Does DNA encode reward feature detectors?

Does DNA encode reward feature detectors? (#p5686)

by **Brian Tomasik** »

The following post is more cognitive-science speculation than applied utilitarianism, but I couldn't think of a better place to ask my questions, so here goes.

Certain stimuli are nearly universally rewarding and others are nearly universally aversive among humans. Attraction and repulsion result when the nervous system detects features about its environment through the senses (taste, smell, appearance, etc.) and transmits these signals to emotional centers in the limbic system and elsewhere.

How is it that emotions get hooked up to feature detector neurons? In some cases, the relationship is purely learned (http://felicifia.org/viewtopic.php?f=29&t=630) through classical conditioning. For example, after I ate some bad chicken nuggets in 1999 and threw up afterwards, I felt nauseous around the smell of chicken nuggets for several years afterward. (The conditioned effect has since become extinct, but hey, I don't plan to eat chicken nuggets anyway (http://www.mccruelty.com/) .) In general, many food proclivities are learned, which we can see by the fact that some cultures love to eat cow tongues and monkey brains. There's evidence that nutrition during pregnancy affects later taste preferences (http://www.npr.org/2011/08/08/139033757/babys-palate-and-food-memories-shaped-before-birth) .

But there are trickier cases. What about the preference for fat, sugar, and salt (http://www.talkingscience.org/2010/08/what-is-responsible-for-our-taste-preferences-and-why-do-they-change-with-age/) ? Is this learned or hard-wired? My guess is that the affective valence of these inputs is learned but in the context of more internal cues which are hard-wired. For example, sugar tastes good when you're hungry but can be uncomfortable when you've eaten too much. The body has systems to control glucose concentrations, as well as other hormonal regulators of hunger and satiety (http://www.ncbi.nlm.nih.gov/pubmed/17212793) , and presumably these interact with the brain to say "go" and "stop" at longer time-scales and drive the learning of the more immediate taste sensations.

While it's easy enough to imagine that many food preferences are learned from internal cues, the case of physical attractiveness seems more difficult. There appear to be dozens of features (http://en.wikipedia.org/wiki/Physical_attractiveness) that determine beauty, and several of them seem fairly universal across cultures. For example, "The hourglass figure is truly timeless (http://www.newscientist.com/article/dn10927) ": "Written texts of all ages have the same drift when it comes to the midriff - they consistently describe women's thin waists as attractive. The conclusion comes from an analysis of British, Indian and Chinese texts dating as far back as the first century AD. According to the researchers, the finding supports the idea that we are hardwired to prefer slender waists, which are linked to good health and fertility."

Where is this preference for a 2/3 waist-to-hip ratio stored? Presumably the brain has feature detectors for curves and shapes. When certain curves and shapes fire, they pass through a neural network with weights set to pattern-match for a particular configuration. The output of this neural network determines the level of activation of reward systems. But how exactly do these weights get set? [OLD TEXT, probably wrong: This is definitely not something that can be learned, because the outcome of a better waist/hip ratio doesn't show up until years after kids have been born, and the influence of this single predictor on their survival is probably so small that you wouldn't notice it even over a lifetime of having children. Nor does it seem at all plausible that males subconsciously survey women they know and correlate waist/hip ratio against number of healthy offspring. I would conjecture that the correlation isn't even very strong in this age of low maternal/child mortality, yet the preference remains.] [NEW TEXT, Nov. 2014: Attractive features can be learned not via immediate rewards but by imprinting. Indeed, there's decent evidence for sexual imprinting, which seems more plausible to me than that DNA stores information about optimal body shapes. Still, DNA does need to tell the imprinting process which kinds of bodies to imprint on...]

This leads to the suggestion that the 2/3 ratio must be stored in some form within DNA (or potentially molecular epigentics, etc.). This strikes me as incredible. DNA codes for proteins that mix together throughout a long human-building process to turn on and off various cellular functions. How can DNA have enough fine-grained control through this indirect protein-creating mechanism to encode the number 2/3 (poetically speaking) into the neural weights for female body-shape attractiveness? And this isn't a one-off phenomenon. There are several other (http://www.psychologytoday.com/blog/the-scientific-fundamentalist/200809/barbie-manufactured-mattel-designed-evolution-i) cross-cultural features of attractiveness based on image feature detection. When seeing this level of detail, my instinct is to run to the explanation of "learning," but I simply can't see how learning could apply in this case.

