AI and Musical Emotions

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Abstract

Embodiment is crucially important in our understanding of the mind. The human body, as modeled in the brain, provides an essential frame of reference for the neural processes that we experience as the mind. We use the physical state of our very living being as the ground reference for the mental constructions which we make about the environment we live in. The human body and the brain establish an inseparable association that creates our consciousness. Everything we do and feel, is evolved from the structural and functional aggregate of these two, rather than from brain alone. Thus, the background state of our body landscape provides a rather neutral "mood," against which we can judge any changes shaken by emotions. When the brain consciously appraises emotional changes in that equilibrium, we are having an emotional response--a feeling. Pretty much like being aware of the goose bumps while listening an effective piece of music. Conscious feeling of these goose bumps creates in one's brain a memorized history of one's body state under the given situation. Feeling depends on the juxtaposition of an image of the body, correlated to an image of something else; such as the auditory image of a piece of music.

Introduction

Recently I came across people arguing about AI and emotions in music. I thought that the argument was not worth pursuing because I tend to believe that the very concept of emotions is subjective, and that there are no objective aspects of music at all for AI to flourish on. My assumption is that everything we know and feel is a matter of interpretation, and there are as many interpretations as there are conscious organisms. To support this point of view I have to start with the study of the headquarters of subjectivity--the human mind.

For a long time the human mind and consciousness fell under the province of metaphysics and were generally considered as topics improper for scientific investigation. Even today, there is an enormous reluctance of scientists to deal with such subjective phenomena. Those who dare to wrestle with these slippery issues, often address the complexity of the mind via the Darwinian theory of evolution and cognitive psychology; or, as neuroscientists do, focus their interest on the structure and workings of brain and its functions. The best results will probably come from a marriage of these two strategies.

There are lots of theories, particularly in AI and cognitive psychology, that try to parallel computer and the brain, but that should be done with extreme carefulness. The most important point to make is, that human brain developed over a period of more than 500 million years under the pressures of natural selection. This development certainly cannot be compared to a deliberate design of computer technology by the engineers. Old computer hardware and the software are often being completely scrapped and redesigned from scratch, in order to reflect totally new and fresh ideas and approaches. The only obstacle to this progress is market's requirement for backwards compatibility. I like to be able to run my old software on new hardware. On the other hand the human brain is entirely designed by evolution-forced backwards compatibility. We have a reptilian, paleomammalian, and neomammalian brains layered on top of each other, all running at the same time.

> If we remove the cerebral cortex--that part of our brain that has evolved over the past two million years or so--we essentially eliminate our humanity. Beneath the cortex is a brain that is not far different from that of a Bengal tiger, a French poodle, or an Arctic fox. We could, if we wish, remove even more to approximate the brain of a salamander or a rattlesnake. (Restak 1984)

Our brain has an archaic multilevel design comprised of several brains each developed in different periods of evolution for different purposes and priorities. There is no way of going back, as in case of computers, to improve the design and rewire it for higher efficiency--we simply got stuck with our reptilian part of the brain.

Let me use an example from technological evolution to illustrate this point. The very computer keyboard that I'm using in writing this article, known as QWERTY keyboard for its letter layout, was designed at the time when fast typing on mechanical typewrites caused letters to jam. To remedy the problem and slow down the typing speed typewriter manufacturers came up with the most speed-inefficient layout of letters-- known as QWERTY. This is the keyboard we use today on the computer which does not have any letters to jam. But, can we go back and redesign the keyboard to achieve the most efficient and application appropriate letter layout. The answer is NO. Considering the number of people that today use QWERTY keyboards trying to improve their typing speed, it is near to impossible to make the change. Through technological evolution we got stuck with QWERTY, just as through biological evolution we got stuck with our limbic part of the brain, which guides our emotional responses and behavior. (Dennett 1995) On the top of everything, this limbic brain is not always in full coordination with celebral cortex and that is one of the reasons why humans sometimes make irrational decisions which get them in trouble.

