Science AMA Series: Hello Reddit! We're psychologist Dr. Duncan Carmichael (Univ. of Sussex, UK) and geneticist Dr. Amanda Tilot (Max Planck Institute for Psycholinguistics, Netherlands), and we're here to chat about the genetics of synesthesia! AMA!

Synesthesia$_{G}$*enetics*[1]*andr*/*ScienceAMAs*[1]

[1]Affiliation not available

April 17, 2023

Abstract

Purple Tuesdays, words that taste like buttered toast, or experiencing the calendar as a winding line in the space around you - these are all examples of synesthetic experiences. The synesthesia research field is exploding, bringing together psychologists, neurobiologists, and even geneticists to understand this neurological phenomenon. There are dozens of different types, and it's much more common than people think - about 1 in 25 people experience one form or another although many have no idea that not everyone shares their perceptions. We've had an inkling that synesthesia might be (at least partially) genetic for 130 years, but we're still hunting for the genes involved. Amanda is leading a large scale study to find these genes, and together we've recruited over 50% of our 1st goal - 1000 people who experience letters and numbers as having colors. You can read more about our synaesthesia genetics work here, and if you'd like to volunteer you can go straight to the project page at www.mpi.nl/synaesthesia. Synesthesia studies and other good links: Looking for areas of the genome linked to auditory-visual synaesthesia Genetic overlap between absolute pitch and synesthesia Synaesthesia occurs in about 4% of undergraduate students and is not more common in women Synesthesia is more common amongst people with autism University of Sussex's synaesthesia FAQ The Synesthesia Battery from David Eagleman's lab at Baylor College of Medicine - Here you can take a variety of synesthesia tests, and participate in research! On Twitter: Amanda - @aktilot Synaesthesia and Sensory Integration lab at the University of Sussex - @SASI_Sussex About us: Duncan (postdoc): Since studying psychology at university, I've always been fascinated by human behaviour and how the brain works. My research focuses on the causes of synaesthesia, how it is related to health, and how synaesthesia develops in children. Hopefully our research will help us to find out more about synaesthesia itself and also a little bit more about the brain in general. Amanda (postdoc): I first heard about synesthesia during an introduction to neuroscience course in college. I went on to spend my PhD studying a new mouse model for autism spectrum disorder based on mutations in a gene we usually associate with cancer (PTEN). While I was finishing grad school, I decided that I wanted to stay focused on questions at the intersection of neuroscience and genetics and began looking for a postdoc. I was excited to find that Prof. Simon Fisher was working on the genetics of synesthesia (synaesthesia in British English), and moved from the US to the Netherlands to join his group last July. Send us any and every question you have about synesthesia, and we'll let you know what the data says! I'll be back at 11 am EST (8 am PST, 4 pm UTC) to answer your questions, ask me anything! 11am: Hi everyone! Thanks for your amazing questions, we're now live! 1pm: Thanks to everyone for the really interesting questions! I'm (Duncan) signing off now, but Amanda will keep going for a bit! Thanks to James Hughes and Jennifer Mankin for their help in providing additional answers. 2pm: Amanda here, signing off for now (it's 8pm in the Netherlands), thank you everyone for the fantastic questions! I know it's still early on the West Coast, so feel free to add questions and I'll try to get back to them this weekend. Many thanks also to the terrific moderators for their help in arranging this opportunity to answer your questions and hear your stories!

the WINNOWER

REDDIT

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SYNESTHESIA_GENETICS R/SCIENCE

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Synesthesia studies and other good links:

Looking for areas of the genome linked to auditory-visual synaesthesia

Genetic overlap between absolute pitch and synesthesia

Synaesthesia occurs in about 4% of undergraduate students and is not more common in women

Synesthesia is more common amongst people with autism

University of Sussex's synaesthesia FAQ

The Synesthesia Battery from David Eagleman's lab at Baylor College of Medicine - Here you can take a variety of synesthesia tests, and participate in research!

On Twitter:

Amanda - @aktilot

Synaesthesia and Sensory Integration lab at the University of Sussex - @SASI_Sussex

About us:

Duncan (postdoc): Since studying psychology at university, I've always been fascinated by human behaviour and how the brain works. My research focuses on the causes of synaesthesia, how it is related to health, and how synaesthesia develops in children. Hopefully our research will help us to find out more about synaesthesia itself and also a little bit more about the brain in general.

Amanda (postdoc): I first heard about synesthesia during an introduction to neuroscience course in college. I went on to spend my PhD studying a new mouse model for autism spectrum disorder based on mutations in a gene we usually associate with cancer (PTEN). While I was finishing grad school, I decided that I wanted to stay focused on questions at the intersection of neuroscience and genetics and began looking for a postdoc. I was excited to find that Prof. Simon Fisher was working on the genetics of synesthesia (synaesthesia in British English), and moved from the US to the Netherlands to join his group last July.

Send us any and every question you have about synesthesia, and we'll let you know what the data says!

I'll be back at 11 am EST (8 am PST, 4 pm UTC) to answer your questions, ask me anything!

11am: Hi everyone! Thanks for your amazing questions, we're now live!

