1. Attractive Things Work Better

Donald A. Norman

Noam Tractinsky, an Israeli scientist, was puzzled. Attractive things certainly should be preferred over ugly ones, but why would they work better? Yet two Japanese researchers, Masaaki Kurosu and Kaori Kashimura[1], claimed just that. They developed two forms of automated teller machines, the ATM machines that allow us to get money and do simple banking tasks any time of the day or night. Both forms were identical in function, the number of buttons, and how they worked, but one had the buttons and screens arranged attractively, the other unattractively. Surprise! The Japanese found that the attractive ones were easier to use.

Tractinsky was suspicious. Maybe the experiment had flaws. Or perhaps the result would be true of Japanese, but certainly not of Israelis. "Clearly," said Tractinsky, "aesthetic preferences are culturally dependent." Moreover, he continued, "Japanese culture is known for its aesthetic tradition," but Israelis? Nah, Israelis are action oriented—they don't care about beauty.[2] So Tractinsky redid the experiment[3]. He got the ATM layouts from Kurosu and Kashimura, translated them from Japanese into Hebrew, and designed a new experiment, with rigorous methodological controls. Not only did he replicate the Japanese findings, but the results were stronger in Israel than in Japan, contrary to his belief that beauty and function "*were not expected* to correlate" -- Tractinsky was so surprised that he put that phrase *"were not expected"* in italics, an unusual thing to do in a scientific paper.

This is a surprising conclusion. In the early 1900s, Herbert Read, who wrote numerous books on art and aesthetics stated that "it requires a somewhat mystical theory of aesthetics to find any necessary connection between beauty and function," [4] and that belief is still common today. How could aesthetics affect how easy something is to use? I had just started a research product examining the interaction of affect, behavior, and cognition, but these results bothered me – I couldn't explain them. Still, they were intriguing, and they supported my own personal experiences, some of which I described in the prolog. As I pondered the experimental results, I realized they fit with the new framework that my research collaborators and I were constructing as well as with new findings in the study of affect and emotion. Emotions, we now know, change the way the human mind solves problems – the emotional system changes how the cognitive system operates. So, if aesthetics would change our emotional state, that would explain the mystery. Let me explain.

Until recently, emotion was an ill-explored part of human psychology. Some people thought it an evolutionary left-over from our animal origins. Most thought of emotions as a problem to be overcome by rational, logical thinking. And most of the research focused upon negative emotions such as fear, anxiety, and anger. Modern work has completely reversed this view. Science now knows that evolutionarily more advanced animals are more emotional than primitive ones, the human being the most emotional of all. Moreover emotions play a critical role in daily lives, helping assess situations as good or bad, safe or dangerous. As I discussed in the prologue, emotions aid in decision making. Most of the research on emotions has concentrated upon the negative: stress, fear, anxiety, anger. But positive emotions are as important as negative ones -- positive emotions are critical to learning, curiosity and creative thought and today, research is turning toward this dimension. One finding particularly intrigued me: The psychologist Alice Isen and her colleagues have shown that being happy broadens the thought processes and facilitates creative thinking. Isen discovered that when people were asked to solve difficult problems, ones that required unusual "out of the box" thinking, they did much better when they had just been given a small gift – not much of a gift, but enough to make them feel good. When you feel good, Isen discovered, you are better at brainstorming, at examining multiple alternatives. And it doesn't take much to make people feel good: all Isen had to do was ask people to watch a few minutes of a comedy film or receive a small bag of candy. [5]

We have long known that when people are anxious they tend to narrow their thought processes, concentrating upon aspects directly relevant to a problem. This is a useful strategy in escaping from danger, but not in thinking of imaginative new approaches to a problem. Isen's results show that when people are relaxed and happy, their thought processes expand, becoming more creative, more imaginative.

These – and related – findings suggest the role of aesthetics in product design: attractive things make people feel good, which in turn makes them think more creatively. How does that make something easier to use? Simple, by making it easier for people to find solutions to the problems they encounter. With most products, if the first thing you try fails to produce the desired result, the most natural response is to try again, only with more effort. In today's world of computer-controlled products, doing the same operation over again is very unlikely to yield better results. The correct response is to look around and see what alternatives exist. This tendency to repeat the same operation over again is especially likely for those who are anxious or tense. This state of negative affect leads people to focus upon the details that are giving trouble, and if this fails to provide a solution, they get even more tense, more anxious, and increase their concentration upon those details. Contrast this behavior to that of people who are in a positive emotional state, but encountering the same problem. These people are apt to look around for alternative approaches, which is very likely to lead to the appropriate response. Afterwards, the tense and anxious people will complain about the difficulties whereas the relaxed, happy ones will probably not even remember them. In other words, happy people are more effective in finding alternative solutions and, as a result, are tolerant of minor difficulties. Herbert Read thought we would need a mystical theory to connect beauty and function. Well, it took one hundred years, but today we have that theory, one based in biology, neuroscience, and psychology, not mysticism.

Human beings have evolved over millions of years to function effectively in the rich and complex environment of the world. Our perceptual systems, our limbs, the motor system – which means the control of all our muscles – everything has evolved to make us more function more effectively in the world. Affect, emotion, and cognition have also evolved to interact with and complement one another. Cognition interprets the world, leading to increased understanding and knowledge. Affect, which includes emotion, is a system of judgment: good or bad, safe or dangerous. It makes value judgments, the better to survive.

The affective system also controls the muscles of the body and, through chemical neurotransmitters, changes how the brain functions. The muscle actions get us ready to respond, but they also serve as signals to others, which provides yet another powerful role of emotion – as communication: our body posture and facial expression tells others our emotional state. Cognition and affect – understanding and evaluation. Together they form a powerful team.

THREE LEVELS OF PROCESSING: VISCERAL, BEHAVIORAL AND REFLECTIVE

Human beings are, of course, the most complex of all animals with brain structures that are accordingly complex. A lot of preferences are wired in at birth, designed to be part of the body's basic protective mechanisms. But we also have powerful brain mechanisms for accomplishing things, for building, constructing, creating, and acting. We can be skilled artists, musicians, sports players, writers, or carpenters. All this requires a much more complex brain structure than is involved in automatic responses to the world. And finally, unique among animals, we have language and art, humor and music. We are conscious of our role in the world and we can reflect upon past experiences, the better to learn and reflect forward to the future, the better to be prepared and reflect inward upon current activities, the better to supervise them.

My studies of emotion, conducted with my colleagues Andrew Ortony and William Revelle, Professors in the Psychology Department at Northwestern University – suggests that these human attributes result from three different levels of brain mechanism: the automatic, prewired layer, the *visceral level*; the part that contains the brain processes that control everyday behavior, the *behavioral level*; and the contemplative part of the brain, the *reflective level*[6]. Each level plays a different role in the total functioning of people. And, as I discuss in detail in chapter 3, each level requires a different style of design.