Another important point is that computer works very fast crunching numbers serially, one after another, operating at the speed of more than 10 million transactions per second. The human brain fires at much slower rate of a hundred spikes per second but makes up the speed loss with its massive parallelism. For example, more than million axons go from each eye to the brain, all working simultaneously. Now we know for sure that the brain is built as a massive complexity of parallel-interacting neurons which lack a hierarchical order and central organizer, but do produce an emergent property--consciousness, which is mainly serial and more importantly subjective in its nature. (Crick 1994) This is the reason why we have a sense of subjective unity regardless of the multilevel and multi-component make-up of the neurons involved. (Restak 1994)

Thinking and Logic

With the idea of developing machine intelligence additional problems arise when making the analogy between thinking and logic. Computer software is a written set of logical (this includes fuzzy logic too) instructions that conform to a specific syntactical structure which depends on the programming language in use. It is totally inadequate to think that syntax produces semantics. Semantic contents involve meanings, and syntax does not in itself deal with meanings.

> In the computer, the meaning is assigned by a human programmer. There is no ambiguity in the interpretation of physical states as symbols because the symbols are represented digitally according to rules in a syntax. The system is *designed* to jump quickly between defined states and to avoid transition regions between them; electronically, each component always goes to a "zero" or a "one." (Edelman, 1992)

Putting it simply: logic, as well as mathematics, operate in the abstract and, let me use that word here, "objective" realms; while semantics consider meanings which are subjective by default.

Here is an example that illustrates this point. Biological objects under evolutionary time have functional properties that are different from, for example, those of electrons. We cannot speak of the "abnormal" function of an electron as a physical object. On the other hand a proper function of a biological device depends on its evolutionary history. A human ear has a proper function to transduce a sound into a bio-electrical signal. There is also an evolutionary explanation for the construction of such a component (an ear) in a species, and this justifies the correspondence of this organ to "normal" ears in that species. Human ears work well or not; badly functioning ones, like Beethoven's, are abnormal and may need a hearing aid. In contrast, atomic particles do *whatever* they do, and whatever they do is part of their "working."

Within the evolutionary context, functions that propel the survival of the fittest are labeled as "normal" functions. Thus, each set of functions may be recognized as "normal" in relation how the system redundantly manages to perform that function. Since we know that the neural making of every human brain is different, as well as the environmental and historical context in which each brain develops, we may consider our brain/minds to be quite different systems. Different systems have different contexts that render all kinds of different "normals."

> Meaning derives from embodiment and function, understanding arises when concepts are meaningful in this sense, and truth is considered to arise when the understanding of a statement fits one's understanding of a situation closely enough for one's own purposes. (Notice the pragmatism!) Thus, there is no absolute truth or God's-eye view. (Edelman 1992)

Meaning, Genetics, and Environment

To come up with a meaning it is necessary to have a conscious human being interacting with environment. This kind of being, unless raised in a deprivation chamber, is going to be loaded with myriad of subjective life experiences. Humans categorize "good" and "bad" experiences based on their interactions with the environment and the ability to detect, memorize, and compare exponentially growing repertoire of new good and bad things. Most of the human intentions are based on these subjective experiences and computers have neither intentions nor experiences of their own.

The home of our conscious subjectivity is cerebral cortex--the last part of the brain to evolve. This is the part that produces consciousness and that we are the most proud of; because it can make complex decisions, create language, write music, play chess, and think of the black holes--which no other animal can do. Unlike other animals, humans are born with only 25% of its adult brain weight, and brain's final development has to be finished after birth. Though human genome specifies in great detail construction of a human body, vast number of the brain circuits are not preset by the genes and ought to be finished later in life. Since every human's being history and circumstances are different, every brain's wiring is going to be quite unique. Humans come to life having a brain endowed with automatic survival mechanisms which work adaptively in an array of socially permissible decision-making strategies. These nurturing conditions under which brain finishes its development are shaped by a certain culture that conforms to "socially agreed" set of values. Educating the brain within such a system of social organization should guarantee the survival of that cultural group (species) within the given environment.

