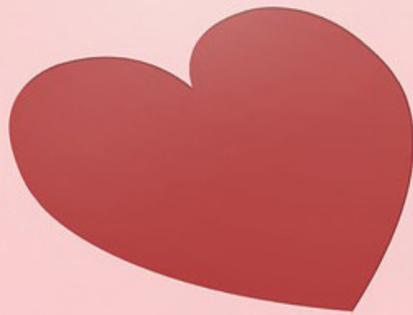


The Brain and Swiping for Love

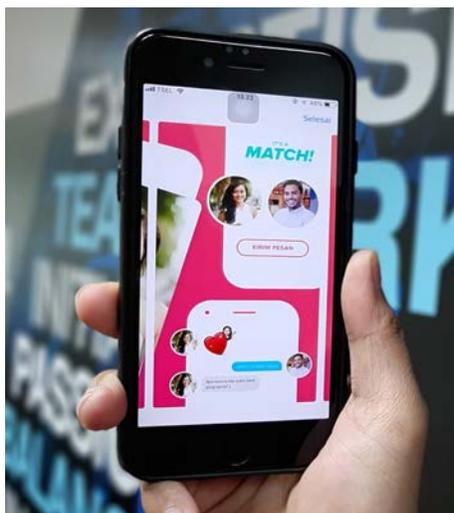
by Samatha Beck



In the age of COVID-19 and social distancing where virtual relationships are all we have, is swiping on dating apps enough to satisfy the human desire for social interaction?

The year is 2020. The COVID-19 pandemic is sweeping the world, leaving fear, instability, and a very isolated human race in its wake. 42% of individuals in the United States now work from the confines of their homes, 33% are not working at all, and the remaining 26% of workers in the United States are deemed “essential” and attend in-person work.¹ In these unprecedented times, we are starved for human connection. Our once vibrant and fulfilling social lives have been reduced to endless TikTok dances, takeout dinners, and Zoom birthday parties with no concrete end in sight. While in social isolation and quarantine, sometimes the only human connection we receive is through the pixels on our phone screens.

In many ways, we have overcome our predicament and created a new normal. Masks are required in almost every public space, prompting fashion enterprises like Gucci and Dior to come out with their own chic face-mask lines. Restaurants have expanded outdoor patios to satisfy the “6 feet apart rule,” so patrons can support local businesses without fear of infection. As playdates for children and happy hours for adults have gone virtual, so has the dating world. This era of instability has prompted many of us to look to what matters most; we cling to family members, friends, and partners, recognizing how lucky we are despite the crumbling world around us. For those who lack a significant other, it is no surprise that the dating app world has seen an increase in use throughout the pandemic. One app, OKCupid,



experienced a 700% increase in dates, while another, Bumble, saw a 70% rise in video calls.²

Our phones vibrate signaling a notification. The words, “Congratulations! You have a match!” splay across the screen in bold letters. This notification used to excite us. It used to fill us with warm and hopeful thoughts of potential love and companionship. But now, months later, this digital intrusion doesn’t even cause us to skip a beat. We swipe the notification out of view and continue scrolling. For better or worse, our dating lives have gone virtual. What does that mean for our brains and human connection?

Humans as Social Creatures

While many people self-identify as introverts on the infamous Myers-Briggs personality quiz, introverts still rely on human presence. While you might not need or want constant socialization to be happy, there are countless case studies that exhibit the primal need for human interaction.

Genie Wiley, a feral child, is an intense example of a human being who never received socialization from her family. Genie spent the first thirteen years of her life strapped in a straitjacket in a dark room, where she was not spoken

to nor allowed to walk or talk.³ This extreme example of consistent neglect and torture throughout development provided scientists with a unique subject to study the importance of socialization. After her rescue, Genie was found to be very intelligent and could string words together to communicate a simple thought, but she could not form complete sentences or socialize in any meaningful way. Scientists at UCLA found a lack of hemispheric maturation and lateralization in Genie’s brain, as well as an under-developed prefrontal cortex, which points to her lack of complex thought and emotional capabilities.⁴ Genie is still alive today, and though she lives a very secluded existence—her last known whereabouts were in an adult foster care home in California—it is clear that her lack of social interaction throughout development permanently scarred her. Genie was unable to fully recover from the abuse that she endured, and her inability to socialize continues to provide insight to the scientific community about the importance of human interaction throughout life. The story of Genie Wiley is a severe case study of abuse and extreme neglect. Her experience is not easily replicated in a healthy family setting, yet scientists are finding that social isolation caused by the COVID-19 pandemic poses different risks to human survival. The increased rates of mental health disorders, substance abuse, and domestic violence charges recorded since the beginning of the global pandemic in March of 2020 points to dangerous societal consequences from COVID-19. However, scientists are only left with educated speculation as there is an extreme lack of longitudinal data about the societal effects of COVID-19—as it still plagues our nation today.