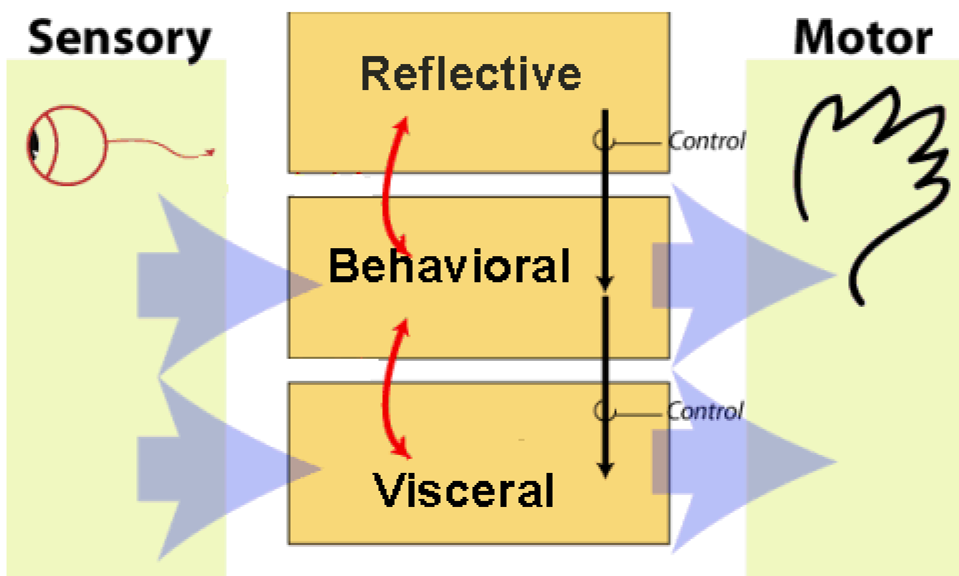

Figure 1.1. Three levels of processing: Visceral, Behavioral, and Reflective. The visceral level is fast: it makes rapid judgments of what is good or bad, safe or dangerous, and sends appropriate signals to the muscles (the motor system) and alerts the rest of the brain. This is the start of affective processing. These are biologically determined and can be inhibited or enhanced through control signals from above. The behavioral level is the site of most human behavior. Its actions can be enhanced or inhibited by the reflective layer and, in turn, it can enhance or inhibit the visceral layer. The highest layer is that of reflective thought. Note that it does not have direct access either to sensory input or to the control of behavior. Instead it watches over, reflects upon, and tries to bias the behavioral level. (Modified from Norman, Ortony, & Russell, 2003)

The three levels in part reflect the biological origins of the brain, starting with primitive one-celled organisms and slowly evolving to more complex animals, to the vertebrates, the mammals and finally, the primates, of which we are a member. For simple animals, life is a continuing set of threats and opportunities, and an animal must learn how to respond appropriately to each. The basic brain circuits, then, are really response mechanisms: analyze a situation and respond. This system is tightly coupled to the animal's muscles. If something is bad or dangerous, the muscles tense in preparation for running, attacking, or freezing. If something is good or desirable, the animal can relax while also approaching and taking advantage of the situation. As evolution continued, the circuits for analyzing and responding improved and became more sophisticated. Put a section of wire mesh fence between an animal and some desirable food: a chicken is likely to be stuck forever, straining at the fence, but unable to get to the food; a dog simply runs around it. Human beings have an even more developed set of brain structures. They can reflect upon their experiences and communicate them to others. Thus, not only do we walk around fences to get to our goals, but we can then think back about the experience – reflect upon it – and decide to move the fence or the food, so we don't have to walk around the next time. We can also tell other people about the problem, so they will know what to do even before they get there.

Animals such as lizards operate primarily at the visceral level. This is the level of fixed routines, where the brain analyzes the world and responds. Dogs and other mammals, however, have a higher level of analysis, the behavioral level, with a complex and powerful brain that can analyze a situation and alter behavior accordingly. The behavioral level in human beings is especially valuable for well-learned, routine operations. This is where the skilled performer excels.

At the highest evolutionary level of development, the human brain can think about its own operations. This is the home of reflection, of conscious thought, of the learning of new concepts and generalizations of the world. Sure, dogs can learn to do lots of actions, but they can't think about them and come up with general knowledge in the way a person can.

The behavioral level is not conscious, which is why you can successfully drive your automobile subconsciously at the behavioral level while consciously thinking of something else at the reflective level. Skilled performers make use of this facility. Thus, skilled piano players can let their fingers play automatically while they reflect upon the higher-order structure of the music. This is why they can hold conversations while playing and why performers report instances of losing their place in the music and having to listen to their playing until they recognized the part: it was the reflective level that was lost, but the behavioral level did just fine.

Figure 1.2 People pay money to get scared. The roller coaster pits one level of affect – the visceral sense of fear – against another level – the reflective pride of accomplishment.

Now let's look at some examples of these three levels in action; riding a roller coaster; cutting food for cooking with a sharp, well balanced knife, a good cutting board, and the act of dicing; and contemplating a serious work of literature or art. These three activities impact us in different ways. The first is the most primitive, the visceral reaction to falling, excessive speed, and heights. The second, the pleasure of using a good tool effectively, refers to the feelings accompanying skilled accomplishment, and derives from the behavioral level. This is the pleasure any expert feels when doing something well, such as driving a difficult course, playing a piece of music, or reciting a poem or joke to an appreciative audience. This behavioral pleasure, in turn, is different from that provided by serious literature or art, whose enjoyment derives from the reflective level, and requires study and interpretation.

Most interesting of all is when one level plays off of another, as in the roller coaster. If the roller coaster is so frightening, why is it so popular? There are at least two reasons. First, some people seem to love fear itself: they enjoy the high arousal and increased adrenaline rush that accompanies danger. The second reason comes from the feelings that follow the ride: the pride in conquering fear and of being able to brag about it to others. In both cases, the visceral angst competes with the reflective pleasure – not always successfully, for many people refuse to go on those rides or, having done it once, refuse to do it again. But this adds to the pleasure of those who do go on the ride: their self image is enhanced because they have dared do an action that others fear.