To be sure, there are plenty of cases in which the emotional salience of visual cues can be learned. Imprinting (http://en.wikipedia.org/wiki/Imprinting_(psychology)) is a classic example. Geese can't store their mother's appearance in their DNA (else it would change every generation), so they have a developmental strategy to learn that the first thing they see moving within a critical period after birth is their mother. Likewise for reverse sexual imprinting (http://en.wikipedia.org/wiki/Westermarck_effect) . And there are all sorts of even abstract pictures to which people learn positive or negative associations through culture, like this (http://en.wikipedia.org/wiki/File:Flag_of_the_United_States.svg) , or this (http://en.wikipedia.org/wiki/File:Flag_of_the_NSDAP_(1920%E2%80%931945).svg) , or this (http://en.wikipedia.org/wiki/File:Star_and_Crescent.svg) . It should also be noted that many images are almost universally regarded as beautiful even though they cannot have direct evolutionary benefit, like this (http://en.wikipedia.org/wiki/File:DAPIMitoTrackerRedAlexaFluor488BPAE.jpg) or this (http://en.wikipedia.org/wiki/File:Antennae_galaxies_xl.jpg) ; presumably these are spandrels of more generic visual affective systems, similar to the human preference for music.

Anyway, one area in which learning *is* used to perceive physical attractiveness is with averageness preference (http://en.wikipedia.org/wiki/Koinophilia#Physical_attractiveness) . About a gazillion and four studies have shown that "average faces" are more attractive than average [sic] and sometimes more attractive than any individual face. You can try it yourself online (http://www.faceresearch.org/demos/average) . The phenomenon appears to be more than mere symmetry detection, because symmetrical faces turned upside down don't have much advantage (http://www.faceresearch.org/students/notes/symmetry.pdf) and because averages of profile views (where symmetry doesn't apply) are still found more attractive (http://www.valentinemoore.co.uk/trv/Attractive.pdf) . In other words, the brain presumably contains networks that check whether a face is close to the average of faces it has seen. Each time it sees a new face, maybe the brain updates these weights with some learning rate. A theoretical test for the averageness hypothesis could be to raise children within a group of people with a particular abnormal feature (say, a really square face (http://linsart.blogspot.com/2010/10/one-of-kind-square-face-cabs.html)), and upon exposing them to a more normal face, see if they like it less (or at least prefer it less than other children do). In any event, even if averages are learned, the fundamental algorithm of "comparing to the average" still has to be hard-wired. Presumably this lies somewhere in DNA as well.

Top

- Edit post (./posting.php?mode=edit&f=10&p=5733)
- Delete post (./posting.php?mode=delete&f=10&p=5733)
- Report this post (./report.php?f=10&p=5733)
- Information (./mcp.php?i=main&mode=post_details&f=10&p=5733&sid=f23d4bbb905f11d2cf06a834daefe4e5)
- Reply with quote (./posting.php?mode=quote&f=10&p=5733)

Re: Does DNA encode reward feature detectors? (#p5733)

by **rehoot** »

> ***Brian Tomasik wrote:***
> How is it that emotions get hooked up to feature detector neurons? In some cases, the relationship is purely learned through classical conditioning. For example, after I ate some bad chicken nuggets in 1999 and threw up afterwards, I felt nauseous around the smell of chicken nuggets for several years afterward.

The ease of conditioning a taste aversion was an important discovery in the history of psychology. A guy named John Garcia (https://en.wikipedia.org/wiki/John_Garcia_%28psychologist%29) did some relatively simple studies that showed that rats can acquire an aversion to "tasty" food in as little as one event if it is followed by negative stimuli. Animals seem to be biologically predisposed to quickly acquire taste aversion but not acquire aversions as quickly in other domains. That suggested a biological (largely genetic) basis for behavior as opposed to the pure conditioning basis suggested by Skinner and the behaviorists. You can also read a bit about it here: https://en.wikipedia.org/wiki/Taste_aversion (https://en.wikipedia.org/wiki/Taste_aversion)

> ***Brian Tomasik wrote:***
> Geese can't store their mother's appearance in their DNA

Correct. Memory is often distributed but relies on some key brain regions such as the hippocampus. The geese thing is another example of a biological predisposition to be easily conditioned to a particular type of stimuli.