Hypothetically, if the mores of the cultural environment do not prescribe the practice of music, these survival mechanisms would certainly guide one to become non-musical. If Mozart was born in this kind of environment, in spite of his genome outline, he might prefer being a carpenter rather than a musician. Emotional responses are socio-culturally shaped while feelings are biologically predetermined. The question is how can AI models encapsulate socio-cultural models, and furthermore which culture is it going to be encapsulated--Italian, American, or perhaps Japanese?

The Matter of the Mind

Humans categorize on culturally adopted set of values. Computers cannot do that, their values are specified in advance and imposed on the system by a human operator as a set of algorithms that define what to do under appropriate conditions and with appropriate error feedback. (Edelman 1992) It would be nice if we could talk about mind, as some psychologists do, only in terms of algorithms. Looking at different brains as if they were replicable machines or black boxes which can be understood solely in terms of inputs and outputs is an oversimplification. It is important to go inside the "black box" and try to figure out the mechanisms which operate our brains. The tissue organization and composition of the brain in form of groups of interacting neurons may be doing this job.

> These groups compete with each other in an effort to create effective representation, or maps, of the infinite variety of stimuli entering from the world. Groups that form successful maps grow still stronger, while other groups wither. (Horgan 1996)

It is not by chance that brain of a person gifted with perfect pitch possesses a thickened area that processes sound--the auditory cortex, while a person with photographic memory has more neurons in its visual cortex. (Restak 1991) This is the feature that we call talent and it is genetically predisposed. The precise structure of a certain neural tissue of the brain exposed to a certain external environment will allow that tissue to develop, for example, a musical talent. For that reason it is wrong to believe that human brain of the youngster is an empty book that experience will write its story on. (Gazzaniga 1992) If the neural circuits are not receptive to the environmental pressures the experiences "written" in the brain will be faint.

Brain's Age

So far I have dealt with two conditions required for design of another Mozart: a) genetic predisposition, and b) stimulating environment for that predisposition. There is yet another very important aspect in this picture to be considered and that is the age of the brain. When the brain is young it displays a neural plasticity which is capable of developing more and more neural connections required for a particular talent. This plasticity diminishes as the brain ages and may be one of the reasons why we get no musical talents suddenly erupted at the age of fifty. Even if the person had a thickened auditory cortex but the environment did not externally stimulate it at the most appropriate time--no Midori will be produced.

> Some circuits are remodeled over and over throughout the life span, according to the changes an organism undergoes. Other circuits remain mostly stable and form the backbone of the notions we have constructed about the world within, and about the world outside. The idea that all circuits are evanescent makes little sense. Wholesale modifiability would have created individuals incapable of recognizing one another and lacking a sense of their own biography. That would not be adaptive, and clearly does not happen. (Damasio 1994)

Generally speaking, development of neural mappings for the "talents" that involve some kind of intensive body coordination, such as playing a violin or a game of basketball, tend to be locked-in very early in life. Other, more "disembodied" talents retain their neural circuit plasticity for much longer period of life.

> A famous pianist said to me, about forgetting a familiar piece of music, "Muscle memory is the last to go," meaning by that term playing the piece automatically and without thinking about it. (Crick 1994)

Emotion and Feeling

Let me now try to explain why the embodiment is so important for our understanding of the mind. The human body, as represented in the brain, provides a fundamental frame of reference for the neural processes that we experience as the mind. We use the physical state of our very organism as the ground reference for the mental constructions which we make about the environment we live in. (Damasio 1994) It is extremely important to understand that the human body and the brain constitute an inseparable interconnection that produces our consciousness. Everything we do, is derived from the structural and functional ensemble of these two, rather than from brain alone.