1pm: Thanks to everyone for the really interesting questions! I'm (Duncan) signing off now, but Amanda will keep going for a bit! Thanks to James Hughes and Jennifer Mankin for their help in providing additional answers.
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CORRESPONDENCE:

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Some people report synesthesia when they are take medium-high doses of LSD. Does the drug cause changes in a "healthy" brain that mimics a brain with synesthesia, or are they caused by different things?

ScenicFrost

Very interesting question! The short answer is we don't know. We tend to make a distinction between developmental synaesthesia (which tends to emerge in childhood) and acquired synaesthesia, which can indeed result from taking drugs such as LSD. These different forms of synaesthesia may be behaviourally similar, but we don't know if they are caused by the same underlying neurological mechanism or not. Some researchers have suggested that serotonin may be involved, but to the best of my knowledge, there are no data that show this conclusively. Your question is a really good one, because finding this out but really help us in understanding how synaesthesia arises

When people who have synesthesia say they "see" music, what does this look like in the brain? Is it like colors dancing in front of them like a hallucination? Or a "minds eye" sensation? Neither?

CanadianMermaid

Hi CanadianMermaid! The comments contrasting "associating" and "projecting" are spot on. Some people experience their additional perceptions out in the world around them, while for others its in "the mind's eye". Thanks for asking!

How do you know for sure that someone has synesthesia?

FriedCheesePie

It's difficult to be entirely sure as we often rely to some degree on what the person tells us about their experiences. That said, most people doing studies with synaesthetes use the consistency of their experience over time to determine whether they are synaesthetic. If you record a person's synaesthetic associations and then ask them again in the future (sometimes after many months), the associations they report will be remarkably similar - far outperforming non-synaesthetes and beyond what we'd expect people to retain using memory only.

I have synaesthesia, I'm aware that it's also related to autism (I have AS too) in regards to sensory processing. I have a couple of questions: How far back in our evolution do you believe synaesthesia extends?

Did it have any sort of evolutionary advantage? Otherwise, are there suggestions of synaesthesia being shared by animals too? You (Dr Tilot) mentioned before how you were examining genes in mice that were linked to autism that really piqued my interest too.

Finally, has there been a discussion amongst yourselves about the implications of studying it further? It seems to me that there are people who either want to experience synaesthesia-like effects through

psychedelics or potentially gene therapy, or because of its associations with autism 'cure' people like me.

Thanks for the AMA, absolutely fascinating work you both do.

JacquesGonseaux

Hi JacquesGonseaux! Amanda here, these are really good questions - here's a commentary on the topic that you might find interesting. Its hard to know what our ancestors may have experienced, but we can think about why it might exist today. It could be that the genetic changes that allowed synaesthesia to develop may still exist only because they didn't cause problems for our ancestors. Alternatively, people have also hypothesized that synaesthesia's ancestral benefits may have been in the realm of sensory processing or other cognitive benefits. Regarding synaesthesia in animals, we don't have evidence in animals for the type of experience that we call synaesthesia in humans. Since you asked about autism, there are lots of different mouse models that researchers use to study genes involved in social behavior and the neurobiology of autism. It's an easier aspect of the human experience to study in mice because we can see and hear their social behavior. We often think about what new avenues in neuroscience will be opened up if we can better understand how and why synaesthesia develops. Hopefully it will shed some light on natural variation in sensory perception, and with luck other areas of neuroscience as well.

In addition to colored numbers and letters I also have what I call space time synesthesia. I see calendar years, numbers, and my place in the universe in a kind of grid. I've always been particularly good at determining what direction is north and attributed that to the synesthesia. What senses are combined in this form of synesthesia?

Zel_daFist_gerald

This is a fairly common and relatively well-studied type of synaesthesia, often called sequence-space synaesthesia. These kind of synaesthetes have been shown to have improved abilities for spatial-related tasks (e.g. Simmer, Mayo, & Spiller, 2009) and it has been suggested that it comes from the fact that the brain areas for representing visual objects and encoding sequences are adjacent (Eagleman, 2009). This kind of synaesthesia also illustrates that lthough synaesthesia is commonly called a "merging of the senses", the word sense here in its traditional meaning of "the five senses" is not entirely accurate. Many common types - like colours for letters or spatial locations for items in a sequence - often don't really involve sensory information but rather concepts (e.g. letters, personalities, units of time). I [Jennifer, PhD researcher at Sussex and grapheme-colour synaesthete] also have this type (for days of the week) and also have quite a good sense of direction; anecdotally, I attribute this to good spatial-mental imagery in general

I personally know a synesthete who has an identical twin brother, that also has synesthesia. However, they both claim to associate words/letter and colors differently (a sound that is green for one will be red for the other etc). Since their genes are the same, how much is known about developmental changes in synesthesia?

spiderdaynightlive

This is an interesting example that gets to the heart of what we're trying to find out in many ways - how do genes and environment interact when synaesthesia develops? As you say, the twins are genetically the same, but experience different synaesthetic associations (despite being raised in largely the same environment, I presume?). We don't know what exactly is going on here, but it suggests that while the predisposition to develop synaesthesia has a genetic basis, the actual synaesthetic associations can

differ between people probably due to environmental input, or even just random noise. We often see this in synaesthetes in the same family - they may both experience synaesthesia, but report having different associations or even different types of synaesthesia.