FOCUS AND CREATIVITY

The three levels do more than simply determine what we find attractive or not, they also affect the very way the brain works. This works in both a bottom-up and a top-down manner. The terms “bottom-up” and “top-down” come from the standard way of showing the processing structures of the brain, with the bottom layers associated with interpreting sensory inputs to the body and the top layers associated with higher thought processes, much as I did in Figure 1.1. Bottom-up processes are those driven by perception whereas top-down are driven by thought. The brain changes its manner of operation when bathed in the liquid chemicals called neurotransmitters. A neurotransmitter does what its name implies: it changes how neurons transmit neural impulses from one nerve cell to another (that is, across synapses). Some neurotransmitters enhance transmission, some inhibit it. See, hear, feel or otherwise sense the environment, and the affective system passes judgment, alerting other centers in the brain, and releasing neurotransmitters appropriate to the affective state. That’s bottom-up activation. Think something at the reflective level and the thoughts are transmitted to the affective system which, in turn, triggers neurotransmitters.

The result is that everything you do has both a cognitive and an affective component – cognitive to assign meaning, affective to assign value. You cannot escape affect: it is always there. More important, the affective state, whether positive or negative affect, changes how we think.

When you are in a state of negative affect, feeling anxious or endangered, the neurotransmitters focus the brain processing. Focus refers to the ability to concentrate upon a topic, without distraction, and then to go deeper and deeper into the topic until some resolution is reached. Focus also implies concentration upon the details. It is very important for survival, which is where negative affect plays a major role. Whenever your brain detects something that might be dangerous, whether through visceral or reflective processing, your affective system acts to tense muscles in preparation for action and to alert behavioral and reflective level to stop and concentrate upon the problem. The neurotransmitters bias the brain to focus upon the problem and avoid distractions. This is just what you need to do in order to deal with danger.

When you are in a state of positive affect, the very opposite actions take place. Now, neurotransmitters broaden the brain processing, the muscles can relax, and the brain attends to the opportunities offered by the positive affect. The broadening means that you are now far less focused, far more likely to be receptive to interruptions, and to attending to any novel idea or event. Positive affect arouses curiosity, engages creativity, and makes the brain into an effective learning organism. With positive affect, you are more likely to see the forest than the trees, to prefer the big picture and not to concentrate upon details. On the other hand, when you are sad or anxious, feeling negative affect, you are more likely to see the trees before the forest, the details before the big picture.

What role do these states have in design? First, someone who is relaxed, happy, in a pleasant mood, is more creative, more able to overlook and cope with minor problems with a device – especially if it’s fun to work with. Recall the reviewer of the Mini Cooper automobile, quoted in the prologue, who recommended that the car’s faults be ignored because it was so much fun. Second, when people are anxious, they are more focused, so where this is likely to be the case, the designer must pay special attention to ensure that all the information required to do the task is continually at hand, readily visible, with clear and unambiguous feedback about the operations that the device is performing. Designers can get away with more if the product is fun and enjoyable. Things intended to be used under stressful situations require a lot more care, with much more attention to detail.

One interesting effect of the differences in thought processes by the two states is its impact upon the design process itself. Design – and for that matter, most problem solving – requires creative thinking followed by a considerable period of concentrated, focused effort. In the first case, creativity, it is good for the designer to be relaxed, in a good mood. Thus, in brainstorming sessions, it is common to warm up by telling jokes and playing games. No criticism is allowed because it would raise the level of anxiety among the participants. Good brainstorming and unusual, creative thinking require the relaxed state induced by positive affect.

Once the creative stage is completed, the ideas that have been generated have to be transformed into real products. Now the design team must exert considerable attention to detail. Here, focus is essential. One way to do this is through deadlines just slightly shorter than feel comfortable. Here is the time for the concentrated focus that negative affect produces. This is one reason people often impose artificial deadlines on themselves, and then announce those deadlines to others so as to make them real. Their anxiety helps them get the work done.

It is tricky to design things that must accommodate both creative thinking and focus. Suppose the design task is to build a control room for operators of a plant -- think of a nuclear power plant or a large chemical-processing plant, but the same lessons apply to many manufacturing and production facilities. The design is meant to enhance some critical procedure or function -- say to enable control room operators to watch over a plant and solve problems as they arise -- so it is probably best to have a neutral or a slightly negative affect to keep people aroused and focused. This calls for an attractive, pleasant environment so that in normal monitoring, the operators are creative and open to explore new situations. Once some plant parameter approaches a dangerous level, however, then the design should change its stance, yielding a negative affect that will keep the operators focused upon the task at hand.

How do you design something so that it can change from invoking a positive affect to invoking a negative one? There are several ways. One is through the use of sound. The visual appearance of the plant can be positive and enjoyable. During normal operation, it is even possible to play light background music, unless the control room is located where the sounds of the plant operating can be used to indicate its state. But as soon as any problem exists, the music should go away and alarms should start to sound. Buzzing, ringing alarms are negative and anxiety producing, so their presence alone might do the trick. Indeed, the problem is not to overdo it: too much anxiety produces a phenomenon known as “tunnel vision”: the people become so focused that may fail to see otherwise obvious alternatives.

The dangers of too much focus are well known to people who study accidents. Thus, special design and training is required of people if we want them to perform well under high stress. Basically, because of the extreme focus and tunnel vision induced by high anxiety, the situation has to be designed to minimize the need for creative thought. That’s why professionals are trained over and over again in accident scenarios, through training exercises and simulators, so that if a real incident occurs, they will have experienced it so many times in training that their responses follow automatically. But this training works only if the training is repeated frequently and performance is tested. In commercial aviation, the pilots and crew are well trained, but the passengers are not. Even though frequent fliers continually hear and see the instructions on how to escape the airplane in case of fire or crash, they sit passively, only partially-attentive. They are not apt to remember them in an emergency.

"Fire," yells someone in a theater. Immediately everyone stampedes toward the exits. What do they do at the exit door? Push. If the door doesn't open, they push harder. But what if the door opens inward and must be pulled, not pushed? Highly anxious, highly focused people are very unlikely to think of pulling.

When under high anxiety – high negative affect – people focus upon escape. When they reach the door, they push. And when this fails, the natural response is to push even harder. Countless people have died as a result. Now, fire laws require what is called "panic hardware." The doors of auditoriums have to open outward, and they must open whenever a body is pushed against it.

Similarly, designers of exit stairways have to block any direct path from the ground floor to those below. Otherwise, people escaping a fire head for the stairs, go to the next floor down, the next, and the next, keeping on until the stairway ends. Unless forced out at the ground floor, they are likely to continue all the way into the basement – and some buildings have several levels of basements – to end up trapped.

The Prepared Brain

Although the visceral level is the simplest and most primitive part of the brain, it is sensitive to a very wide range of conditions. These are genetically determined, with the conditions evolving slowly over the time course of evolution. They all share one property, however: the condition can be recognized simply by the sensory information: the visceral level is incapable of reasoning, of comparing a situation with past history. It works by what cognitive scientists call "pattern matching." What are people genetically programmed for? Those situations and objects that, throughout evolutionary history, offer food, warmth, or protection give rise to positive affect. These conditions include:

warm, comfortably lit places,
temperate climate,
sweet tastes and smells,
bright, highly saturated hues,
"soothing" sounds and simple melodies and rhythms,
harmonious music and sounds,
caresses,
smiling faces,
rhythmic beats,
"attractive" people,
symmetrical objects,
rounded, smooth objects
"sensuous" feelings, sounds, and shapes.

