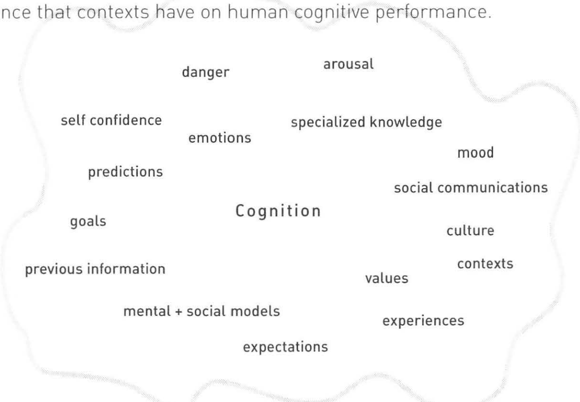
Abstract

There is an Aristotelic tradition in cognitive psychology, information design and artificial intelligence, to understand human information processing as a mechanism, that is, as a complicated system, ultimately explainable on the basis of the understanding of every one of its multiple components and their interactions. Instead of looking at human information processing as a complicated system, I propose to look at it as a complex system, distinguishing for this paper the complicated from the complex; the first being composed by a high number of discrete parts with many interconnections — as in a computer circuit — the second being an integrated system where everything affects everything — as in the relation between two people. Since I have chosen as my theme the contextualization of cognition with other human factors, I will be dealing with the complex, and I will therefore not attempt to enu-merate parts and connections; I will instead concentrate on certain insights about field interactions that I hope will reposition our understanding of mental processes, moving it from an analysis of logical steps to the exploration of the influence that contexts have on human cognitive performance.



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Cognition and All the Rest

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Cognition and all the rest

The human capacity for effective and efficient action is affected by many factors. Discussing constancy in color perception, Maturana and Varela argue that in the perception of color we cannot find a direct correspondence between the color consistency of the objects we see and the light waves reflected from them. They claim that it is not easy to explain how we see colors, but that we must stop thinking that the color of the objects we see is determined by the features of the light we receive from them. Rather, they suggest that the experience of a color corresponds to a specific pattern of states of activity in the nervous system that can be triggered by a number of different light perturbations (1992, 22. Also see 252, 253, 254).

Following this model, I would suggest that the cognitive function of people is not "distorted" by circumstances; rather, that human cognitive performance is context-dependent and multidimensional, and that to really understand human cognition it is not possible to approach it as a self-contained system. Human cognition should be approached as an integrated structure, where cognitive processes vary from situation to situation, depending on situational differences that relate to a broad variety of categories which overflow traditional definitions of cognition. These factors affect cognitive performance not necessarily in negative ways; experience permits people to develop efficient strategies to deal with new situations, responding to them by taking shortcuts and leaps of faith, in high-speed information-processing acts commonly called intuitive jumps. These "intuitive jumps" are connected with the goal-seeking character of our interaction with the environment and bring to the fore the role that guessing plays in cognitive performance.

Guessing as a cognitive strategy Guessing is a very efficient way to strategize an action on the basis of existing information; guessing is connected to meaning in information already possessed. Bateson suggests that meaning may be regarded as an approximate synonym of pattern, redundancy, information and restraint. He suggests that any aggregate of events or objects contains redundancy or pattern. If we divide the aggregate into two parts, the observer that sees only one part "can guess, with better than random success" what is in the other part. Bateson suggests that what is in one part contains information, or has meaning, or redundancy about what is in the other part. In cybernetic terms "the information available on one side will restrain (i.e., reduce the probability of) wrong guessing" (Bateson, 1985, 131).

Guessing is then based on information possessed, on redundancy and on the resulting predictability, and it is as much a proof of human economy of action in the realm of cognitive strategies as the reading of instructions.

The importance of guessing and its shortcomings have been frequently noted. Designers of interactive machines such as ticket vending machines, know that people tend to begin their approaches to using machines by guessing, rather than by reading the instructions. If guessing does not work, then they tend to fall into the intuitively less efficient task of reading the written information.