> ***Brian Tomasik wrote:***
> And there are all sorts of even abstract pictures to which people learn positive or negative associations through culture, like this, or this, or this. It should also be noted that many images are almost universally regarded as beautiful even though they cannot have direct evolutionary benefit, like this or this; presumably these are spandrels of more generic visual affective systems, similar to the human preference for music.

The study of beauty and "liking" is quite interesting. It is also related to why people have so many prejudices. You already posted my favorite link on the subject: http://www.faceresearch.org/demos/average (http://www.faceresearch.org/demos/average) . That page that shows that the average of many pictures of "average" people produces an image that seems to be more beautiful than any of the individuals:

The research on faces has suggested that people can detect certain features and have a preference for them, such as symmetry, but a large part of our preference for any style or fashion is largely influenced by mere exposure (https://en.wikipedia.org/wiki/Exposure_effect) . Some of the studies on mere exposure show that people who wait in a waiting room and here a song that was previously rated as "bad" by students became the preferred song when heard at a later time. In another study, undercover experimenters sat in the back of classrooms and said absolutely nothing for several weeks (I forget the exact amount of time) but these people were rated as more likeable that randomly assigned strangers (who were picked as more likeable when they were the ones sitting in the back of the room).

I will introject my philosophy here: I think that people typically err when they claim that they like something because of the physical attributes of something. When people say that, they are often claiming that there is objective value in the physical shape or attributes of something (you are not saying that). I think they misunderstand the true origins of why they prefer something because humans are not consciously aware of the unconscious processes involved with perception and interpretation. The claim that our brains are wired to like things of a certain shape is more plausible, but it is incomplete if it excludes consideration of all the social influences on perception and interpretation.

> ***Brian Tomasik wrote:***
> In other words, the brain presumably contains networks that check whether a face is close to the average of faces it has seen.

I'm not sure if we can draw that conclusion or if all we can say is that people can detect outliers that are not within the norm. There is no research that I know of that people unconsciously perform mathematical calculations to average a historical record of stimuli (even in some test in which people are given lots of numbers and asked to average them), but they rely on heuristics (gut feelings or impressions not based on mathematical calculations). Perception of immediate experience might involve some responses that follow mathematical patterns (like the response to loudness of sounds following a logarithmic curve), but this does not happen when some of the stimuli are in the past and some are current.

> ***Brian Tomasik wrote:***
> In any event, even if averages are learned, the fundamental algorithm of "comparing to the average" still has to be hard-wired. Presumably this lies somewhere in DNA as well.

What can be genetically based is a disposition to focus on differences from the norm--where differences are based on past experience-- and, to some degree on some feature-detection like symmetry. Many animals have strong reaction to seeing snakes. There are neurons in the visual cortex that respond specifically to motion and curvy lines that might be partially responsible for this, but another way to view this is that the biological basis causes people to respond more strongly to some stimuli than they do to others.

> ***https://en.wikipedia.org/wiki/Visual_cortex wrote:***
> Current consensus seems to be that early responses of V1 neurons consists of tiled sets of selective spatiotemporal filters. In the spatial domain, the functioning of V1 can be thought of as similar to many spatially local, complex Fourier transforms, or more accurately, Gabor transforms. Theoretically, these filters together can carry out neuronal processing of spatial frequency, orientation, motion, direction, speed (thus temporal frequency), and many other spatiotemporal features.

Some people have a strong reaction to detecting differences from the norm, and then people can vary in cognitive skill to influence how they react to the detected differences (i.e., some people see a person of a different color and react with suspicion or violence and some with interest).

Now consider an earlier statement:

> ***Brian Tomasik wrote:***
> This leads to the suggestion that the 2/3 ratio must be stored in some form within DNA

Can we really say that there is a preference for a 2/3 ratio as opposed to a preference for something within the norm (perhaps influenced by what is perceived to be the norm for people of high status/power)? I would argue that the weight of female sex symbol has changed over the decades, as has that ratio. In the art world, there is something called the golden ratio (https://en.wikipedia.org/wiki/Golden_ratio) . If you divide a rectangular canvas into two parts according to the ratio, and paint them different colors, it generally looks good. That might be a stronger case for a biological basis, but it could be related to perceived symmetry in some way. I don't know the biological basis for this.