Since the dawn of humanity,

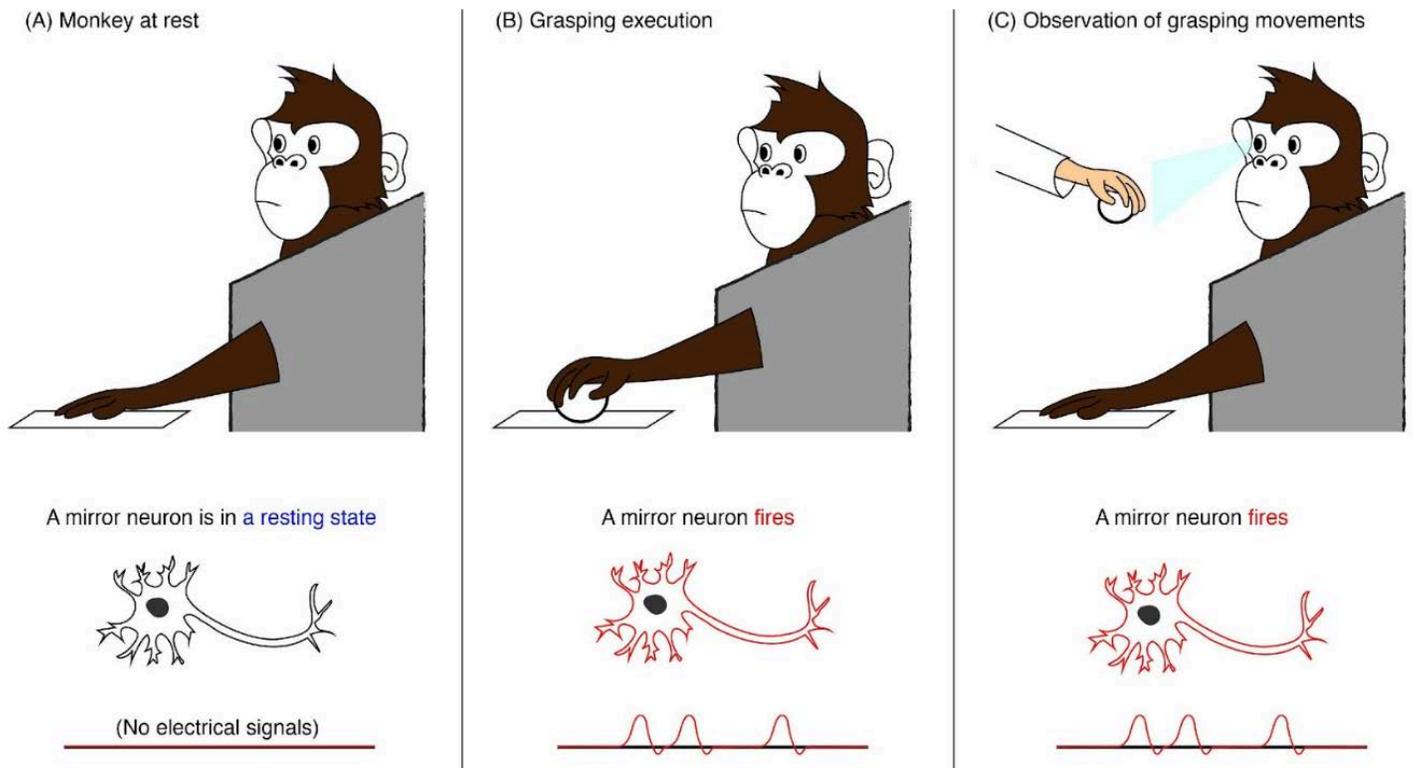


Figure 1. Mirror neurons in action. A mirror neuron fires an electrical pulse, or action potential, when the monkey either observes or executes a specific action. In this case, the mirror neuron responds to grasping actions. The graph at the bottom shows what the action potentials (each depicted as a hump) would look like when measured with an electrode, as used by the researchers. By Harvard University, John Taylor, Yongeun Choi. Available under Public Domain.