Interesting insights emerge when we connect guessing with self-confidence. Fischhoff, Slovic and Lichtenstein (1977, cited by Piattelli-Palmarini, 1994, 116-119), report that the more subjects are familiar with a field, the more they are at risk of being overconfident about their knowledge. Their studies indicate that discrepancy between correctness of response and overconfidence increases as the respondent is more knowledgeable. Those who know less have a reduced level of overconfidence. On the other hand, when people possess greater knowledge about an issue, their level of overconfidence increases to a far greater degree. Thus, people with no experience of vending machines are more likely to read the instructions than people with experience. The more people are familiar with a given kind of machine, the less they are likely to read the instructions: they will try their guesses, even if they prove wrong, insistently pressing the wrong button until it breaks or inserting coins in the ticket dispensing slots of machines in parking lots. This has made parking lot operators many times add ad-hoc hand-written signs indicating to users that they should not insert coins but should pay upon exiting. It doesn't necessarily follow that people are obtuse. When police in Alberta found out that ninety-seven percent of child restraint seats were not installed properly in private cars, it became evident that it was not the users who were at fault, but the manufacturers, who put in the market a product whose use and instructions for use people could not understand. Given that guessing operates on the basis of broad generalizations and bypasses written information, it is not surprising that in many cases instructions for the use of machines cannot undo the wrong messages implied by the machines themselves.

Vending machines are not the worst example of the dangers of excessive self-confidence. Several air disasters have been the result of overconfidence — they tend to happen to experienced pilots and to those trained in the air-forces. Extensive, specialized knowledge, under certain conditions, gives these people the feeling that their perceptions and estimations are more than the instruments. This leads them to disregard instrumental information on altitude, orientation or spatial upside-down rotation, sometimes resulting in crashes.

Designing interfaces for interactive machines, from ticket dispensers to fighter plane control panels, cannot be exclusively based on a knowledge of cognitive processes modeled on artificial intelligence: it needs to consider interactions between people and machines as inscribed in goal-seeking activities, embedded in moods, emotions, social communications and value systems. To understand a machine in a lab in order to get a ticket (to please the experimenter and to prove one's level of skill), is different from trying to understand a machine in a railway station fast enough so as not to miss the train. Different still is to try to operate a machine properly when one is being shot at. Baddeley (1972) reports that "the [cognitive] performance of a soldier in combat is another source of evidence of the effects of danger" (Baddeley, 1972, 539-540). The probability that a soldier will use his rifle effectively in the heat of battle is considerably less than in training. Walker and Burkhardt (1965) report that, after the battle of Gettysburg in the American Civil War, over two-hundred of the muzzle-loading rifles were found to have been loaded five or more times without being fired, and one had been loaded twenty-one times without being fired once. Inadequate training was blamed, but other war reports suggest that even with fully trained troops performance in action is much worse than performance in training (Egbert et al., 1957, 1958).

For the purpose of psychological research it has been possible to produce simulated danger situations which impair performance. In one experiment, an emergency was simulated in a flight, using service men as subjects. After an engine shut off, they were told that the landing gear was faulty and that they had to ready themselves for an eventual crash landing at sea. They were then required to fill out two forms: one about the disposal of their belongings and the other about emergency procedures, to convince the insurers that all precautions had been taken. As well, the forms had been poorly designed to increase the possibility for errors. The results, as expected, showed that the subjects performed worse than the control group that filled out the forms on the ground (Berkun et al, 1962).

Many experiments have been conducted where it was found that dangerous situations tended to reduce efficiency. Discussing these experiments in a very detached and cool way, Baddeley suggests that "although these studies show that it is possible to simulate danger successfully, the problems raised by this type of experiment on both moral and practical grounds are considerable, and this does not seem to be a very promising line of development"(Baddeley, 1972, 539-540).

Without exclusively looking at strong emotions like stress or terror, it is clear that previous experiences, fear, beliefs, arousal level, moods, expectations, purposes, models of behavior, familiarity, adaptability, intelligence and temperament, play roles in cognitive performace, overflowing measures and predictability exclusively based on an abstract concept of logical thinking.

Typically, cognitive performance is affected by overconfidence, illusory correlations, missestimation of probability, immediate contexts (things that have just happened, or that have just come to our attention) and ease of representation. "The easier it is for us to imagine an event or situation and the more the occurrence impresses us emotionally, the more likely we are to be affected by it for subsequent cognitive tasks" (Piattelli-Palmarini, 1994, 128). These considerations call for caution when seeking a basis for design criteria in traditional, lab-based experimental psychology: it is quite difficult to estimate the cognitive proficiency of an individual in a given task, in a real situation, on the basis of lab tests.