With synesthesia likely having a genetic link, that should mean that children of parents that experience synesthesia should have a higher likelihood of experiencing it themselves. You said that the baseline probability is 1:25, what is it with one parent and two parents who are synesthetic?

Given the increase in the amount of associated information related to the the subject associated with a synesthetic experience, is synesthesia associated with better memory retention? In other words, if s person experiences shapes and colors relating to number, are they more likely to remember a phone number based on the way it "looks" to them?

Are there effective ways to induce synesthesia in people?

Do these experiences start at a certain point in a person's life, or are they life-long?

Ustice

Great questions! The 1 in 25 number comes from a large study done by Prof Julia Simner in 2006 where a random sample of students were interviewed about their synesthetic associations. If both parents had synaesthesia, I would guess that their children would be more likely to be synaesthetic. There's one study from David Eagleman's group where they interviewed twins about their synaesthesia, and they found less support than they were expecting for a clear "yes synaesthesia is highly heritable" answer. Ideally we would also like to hear from large numbers of families where everyone has been asked about whether or not they experience synaesthesia. There's lots of work to be done!

My working hypothesis these days is that synaesthesia's genetic basis is going to be really complex, with many genes involved. We're addressing that complexity right now by taking two approaches - looking for common genetic differences that might have small effects on a person's chances of having synaesthesia, and looking for rare genetic changes that go along with synaesthesia in large families where several members are synesthetic.

About 2 decades ago I swam a lot. It was hypnotic and soothing, and sometimes towards the end I'd get these amazing smells that I loved. I'd think 'oh I smelt that when I was a kid; what IS that?', but as fast as I swam I couldn't force it, and I couldn't define the smells. It was as if they were memories from being a young child, but so intense and lovely. It didn't happen every time I swam but I always hoped it would. (And it was far stronger than the chlorine smell of the public pool). I probably have autism. I only had such experiences when I'd be swimming for a lot. So is it possible that the swimming somehow triggered it? What are your thoughts on that?

PyjamaTime

Thanks for the question! There has actually been one verified case of swimming style - colour synaesthesia, which may be the closest similar case I know of (Nikolić, Jürgens, Rothen, Meier, & Mroczko, 2009; Rothen, Nikolić, Jürgens, Mroczko-Wąsowicze, Cock, & Meier, 2013). It could be that that particular environment or activity triggered a synaesthetic (or synaesthesia-like) experience of smell. It could also be a similar to a hypnogogic hallucination, in which a state of relaxation or comfort triggers a sensory experience.

As a classical musician, I know many musicians with synesthesia, most of whom are remarkably talented. Have you found that people with synesthesia are more musically inclined because of it?

veecter

Hello! There has been some work done is this area. There's a suggestion that absolute pitch and synaesthesia might be genetically linked, which may predispose synaesthetes to become musicians. There is also some work which suggests that in general, synaesthetes are more likely to indulge in creative pursuits, and the specific outlet for their creativity depends to some extent on the type of synaesthesia they experience (so people who experience musical synaesthesias are more likely to play an instrument, for example). It's also possible that there are other, unknown factors that may predispose people to (a) develop synaesthesia and (b) be good at music as well.

Do people with a Synesthesia attributed to colour feel more emotionally attached to colours?

Are there specific colours that a person with Synesthesia would use as emotions?

Say, would the person see the colour green more if they are sad, then the colour would pop up when they are sad, or is Synesthesia only working in relation to physical stimuli?

Sorry for the long (and possibly stupid) questions! I find Synesthesia interesting :)

WolfTitan99

Great questions, not stupid at all! Some people do experience synaesthesia between emotions and colors, where particular emotions are strongly associated with certain colors. On the other side of that, we don't know whether people who have color associations with things other than emotions (e.g. weekdays, numbers) necessarily feel more emotionally attached to colors overall. That specific topic is not very well studied, but it's a good question!

Are there any links between synaesthesia and brain damage? My MIL has self-reported synaesthesia (mostly colors with numbers, I think), and had gotten a concussion from a car accident a year and a half ago. She's been a bit different ever since - anxious, more irritable, less able to handle stress, sleep loss, memory loss, and she cries more easily.

Is it possible to enhance, negate, or cause synaesthesia through brain trauma?

Thanks for the AMA!

positive_electron42

Good question! We tend to make a distinction between developmental synaesthesia (which tends to emerge in childhood) and acquired synaesthesia, which can indeed result from brain damage. There are a number of documented cases of people experiencing synaesthesia after brain trauma, such as stroke, for example. I know of other cases in which people have temporarily lost their synaesthesia - one such case occured when a person developed PTSD after experiencing an earthquake whilst in a skyscraper. Their synaesthesia returned after a few months.

Do associated blended senses typically appear in neighboring locations in the brain?

Is there more of a physical connection of neurons between areas that are "blended"

Is there a chemical association between the two areas that are blended?

Can MORE than two senses be blended? Could a person both see and hear a smell for example?