Similarly, here are some of the conditions that appear to produce automatic negative affect:

heights,
sudden, unexpected loud sounds or bright lights,
"looming" objects (objects that appear to be about to hit the observer),
extreme hot or cold,
darkness,
extremely bright lights or loud sounds,
empty, flat terrain (deserts),
crowded dense terrain (jungles or forests),
crowds of people,

rotting smells, decaying foods
bitter tastes,
sharp objects,
harsh, abrupt sounds,
grating and discordant sounds,
misshapen human bodies,
snakes and spiders,
human feces (and its smell),
other people's body fluids,
vomit.

These lists are my best guess about what might be automatically programmed into the human system. Some of the items are still under dispute, others will probably have to be added. Some are politically incorrect in that they appear to produce value judgments on dimensions society has deemed to be irrelevant. The advantage of the human being over other animals is our powerful reflective level that enables us to overcome the dictates of the visceral, pure biological level. We can overcome our biological heritage.

Note that some biological mechanisms are only predispositions rather than full-fledged systems. Thus, although we are predisposed to be afraid of snakes and spiders, the actual fear is not presenting all people: it needs to be triggered through experience. Although human language comes from the behavioral and reflective levels, it provides a good example of how biological predispositions mix with experience. The human brain comes ready for language: the architecture of the brain, the way the different components are structured and interact, constrains the very nature of language. Children do not come into the world with language, but they do come predisposed and ready. That is the biological part. But the particular language you learn, and the accent with which you speak it, are determined through experience. Because the brain is prepared to learn language, everyone does so unless they have severe neurological or physical deficits. Moreover, the learning is automatic: we may have to go to school to learn to read and write, but not to listen and speak: spoken language – or signing, for those who are deaf – is natural. Although languages differ, they all follow certain universal regularities. But once the first language has been learned, it highly influences later language acquisition. If you have ever tried to learn a second language beyond your teenage years, you know how different it is from learning the first, how much harder, how reflective and conscious it seems compared to the subconscious, relatively effortless experience of learning the first language. Accents are the hardest thing to learn for the older language-learner, so that people who learn a language later in life may be completely fluent in their speech, understanding, and writing, but maintain the accent of their first language.

Tinko and losse are two words in the mythical language Elvish, invented by the British philologist J. R. Tolkien for his trilogy, *Lord of the Rings.* Which means "metal," which "snow"?[7] How could you possibly know? The surprise is that when forced to guess, most people can get the choices right, even if they have never read the books, never experienced the words. "Tinko" has two, hard, "plosive" sounds – the "t" and the "k." "Losse" has soft, liquid sounds, starting with the "l" and continuing through the vowels and the sibilant "ss." Note the similar pattern in the English words where the hard "t" in "metal" contrasted with the soft sounds of "snow." Yes, in Elfish, "tinko" is metal and "losse" is snow.

The Elfish demonstration points out the relationship between the sounds of a language and the meaning of words. At first glance, this sounds nonsensical – after all, words are arbitrary – just look how difficult it is to learn the vocabulary of a foreign language. But more and more evidence piles up linking sounds to particular general meanings: vowels are warm and soft: feminine is the term frequently used. Harsh sounds are, well, harsh – like the word "harsh" itself – the sound of "sh" in particular. Snakes hiss and slither: and note the sibilants, the hissing of the "s" sounds. Plosives, sounds caused when the air is stopped briefly, then released -- explosively -- are hard, metallic – the word "masculine" is often applied to them. The "k" of "mosquito" and the "p" in "happy" are plosive. And, yes, there is evidence that word choices are not arbitrary: a sound symbolism governs the development of a language.[8] This is another instance where artists, poets in this case, have long known the power of sounds to evoke affect and emotions within the readers of – or, more accurately, listeners to – poetry.

All these prewired mechanisms are vital to daily life and our interactions with people and things. Accordingly, they are important for design: While designers can use this knowledge of the brain to make designs more effective, there is no simple set of rules. The human mind is incredibly complex, and although all people have basically the same form of body and brain, they also have huge individual differences.

Emotions, moods, traits, and personality are all aspects of the different ways in which people's minds work, especially along the affective, emotional domain. Emotions change behavior over a relatively short term, for they are responsive to the immediate events. Emotions last for relatively short periods – minutes or hours. Moods are longer lasting, measured perhaps in hours or days. Traits are very long-lasting, years or even a lifetime. And personality is the particular collection of traits of a person that last a lifetime. But all of these are changeable as well. We all have multiple personalities, emphasizing some traits when with families, a different set when with friends. We all change our operating parameters to be appropriate for the situation we are in.

Ever watch a movie with great enjoyment, then watch it a second time and wonder what on earth you saw in it the first time? The same phenomenon occurs in almost all aspects of life, whether in interactions with people, in a sport, a book, or even a walk in the woods. This phenomenon can bedevil the designer who wants to know how to design something that will appeal: one person's appeal is another one's rejection. Worse, what is appealing at one moment may not be at another.

The source of this complexity can be found in the three levels of processing. At the visceral level, people are pretty much the same all over the world. Yes, individuals vary, so although almost everyone is born with a fear of heights, this fear is so extreme some people that they cannot function normally – they have acrophobia. Yet others have only mild fear, and they can overcome it sufficiently to do rock climbing, circus acts, or other jobs that have them working high in the air.

The behavioral and reflective levels, however, are very sensitive to experiences, training, and education. Cultural views have huge impact here: what one culture finds appealing, another may not. Indeed, teenage culture seems to dislike things solely because adult culture likes them.

So what is the designer to do? In part, that is the theme of the rest of the book. But the challenges should be thought of as opportunities: designers will never lack for things to do, for new approaches to learn.

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ENDNOTES

[1] "two Japanese researchers, Masaaki Kurosu and Kaori Kashimura" (Kurosu & Kashimura, 1995)

[2] "Japanese culture is known for its aesthetic tradition," (Tractinsky, 1997)

[3] "So Tractinsky redid the experiment." (Tractinsky, 1997; Tractinsky, Adi, & Ikar, 2000)

[4] It requires a somewhat mystical theory." (Read, 1953, p. 61.)