Cognition and emotion Danger reduces human performance efficiency, except in the case of experienced subjects. Part of the reason for this reduction of efficiency seems to be owed to a narrowing of attention (Baddeley, 1972, 537). Experiments with deep sea divers used as subjects to study the impact of nitrogen narcosis (an intoxication that occurs when air is breathed at high pressure) on cognitive performance have shown discrepancies between open sea and pressure chamber simulation results. This suggests that fear plays a decisive role in cognitive performance, generating attention-narrowing, irrespective of levels of nitrogen in the body. Stress apparently generates arousal, and this tends to narrow the field of attention, affecting cognitive performance. Arousal fosters an increase of efficiency in centrally located fields, while peripheral attention diminishes. This is the case with rage and the obsessive repetition of the wrong action, such as inserting coins in the ticket dispensing slot and failing to scan efficiently the whole face of a ma-chine, for instance. This leads to a constant increase of rage, paralleled by a constant narrowing of the field of attention, resulting sometimes in kicking the machine as a final cognitive-magical response. Baddeley suggests that an increase in arousal will focus the subject's attention narrowly on that aspect of the situation that the subject believes to be of greatest importance. If this happens to be the center of the problem faced, then the efficiency of the action will be increased. If not, the subject's performance will deteriorate until the task is abandoned (543). Existing research indicates that people tend to suppress fear when approaching dangerous situations if they are experienced in those situations, possibly as a way of securing a high level of cognitive performance. It is not that they don't suffer fear, but they have learned to suppress it. This has important implications for the design of instructions: teaching how to prepare deep sea diving equipment for use is one thing, learning how to rescue one's equipment from the bottom of a deep pool, turning on the air in the acqualung and putting on all the equipment without surfacing is quite another. The first measures cognitive skills; the second measures emotional self control (544-545). This brings back the issue of the complex and the complicated: instructions can be complicated, based on sequential steps that must be performed with accuracy. But the design of instructions many times, rather than being complicated becomes complex, because human beings, and not computer driven optical character recognizers, have to use them. People require fuzziness in instruction systems, so that different thinking styles can operate with them. Cognitive performance is context-dependent and many contexts take part in any communication event. E-mail addressing systems are different: if one replaces an "i" for a "y," the system cannot solve the problem. People use fuzziness as a way to solve those problems, dealing efficiently with the vague and the ambiguous.

This problem is faced by designers working on instructions for emergency procedures, such as those for passenger aircrafts. If danger hampers human cognitive performance, and more so for the person without experience in a given situation (such as is the case for airline passengers), then the level of actual cognitive ability to be expected has to be quite low. This is the reason why many years ago, Paul Mijksenaar, a well known Dutch information designer, when asked to redesign emergency instructions for the opening of a door in a Fokker aircraft, recommended to have the door mechanism redesigned. Given the obscure door opening mechanism it was not possible to make the instructions clear to an untrained user in a stressful situation.

Of course, instructions are not always embedded in situations that make the problem complex; many times it remains only complicated. I used these examples to highlight the complexity of the cognitive field, which to a greater or to a lesser extent always overflows the complicated.

Actually, not only difficult situations like danger affect cognitive performance: happiness also does. According to Robert Sinclair and Melvin Mark (1992) "positive mood states lead to less systematic information processing than do neutral states, while negative states lead to more systematic processing" (169). "...Subjects in a positive mood appear to process information in a way that can be characterized as less systematic, more heuristic, more superficial and less careful" (166). They argue that this difference might result from the double notion of "mood maintenance and mood repair." That is, if one is happy, one will normally wish to focus attention on enjoying the feeling and on maintaining the feeling, and would therefore be reluctant to engage in a demanding cognitive task. A happy person will likely fear that this task: a) might distract from the enjoyment of the feeling, and b) might lead to information that could negatively affect the feeling. Conversely, a depressed subject might favor the distracting effect of demanding cognitive activities and might hope that these activities could contribute to repairing their mood.

Happy moods seem to foster positive attitudes: optimism and the consequent disposition to believe as good that which appears to be so without mistrust. Happy subjects, however, tend to perform as critically as sad subjects when they perceive that the cognitive task does not threaten their present mood. Sinclair and Mark's basic tenet is that "mood state influences processing strategy, which in turn leads to effects on judgment and action" (170).

Heuristic and systematic approaches to information processing appear to be prompted by subject mood, but not exclusively: the relation between the subject and the topic (relevance) plays an active role. Relevance, and potential rewards, increase the motivation to use systematic approaches, while confidence in the source of a message fosters acceptance and heuristic strategies (Chaiken, 1980).