humans have evolved to prioritize cooperation and socialization.⁵ Understanding social cues and learning from others has demonstrated to be critical throughout evolution; for example, early humans who shared their food or learned survival skills from others were more likely to survive and reproduce. While this might seem like an obvious conclusion, scientists also discovered that throughout the generations, these social individuals who utilized cooperation to their advantage (and survived) were slowly altering their genetic code and passing on a robust prefrontal cortex and mirror neurons to their offspring—which ultimately contributed to the extreme degree of socialization we see today in modern society.⁶

Mirror neurons are constantly cited in scientific literature as a reason for why humans strive to connect with one another (Figure

1). These neurons, which are primarily found in the F5 area of the inferior frontal cortex and inferior parietal lobe, have the ability to read social cues, facial expressions, and gestures to allow humans to comprehend more nuanced social interaction.⁷ These particular areas of the brain which house mirror neurons are known to be responsible for language processing and production, as well as more psychologically complex skills like the perception of emotions.⁸ Emphasized in Figure 1, the monkey elicits the same neurological response (the action potential highlighted in red) to watching the ball being picked up from the table as when the monkey performed the action itself. Not only do these neurons demonstrate how humans learn skills that could assist with survival, but these neurons play a fundamental role in the mechanism of empathy in

the brain.⁶ These neurons provide insight into the human ability to copy the actions of others and can even describe how watching and fulfilling the actions of others is intuitive social behavior.

Even though our priorities as humans have drastically shifted throughout generations—our survival is not usually threatened on a regular basis—our social and moral code as humans has only gained significance. In modern times, people who are more social are actually deemed “more successful.” A longitudinal study conducted by Duke University in 2015 found that social kindergartners were twice as likely to graduate from an undergraduate collegiate program than their “non-social” counterparts.⁹ Furthermore, social kindergartners were almost 50% more likely to have a full-time paying job by the age of 25. Studies like these demonstrate

the importance of socialization at a young age and how it predicts potential success in adulthood. We might not need to be social to survive in modern day society, but we definitely need to be social to thrive.

Technology as a Crutch

We can swipe on Tinder, snap a picture of our freshly baked sourdough, and text our grandmother all in the same minute, but what does that mean for the quality of our virtual relationships?

Social interaction is essential for human success, and technology provides a virtual world where that can happen at the drop of a hat. During a time period when in-person relationships are unsafe and unattainable, technology allows us to remain connected. Whether it is video chat, social media, or instant messaging, there is always a way to interact with those we love most. As the use of technology continues to skyrocket in every setting, it is pivotal to investigate how constant screen time affects our brain health. Is there such a thing as being too connected?

Interpersonal intimacy suffers when existing through social media.¹⁰ Three factors have been highlighted as being incredibly important in predicting the success of a romantic relationship: self-disclosure, social support, and physical contact. Self-disclosure is defined as the act of confiding in and trusting your partner, while social support is receiving reassurance and emotional support from your partner. While these two factors are demonstrated to transcend in-person relationships and can exist in some capacity virtually through phone calls and FaceTimes, physical contact obviously cannot endure in a remote environment. Furthermore,

the quality of self-disclosure and social support has been shown to lack empathy when being practiced in virtual environments.¹¹

When looking at how in-person interactions differ from virtual interactions in the brain, scientists find that live conversation elicits a higher response of activation in the dorsal medial prefrontal cortex, right posterior superior temporal sulcus, and right temporoparietal junction in contrast with recorded interactions (Figure 2).¹² Not only is there higher activation in these specific brain regions for in-person interactions compared to virtual ones, but there is also greater stimulation in the reward pathways of the brain, demonstrating that in-person conversation is more fulfilling and satisfying than remote conversation. Figure 2 includes the scan of one brain from four different vantage points: the right sagittal section, left sagittal section, medial section, and coronal section.