[5] "The psychologist Alice Isen and her colleagues" (Ashby, Isen, & Turken, 1999; Isen, 1993)

[6] "My studies of emotion, conducted with my colleagues." (Ortony, Norman, & Revelle, In progress)

[7] "two words in the mythical language Elvish" Tolkien's books are, of course, well known .The demonstration, that given ten novel words in Elfish, (Tolkien, 1954a, b, c, 1956). This particular experiment was done in my classroom by Dan Halstead and Gitte Waldman (in 2002) for introduced me to the sound symbolism of Tolkien and, in a class demonstration, showed that people who had never heard Elfish could still reliably determine the meaning of its words.

[8] "there is a sound symbolism." (Hinton, Nichols, & Ohala, 1994)

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Aesthetics and Apparent Usability: Empirically Assessing Cultural and Methodological Issues

Noam Tractinsky
Industrial Engineering and Management
Ben Gurion University of the Negev
P.O. Box 653, Beer Sheva, 84105, Israel
+972 (7) 647 2226
noamt@bgumail.bgu.ac.il

> "... it requires a somewhat mystical theory of aesthetics to find any necessary connection between beauty and function."
> *Herbert Read, Art and Industry, p.61*

ABSTRACT

Three experiments were conducted to validate and replicate, in a different cultural setting, the results of a study by Kurosu and Kashimura [12] concerning the relationships between users' perceptions of interface aesthetics and usability. The results support the basic findings by Kurosu and Kashimura. Very high correlations were found between perceived aesthetics of the interface and a priori perceived ease of use of the system. Differences of magnitude between correlations obtained in Japan and in Israel suggest the existence of cross-cultural differences, but these were not in the hypothesized direction.

Keywords

Aesthetics, apparent usability, system acceptability, cross-cultural HCI, human-computer interface.

INTRODUCTION

The quest for usable computer technology is one of the major goals in the field of Human-Computer Interaction (HCI), and critiquing the poor usability of systems designed for human use has become the bon ton in the field (e.g. [14]). Shackel [27] and Nielsen [21] place the concept of usability within the framework of system acceptability: Together with other system attributes, such as cost, utility (functionality) and likeability, system usability determines whether people will accept the use (or purchase) of a computerized system. With issues of cost determined by technological and economic factors, and utility predominated by specific tasks, HCI researchers have concentrated mainly on the study of usability. Here, knowledge of human cognitive and perceptual capabilities and limitations has provided fertile ground for formulating principles (e.g., [22]) and guidelines (e.g., [28 , 21]) of usable systems. Nielsen [21]defines the usability of a computer system in terms of five attributes: Learnability, efficiency, memorability, errors, and satisfaction. In general, the evaluation of system usability requires that these attributes be measured during or after people have actually used the system. Thus, while designers might rely on principles and guidelines to design usable systems, the use of certain inspection methods, if not extensive testing, is required to establish a certain degree of usability. On the other hand, evaluating other determinants of system acceptability may not require such a lengthy process. For example, system cost or likeability can be evaluated relatively simply and quickly. Thus, much effort might be invested by HCI designers in their attempts to evaluate and improve usability whereas, at the same time, other acceptability attributes may have an overriding effect on purchase or usage decisions. Whether these attributes are not considered to be an integral part of the HCI field, or because of an implicit assumption of orthogonality between these attributes and usability, the relationships between system usability and other determinants of system acceptability have not received extensive treatment in the HCI literature. This study calls attention to these relationships and to their potential contribution to our evaluation of system acceptability and to our understanding of its antecedents.

AESTHETICS AND USABILITY

The role of aesthetics in human affairs has been widely documented (e.g., [17]). Conventional wisdom relates it to our appreciation of, and attitudes towards computer systems as well. However, aesthetics may not always coincide with usability. In fact, the opposite might occur. In one of HCI's most influential books, "The Psychology of Everyday Things", Norman vividly ridicules the tendency of designers to neglect usability in favor of aesthetics [21] (pp. 151-155). Similarly, others (e.g. [7, 18]), while acknowledging the role of aesthetics in HCI, warn against a tendency among designers to emphasize the aesthetic elements of the user interface, because these might degrade usability. The contribution of aesthetics to HCI, they argue, should be measured in terms of facilitating information processing, not in terms of engaging the user in a pleasing experience. Perhaps, because aesthetics mainly reflect on the latter, HCI literature in general, and on usability in particular, mostly seem to neglect the aesthetics issue completely. For example, the indices of 4 prominent HCI textbooks and reading collections [1, 4, 24, 28] do not contain a single entry for "aesthetics" (or synonyms and related concepts such as “appearance”, “attractiveness”, “beauty” or “form”). Thus, it would appear that mainstream HCI (but, of course, see Laurel [15,16] for a notable exception) either belittles the importance of aesthetics or ignores it altogether.

A recent study by Kurosu and Kashimura [12] hints that interface aesthetics may play a greater role in people's attitudes towards computerized systems than we might be willing to admit. In their study, Kurosu and Kashimura (KK) explored the relationships between a priori perceptions of the ease of use of an automatic teller machine (ATM)—which they termed "apparent usability"—and other variables. These included factors believed by HCI professionals to enhance usability (termed "inherent usability"), and the appearance (beauty) of the interface. Surprisingly, high relationships were found between the interface judgments of aesthetics and apparent usability ($r = 0.59$). The correlations between the apparent usability and inherent usability factors were mostly negligible, with the exception of one variable (familiarity with the numeric keypad). It can be argued that KK found close relationships between aesthetics and perceived usability before the actual use, whereas usability should actually be measured during or after system use. While this argument is valid, it should be noted that first impressions often influence attitude formation to a large extent (e.g., [3]). There is no reason to assume that this process of attitude formation does not pertain to the HCI domain. In fact, in a study of information systems use, researchers found that "if computers were perceived *initially* as difficult to use, users were more likely to express dissatisfaction with the interface of the system *after* four months of use." [10] (p. 752, italics added). Thus, it is possible that among the various factors that affect system usability in particular and system acceptability in general, interface aesthetics play a major role. Aesthetics affect people's perceptions of apparent usability—which, in turn, may influence longer term attitudes towards the system.

PURPOSE OF THE STUDY

The main motivation for this study is twofold. First, Kurosu and Kashimura's findings are somewhat unexpected. If these results are robust, then the importance of aesthetics in HCI should rise considerably, given the relationships between interface aesthetics, initial perception of usability, and later attitudes towards computers. However, KK's study was not void of a potential method bias that might have shifted the results in favor of stronger relations between apparent usability and aesthetics. Some modifications to their design are needed to assess the robustness of their findings.