Emotion and Cognitive Processing Strategy

Relevance of Content to Subject / Mood of Subject	High	Low
• Happy • More positive • More confident of self and others • Categorizes broadly	• Systematic • Emphasis of attention to context	• Heuristic • Emphasis on attention to source and other contextual factors
• Sad • More negative • More rigid • Less confident of self and others • Makes more distinctions	• More systematic • Scrutinizing context	• Somewhat less systematic • Attention to context

Emotion and Experience

Experience / Danger Level	High	Low
Dangerous Situation or Stress	• Normal cognitive performance on the basis of emotional self control	• Reduced cognitive performance • Arousal • Narrow focus of attention
Non-dangerous Situation	• High cognitive performance • Risk of excessive self confidence leading to wrong guessing • Increased risk in a happy subject (Even more if the event is irrelevant)	• Normal cognitive performance • Low risk of wrong guessing • Scrutinizing of information is high (More so for unhappy subject)

Emotion and Judgement

Relevance / Emotion	Situation Relevant to Emotional Source	Situation Not-relevant to Emotional Source
Emotions with clear Attribution of Source	Judgment Affected	Judgment Not Affected
Generic Moods, without Conscious Source	Judgment Affected	Judgment Affected

It should not be concluded that it is better to be depressed when good cognitive performance is required. People in good moods are often more motivated and have "higher expectations about their ability to achieve positive outcomes... While negative moods may lead to more systematic processing, they may also lead to less risk taking and to less creative and more pragmatic thinking. People in negative states may not be able to afford the risk of a more expansive creative strategy (Sinclair and Mark,188). Schwarz and Bless converge on this position, indicating that "while early research on this issue emphasized the disruptive nature of affective states" (e.g., Easterbrook, 1959), the accumulated evidence suggests a considerably more complicated picture. Apparently, "feeling good and feeling bad may both facilitate and impair cognitive performance, depending on the nature of the task" (1991, 55).

The influence of emotions on judgment varies depending on whether the motive of the emotion is conscious or not. To put it more precisely, specific emotions do not tend to bias judgment as much as moods do (Schwarz and Bless, 1991, 58; Johnson and Tversky, 1983). Individuals interviewed on sunny days tend to be more satisfied with their lives than subjects interviewed on rainy days. Schwarz and Bless, however, report that the influence of the weather was eliminated in an experiment when the interviewer, who pretended to call from out of town, asked about the weather at the beginning of the interview (1991, 57). According to Clore and Parrott, the effects of mood on judgment often depend on a perception that the affective experience accompanying a mood state is occasioned by the aspect to be judged (1991-121). This is to say that there is a dimension of attribution that plays a role here. If we feel down, but have no perception of the cause of our feelings, negative perceptions about everything will likely occur. If we, instead, can localize the source of our feelings, these will not bias our judgments of things not connected with the source of our grief.

Cognition and persuasion The distinction between the cognitive performance of happy and depressed subjects has an interesting connection with some aspects of persuasion theory. It has been suggested that, generally, "subjects who are low in need for cognition, who scrutinize messages less and engage in less effortful processing, do not discriminate between strong and weak arguments in persuasive appeals, while subjects who are high on need for cognition, who scrutinize more and engage in more effortful processing, do discriminate between strong and weak arguments" (Sinclair and Mark, 171; see also Petty and Cacioppo, 1986).

There is an additional argument worth mentioning here, defined in the literature as "mood as information." Happy subjects are happy with themselves and they are more lax in their judgment because they trust it. That is, a happy subject believes to have good judgment, believes to have made good decisions in life and has therefore confidence in his/her choices. It may very well be that unhappy subjects do not totally trust their own judgment and therefore tend to scrutinize more for that reason. Given their self-confidence, happy subjects tend to categorize broadly and their judgments tend to be more affected by stereotypes than is the case for subjects in other moods (Sinclair and Mark, 186).

Apparently, happy subjects tend to evaluate a persuasive message more on the basis of the source and other contextual elements, while sad subjects tend to concentrate more on the content. In a heuristic approach "recipients may rely on (typically) more accessible information such as the source's identity or other non-content cues in deciding to accept a message's conclusion" (Chaiken, 1980, 752).

Cognitive response to persuasive messages is not exclusively connected to situational moods; it can also relate to temperaments. "People who enjoy thinking tend to focus on the perceived quality of the arguments when they process a persuasive message, but people who do not enjoy thinking tend to rely on simple cues in the persuasion context" (Petty, Gleicher and Baker, 1991, 194).