Since oir brain power is so dedicated to the visual do visually blended/crossed people have better memoory in the blended sense? Ie can a blended smell amd sight person remember smells better?

Do people ever have a sense of touch that is blended?

GWtech

Hi GWTech, Amanda here, great questions! I'll try my best to add some answers. Sometimes the areas we think are involved with processing the inducer (e.g. letters) and concurrent (e.g. color) are near each other, but not always. Some studies have shown increased physical connectivity between the regions, and others have shown increased connections at the functional level using different brain imaging techniques. Those studies look at how the brain may be different in synaesthesia from a very large scale, while your chemical question gets at a much finer level of analysis. There's a major hypothesis in the field right now that synesthesia may be due in part to increased connectivity in the brain. This eventually comes down to increased numbers of synaptic connections between neurons, and at that level we're talking about chemicals in the form of neurotransmitters. Finding genes related to synaesthesia will help us move from hypothesis generating to testing, as we will be able to study the functions of those genes and how they influence brain connectivity at both large and very small scales. There have been studies that show synesthetes as having better memory, especially visual. Here's a review on the topic. Yes, some people do experience synaesthesia with their sense of touch - mirror-touch synaesthesia is particularly famous example. Thanks for your questions!

What are the genetic factors and reasons behind my synesthesia type, ordinal linguistic personification?

Leproce

Amanda here, good question! The quick answer is - we don't know. In our department at the MPI, we're working on identifying the genetic factors involved in grapheme-colour synaesthesia because it's fairly easy to test online and relatively common, so we can build larger groups of participants. It's possible that what we discover in grapheme-color will apply to other forms of synaesthesia as well, but that is still to be determined. Certainly there are many people who experience multiple forms of synaesthesia and so I expect there to be at least some shared genetic underpinnings across types.

What would happen if everybody was synesthetic? how different would it be our notion of art and aesthetics?

qumaph

Jennifer here - I can't speak to the ramifications in art, culture, and society (it's a bit out of my realm of expertise!) but I did want to mention the difference between synaesthesia and cross-modal correspondences. Cross-modal correspondences refer to qualities that tend to be paired together (like brightness, smallness, and high spatial location, for example), and these tendencies are commonly found as part of normal cognition and therefore frequently appear in art and aesthetics. Synaesthetic associations often match up with these correspondences (see, for example, Ward, Huckster, & Tsakanikos, 2006) but synaesthesia is a qualitatively different experience (as verified by Stroop tasks, brain imaging, etc.). However, some synaesthesia researchers have proposed that synaesthesia is the same type of thing as cross-modal correspondences, although the debate is still ongoing.

What would happen if everybody was synesthetic? how different would it be our notion of art and aesthetics?

qumaph

Interesting question! The particular associations that synesthetes make are quite unique, and so I can imagine that there would be a lot of disagreement! Someone's painting of a song might be very beautiful, but the colours and shapes used may be completely different from my own synesthetic experience of the same music.

I developed synesthesia when I started djing. I hear a lot of people can hear the color of individual sounds but I hear color only in a whole production. As if the combination of sounds equal a color. I think there is some consistency. Yellow songs would mix well. Yellow and dark blue would work really well as if dark blue is a perfect 5th of Yellow. I also noticed that the record sleeve artwork would more often than not consistent with the tracks color.

When I explain this to people they have a hard time understanding that I don't literally see the color. I sense the color in a way that is matter of fact. I don't see yellow, it just is yellow.

My question: Is there any consistency between people? If I hear a red song will it appear red to other folk with synesthesia? Is their an attribute of sound that could be measured as color?

FracMental

Thanks to my colleague Jennifer Mankin (fellow synaesthesia researcher) for providing this great answer..)

On the whole, the hue (that is, the identity of the colour, like "red" or "yellow") associated with songs or music appears to be fairly unique to each person. That is, if you hear a song as red, another synaesthete might hear it as blue (for example, Franz Liszt instructing an orchestra to their bafflement, “O please, gentlemen, a little bluer, if you please! This tone type requires it!"). However, there may be some trends in the colours of particular notes or chords, especially when the colours of the notes correspond to the colours of the letters. For example, the colour for an F note might be the same colour as the letter F for that synaesthete. Since colours for letters have some consistent trends across large populations (see /u/supernovasauce's question on this), the colours for notes may have similar trends. There may also be consistencies in finer-grained aspects of music and colour. In one study, both music-colour synaesthetes and non-synaesthetes associated higher pitch with brighter (more luminant) colours (Ward, Huckstep, & Tsakanikos, 2006). Overall, though, there doesn't seem to be a consistent, systematic mapping between particular colours and music.

When I've met other synesthetes, the colors that they associate with letters and numbers are different than mine. I've always wondered if that meant their personality was vastly different than mine? And would someone who saw the same colors as me be more likely to have a similar personality?

jedi-in-jeans

Amanda here - I wouldn't say that a person's particular coloured alphabet reflects specific personality traits in the way that you're thinking. The colours that people associate with letters/numbers/weekdays/months/etc. are quite personal, although there are some pairings that are more common. For grapheme-colour synaesthetes, the letters I and O, and numbers 0 and 1 tend to be black or white more often than would be expected, for example.