Second, living in a culture that does not seem to value aesthetics as much as do the Japanese, the author of this study was particularly surprised by the high correlations between apparent usability and aesthetics. Clearly, aesthetic perceptions are culturally dependent [6, 17]. Thus, one can reasonably expect the relationships between aesthetics and apparent usability to vary across cultures. For example, whereas Japanese culture is known for its aesthetic tradition (e.g., [6]), Israeli culture is probably better known for its action orientation [8, 11]. Unfortunately, there is no scientific literature that assesses Israeli aestheticism, so mere intuition and shared feelings among Israeli colleagues were used in proposing that: Japan and Israel potentially represent two different attitudes towards the importance of aesthetics in computerized systems and its relationships to usability and overall acceptability.

METHODOLOGY

Three experiments were designed and conducted in Israel to test the robustness of Kurosu and Kashimura's findings to cultural and methodological bias. Experiment 1 tested the cross-cultural robustness of KK's findings. Experiment 2 tested for possible response dependency bias in KK's experimental procedure, and Experiment 3 tested for potential medium bias. The unique aspects of each experiment and its main results are described in the next section.

Study Materials

The original study materials (26 ATM layouts in Japanese) were provided to the author by Kurosu and Kashimura. The ATM layouts were solicited by KK from a group of 26 people: 9 GUI designers, 6 industrial engineers, 8 engineers and 3 secretaries. All layouts included the same components and were differed only by how these components were arranged [12]. Where necessary, the materials were translated into Hebrew and the 26 layouts were replicated. A few problems of user interface translatability were encountered at this stage. Trade-offs had sometimes to be made between ensuring the natural look of the interface to Israeli eyes on one hand, and totally preserving the Japanese original version on the other hand. In most cases, the former approach was preferred. For example: (a) Several controls in the Japanese interface are represented as one character, whereas in Hebrew they require a whole word.

(b) The Japanese interface included an image of a lady who is presumed to bow repeatedly to indicate that the system is processing. This concept was totally foreign to Israelis and potentially would have looked odd. Therefore, the image was replaced with a an image of an hourglass which is a more familiar representation of an active system in Israel.

(c) In Japan, some actions are represented by a symbol that can't be translated directly into Hebrew. For example, the currency (Yen) symbol in the Japanese interface (one character) denotes an operation for which Israeli ATMs use (the Hebrew word for) "confirmation". Thus, it was translated to the Hebrew equivalent of "confirmation" rather than to the Israeli currency symbol.

(d) The Japanese material was produced using Claris Works for the Mac. To use the original Japanese software one had to use a Kanji-aware Mac operating system. These are such rare birds in Israel, that different software was eventually used on a different platform (Microsoft's Visual Basic).

The results of the translation process can be seen in Figures 1 and 2, which show two examples of original Japanese layouts and their Israeli counterparts. Figure 1 presents a layout that was rated high on apparent usability and aesthetics both in Japan and in Israel. Figure 2 presents a low rating layout. (Unfortunately, for technical reasons the reproduction of the Japanese layouts in this paper is of lower quality.)

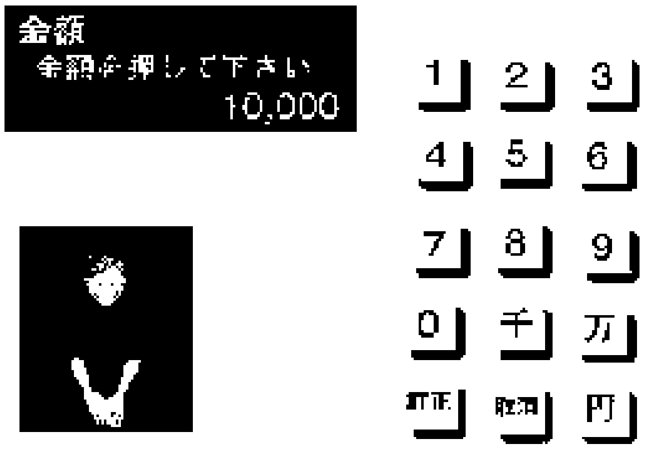

Figure 1(a). An original Japanese interface, rated high on apparent usability and aesthetics.

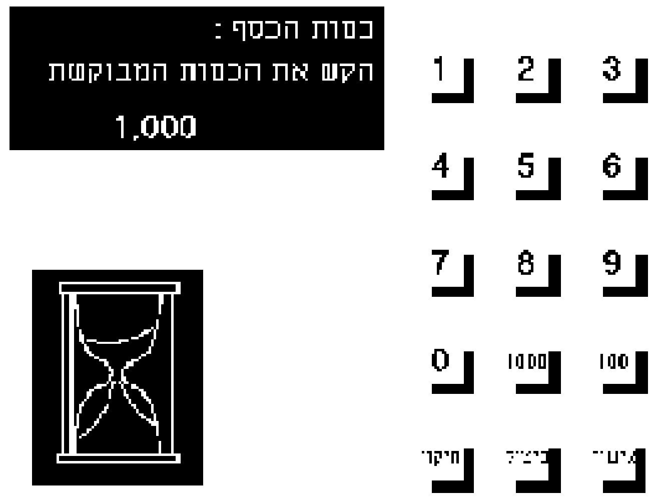

Figure 1(b). The equivalent Israeli interface, rated high on apparent usability and aesthetics.

Figure 2(a). An original Japanese interface, rated low on apparent usability and aesthetics.

Figure 2(b). The equivalent Israeli interface, rated low on apparent usability and aesthetics.

Variables

In this study, seven independent, objective variables, which KK considered to be the determinants of inherent usability of the ATM layout were used. These variables reflect design strategies that were actually used by designers of the ATM interfaces to affect the cognitive and the operational efficiency of user interaction with the ATM. These variables included: (1) location of the main display (DISTANCE), (2) type of numeric keypad (KEYPAD), (3) grouping of keys according to their functions (GROUPING), (4) sequence of the special numeric keys (SEQUENCE 1), (5) location of the numeric keypad (HAND-DOMIN), (6) location of the "Confirm" key (SEQUENCE 2), (7) location of the "Cancel" key (SAFETY). A more detailed description of the variables can be found in [12]. Two dependent variables, *apparent usability* and *aesthetics*, were operationalized by asking participants to rate each design on two 1-10 scales: How easy it is to use (apparent usability), and how beautiful it is (aesthetics).

THE EXPERIMENTS

Experiment 1: Replicating KK's study in Israel

Experiment 1 was designed to test the robustness of KK's results to cultural variation. Participants were 104 first-year engineering students in an Israeli University. The procedure used was identical to the one used by [12]: The twenty-six design layouts were displayed in a large classroom, using an overhead screen projector. Each layout was displayed for about 20 seconds. During that time, participants rated each layout on a 1 to 10 scale regarding how usable it appeared to be, and how beautiful it was.