Priming, or the power of immediate contexts, is important when considering ephemeral circumstances affecting persuasion. If one wants to ask one's employer for a raise, or convince a potential client to buy a product, or persuade a voter to support a given side of a conflict — how could one create the perfect conditions under which to make the appeal? One would want to have the target of one's influence attempt in a good mood (Mackie and Worth, 1991, 201).

In addition to priming, the number of arguments used and their quality affect the power of persuasive messages, albeit to different extents depending on other factors already discussed. If a persuasive message varies the number of arguments and employs only cogent arguments, we find that both naive and scrutinizing subjects will show an increase in agreement with the message when the number of arguments is higher.

Varying the quality of arguments allows a distinction of public reactions based on relevance: argument quality can affect agreement only if people think critically about, scrutinize and evaluate the information presented. The number of arguments in a message serves as a peripheral cue under low cognitive involvement, but the quality of the arguments presented is carefully evaluated only under high involvement (Petty and Cacioppo, 1984, 78). High involvement tends to appear when subjects are unhappy, when they enjoy thinking or when they are happy, but the message appears as relevant or as potentially contributing to maintaining their feeling.

No prediction can be made with certainty exclusively on the basis of these factors. "A general framework for understanding attitude change must consider that in some situations people are avid seekers and manipulators of information, whereas at other times people are best described as 'cognitive misers' who eschew any difficult information-processing activity" (Petty and Cacioppo, 1984, 79).

Methods of study

Cognitive psychology experiments provide an insufficient base for the understanding of social behavior or even human behavior in situations different from those of a psychological experiment. As it has already been mentioned in relation to the pressure tank situation, emotional states affect people's skills and cognitive performance. Michael Argyle argues that cognitive social psychology has become one of the dominant approaches to social psychology, but that its focus is set on internal cognitive processes, decisions and attributions, and not on social behavior, interaction or real-life judgments. It deals always with one person, not with two. In extreme cases cognitive social psychology "sees social behavior and judgments as a kind of rational problem solving, performed by computer-like processes in the head" (Argyle, 1991, 161). It is this kind of bias that has turned many designers to anthropology as a complementary source of information and methodological models for research relevant to the practice of design. While psychology has traditionally taken an approach directed at identifying the specific processes that explain specific aspects of human performance, anthropology has followed the observational-descriptive model fostered initially by Margaret Mead and the structural interpretations proposed by Levi-Strauss, developing also an increasing consciousness of the inescapable presence of the observer in the observed (Mead, cited by Bateson, 1985, 159). Anthropology looks at actual situations of social interaction, applying analytical routines to categorize and describe the observation of those situations. Anthropologists do not engage in the search for explanations of the reasons why subjects undertake a given activity: they concentrate on understanding the patterns that connect individual observations of events (Bateson, 1972, 1985, 130-134, 449; Wilden, 1987, 188, 230, 298).

For designers, generally, the purpose of collecting information about a given situation is to understand it so as to create objects, information or environments that will facilitate the realization of desired and desirable activities. As designers we do not concern ourselves with the physiological or psychological reasons that cause an existing behavior: we concern ourselves with noting that a given behavior exists and with the possibilities to affect that behavior by facilitating it or discouraging it through design, according to a value system that defines the desirable. This can apply to two distinct terrains: task-oriented and judgment-oriented cognitive performance. The first falls into what we commonly call "information design," the second is in the terrain of persuasive communications; albeit that we recognize that all information design includes elements of persuasion and all persuasion design includes information. It is a matter of emphasis that distinguishes them, not of mutual exclusion (see Deleuze and Guattari, 1987, introduction).

It can be suggested that cognitive performance is affected in somewhat predictable directions by many factors, that these factors pertain to different categories and that the action-oriented character of design (as different from psychology or anthropology, which concentrate on knowledge construction, not on intervention) forces us to deal with complex systems; and to act always on the basis of insufficient information. Nevertheless, informed actions are more likely to obtain desired effects and to avoid undesirable ones.

Every design intervention creates a disturbance in the environment in which it occurs. I propose that we, as information designers, should look at existing knowledge in the sciences of observation, but should develop fast and further the existing knowledge of effective intervention. This is not to be exclusively task-oriented, exclusively centered on the design brief, but also critical of the cultural impact that every public action inevitably has. This takes us to the need to explore in other occasions the generally unknown terrain of the interaction between cognitive performance and culture (Frascara, 1999).

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