Top
- Edit post (./posting.php?mode=edit&f=10&p=5773)
- Delete post (./posting.php?mode=delete&f=10&p=5773)
- Report this post (./report.php?f=10&p=5773)
- Information (./mcp.php?i=main&mode=post_details&f=10&p=5773&sid=f23d4bbb905f11d2cf06a834daefe4e5)
- Reply with quote (./posting.php?mode=quote&f=10&p=5773)

Re: Does DNA encode reward feature detectors? (#p5773)
by **Brian Tomasik** »

> ***rehoot wrote:***
> Animals seem to be biologically predisposed to quickly acquire taste aversion but not acquire aversions as quickly in other domains. That suggested a biological (largely genetic) basis for behavior as opposed to the pure conditioning basis suggested by Skinner and the behaviorists.

Great point to add -- thanks!

> ***rehoot wrote:***
> The claim that our brains are wired to like things of a certain shape is more plausible, but it is incomplete if it excludes consideration of all the social influences on perception and interpretation.

Yep, agreed.

> ***rehoot wrote:***
> I'm not sure if we can draw that conclusion or if all we can say is that people can detect outliers that are not within the norm.

But if it were just about outliers, then why would the average face be more pretty than a non-abnormal face? Also, how would the brain store information about what's an outlier?

> ***rehoot wrote:***
> There is no research that I know of that people unconsciously perform

> mathematical calculations to average a historical record of stimuli (even in some test in which people are given lots of numbers and asked to average them), but they rely on heuristics (gut feelings or impressions not based on mathematical calculations).

Not necessarily a real mathematical average, but an implicit average built up by successive updates to neural connection weights. Each time there's a new observation, the updated weight is a combination of the old value with the new observation. This might be a weighted average that decays older data. (I don't know if this is plausible biologically without studying the matter more.)

What I'm proposing above is an average where each instance does an update. Showing people abstract numbers wouldn't be expected to have the same effect, because who knows if symbolic things like numbers could affect connection weights in the same way? If instead the average were done by showing a bunch of +1's and -1's in some proportion, then I would expect neural weights to track the average fairly well.

> ***rehoot wrote:***
> Many animals have strong reaction to seeing snakes. There are neurons in the visual cortex that respond specifically to motion and curvy lines that might be partially responsible for this, but another way to view this is that the biological basis causes people to respond more strongly to some stimuli than they do to others.

Good point! Snake aversion has to be pretty innate, because organisms don't learn to fear snakes only after a bad encounter with one.

> ***rehoot wrote:***
> Can we really say that there is a preference for a 2/3 ratio as opposed to a preference for something within the norm (perhaps influenced by what is perceived to be the norm for people of high status/power)?

I think we can for waist-to-hip ratio more than other things, because as the article (http://www.newscientist.com/article/dn10927-the-hourglass-figure-is-truly-timeless.html) that I cited before notes, WHR preferences are surprisingly similar across cultures and historical periods. If it were just based on norms, we wouldn't see such consistency.

The exact number may vary a bit (http://en.wikipedia.org/wiki/Waist-hip_ratio) , but not wildly:

> Some researchers have found that the waist-hip ratio (WHR) is a significant measure of female attractiveness.[20] Women with a 0.7 WHR are usually rated as more attractive by men from Indo-European cultures.[21] Preferences may vary, according to some studies,[22] ranging from 0.6 in China, South America, and some of Africa[23] to 0.8 in Cameroon and among the Hazda tribe of Tanzania, [14][24][25] with divergent preferences according the ethnicity of the observed

being noted.[26][27]

Top

- Edit post (./posting.php?mode=edit&f=10&p=5787)
- Delete post (./posting.php?mode=delete&f=10&p=5787)
- Report this post (./report.php?f=10&p=5787)
- Information (./mcp.php?i=main&mode=post_details&f=10&p=5787&sid=f23d4bbb905f11d2cf06a834daefe4e5)
- Reply with quote (./posting.php?mode=quote&f=10&p=5787)