I've long suspected I've had ideasthesia (objects have distinct personalities). How is this related to synesthesia, neurologically and genetically? Can your research shed any light on this? Fascinating stuff, thank you!

DilavniEmanresu

It could well be a similar phenomenon to a form of synaesthesia known as ordinal linguistic personification (whereby numbers/letters are associated with personalities etc). Currently, we don't know if the two things share common genetics or neurology but it is something we want to investigate further!

What are the best documentaries about this subject?

JurijFedorov

Amanda here, we gave some book recommendations in another response, you might find them interesting!

Hi, thanks for doing this!

So I read a little on this and there seems to be many different types. Has there been any association between type of synesthesia and learning type? For example, would people who have see colors when looking at numbers or listening to sounds be more likely to benefit from a visual learning style?

Also, I also wanted to ask when synesthesia begins and personality ends. For example when ever I think of my favorite number, I also think of my favorite color (a blue two) or how about imagery by famous writers like Shakespeare who described jealous as green?

BlackKatPact

Amanda here! There have been studies looking at synaesthesia and memory, trying to see what benefits synaesthesia may bring. Here's a review on the topic, where they point out that synaesthetes can have better overall memory, especially in the visual realm. We definitely hear lots of case reports of people putting their synaesthesia to use, especially for numbers > colours or sequence-spatial synaesthesia.

If often associate certain colours and letters with genders and personalities. I was wondering to what degree the association of two distinct features counts a synesthesia.

Also, my mother does the same thing but none of my friends do. Perhaps the environment in which I was raise?

gubsy

This is definitely a form of synaesthesia, it even has a name already - Ordinal Linguistic Personification, or OLP - which involves the exact things you describe, assigning personalities and genders to things like letters and numbers. It's a good point about the environment too - it's possible you inherited this from your mother, but also possible that your shared environment played a part (although your mothers synaesthesia probably developed when she was young, before you were born, in a different environment?)

As a synesthete, I've noticed that the colors I associate with words have faded as I got older, and so has my ability to spell. I've also noticed a correlation between my emotional state and the brightness of the colors. With your research into the genetics of synesthesia, have you found any correlations with other genetic properties, or risk factors such as for dementia or depression?

peterpanisavampire

Hi, your experience as you've aged is certainly backed up by a couple of studies in the literature - synaesthesia seems to fade later in life, synaesthetic colours change a bit and people may even 'lose' colours. There also seems to be a relationship with mood. People who were feeling depressed had synaesthetic colours that were lower in luminance than if they were in good moods.

I want to share a graphic novel with you, maybe you might like it. It is a fantasy-horror story about a boy who sees or feels colors when he hears sounds, mostly voices.

http://www.webtoons.com/en/fantasy/catharsis/list?title_no=396

I do have a couple questions:

Have you ever found a deaf person that may have the genes? I am curious about the deaf that acquired sounds through cochlear implant, or anyone who received cochlear implant at all... Or even those that utilize hearing aids, would they experience synaesthesia?

DeafLady

Hello, Amanda here - thanks for your questions! We don't yet have a list of specific genes that are associated with synaesthesia, but we do know a little about synaesthesia in people who use sign language. There are studies of people who experience synaesthesia between sign language and color, here's one published study and an ongoing research study on the topic.

Can this be learned? Or are you just born with it? I've heard of parents trying to teach their kids music through colors. Always thought that was weird to try to force.

aasteveo

Hi there, Amanda here! I'm posting the permalink to Duncan's earlier answer to a very similar question. Thanks for asking, and to the other users for the lively discussion!

Hi, thanks for taking the time to do this! I have a couple of questions:

1) Have there been any studies in which synesthesia has been observed in other mammals?

2) Is synesthesia treated as a medical condition and/or disability, or just as a genetic difference as much as hair color or eye color?

Thanks again!

ILikeOxygen

Hello! There has been mention of synaesthesia in other animals, but personally, I'm very skeptical of this..

Personally, I would view synaesthesia as an alternative form of perception (with probably genetic

origins), rather than a medical condition

Hi, thanks for taking the time to do this! I have a couple of questions:

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2) Is synesthesia treated as a medical condition and/or disability, or just as a genetic difference as much as hair color or eye color?

Thanks again!

lLikeOxygen

Good questions! We don't have good evidence for synaesthesia in animals yet. Synaesthesia is probably best described as a "neurological phenomenon" rather than as a condition or a disability, as most people don't consider it unpleasant and many are completely unaware that it's something a little out of the ordinary. Thanks for asking!

Hello there!

I've wanted to ask about this for a long time. Basically, a few years ago my father and I were sitting talking about mathematics and he said something along the lines of "Oh, you know it's easy to do so and so because the numbers are right next to each other up there so you can remember to divide them easily". I asked him to draw me a diagram of what he meant and (being a bit of a neurology nerd at the time), I was astounded that what he produced was a near-perfect recreation of a diagram I'd seen in a book of a diagram Franz Gall used (I believe, I can't quite remember now) in describing number line synaesthesia. My father had absolutely no idea for his entire 65 years that this was abnormal and nobody else viewed digits the way that he did. What I want to know is, how common is this condition? And what on earth would cause it?

