory adaptation behaviour, the evidence suggesting that lower communication media naturalness leads to greater communication ambiguity is beyond much doubt.

Physiological arousal

There is little doubt that a fully developed biological communication apparatus has been particularly important in terms of survival and mating for our prehistoric ancestors, as it is for us today (Boaz and Almquist 1997; Dunbar 1993; Miller 2000). While there is substantial evidence suggesting that our biological communication apparatus is designed for face-to-face communication, there is also ample evidence that such apparatus (including the neural functional language system) cannot be fully developed without a significant amount of practice (Pinker 1994). Evolution is likely to have led to the development of mechanisms to compel human beings to practice the use of their biological communication apparatus; mechanisms that are similar to those compelling animals to practice those skills that play a key role in connection with survival and mating (Wilson 2000). Among these mechanisms, one of the most important is that of *physiological arousal*, which is often associated with 'excitement' and 'pleasure' (Boaz and Almquist 1997; Miller 2000).

It is a plausible conclusion that engaging in communication interactions, particularly in face-to-face situations, is likely to trigger physiological arousal in human beings. This conclusion underlies the theoretical hypothesis that modern humans possess what Pinker (1994) refers to as a 'language instinct', and can be taken further through the associated conclusion that each face-to-face communication element (e.g. the use of facial expressions to convey thoughts and feelings) contributes to physiological arousal. Indeed, there is evidence that face-to-face communication elements such as certain types of facial expressions, oral utterances, and body language expressions, even when used in isolation, evoke physiological arousal in human beings (Bates and Cleese 2001; McNeill 1998; Zimmer 2001).

It would thus be reasonable to also conclude that communication interactions in which certain elements of 'natural' face-to-face communication are suppressed (e.g. the ability to employ/see facial expressions) involve a corresponding suppression of physiological arousal, and, in turn, a consequent decrease in the perceived 'excitement' in connection with the communication interaction. In other words, suppression of media naturalness elements is likely to make communication interactions 'duller' than if those elements were present.

Obviously, as with other conclusions set out in this chapter, the above conclusion assumes 'other things being equal'. For instance, the topic of a communication interaction and the identity of the other person are factors that may influence physiological arousal more strongly than the communication medium itself, which is a point that is not disputed here and is perfectly compatible with the hypothesis. Having said that, it is interesting to point out that the above conclusion is consistent with, and provides a plausible explanation for the ample evidence suggesting that e-communication systems users consistently perceive computer-mediated communication in general as less 'exciting', 'duller', or less 'emotionally fulfilling' than face-to-face communication (Ellis et al. 1991; Kiesler et al. 1988; Kock 1999; Markus 1994b; Reinig et al. 1995; Sproull and Kiesler 1986; Walther 1996).

Decreases in physiological arousal may influence media choices towards media of high naturalness, but, when choice is limited to low naturalness media, they may arguably

influence task outcome quality positively under the appropriate circumstances. A decrease in physiological arousal may induce the members of a group to engage in more focused communication, particularly when an e-communication medium is used to support task-oriented interaction, as opposed to relationship-oriented interaction (see Walther 1996). That is, the lack of excitement resulting from the use of an e-communication medium to support a particular group task may be associated with a higher degree of communication focus on the task at hand, rather than gossip or tangential topics, somehow counteracting the negative effects on task outcome quality associated with increase cognitive effort and communication ambiguity. Kock's (1999) study of process improvement groups provides evidence that supports in part this conjecture.

The media naturalness hypothesis

Now that the three main dependent constructs of cognitive effort, communication ambiguity and physiological arousal have been identified and defined, we can formally enunciate the media naturalness hypothesis, as follows:

> Other things being equal, a decrease in the degree of naturalness of a communication medium leads to the following effects in connection with a communication interaction: (a) an increase in cognitive effort, (b) an increase in communication ambiguity, and (c) a decrease in physiological arousal.

The hypothesis assumes that the face-to-face medium is the most natural of all. As discussed before, the media naturalness construct is made up of five main elements: co-location, synchronicity, and the ability to convey facial expressions, body language, and speech. Thus, two assumptions can be made which are useful for managers who need to decide which features to have on their e-communication systems in the face of limited resources. The first assumption is that, other things being equal, an e-communication medium that incorporates one of the media naturalness elements—i.e. co-location, synchronicity, and the ability to convey facial expressions, body language, and speech—will have a higher degree of naturalness than another e-communication medium that does not incorporate that element. The second assumption is that, other things being equal, an e-communication medium that incorporates one of the five media naturalness elements to a larger degree than another will have the highest degree of naturalness.