Orange BOLD signal intensity demonstrates action in these areas of the brain for live interactions rather than recorded interactions. Furthermore, scientists are starting to make connections about the relationship between remote interaction and mirror neurons. Mirror neurons do not activate at the same degree when learning is performed through technology. This finding, along with research that online learning drastically alters memory and attention spans, demonstrates connections between remote schooling and mirror neurons.

As the use of technology continues to grow, it is important to acknowledge the mental health implications of constant screen time. Interpreting mental health research is difficult in a longitudinal context due to the introduction of advanced technology within

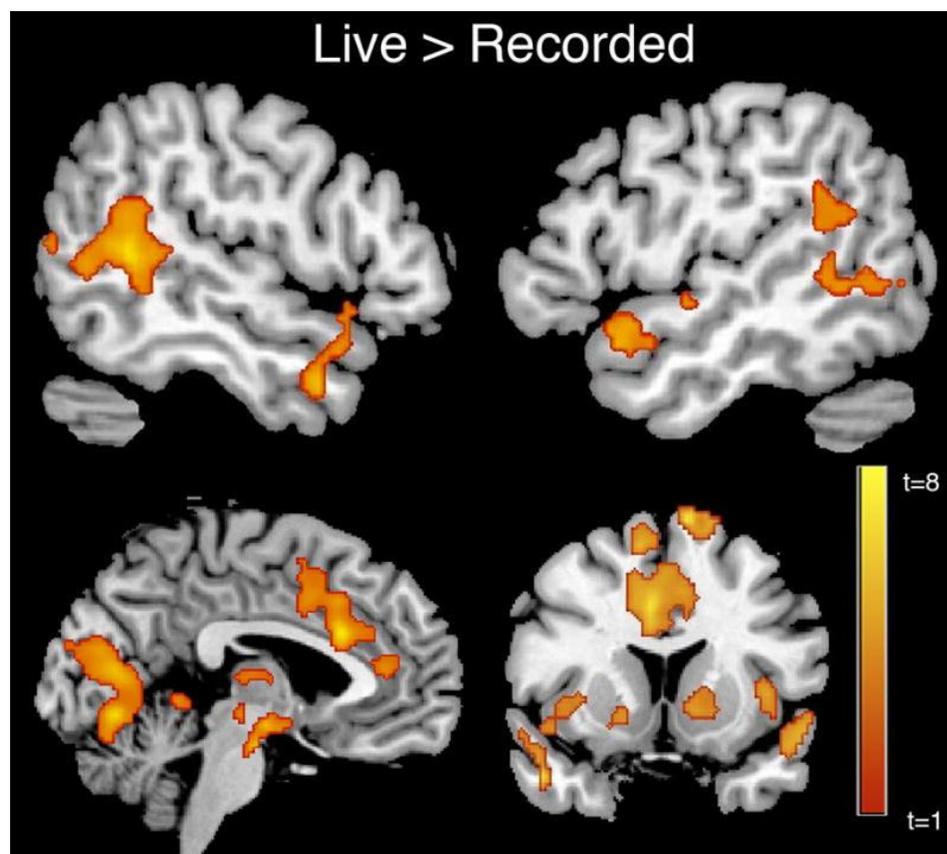


Figure 2. Live vs Recorded conditions. T-values for regions showing significantly greater BOLD signal during live presentation of a person as compared to a video recording are displayed on a template brain. Left sagittal ($x=-52$), Right sagittal ($x=52$), medial ($x=-4$), and coronal ($y=12$) sections are displayed. By Massachusetts Institute of Technology, Elizabeth Redcay, David Dodell-Feder, Mark J. Pearrow, etc.. Available under the Public Domain.



Figure 3. Examples of photo filters. From left to right, the presented images illustrate profile pictures that apply no filter (A), slight photo filter (B), and “unnatural” photo filter (C). The portraits are modeled by a research assistant. By Universidad Catolica Luis Amigo, Antonio Olivera-La Roasa, Olber Eduardo Arango-Tobon, Gordon P.D. Ingram. Available under Public Domain.

the last 20 years. However, scientists have discovered that consistent screen time throughout development is highly correlated with depression, anxiety, and a lack of self-esteem.¹³ The proposed mechanism is currently under debate, but many scientists agree that the physical computer or phone screen itself is not causing the negative symptomatology of depression and anxiety. Instead, the lack of sleep, stress on interpersonal relationships, and exposure to age-inappropriate content is what causes problems with mental health.¹⁴ Whether it is content of harassment, cyberbullying, or promoting disordered eating, digital platforms often expose children to nuanced topics before they are necessarily ready.