Edit: I thought I would describe what he produced for me in his diagram, as it was a sort of circle of numbers in the region of 1-10 like a clock and then basically an infinite field of loops with some very specific angles and right/left turns at the beginning.

Thank you!

seriousanalpirate

Hi there seriousanalpirate! That's a great story about your dad, and really reflects how we take for granted that our perceptions of the world are shared by everyone. There's much more variability than we think! Mann et al (2009) found that time-space synesthesia occurred in 26% of a sample of 50 undergraduate students, but maybe Duncan can point to another sequence-spatial synesthesia prevalence survey. We're working on identifying the genetic basis, but for now the leading hypotheses revolve around connectivity differences in the brain, either extra physical connections between regions in synesthetes or more activity along a normal set connections.

Hello there!

I've wanted to ask about this for a long time. Basically, a few years ago my father and I were sitting talking about mathematics and he said something along the lines of "Oh, you know it's easy to do so and so because the numbers are right next to each other up there so you can remember to divide them easily". I asked him to draw me a diagram of what he meant and (being a bit of a neurology nerd at the

time), I was astounded that what he produced was a near-perfect recreation of a diagram I'd seen in a book of a diagram Franz Gall used (I believe, I can't quite remember now) in describing number line synaesthesia. My father had absolutely no idea for his entire 65 years that this was abnormal and nobody else viewed digits the way that he did. What I want to know is, how common is this condition? And what on earth would cause it?

Edit: I thought I would describe what he produced for me in his diagram, as it was a sort of circle of numbers in the region of 1-10 like a clock and then basically an infinite field of loops with some very specific angles and right/left turns at the beginning.

Thank you!

seriousanalpirate

This is known as sequence-space synaesthesia, and is actually one of the more common types. A study about subtypes of synaesthesia across 19,000+ synaesthetes showed that just over 30% of those synaesthetes reported a spatial type like this (Novice, Cheng, & Eagleman, 2011). The causes are still under investigation, as with other types of synaesthesia, but these kind of synaesthetes have been shown to have improved abilities for spatial-related tasks (e.g. Simmer, Mayo, & Spiller, 2009) and it has been suggested that it comes from the fact that the brain areas for representing visual objects and encoding sequences are adjacent (Eagleman, 2009).

Can synaesthesia be learned? Such as a young child learning letters in kindergarten and associating letters with colors because they are presented in those colors to him/her for their first time. E.g. A colored poster or slide presentation

Are letter to color synaesthesiacs better at visualizing books. Like reading books is watching a movie for them.

Shameless bragging (future employers disregard): I got a 0.97 on SynQuiz suckas

Entrepre_Nerd

Hi there /u/Entrepre_Nerd, nice job on SynQuiz! Amanda here, I told our web developer, he was happy to hear it! Regarding learning synaesthesia, here's our reply to a similar question.

I've got what I've termed "A/V" synesthesia; I experience music as a series of swirling colors, shapes, lights and textures in my mind's eye, if that makes any sense. :-)

I've read that synesthesia is the result of a "pruning error" in the brain, where certain brain connections that are supposed to be severed stay intact during development. (i.e. audio/visual centers). Is there any indication why these connections stay intact in some individuals, or what benefit these pruning errors may have from an evolutionary standpoint?

On a more personal note, how can those with synesthesia explain their experiences to those without? I've been mocked and questioned by friends before when trying to explain my experiences with music, and it gets pretty tiring to hear the same "Are you on drugs?" jokes time and time again. What's the best way to explain synesthesia so it doesn't sound like a neurological disorder or mental illness, but rather as a genetic quick with an odd side benefit?

aoi_to_midori

Great questions /u/aoi_to_midori! Amanda here, I'll try to answer. On the evolutionary side, here's a link to a paper that speculates on why synaesthesia might be part of our modern range of sensory

perception. The options they propose are that it just comes along for the ride because its not harmful, or that it gives an advantage in some aspect of cognitive processing. Hopefully we can give a more concrete answer after learning more about its genetic basis. The types of genes that we find, and the amount of evolutionary pressure they've been under, might provide some additional clues to your question. Time will tell!

Regarding how to convince your friends that you're not on drugs, please feel free to tell them that you asked a team of psychologists and geneticists and we said that it's a quirk of biology and not a disorder. More scientifically, we have multiple studies showing that synaesthesia has a genetic component, and one of them was even based in families with audio-visual synaesthesia. They looked at 43 different families that each had more than one person with synaesthesia similar to yours.

Purely anecdotally, I've noticed a strong correlation between synaesthesia, OCD and Ehlers-Danlos Syndrome. I'm sure it's just a sampling error - I notice it because I have all three - but I wondered if you have noticed any correlation to conditions other than autism, whether confirmed by research or not?