Results

Participant ratings were averaged to form an apparent usability and an aesthetics score for each of the 26 designs. Mean scores for all 26 designs were similar for this and KK's study (5.9 vs. 6.0 for aesthetics and 5.4 vs. 5.8 for apparent usability in Israel and Japan, respectively). Scores' variability was higher in Israel than in Japan. Aesthetics scores ranged between 3.5 and 8.5 in Israel, compared to a range between 5.2 and 6.8 in Japan. Similarly, apparent usability scores for the 26 designs in Israel ranged between 2.7 and 8.5, compared to 4.4 to 6.5 in Japan. Relationships with apparent usability using the coefficient of correlation for the interval scales and the coefficient of contingency for the categorical variables are presented in Table 1, alongside the corresponding correlations from KK. In general, the relationships resemble those obtained by KK. However, the magnitude of correlation between aesthetics and apparent usability (0.921) was notably higher in this experiment. A test for differences between correlations [9] found a significant difference between this correlation and the one obtained by KK ($Z = 3.09$, $p = 0.001$). This suggests that, even more than their Japanese counterparts, Israelis perceived ease of use and design aesthetics to be closely related. These results are quite surprising, given the expectation that Israeli students would be less sensitive to the aesthetic aspects of the interface.

Variable	**Correlations with Apparent Usability**			
	KK	**Exp. 1**	**Exp. 2**	**Exp. 3**
AESTHETICS	**.589**	**.921**	**.832**	**.920**
DISTANCE	.000	.001	-.042	-.129
KEYPAD TYPE#	.730	.671	.751	.760
GROUPING	.075	**-.462**	**-.529**	**-.667**
SEQUENCE 1#	.113	.352	.197	.397
HAND-DOMIN	-.127	-.002	-.125	-.203
SEQUENCE 2	-.306	.233	.137	.153
SAFETY	.137	-.019	-.006	-.061

Table 1. Correlations (bold: $p<.01$) and coefficients of contingency (#) of aesthetics and seven inherent usability variables with apparent usability for the experiment in Japan (KK) and for the three experiments in Israel.

Among determinants of inherent usability, only keypad type and the number of grouped elements were correlated with apparent usability. Table 2 presents a contingency table in which 4 equal interval categories are used to rank the 26 designs according to their apparent usability rating. Despite the similarity in magnitude of the coefficient of contingency between Israeli and Japanese participants, a closer look at the contingency table reveals that, while the Japanese associated better usability with the horizontal keypad layout, Israelis related it to the telephone keypad. In addition, significant correlations were found in this experiment between apparent usability and the number of grouping elements in the ATM design. Higher apparent usability was associated with less groups, defying conventional advice in the usability literature, which calls for the separation of functionally unrelated controls (e.g., [18]).

Rank	Numeric Keyboard Type, KK vs. Exp. I (Japan/Israel)			
	Telephone	Calculator	Horizontal	Other
1 (Lowest)	0 / 0	1 / 1	0 / 3	1 / 1
2	2 / 4	4 / 4	0 / 1	0 / 0
3	7 / 8	1 / 1	0 / 0	0 / 0
4 (Highest)	6 / 3	0 / 0	4 / 0	0 / 0

Table 2. Ranking of Numeric Keyboard Types in Japan vs. Experiment 1 in Israel

Experiment 2: Testing for potential response dependency

As noted above, in both KK's study and Experiment 1, 26 different designs of an ATM interface were displayed using an overhead projector. Participants were asked to rate each design on two consecutive 1-10 scales before advancing to the next design. Given this procedure, it is possible that the strong correlation between apparent usability and aesthetics is an artifact of a potential dependency between the responses to these questions. In Experiment 2, the procedure was modified to overcome this potential problem. The 26 designs were projected in two separated rounds. The order of presentation of the designs was determined randomly for each round. A different group of eighty-one first-year engineering students participated in this study. The students were assigned randomly to one of two conditions. In one condition, participants evaluated the design aesthetics for all 26 designs in the first round, and the apparent usability for the 26 designs in the second round. In the other condition, the order of evaluation was reversed. Because only one evaluation per overhead was needed, presentation time was cut to about 15 seconds per overhead.

Results

Correlations and contingency coefficients are presented in Table 1. The results resemble those of Experiment 1, weakening the alternative explanation that the relationships between aesthetics and apparent usability are primarily the result of a response dependency bias caused by the method used in KK and in Experiment 1. Experiment 1's results, regarding apparent usability relationships with keypad type and number of groupings are also replicated here. Thus, experiment 2 lends further support to the overall strong correlation between apparent usability and aesthetics, and to the differences between Israelis and Japanese concerning these relationships.

Experiment 3: Testing for medium bias

The two previous experiments—like KK's experiment—used an overhead projector to display the designs on a large screen. Participants saw the designs from different distances (which were generally large), and from different angles. The third experiment was designed to test whether judgments would differ if the ATM designs were presented on a terminal display rather than on a large public screen. Working with personal computers had additional advantages from the experimenter's viewpoint. It increased the uniformity of the viewing conditions, enabled participants to work in their own pace, and allowed for full randomization of the stimuli presentation (i.e., both the order of the questions and the designs). Participants were 108 3rd year engineering students who participated in the study in part fulfillment of their requirements for an HCI course.

Procedure

Participants were seated in front of a personal computer. A computer program, written in Visual Basic was used to present the stimuli material, accept user responses, and measure response times. The program started with a short on-line introduction, after which participants were presented with the 26 ATM designs. The designs were displayed in a random order. At the bottom of the screen, one of the two questions regarding aesthetics and apparent usability was presented. The participants answered the question on the 1-10 scale by selecting one of ten available response buttons. To proceed to the next design, they had to select a "Continue" button. After responding to the first question for all 26 designs, the 26 designs were presented once again (in a newly randomized order) and the participants answered the other question (apparent usability or aesthetics) for each design.

Results

The results from Experiment 3 are presented in Table 1. By and large, the results are consistent with those obtained in Experiments 1 and 2, reinforcing the patterns observed thus far. The use of computers in this experiment allowed for the measurement of the time it took participants to evaluate the designs. On the average, people took more time to evaluate usability than aesthetics (mean evaluation times = 8.68 sec. vs. 7.58 sec. respectively; $t=2.49$, $df=107$, $p=.014$). Though not very large, the difference in latencies supports the intuitive expectation that evaluating apparent usability is more complex, and hence more time consuming, than the evaluation of the interface aesthetics.