Context is pivotal when determining if technology is a net negative or positive contribution to human life. During these unprecedented times of the COVID-19 pandemic, technology is our saving grace and the reason that education, jobs, and relationships can continue despite a deadly virus ravaging the country. It allows for the rapid distribution of news, connection to people around the world, and constant

entertainment in an otherwise isolated environment. On the other hand, technology ultimately hurts our interactions with others and consistent use allows for complete societal acceptance of virtual communication behind the confines of a 5.7 x 2.6 inch retina display.

The Gamification of Dating Apps

As humans strive to be social during a time period of distancing, dating apps have become a common way for single individuals to meet potential partners. Marketing tactics by the big names in online dating like Tinder, Bumble, OkCupid, and Match.com, cause users to scroll through profiles for an average of 20 hours a week, producing 1.6 billion swipes per day (on Tinder alone).¹⁵ While Tinder is not necessarily technologically advanced in comparison to its competitors, Tinder quickly became the most popular dating app on the market with its 7.86 million active users due to the game-like environment the company fosters for finding love.¹⁶ The infinite swipe function of dating apps allows Tinder to

“game-ify” the process of finding a relationship. Gamification is the idea of applying game elements to non-gaming situations—like dating. This unhealthy environment of unlimited swipes convinces users that there are always new people to meet and potential matches to be made, even if that is not necessarily the truth.

While the gamification and unlimited swipe aspect of dating apps can be beneficial in theory due to the idea that there are “more fish in the sea,” it fosters a dangerous and shallow mentality for finding a serious life partner.¹⁷ Depending on the dating app of choice, images and a person’s physical appearance are usually focal points in the decision to “swipe right” or select an individual as a potential match. When asked to identify the most important quality in a match on dating apps, men ranked looks of their potential match as most important, while women ranked looks second behind humor and conversational skills.

Furthermore, the environments of dating apps cause users to focus more on physical appearance than personality. Figure 3 demonstrates the nuance of images on dating apps by illustrating the concept of

“face-ism,” which is the unhealthy tendency to stereotype individuals based on their facial appearance.¹⁸ The figure emphasizes how humans are drawn away from the “uncanny” or “unnatural” and towards images that are familiar to them. Panel A, which is the only unedited image in Figure 3, has been shown to elicit the most positive responses, relative to panels B and C. Panel C, which differs from the others due to photoshopped eyes, highlights that even after a quick scan through the images, a user would be thrown off by the bug-like appearance of the woman in panel C and would choose not to match with her. Looks are prioritized over other factors when determining a match due to the lack of other accessible personality traits that can be distributed on a platform like Tinder. This fact leads many social neuroscientists to worry about the long-term mental health implications about the extreme prioritization of physical appearance.¹⁹ As it is difficult for scientists to predict the future and understand the long-term implications of dating app use in society, it is clear that the industry of online-dating is definitely an area of interest for social scientists and neuroscientists alike.

Addicted to Dating Apps

An addiction to dating apps is categorized as a behavioral addiction, or an addiction to a behavior rather than an exogenous substance like a drug. Many people underestimate the severity of a behavioral addiction (others include compulsive gambling, addiction to sex, and kleptomania), but these addictions often inhibit individuals from leading a normal life.²⁰

Being addicted to dating apps is no different. While your initial intention to join a social media site or dating app might be to meet



new people, the marketing tactics of dating apps are so addicting that around half of the users demonstrate compulsive swiping.²¹ Once you get hooked on the unique ability of social media to quantify how much others love you via likes, retweets, super-likes, and comments, you become obsessed with distinguishing and comparing your own position in the virtual hierarchy. This process of posting, receiving likes and comments, engaging in others' posts, and comparing your social media presence to others is so ubiquitous that you probably performed similar actions when you woke up this morning. While participation in social media might seem harmless, the process can be traced to incredibly negative neurocognitive effects consistent with addiction to a drug like nicotine or cocaine.²² Swiping on dating apps activates the same reward pathway in the brain that addictive drugs do—the mesolimbic dopaminergic pathway—and when this pathway is activated, it is a telltale sign to neuroscientists that the behavior has the potential to be addicting.