The media naturalness hypothesis can be used as a basis for management decisions regarding which new features to add to an e-communication tool depending on resource constraints. For example, let us imagine a Web-based application that allows two individuals to communicate through text-based chat in a business-to-consumer type of interaction, such as that involving a customer service representative of an online broker and one of its customers who needs to learn how to purchase a particular investment instrument. According to the media naturalness hypothesis, if a nearly identical application is developed, where the only difference is the ability to convey facial expressions though streamed video (in addition to the text-based chat feature), this latter application will create a communication medium with a higher degree of naturalness than that of the text-based, chat only application. A likely consequence will be higher perceived quality of the online interaction, due to, for example, the lower cognitive effort required.

The media naturalness hypothesis also provides the basis for management decisions regarding 'partial' incorporation of a naturalness element to an e-communication medium depending on resource constraints. Each of the five naturalness elements can be incorporated into an e-communication medium to varying degrees; *full* incorporation means that the element is identical to what would be available in the face-to-face medium.

Contrasting the hypotheses

If the media naturalness hypothesis is to be considered a viable and useful alternative to the media richness hypothesis, key differences between the hypotheses must be explicitly identified. While the media naturalness hypothesis may seem similar to the media richness hypothesis, at least two key differences exist between the two. The first refers to the main dependent constructs of the hypotheses. The media richness hypothesis has two main dependent constructs, which are hypothesized to vary depending on the degree of richness of the communication medium being used. These constructs are: 1) media choice, which is hypothesized to match the richness requirements of a task in the case of 'effective' workers; and 2) task outcome quality, which is hypothesized to be negatively affected if choice is limited to media that possess a level of richness that is lower than the optimal for the task (Daft et al. 1987; Lee 1994; Lengel and Daft 1988; Markus 1994b).

The media naturalness hypothesis, on the other hand, does not relate low media naturalness with certain types of behaviour or task outcomes, like the media richness hypothesis does, but with high cognitive effort and communication ambiguity, and with low physiological arousal. This in turn may or may not lead to certain types of behaviour or task outcomes.

For example, as mentioned before, empirical studies conducted by Kock (1998, 1999) of process improvement groups interacting through different communication media showed that 'fluency' (the number of words conveyed per unit time) is about 10 times higher face-to-face than over e-mail in complex group tasks, even when the effect that 'typing is slower than speaking' is controlled for. Yet, the studies found that most groups voluntarily chose e-mail to perform their tasks (even though interviews suggested that they consistently perceived e-mail as an 'ambiguous' and 'poor' communication medium), and that the task outcome quality was slightly better for the e-mail groups when compared with the face-to-face groups. Interviews also suggested that e-mail was chosen primarily because of what most perceived as advantages, such as the ability to support distributed and asynchronous communication.

The explanation given for these seemingly paradoxical results was that individuals 'compensated' for the lack of naturalness of the communication medium used by preparing better thought out, more focused, and better structured contributions than in face-to-face meetings (Kock 1998, 1999). The studies provide evidence that while cognitive effort was increased, which is consistent with the media naturalness hypothesis, media choice and task outcome quality were different from predicted by the media richness hypothesis. The media naturalness hypothesis provides a basis on which media choices and task outcomes can be more deeply understood as the result of the interplay of biological, social, and environmental influences.

The other key difference between the two ideas is that the media richness hypothesis assumes that different communication media can be classified according to a continuum of media richness, particularly based on the information-carrying capacity of the media. This opens the door for the conclusion that communication media that incorporate more of those features that increase their richness (e.g. feedback immediacy or synchronicity) will be even 'better' than face-to-face interaction in some circumstances—for instance, they may allow individuals to deal with tasks of extremely high equivocality by supporting parallel communication interactions with several individuals at the same time.

The media naturalness hypothesis, however, argues that the face-to-face medium is, other things being equal (including the communication topic and task), the one likely to lead to the least cognitive effort and communication ambiguity, and the most physiological arousal during communication. The reason is that the face-to-face medium is precisely the medium used for communication during the vast majority of our evolutionary history. This implies that

e-communication tools with features that allow group members to synchronously generate and access substantially more information than in face-to-face interactions, will also lead to problems, likely due to information overload and other negative effects.