I only have mild synaesthesia - when I was small and doing the 'what comes next in the sequence?' maths problems I'd often choose the next pink number and get confused when that wasn't an acceptable answer. Once I realised that other people didn't see numbers as having colours, and that my colours didn't correspond to some hidden mathematical truth, I kept my mouth shut about it for years. Music is the other thing I have pleasant sensations with - I see colours and shapes, and a certain type of female voice feels like cool running water to me. I also have a bunch of sensory processing issues - some noises and colours make me nauseous - but I always associated that with the cognitive dysfunction aspect of EDS until I was talking to other people with EDS who talked about similar synaesthetic sensations.

knittingquark

Hello! It's funny you mention OCD, because we've just submitted a study for publication that found an association between OCD and synaesthesia. There are quite a few studies in the literature that link synaesthesia to a range of conditions (eg. migraine, IBS) but currently I'd say the jury is still out, we really need more evidence before we can really understand what might be going on. It's often tricky to find enough synaesthetes to make statistically meaningful comparisons (as you say yourself, 1 person isn't a large enough sample). I don't know anything about EDS though - I'll investigate further!

I have always seen letters and numbers with very specific colours, since I was a child. I can also 'feel' 3 dimensional form when I am creating a painting on a flat canvas. I can also 'see' movement in colours when music is played. I can 'feel' forms when sound occurs. Thank you for this ama. I feel much less weird.

mrsbrown3333

Amanda here, you're welcome! I know a pianist who experiences a form of texture-sound synaesthesia, and her descriptions are very beautiful!

What progress has been made to identify the loci involved?

If we accept synesthesia as incomplete pruning, is there evidence that neuronal cell adhesion molecules or similar surface recognition elements are playing a role? Are any candidate protein molecules identified?

backgroundN015e

There are a small number of genetic studies that have looked into synaesthesia (eg Asher, 2009, Tomson 2011). Both these studies identified regions of the genome that may be associated with synaesthesia. These regions contain many many genes, so no individual genes have yet been identified that are specifically linked to syn. We're halfway through recruiting for the first GWAS of synaesthesia, so hopefully this will help us locate specific genes!

Can you elaborate on some of the most amazing cases you have found?

IrwinElGrande

Hi! You might enjoy reading some of the general audience books that have been written about synesthesia by researchers, they contain a lot of great case studies! * The Frog Who Croaked Blue by Jamie Ward * Wednesday is Indigo Blue by Richard Cytowic and David Eagleman

How common is synesthesia in general?

I know there's a lot of different kinds. I always assumed I was normal until I learned not everyone has colors for days and calendars in the empty space in front of their eyes.

chibicb

Amanda here! We estimate that about 4% of the population experiences at least one type of synaesthesia, so it's much more common than people think! Your experience of not realizing your perceptions were different from the norm is very common amongst synesthetes. :)

How common is synesthesia in general?

I know there's a lot of different kinds. I always assumed I was normal until I learned not everyone has colors for days and calendars in the empty space in front of their eyes.

chibicb

Hi, the best estimate we currently have of synaesthesia prevalence is about4.4% of the population have some form of synaesthesia

I have lexical-gustatory synesthesia and my sister has misophonia, which we have read is a form of synesthesia. While my synesthesia is not at all bothersome, her misophonia is very much so. Is there something that can be done to lessen or eliminate these automatic responses? In particular, she feels immense rage and disgust when she hears mouth noises like chewing, popping gum, or even certain sounds people's mouths make as they speak. It even prevents her from being around particular people very often, if their mouths happen to make noises that are particularly bothersome to her.

Also, is there some sort of evolutionary basis as to why synesthesia develops? Meaning, is it ever advantageous in any way or in particular forms?

Thank you for this fascinating AMA.

MissElphie

Hi /u/MissElphie, thanks for your question! Amanda here, and while I'm not sure about lessening misophonia, we do have a response to another question about the potential evolutionary role of synaesthesia.

I'm a synesthete with chromesthesia, spatio temporal, and concept color. I also associate individual people with color.

I was recently diagnosed with narcolepsy; I've found that after some time of being medicated and having truly "woken up" for the first time in many many years, my syn is stronger and appearing in new ways? Is this possible?

For instance, I just touched a pan the other day and experienced instant revulsion and strongly painful numbness in my teeth. Same thing happened when I put my hand on a wooden pizza board. Some kind of tactile->emotion? I don't know. It doesn't happen all the time, but I can't make it stop when it does. My mother flat-out refuses to touch anything with a velvet texture, and her mother will not touch small wooden objects like toothpicks, or popsicle sticks. Maybe now I know why? Could this form have been suppressed by mind-numbing exhaustion for years, or:

1. Has synesthesia been found to suddenly appear in additional, different forms?
2. Can synesthesia change over time? I'm learning music theory and the colors are shifting to represent the appropriate concepts as I learn them.
3. Has there been a statistic discovered with how *likely* it is that a synesthete has a synesthetic parent?
4. Is there a typical way that psychedelics affect existing synesthesia, or is it mostly random how it goes?

Thank you so much for your time. It's difficult finding people who understand this enough to answer questions.

Izonus

Hello, thanks for the many interesting and in-depth questions.

Re: being medicated, I would definitely say medication can influence synaesthesia. This is currently under-researched and not understood at all, but we do have anecdotal evidence that this can happen. For example, Richard Cytowic wrote about a person whose epilepsy medication lessened their synaesthesia.