Step 1: Binge and Intoxication— “Congratulations! You have received a match!”

Dating apps are brilliantly designed, and companies like Tinder, Bumble, and Hinge all profit on romantic vulnerability. When you receive a notification that you have a match, the release of a myriad of hormones and neurotransmitters elicit feelings of euphoria and social acceptance. Not only is this a sign that the hours of manicuring and agonizing over your profile images to optimize your looks paid off, but now you really might have met someone special!

Dopamine is the most widely known and understood neurotransmitter in the brain that plays a pivotal role in addiction. When you receive a match on Tinder, there is a flood of dopamine in the mesolimbic dopaminergic reward pathway to the nucleus accumbens that is particularly powerful due to the surprise of the notification—

an unprecedented reward.²³ In comparison to an expected reward, the surprise reward of a Tinder notification wrapped in a little metaphorical bow sends a dopamine rush that is so addictive that users will wait all day to receive that same notification.

Step 2: Withdrawal and Twitchy Fingers

You may or may not have realized that you have been spending too much time on dating apps. Even in those off moments where you aren't able to scroll through your dating app of choice, your brain is still desperate to replicate the dopamine rush you received from your first match. Due to the consistent dopaminergic influx your brain was experiencing

in the binge/intoxication phase of finding matches, your brain responds accordingly by trying to regain the normal dopamine action by reducing the amount of receptors to bind. To account for the rapid increase in dopamine neurotransmitters, your brain adapts to maintain its equilibrium.²⁴ To illustrate this point, imagine your home's thermometer. When you set the temperature to 70 degrees and the climate of your home inches above that number, the system responds by decreasing the temperature back to 70. The same thing is happening in your brain. When the amount of dopamine gets "too high" to unnatural levels, your brain responds by decreasing the amount of receptors, so dopamine cannot bind.

To add insult to injury, the initial excitement of using dating

apps has worn off. Emotionally, you don't get that same rush of euphoria as you did when you first started matching, and physiologically, your brain is not pumping out as much dopamine as it was when you first started swiping. This double-whammy of deficits caused by both a lack of dopamine release and dopamine receptors to bind, leads to feelings of depression, anxiety, and hopelessness.²⁵

Furthermore, during withdrawal many users experience twitchy fingers. Twitchy fingers, a physiological pattern highly correlated with technology addiction, is characterized by rapid small finger movements (especially thumb motions) for when you are not scrolling through social media.²⁶ Your brain is missing swiping on dating apps, and your hands are too.