That is, the media naturalness hypothesis allows us to place the face-to-face medium at the centre of a one-dimensional scale of naturalness where the distance from the centre (either to the 'left' or 'right') could be seen as a measure of decreased naturalness. Anything 'less' or 'more', so to speak, than face-to-face communication would be likely to lead to problems in communication interactions. This conclusion is consistent with previous studies of group decision support systems (Dennis et al. 1996; Reinig et al. 1995). Those systems are typically used to enhance face-to-face communication by allowing individuals in the same room to interact synchronously through computers without having to share 'airtime' with each other, i.e. all individuals can contribute ideas at the same time, which a human facilitator manages for the group with the help of the system. Even if used by pairs of individuals, these systems are generally believed to allow for the exchange of significantly more information than 'pure' face-to-face meetings (Johansen 1988).

Consistent with this conclusion, Reinig et al. (1995) found that the use of group decision support systems make meetings less 'exciting' for the participants. Furthermore, a consistent finding from studies of the impact of group decision support systems on meetings has been that they increase the number of ideas generated, but do not improve the quality of the outcomes produced through the meetings (Dennis et al. 1996), which led Dennis (1996) to conclude that the use of the systems leads to information overload. That is, on the surface, individuals seem to exchange more information, but the information is never used to achieve better task outcomes because the rate of information exchange is higher than the information processing capacity of the individuals.

Implications for researchers

The media naturalness hypothesis cannot fully explain e-communication behaviour. Arguing otherwise would be akin to proposing a modern-day version of biological determinism. Other factors in connection with the use of e-communication media need to be considered, such as social influences (Fulk et al. 1990; Markus 1994a, b). For example, the media naturalness hypothesis could not have been used to fully explain the behaviour of the employees in Markus's (1994a) study, who used e-mail, in spite of perceiving it as a poor communication medium, because of pressure from senior managers. That is, it was primarily a social influence (Fulk et al. 1990) that led them to behave in the way they did in connection with media choice. Moreover, they used e-mail in a relatively effective way for complex communication, in spite of their negative perceptions about the medium, which suggests another phenomenon that is not predicted by the media naturalness hypothesis, namely the phenomenon of compensatory adaptation (Kock 1998, 2001b).

Nevertheless, a key contribution of the media naturalness hypothesis, and one of its most important implications for researchers, is that it provides a missing link that may pave the way for the integration of different e-communication theories. Previous theoretical reviews have categorized e-communication theories in similar ways. Webster and Trevino (1995) grouped them into two categories: theories proposing rational explanations of media choice, and theories proposing social explanations. Carlson and Davis (1998) classified theories into two similar categories: trait theories and social interaction theories.

These categorizations suggest key differences between 'socially-deprived' theories, of which Daft and Lengel's (1986) media richness theory is often seen as the paragon, and theories placing emphasis on social elements as determinants of behaviour towards e-communication media.

This 'theoretical polarization' was later highlighted in another theoretical review, suggesting that these two main types of theories have '. . . often been pitted against each other rather than considered as complementary in more comprehensive studies' (Trevino et al. 2000, p. 163).

In spite of attempts to combine both types of theories (Trevino et al. 2000; Webster and Trevino 1995), other studies provide evidence that the media richness hypothesis cannot be effectively combined with hypotheses espoused by social theories without radical revisions (Lee 1994; Ngwenyama and Lee 1997). The development of the media naturalness hypothesis is a first step in the pursuit of a solution to this problem. Evidence of this is that the media naturalness hypothesis, as discussed earlier, is not only compatible with Fulk et al.'s (1990) social influence model, but also adds to our understanding of e-communication behaviour phenomena that are not completely explained by that model.

The above must be followed by a caveat regarding the limitations of the theoretical perspective taken here. The argument presented in this chapter focuses on a human-to-human communication perspective, which is arguably a narrow perspective of human communication and cognition. Different and possibly broader perspectives exist, such as the systemic perspective proposed by Hutchins (1996), who deems a culturally diverse group of individuals as a key unit of cognition, and the 'metaindexicality' perspective proposed by Henderson (1998), who sees visual representations as cognitive artefacts that allow for rich communication at multiple cognitive levels. One could also take a human-to-object perspective, by looking at interactions between humans and inanimate objects as legitimate instances of communication. The relatively narrow human-to-human communication perspective is adopted here because it is arguably the perspective adopted by the media richness hypothesis, for which this chapter attempts to propose a viable alternative.