> Can one fancy the state of rage and picture no ebullition of the chest, no flushing of the face, no dilatation of the nostrils, no clenching of the teeth, no impulse to vigorous action, but in their stead limp muscles, calm breathing, and placid face. (James 1950)

In short, the background state of our body landscape provides a rather neutral "mood," against which we can judge any changes shaken by emotions. When the brain consciously appraises emotional changes in that equilibrium, we are having an emotional response--a feeling. Pretty much like being aware of the goose bumps while listening an effective piece of music. Conscious feeling of these goose bumps creates in your brain a memorized history of your body state under the given circumstances. Feeling depends on the juxtaposition of an image of the body, correlated to an image of something else; such as the auditory image of a piece of music. (Damasio 1994) Thus, later on in life, under the similar listening conditions, your brain may recreate this correlation of the images, and you may experience the feeling of goose bumps again.

Our individual identity of selfhood is firmly grounded on this illusion of living sameness, against which we can be aware of the infinite changes in our environment and consequently in our body. For this reason the sheer fact of a change in a room temperature, while listening to piece of music, may dramatically affect your emotional responses. Here it lies one of the central problems of the western medicine which subspecializes in treating diseased organs and system throughout the body but rarely addresses its most precious product--the mind. (Damasio 1994) Needless to say, that computers are not only disembodied; but cannot by themselves provide a meaningful relation between symbols and world entities.

Attention and Memory

We also have to be aware that not all operations of the brain correspond to consciousness, as I mentioned earlier in the case of the background body felling. Awareness starts when we consciously focus on a point of interest. Here, I would like to concentrate on consciousness which involves very short term of memory and it is closely associated with attention. Attention is, as William James said, "withdrawal from some things in order to deal effectively with others." There is general agreement that attention and primary consciousness involve some kind of a bottleneck. At first, the brain is processing the vast amounts of incoming information in parallel. Then the selective attention of hearing, for example, concentrates on one or a few objects at the time using the serial processing of the bottleneck--attending to one object after another. This is done by temporarily focusing on the objects of our interest while filtering out unattended information. (Crick 1994) Pretty much like listening to Bach's fugue while focusing our attention to the thematic workings of the dux and comes.

We may assume that primary consciousness of short-term memory deals with attention which is value-free perceptual categorization. This takes place *before* perceptual events contribute further to the alteration of neuronally structured and experience shaped value-dominated long-term memory. When short-term memory starts to contribute to the modification of a subjective long-term memory (this could be called a learning process) events are no longer in the remembered present, that is, they are no longer in primary consciousness. (Edelman 1992)

> Primary consciousness is required for the evolution of higher-order consciousness. But limited to a small memorial interval around a time chunk I call the present. It lacks an explicit notion or a concept of personal self, and it does not afford the ability to model the past or the future as part of correlated scene. (Edelman 1992)

Musical Experiences

Now, just for the sake of experiment, lets assume for a moment that under the same external environmental circumstances, for me to perceive a middle C, certain groups of neurons and molecules in my head must behave in a very specific way. If the neural correlate of middle C in your head is exactly the same as in mine, which we know is probably not true, we may conclude that you hear middle C the same way I do. Stating this, we inevitably run into a problem with "exactly." The word "exactly" functions properly only in mathematics $1 + 1 = 2$. On the abstract level "exactly" makes perfect sense but in practical world of everyday's living, nothing is exactly precise. Moving further on, to consider a major scale, things get indeed considerably obscure. When the brain receives sequences of musical tones, it does what it does with other patterns: it attempts to "interpret" them by using the information stored in its long-term memory about previous, similar experiences. This information may allow some aspects of a future signal to be anticipated--as it happens when we hear the first line of a familiar song. This ability to extrapolate forwards on the basis of past experience is one form of that ability that we call "intelligence"; it can dramatically enhance an organism's chances of survival. Thus, if my neural correlate of middle C depends on my past experiences, which we assume is true, then my neural correlate for major scale is going to have totally different wiring than yours. My past musical experiences had grossly influenced my neural mapping which correlate in my brain with a concept of major scale.