I don't know of additional forms of synaesthesia appearing or disappearing suddenly, but synaesthesia can definitely change over time. As people age, synaesthesia can fade or associations can 'drift'. I have heard of people who have grapheme-colour synaesthesia developing new colour associations when learning new languages with different alphabets, which certainly sounds similar to your experience with music.

I don't know if psychedelics affect synaesthesia in a specific way. I think it's a good question that could really shed some light on the underlying neurological mechanisms underlying syn. Most people seem to be interested in whether or not psychedelics can induce synaesthesia, rather than the effect of drugs on synaesthesia per se..

How does synesthesia affects reading a book?

nicco695

As far as I [Jennifer, PhD researcher at Sussex and grapheme-colour synaesthete] know, there's very little research on the experience of synaesthesia in reading longer texts, maybe in part because this is hard to test with the usual methods. Personally, I don't experience colours for letters or words when I'm reading for meaning, like when reading a novel, but when I start paying attention to the words or letters as such (in order to spell them, for instance), then the colours resurface. Studies have shown that experience of synaesthesia is modulated by attention (see e.g. Rich & Mattingley, 2003; Mattingley, Payne, &Rich, 2006; Sagiv, Heer, & Robertson, 2006). Of course, different synaesthetes may have different experiences, depending on the type and strength of their synaesthesia.

How close are you to finding the gene that holds the synthesia allele

midozer416

Amanda here - I'd say we have a ways to go, but we're getting closer! Earlier studies were able to find associations with fairly broad sections of the genome (linked above, they contained dozens of genes), and our goal now is to narrow that down - hopefully to individual genes or much smaller genomic regions. We're in the middle of a large study to identify the contributions of common genetic variation (single letter differences, or SNPs) to grapheme-colour synaesthesia. Since its also possible that rare genetic differences contribute to synaesthesia, we're also studying families that have multiple synaesthetes, to find the changes that might underlie synaesthesia in that particular family. When both sets of results are in, we can start to figure out the overall genetic architecture of synaesthesia. With luck, that will open up a lot of doors for molecular studies that test the hypotheses that we have from the brain imaging work that's been done.

Is there a known reason why synesthesia for a single type (colors in letters or numbers, for example) might not follow through for all things in that type? In my case, I see definite colors for numbers 1-9 but everything after that is just white. While 4 is blue, 5 is red, and 8 is purple. Also, are there any noted consistencies? Maybe a majority of people reporting pink 2s, for example?

supernovasauce

Thanks to fellow synaesthesia researcher Jennifer Mankin for providing this great answer!)

First, we're not sure yet why some letters or numbers have colour and some don't. For numbers specifically, many synaesthetes report that numbers outside 0-9 are combinations of the colours of the individual numbers - so a blue 4 and red 5 would mean 45 would be blue and red. If you don't have those colour combinations for multi-numeral numbers, then that may just be how your synaesthesia works. There are indeed consistent letter- or number-colour associations across large groups. For synaesthetes especially, A is often red, D is brown, F is green, X, I, and Z are black, and O is white, for example. For numbers, 1 is often black, 0 is white, 3 pink and 4 red. Several papers have investigated this; see Rich et al. (2005), Simner et al. (2005), Rouw et al. (2014) and Witthoft, Winawer, and Eagleman (2015). These are trends, though, across large samples (usually hundreds of people), and any particular synaesthete has their own unique set of colours. A very interesting question, currently under investigation by our lab and several others, is why these consistencies exist in synaesthete and non-synaesthete groups. Different studies suggest that there are many possible influences. For example, letters that occur in the language more often tend to be paired with colour terms that are also more frequent, like A with "red" (Simner & Ward, 2008). Others have suggested that associations learned in childhood help form synaesthetic associations, like coloured alphabet toys or books (Witthoft & Winawer, 2006, 2013; Mankin & Simner, 2016), or that even babies pair certain shapes and colours, like X with black and O with white (Spector and Maurer, 2011). Most likely, these letter-colour trends

are partly cultural (like "A is for apple" from alphabet books, which may become "A is red" via "apples are red"), partly statistical (high-frequency letter A paired with high-frequency "red"), and partly experiential (seeing a red A in a magnet set).

TL;DR: We don't yet know why some letters or number don't have a particular colour associated with them. There are commonly known trends in associating letters and numbers with colours across large groups of synaesthetes AND non-synaesthetes, and there are lots of explanations for this currently under investigation.

Is synesthesia a spectrum? Can it be learned/improved?

nihilnegativum

There are some researchers who consider synaesthesia to exist on a spectrum, in this case synaesthesia would simply be defined as those individuals who score on the extreme end of the spectrum. More conventionally however, we consider individuals to have synaesthesia if they score below a certain threshold on the most widely used test of synaesthesia. The majority of our studies use what is called the Eagleman Battery (or some variation of) in order to define whether an individual has associations (for instance between colours and letters) that are strong enough to be considered synaesthetic. It could be argued that synaesthesia, to some extent, exists in us all. But as I said, our lab currently adheres to using a cut-off score in order to separate those that have strong and consistent associations (i.e. synaesthetes) and those that do not. In this way we can separate individuals into separate groups for our studies (e.g. synaesthetes and non-synaesthetes).