Implications for managers

The media naturalness hypothesis leads to predictions that are particularly relevant for communicative tasks brought about by the advent of e-business. The hypothesis leads to the prediction that cognitive effort and communication ambiguity should increase, and physiological arousal decrease, with decreases in e-communication media naturalness. And, in business-to-consumer interactions conducted online, increased cognitive effort and communication ambiguity, and (possibly) decreased physiological arousal (especially in entertainment-related interactions), may lead to lower perceived quality and dissatisfaction from the part of customers.

Since the Internet makes it much easier for customers to change suppliers, who are literally 'a few clicks away', the use of e-communication media of lower naturalness than those provided by the competition can have negative consequences for companies that rely heavily on online interactions with their customers to increase or maintain their revenues. This conclusion is aligned with, and partially explains, the constant calls in the popular business literature for the use of more natural forms of online communications between business and consumers (Metz 2000; Wasserman 2001)[1]. That is, even though a decrease in communication medium naturalness may not have a negative effect on task outcome quality (Kock 1998, 2001b), it will lead to other problems in certain situations—e.g. online business-to-consumer interactions.

The media naturalness hypothesis provides the basis on which managers with limited resources can decide how to maximize the naturalness of their companies' online communications with their customers. One area in which these decisions have to be made in many businesses,

[1] See also Mottl, J.N. (2000). A wake-up call for e-retailers, *InternetWeek*, September 25, http://www.internetweek.com/indepth/indepth092500.htm

regardless of type and size, is that of online customer support, where customer support representatives interact with customers electronically.

The widespread availability of generic video players and instant-messaging technologies allow for the selective incorporation of synchronicity and the ability to convey speech and facial expressions to these Internet-based interactions, which according to the media naturalness hypothesis is likely to lead to a decrease in the amount of cognitive effort and communication ambiguity. This is likely to contribute to an increase in perceived customer service quality, and potentially in market share (Macdonald 1995; Walkins 1992), particularly in sectors such as financial services, which relies heavily on e-communication tools to provide customer support through the Internet.

The media naturalness hypothesis also provides the basis on which managers and venture capitalists can predict the likely evolution of e-communication technologies and thus better target their investments in those types of technologies. This chapter argues that this evolution will likely be towards e-communication tools that achieve the maximum naturalness at the lowest cost possible. Although this may not be obvious at first glance, e-mail fits this prediction reasonably well, because e-mail is more natural (e.g. it provides a higher degree of synchronicity) and arguably less costly today than paper-based mail, which is what it was originally meant to replace (Keen 1994; Sproull and Kiesler 1991).

This conclusion also explains the relative commercial success of sophisticated text-based chat tools that add synchronicity to online business-to-consumer interactions, making it easier and more exciting for customers to obtain information about products and services (Eichler and Halperin 2000; Gilbert 1999). Finally, it explains the relative commercial success of virtual news anchors such as 'Ananova' (Cracknell 2000; Orubeondo 2000), whose cost is a fraction of their human counterparts', since many Internet users seem to prefer to listen to news online while looking at a virtual newscaster, rather than the arguably more cognitively demanding and less exciting option of reading them on a Web page.

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References

Bandura, A. (1986). *Social foundations of thought and action.* Prentice Hall, Englewood Cliffs, NJ.

Bartlett, F. (1932). *Remembering: a study in experimental and social psychology*. Cambridge University Press, Cambridge, MA.

Bates, B. and Cleese, J. (2001). *The human face*. DK Publishing, New York.

Boaz, N.T. and Almquist, A.J. (1997). *Biological anthropology: a synthetic approach to human evolution*. Prentice Hall, Upper Saddle River, NJ.

Bryson, S. (1996). Virtual reality in scientific visualization. *Communications of the ACM*, **39**, 62–71.

Buss, D.M. (1999). *Evolutionary psychology: the new science of the mind*. Allyn and Bacon, Needham Heights, MA.