Re: Does DNA encode reward feature detectors? (#p5787)

by **rehoot** »

> ***Brian Tomasik wrote:***
>
> > ***rehoot wrote:***
> > There is no research that I know of that people unconsciously perform mathematical calculations to average a historical record of stimuli (even in some test in which people are given lots of numbers and asked to average them), but they rely on heuristics (gut feelings or impressions not based on mathematical calculations).
>
> Not necessarily a real mathematical average, but an implicit average built up by successive updates to neural connection weights. Each time there's a new observation, the updated weight is a combination of the old value with the new observation. This might be a weighted average that decays older data. (I don't know if this is plausible biologically without studying the mater more.)
>
> What I'm proposing above is an average where each instance does an update. Showing people abstract numbers wouldn't be expected to have the same effect, because who knows if symbolic things like numbers could affect connection weights in the same way? If instead the average were done by showing a bunch of +1's and -1's in some proportion, then I would expect neural weights to track the average fairly well.

I'm not really sure, but it could work something like this... Neurons that fire as a group repeatedly tend to develop more physical connections between them and the probability of a future action potential is increased (that set of neurons becomes more likely to be activated as a group). People can often recognize a familiar face or a familiar image if it made an impression on them--this is probably related in some way to the frequency with which groups of neurons fire and encode 'familiar' features. If I see a new person, I might recognize their general shape or features because the neurons that fire in response to the given stimuli are well developed. If I see an unusual looking person, I might have no memory of seeing somebody who fits that pattern and if I consciously review the attributes of people I know, I might not be able to recall anybody with the given features (or I might recall very few people like that). There are some processes that work like this, and it is not exactly mathematical calculation, although there is probably a mathematical relationship between the number and intensity of perceptual experience and the strength of connections between groups of neurons that fire in response to a particular stimuli (behaviorists have estimate equations that describe things like the probability of a pigeon pecking at something after it has been exposed to a known number of conditioning stimuli).

Some links
https://en.wikipedia.org/wiki/Neuroplas ... urobiology (https://en.wikipedia.org/wiki/Neuroplasticity#Neurobiology)
https://en.wikipedia.org/wiki/Synaptoge ... enrichment (https://en.wikipedia.org/wiki/Synaptogenesis#Environmental_enrichment)

Re: Does DNA encode reward feature detectors? (#p5796)

by **Brian Tomasik** »

Thanks for the further thoughts, rehoot!

> ***rehoot wrote:***
> Neurons that fire as a group repeatedly tend to develop more physical connections between them and the probability of a future action potential is increased (that set of neurons becomes more likely to be activated as a group).

Yep.

> ***rehoot wrote:***
> If I see an unusual looking person, I might have no memory of seeing somebody who fits that pattern and if I consciously review the attributes of people I know, I might not be able to recall anybody with the given features (or I might recall very few people like that).

Yes, although the process might not actually require a lookup into memory to compute the answer (especially not a conscious one, in view of how fast these processes are). Rather, the past data may be implicitly stored in a "model" made up of the brain's connection weights.

For example, if I see a bunch of data points from a bell-shaped distribution, I can fit a normal curve to them and find a mean and standard deviation. Then, for new data points, to see how unusual it is, I just compute its z score. I don't have to look at its distance to all the past data points I saw. I suggest the brain might store information roughly analogous to mean/stddev in its connection strengths.

Cf. unsupervised neural networks (http://en.wikipedia.org/wiki/Neural_network) :

> Unsupervised neural networks can also be used to learn representations of the input that capture the salient characteristics of the input distribution, e.g., see the Boltzmann machine (1983), and more recently, deep learning algorithms, which can implicitly learn the distribution function of the observed data.

Re: Does DNA encode reward feature detectors? (#p6534)

by **CarlShulman** »

> But if it were just about outliers, then why would the average face be more pretty than a non-abnormal face?

A confounder in those face-averaging studies is that the averaging process wipes out facial blemishes, makes skin look smoother (a sign of youth and health) and has a few other effects that may be valued in their own right.

Quick reply

Preview Submit

Return to General discussion

Jump to: General discussion Go

Quick-mod tools: Lock topic Go

Who is online

Registered users: Brian Tomasik, Google [Bot]