DISCUSSION

The results of this study replicate the basic findings of Kurosu and Kashimura [12]. However, because of the unexpectedly high correlations between apparent usability and aesthetics found in Israel, it is still premature to rule out the possibility of method variance as a major cause of the obtained results. When traits are expected to correlate, it is preferable to add to the study traits that are expected to be independent of each other, in order to rule out method effects. Unfortunately, this was not done in this case, because apparent usability and aesthetics *were not expected* to correlate in Israel (recall the original proposition of this study). Some support exists, though, for the dominance of true trait correlation between apparent usability and aesthetics. Table 3 presents the correlations obtained in the 3 experiments between these variables in a multitrait-multimethod matrix format [2]. The resulting matrix indicates that, at the very least, the results cannot be attributed solely to method variance. Clearly, all validity diagonals (italicized numbers) are very large, providing evidence of convergent validity (cf. [2]). Support for discriminant validity is more tentative. Each validity value is higher than the values lying in its column and row within the heteromethod blocks (enclosed by broken lines). On the other hand, to establish discriminant validity correlations of independent measures of the same trait (e.g., A1 and A2, U2 and U3) need to exceed the correlations between different traits measured by the same method (e.g., A1 and U1, A3 and U3). This happens in only 5 out of 12 comparisons. However, most violations of this requirement occur with comparisons that involve Experiment 1 (the experiment most likely to include method bias). Comparisons involving only Experiments 2 and 3 meet this requirements 3 out of 4 times. Thus, it appears that some method bias indeed existed in Experiment 1 and was removed in the subsequent experiments. Another argument for a true correlation of apparent usability and aesthetics stems from the fact that very similar results were obtained under three considerably different experimental contexts and procedures. Thus, it can be concluded with some confidence that despite the potential method bias, people's perceptions of apparent usability and aesthetics are quite high in general.

Unfortunately, the experiments reported above are too exploratory in nature to explain the process by which people associate usability and aesthetics. Nevertheless, the high correlations across cultures and experimental conditions challenge our assumptions regarding the dimensions of system acceptability in general and the relationships between aesthetics and usability in particular. The various design disciplines have long been occupied with the fragile equilibrium between form and function, aesthetics and usability (e.g. [23, 25]). The field of HCI has taken an unequivocal stand on this matter, concentrating on usability. The results of this study, however, suggest that to achieve the ultimate goal of an acceptable system, a more balanced approach may be needed. The influence of attractive appearance on attitudes and behavior has been documented by social psychologists (e.g., [3, 19, 29]), and has been used by advertisers and persuaders of all sorts. The potential effect of aesthetic experience has not escaped software vendors as well, nor is it ignored by the trade literature in its evaluation of computer products. In their attempts to shift the balance back towards a more user-oriented — rather than customer-oriented — design, it seems that HCI researchers have thus far ignored the possible interplay between aesthetics and usability. Clearly, future research is needed to discriminate between different concepts of usability (for example, intended-, apparent-, and measured usability) and to evaluate the effects of aesthetics on each and on the overall acceptability of the system. The results obtained in this study, together with the potential effect of apparent usability on post- use satisfaction [10,13], strongly suggest that we pay more attention to people's perceptions of the interface aesthetics then we have done thus far. In a sense, this study provides empirical support to Laurel's [15] call for asking "not what the users are willing to endure, but what the ideal user experience might be, and what sort of interface might provide it" (p. 69).

		Experiment 1		Experiment 2		Experiment 3	
		U1	A1	U2	A2	U3	A3
Experiment 1							
Apparent Usability	U_1	( )					
Aesthetics	A_1	.92	( )				
Experiment 2							
Apparent Usability	U_2	*.92*	.79	( )			
Aesthetics	A_2	.87	*.90*	.83	( )		
Experiment 3							
Apparent Usability	U_3	*.84*	.77	*.90*	.89	( )	
Aesthetics	A_3	.81	*.85*	.79	*.94*	.92	( )

Table 3. A multitrait-multimethod matrix presentation of apparent usability and aesthetics as measured in three experiments. The table is arranged according to Campbell and Fiske [2]. Validity diagonals are marked in bold italics; heteromethod blocks enclosed within broken lines.

The other major finding of this study suggests that the degree to which aesthetics relate to apparent usability is culturally dependent. We hypothesized that Japanese are more sensitive to aesthetics than Israelis, and would therefore emphasize more the role of aesthetics in interface design. Apparently, this is not the case. In Israel, correlations between apparent usability and aesthetics were considerably higher than in Japan. Apparently, our knowledge of how culture-specific aesthetics affect HCI issues is still limited. Possibly, with greater aesthetic sensitivity come also greater sophistication and critical skills which perhaps allow the Japanese in KK's study to not completely associate aesthetics with apparent usability as did their Israeli counterparts. An alternative explanation can be based on the larger variability in scores exhibited by Israeli students. The tendency by Israelis to provide more extreme evaluations could be attributed to their tendency to freely express opinions and preferences [11]. Another possible explanation, suggested by an anonymous reviewer, relates the larger variance among Israeli participants to their more diverse cultural background. Thus, the relatively unrestricted range of ratings provided by the Israelis for both variables may have led to higher correlations between aesthetics and apparent usability. Clearly, relating aesthetics to HCI in general, and to cross-cultural issues in particular should benefit from a more disciplined approach than has been taken thus far. The HCI literature on cross-cultural issues is scarce and limited [20, 26]. There is no theory of cross-cultural HCI, and recommendations are not based on thorough empirical investigations. Consequently, its usefulness is quite limited. For example, Graphical User Interfaces (GUIs), once considered a panacea for interface globalization, now appear to be just as culturally specific and limited as older interfaces. And attempts to apply rules of thumb for GUIs aimed at culturally diverse users have failed when tested empirically, as demonstrated effectively by Teasley et al. [31]. Thus, while cultural aesthetics might serve as a good starting point for a cross-cultural research agenda in HCI, developing a cross-cultural theory of HCI requires us to apply more rigorous research methods and to empirically test our hunches and conventional wisdom. Future research should also focus more on identifying and measuring relevant aesthetic components (cf. [5]) that might help explain our experience with, and evaluation of, computer aesthetics.

CONCLUSION

This study was designed with the prospect of demonstrating that high correlations between aesthetics and apparent usability are culture specific. It was expected that the correlations in Israel would be lower than those obtained in Japan. Surprisingly, the results indicated the opposite. This leads to three major conclusions: First, aesthetic perception and its relations to HCI relevant constructs are culturally dependent. Second, our current knowledge limits our ability to accurately predict how culture influences HCI related issues. Third, the results provide further support for the contention that perceptions of interface aesthetic are closely related to apparent usability and thus increase the likelihood that aesthetics may considerably affect system acceptability. The first two conclusions call for future efforts in defining the areas in which culture interacts with the domain of HCI and in systematically studying these areas. The third conclusion postulates that objective measures of system behavior and use may not suffice in predicting system acceptability. Perhaps a more holistic approach towards understanding how people experience and judge information systems is needed [30].

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Aesthetics :In the context of this study, we adopt a narrow definition of aesthetics in which aesthetics can be seen as a synonym for visual beauty.

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