Carlson, P.J. and Davis, G.B. (1998). An investigation of media selection among directors and managers: from 'self' to 'other' orientation. *MIS Quarterly*, **22**, 335–62.

Carlson, J.R. and Zmud, R.W. (1999). Channel expansion theory and the experiential nature of media richness perceptions. *Academy of Management Journal*, **42**, 153–70.

Cartwright, J. (2000). *Evolution and human behavior: Darwinian perspectives on human nature*. MIT Press, Cambridge, MA.

Cosmides, L. and Tooby, J. (1992). Cognitive adaptations for social exchange. In: J.H. Barkow, L. Cosmides, and J. Tooby (eds), *The adapted mind: evolutionary psychology and the generation of culture*, pp. 163–228. Oxford University Press, New York.

Cracknell, M. (2000). A cyberstar is born. *Marketing Week*, **23**, 54.

Daft, R.L. and Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, **32**, 554–71.

Daft, R.L., Lengel, R.H., and Trevino, L.K. (1987). Message equivocality, media selection, and manager performance: implications for information systems. *MIS Quarterly*, **11**, 355–66.

Darwin, C. (1859). *On the origin of species by means of natural selection.* Harvard University Press, Cambridge, MA.

Dawkins, R. (1989). *The selfish gene*. Oxford University Press, New York.

Dennis, A.R. (1996). Information exchange and use in group decision making: you can lead a group to information, but you can't make it think. *MIS Quarterly*, **20**, 433–55.

Dennis, A.R., Haley, B.J., and Vanderberg, R.J. (1996). A meta-analysis of effectiveness, efficiency, and participant satisfaction in group support systems research. In: J.I. DeGross, S. Jarvenpaa, and A. Srinivasan (eds), *Proceedings of the 17th International Conference on Information Systems*, pp. 278–89. The Association for Computing Machinery, New York.

Dennis, A.R., Kinney, S.T., and Hung, Y.C. (1999). Gender differences and the effects of media richness. *Small Group Research*, **30**, 405–37.

Dobzhansky, T. (1971). *Mankind evolving: the evolution of the human species.* Yale University Press, New Haven, CN.

Dunbar, R.I.M. (1993). Coevolution of neocortical size, group size and language in humans. *Behavioral and Brain Sciences*, **16**, 681–735.

Eichler, L. and Halperin, L. (2000). LivePerson: keeping reference alive and clicking. *Econtent*, **23**, 63–6.

Ellis, C.A., Gibbs, S.J., and Rein, G.L. (1991). Groupware: some issues and experiences. *Communications of ACM*, **34**, 38–58.

Fulk, J. (1993). Social construction of communication technology. *Academy of Management Journal*, **36**, 921–38.

Fulk, J., Schmitz, J., and Steinfield, C.W. (1990). A social influence model of technology use. In: J. Fulk and C. Steinfield (eds), *Organizations and communication technology*, pp. 117–40. Sage, Newbury Park, CA.

Gardner, H. (1985). *The mind's new science*. Basic Books, New York.

Gilbert, J. (1999). LivePerson focuses on the human touch. *Advertising Age*, **70**, 62.

Graetz, K.A., Boyle, E.S., Kimble, C.E., Thompson, P., and Garloch, J.L. (1998). Information sharing in face-to-face, teleconferencing, and electronic chat groups. *Small Group Research*, **29**, 714–43.

Henderson, K. (1998). *On line and on paper: visual representations, visual culture, and computer graphics in design engineering.* MIT Press, Cambridge, MA.

Hutchins, E. (1996). *Cognition in the wild*. MIT Press, Cambridge, MA.

Johansen, R. (1988). *Groupware: computer support for business teams*. The Free Press, New York.

Keen, T. (1994). E-mail: from simplicity to ubiquity. In: P. Lloyd (ed.), *Groupware in the 21st century*, pp. 92–6. Praeger, Westport, CT.

Kiesler, S., Siegel, J., and McGuire, T.W. (1988). Social psychological aspects of computer-mediated communication. In: I. Greif (ed.), *Computer-supported cooperative work: a book of readings*, pp. 657–82. Morgan Kaufmann, San Mateo, CA.