> ... we constantly judge by comparison, and our judgment of any item depends upon what we are comparing it to at that moment. (Ornstein 1986)

Different parts of brain handle specific mental processes but even this changes with our experiences. Comparing the brain activities while listening to music by trained musicians and people who have no specialized musical training shows very interesting results. Researchers discovered that musicians process music mostly in their left hemisphere which is concerned with analyzing and comparing different patterns, for example the musical form and structure. Non-musicians' brains reacted to music mostly with the right hemisphere in a more holistic and emotional way "I like this but not that"--which does not involve too much pattern analysis. When non-musicians became more involved with appreciating the way music is structured, the PET (positron emission tomography) scan illustration of their brains showed a shift towards the left hemisphere because now they were equipped with new musical knowledge which enabled them to analyze. (Restak 1991)

Addressing the past experiences we have to also consider the way our brain handles the long-term memory. These memories are not stored in the brain photographically as intact individual events; and there are no stores of audio tapes, or albums of pictures. This is completely unlike computer-based memory which deals with exact reproductions. Human brain operates with a reconstructed version of the original--an interpretation. In order to compile a musical tune, the brain has to fire a certain set of neural mappings as a means to paraphrase "the music." These firing patterns trigger the momentary reconstruction of an *approximate* representation of the "Star Spangled Banner," for example. Your interpretation of music today, depends on: who you are, what are you doing at that moment, and your past experiences stored in the long-term memory. But, the next day, you are going to be different, what you will be doing is going to be different, and your past experiences in long-term memory will change as well.

The "mass of soothing sound" your mother made while singing lullabies to you in childhood, is reduced to Twinkle, Twinkle Little Star, later on in life. Our memory of a certain musical piece is influenced not only by previous knowledge but also by events that happen between the time an event is perceived and the time it is recalled. (Ornstein 1991) Furthermore, we can only recall memories that are related to our present situation--where you are and what are you doing. If you are composing an orchestral piece your brain more likely focuses on recalling memories related to the instrumental ranges, rather than memories of how to change a flat tire on your car.

> So our memories, as exact, recorded, fixed images of the past, are an illusion. We believe we are stable, but this is one of the built-in illusions of the mental system. We believe we remember specific events, surely. Yet we don't. We make them up on fly. We change our minds all the time, from our estimate of the odds on a bet, to how we view our future. And we are unaware that the mind is doing this. (Ornstein 1991)

Limitations of Artificial Intelligence

All this is pointing out that human mind deals exclusively with subjective phenomena and what we call objective is nothing but what most people agree to within a given socio-cultural context. Yes, we may listen to Beethoven's symphony in terms of air-pressure waves and on that level probably most people would have similar experiences. The question is, what is the use of doing that.

Herein lies the insurmountable problem of Artificial Intelligence--to emulate the human mind, science's final frontier. Holding that the brain is nothing more than a very complicated machine whose properties can be duplicated with computers seems very implausible. Even the system like the Internet is absolutely trivial compared to a brain. If there is a computer model of the brain/mind to be manufactured, it would have to mimic the human development of going to kindergarten, playing around the house, listening to music, and being traumatized by your neighbor's dog. Marvin Minsky, one of the founders of AI, made a statement which essentially undermines the whole project of AI in human terms.

> Minsky confessed that he would love to know what Yo-Yo Ma, the great Japanese cellist, felt like when playing a concerto, but Minsky doubted whether such an experience would be possible. To share Yo-Yo Ma's experience, Minsky explained, he would have to possess all Yo-Yo Ma's memories, he would have to become Yo-Yo Ma. But in becoming Yo-Yo Ma, Minsky suspected, he would have to cease to be Minsky. (Horgan 1996)

This claim is the admittance that everything we know is nothing but a subjective interpretation shaped by person's biological make-up of the brain and neural correlates of the past experiences which define the self of that very person. Now, we are left with exclusively subjective properties of music to deal with, and in this dealing we may use the computers, because they are the most powerful heuristic tools we have in our attempt to understand the matter of the mind. (Edelman 1992)

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