Kinney, S.T. and Dennis, A.R. (1994). Re-evaluating media richness: cues, feedback, and task. In: J.F. Nunamaker and R.H. Sprague (eds), *Proceedings of the Hawaii International Conference on System Sciences, Vol. 4*, pp. 21–30. IEEE Computer Society Press, Hawaii.

Kinney, S.T. and Watson, R.T. (1992). Dyadic communication: the effect of medium and task equivocality on task-related and interactional outcomes. In: J.I. DeGross, J.D. Becker, and J.J. Elam, (eds), *Proceedings of the 13th International Conference on Information Systems*, pp. 107–117. The Association for Computing Machinery, Dallas, TX.

Kock, N. (1998). Can communication medium limitations foster better group outcomes? An action research study. *Information and Management*, **34**, 295–305.

Kock, N. (1999). *Process improvement and organizational learning: the role of collaboration technologies*. Idea Group Publishing, Hershey, PA.

Kock, N. (2001a). Asynchronous and distributed process improvement: the role of collaborative technologies. *Information Systems Journal*, **11**, 87–110.

Kock, N. (2001b). Compensatory adaptation to a lean medium: an action research investigation of electronic communication in process improvement groups. *IEEE Transactions on Professional Communication*, **44**, 267–85.

Kock, N. (2001c). The ape that used email: understanding e-communication behavior through evolution theory. *Communications of the Association for Information Systems*, **5**, 1–29.

Kock, N. (2004). The psychobiological model: towards a new theory of computer-mediated communication based on Darwinian evolution. *Organization Science*, **15**, 327–48.

Kock, N. (2005). Media richness or media naturalness? The evolution of our biological communication apparatus and its influence on our behavior toward e-communication tools. *IEEE Transactions on Professional Communication*, **48**, 117–30.

Kock, N. (ed.) (2008). *Encyclopedia of e-collaboration*. Hershey, PA.

Kock, N. (2009). Information systems theorizing based on evolutionary psychology: an interdisciplinary review and theory integration framework. *MIS Quarterly*, **33**, 395–418.

Kotulak, R. (1997). *Inside the brain: revolutionary discoveries of how the mind works*. Andrews McMeel Publishing, Kansas City, KA.

Kurzweil, R. (1999). *The age of spiritual machines.* Viking, New York.

Laitman, J.T. (1984). The anatomy of human speech. *Natural History*, **20**, 20–7.

Lee, A.S. (1994). Electronic mail as a medium for rich communication: an empirical investigation using hermeneutic interpretation. *MIS Quarterly*, **18**, 143–57.

Leganchuk, A., Zhai S., and Buxton, W. (1998). Manual and cognitive benefits of two-handed input: an experimental study. *ACM Transactions on Computer-Human Interaction*, **5**, 326–59.

Le Grand, R., Mondloch, C.J., Maurer, D., and Brent, H.P. (2001). Early visual experience and face processing. *Nature*, **410**, 890.

Lengel, R.H. and Daft, R.L. (1988). The selection of communication media as an executive skill. *Academy of Management Executive*, **2**, 225–32.

Lieberman, P. (1991). *Uniquely human: the evolution of speech, thought, and selfless behavior*. Harvard University Press, Cambridge, MA.

Lieberman, P. (1998). *Eve spoke: human language and human evolution*. W.W. Norton and Company, New York.

Lieberman, P. (2000). *Human language and our reptilian brain: the subcortical bases of speech, syntax, and thought*. Harvard University Press, Cambridge, MA.

Lorenz, K. (1983). *The waning of humaneness*. Little, Brown and Co, Boston, MA.

Macdonald, J. (1995). Quality and the financial service sector. *Managing Service Quality*, **5**, 43–6.

Markus, M.L. (1990). Toward a critical mass theory of interactive media. In: J. Fulk and C. Steinfield (eds), *Organizations and Communication Technology*, pp. 194–218. Sage, Newbury Park, CA.

Markus, M.L. (1994a). Electronic mail as the medium of managerial choice. *Organization Science*, **5**, 502–27.

Markus, M.L. (1994b). Finding a happy medium: explaining the negative effects of electronic communication on social life at work. *ACM Transactions on Information Systems*, **12**, 119–49.

Mass, Y. and Herzberg, A. (1999). VRCommerce: electronic commerce in virtual reality. *Proceedings of the 1st ACM Conference on Electronic Commerce*, pp. 103–9. The Association for Computing Machinery Press, New York.

Mayr, E. and Provine, W.B. (1998). *The evolutionary synthesis: perspectives on the unification of biology*. Harvard University Press, Cambridge, MA.

McNeill, D. (1998). *The face: a natural history*. Little, Brown and Company, Boston, MA.

Metz, C. (2000). Customer support: service on the fly. *PC Magazine*, **19**, 143–4.

Miller, G.F. (2000). *The mating mind: how sexual choice shaped the evolution of human nature*. Doubleday, New York.

Ngwenyama, O.K. and Lee, A.S. (1997). Communication richness in electronic mail: critical social theory and the contextuality of meaning. *MIS Quarterly*, **21**, 145–67.

Orubeondo, A. (2000). Security and senses enlivened with speech technologies. *InfoWorld*, **22**, 86–7.

Pinker, S. (1994). *The language instinct*. William Morrow and Co., New York.

Pinker, S. (1997). *How the mind works.* W.W. Norton and Co., New York.

Pinker, S. and Bloom, P. (1992). Natural language and natural selection. In: J.H. Barkow, L. Cosmides, and J. Tooby (eds), *The adapted mind: evolutionary psychology and the generation of culture*, pp. 451–93. Oxford University Press, New York.

Reinig, B.A., Briggs, R.O., Shepherd, M.M., Yen, J., and Nunamaker, J.F. (1995). Affective reward and the adoption of group support systems: productivity is not always enough. *Journal of Management Information Systems*, **12**, 171–85.

Rheingold, H. (1993). *The virtual community: homesteading on the electronic frontier*. Addison-Wesley, Reading, MA.

Rice, R.E. (1992). Task analyzability, use of new media, and effectiveness: a multi-site exploration of media richness. *Organization Science*, **3**, 475–500.

Rice, R.E. (1993). Media appropriateness: using social presence theory to compare traditional and new organizational media. *Human Communication Research*, **19**, 451–84.

Rice, R.E. and Shook, D.E. (1990). Relationship of job categories and organizational levels to use of communication channels, including electronic mail: a meta-analysis and extension. *Journal of Management Studies*, **27**, 195–230.

Russel, S. and Norvig, P. (1995). *Artificial intelligence: a modern approach*. Prentice Hall, Upper Saddle River, NJ.

Schacter, D.L. (2001). *The seven sins of memory: how the mind forgets and remembers*. Houghton Mifflin, New York.

Sproull, L. and Kiesler, S. (1986). Reducing social context cues: electronic mail in organizational communication. *Management Science*, **32**, 1492–512.

Sproull, L. and Kiesler, S. (1991). Computers, networks and work. *Scientific American*, **265**, 84–91.

Todd, P. and Benbasat, I. (1999). Evaluating the impact of DSS, cognitive effort, and incentives on strategy selection. *Information Systems Research*, **10**, 356–74.

Tooby, J. and Cosmides, L. (1992). The psychological foundation of culture. In: J.H. Barkow, L. Cosmides, and J. Tooby (eds), *The adapted mind: evolutionary psychology and the generation of culture*, pp. 19–136. Oxford University Press, New York.

Trevino, L.K., Webster, J., and Stein, E.W. (2000). making connections: complementary influences on communication media choices, attitudes, and use. *Organization Science*, **11**, 163–82.

Walkins, J. (1992). Information systems: the UK retail financial services sector. *Marketing Intelligence and Planning*, **10**, 13–18.

Walther, J.B. (1996). Computer-mediated communication: impersonal, interpersonal, and hyperpersonal interaction. *Communication Research*, **23**, 3–43.

Walther, J.B., Slovacek, C., and Tidwell, L.C. (2001). Is a picture worth a thousand words? photographic images in long term and short term virtual teams. *Communication Research*, **28**, 105–34.

Wasserman, L. (2001). Live interaction: what's needed on the Web. *Customer Interaction Solutions*, **19**, 58–61.

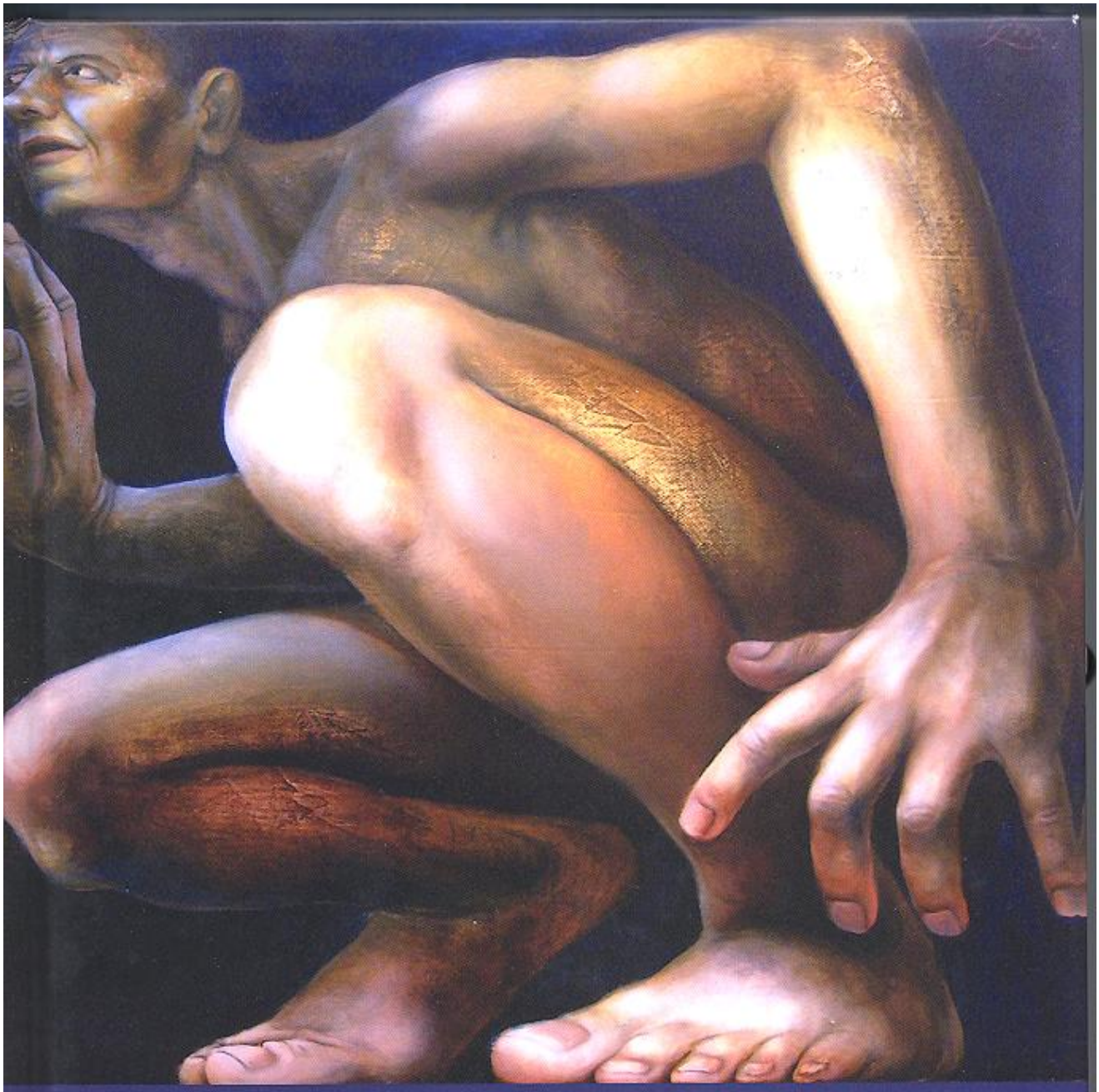
Webster, J. and Trevino, L.K. (1995). Rational and social theories as complementary explanations of communication media choices: two policy-capturing studies. *Academy of Management Journal*, **38**, 1544–73.

Weisband, S. (1994). Overcoming social awareness in computer-supported groups: does anonymity really help? *Computer Supported Cooperative Work*, **2**, 285–97.

Weisband, S.P., Schneider, S.K., and Connolly, T. (1995). Computer-mediated communication and social information: status salience and status differences. *Academy of Management Journal*, **38**, 1124–51.

Wilson, E.O. (2000). *Sociobiology: the new synthesis*. Harvard University Press, Cambridge, MA.

Zimmer, C. (2001). *Evolution: the triumph of an idea*. HarperCollins Publishers, New York.



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