Addiction to Swiping

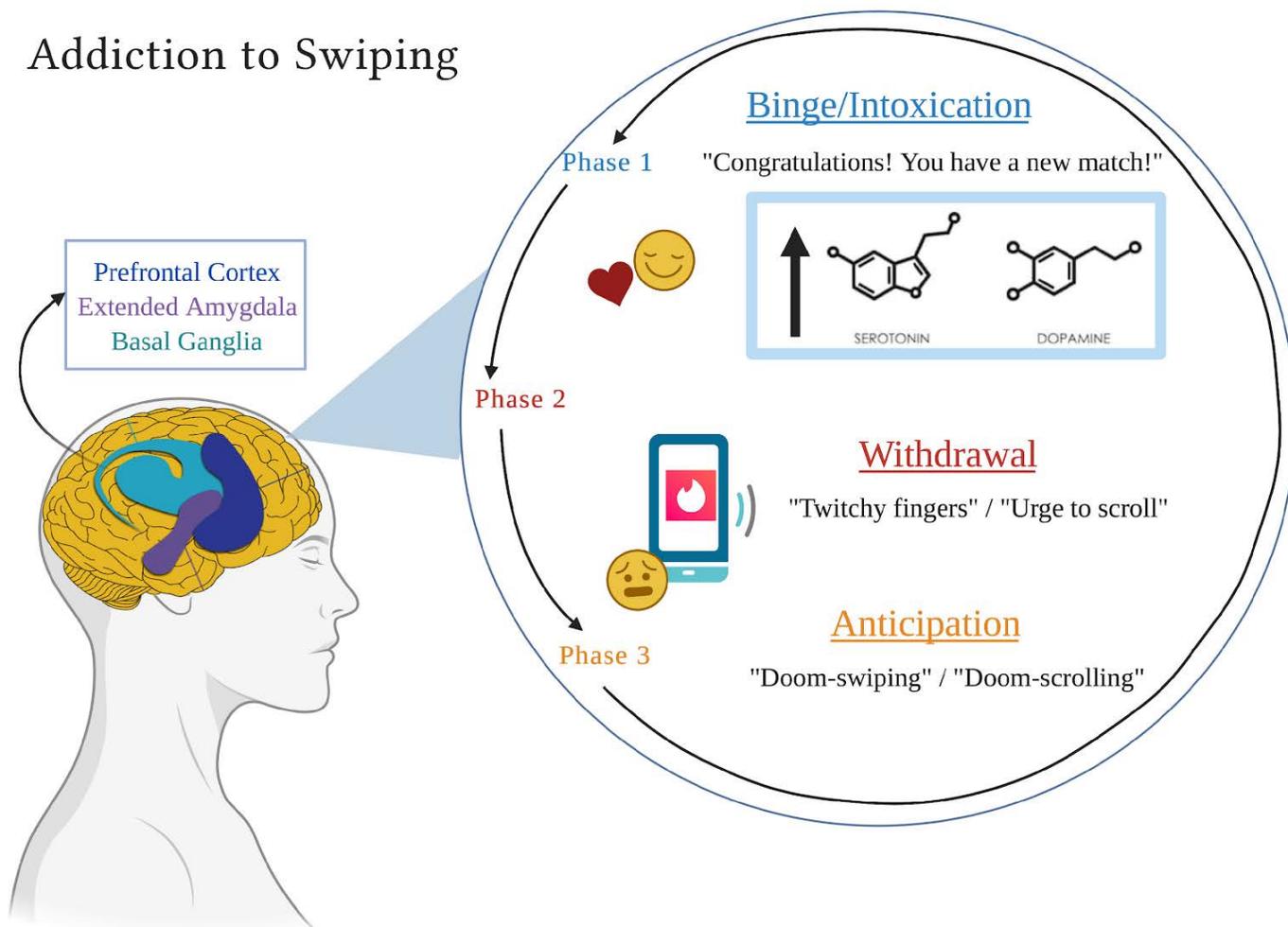


Figure 4. Original figure by Samantha Beck. Created in BioRender.

Step 3: Preoccupation and Anticipation—Doom Scrolling

Due to the surprise nature of a match on a dating app, you never know when your next match will come. This leads to users mindlessly scrolling and swiping and liking and commenting as they wait for that reward of a virtual match. The concept of doom-scrolling is not specific to dating apps, and manifests itself in a variety of contexts. For example, throughout the pandemic, “breaking news” was always easily accessible at the tap of a few buttons. Social neuroscientists are finding that the act of obsessively checking news sources and social media is detrimental to mental health and can cause hopelessness and depression—hence the name: “doom scrolling”.²⁷

This act of helplessly scrolling while waiting for a notification that might never arrive has been correlated with a rise in cortisol levels. Cortisol, which is a hormone that maintains the hypothalamic-pituitary-adrenal (HPA) axis, is made by your adrenal glands to regulate inflammation, blood pressure, and controls your sleeping schedule.

Furthermore, scientists have found that a rise in cortisol actually delays the ability for individuals to recover from physiological stress.²⁸ Therefore, it is not calming to scroll through social media. Due to the increased levels of cortisol caused by scrolling, your body actually increases its heart rate, blood pressure, and prepares for a fight or flight response.

What Does This All Mean?

Dating apps aren’t all bad. Scientists argue that due to the diverse connections created via algorithms on dating apps, individuals are matching with people who do not have the same socioeconomic, cultural, or political background, which leads to a more integrated and accepting society overall. Furthermore, nearly 80% of gay, lesbian, and bisexual users believe that online dating is very or somewhat safe, which demonstrates that virtual dating apps can be an inclusive space for LGBTQ+ communities.²⁹

I appreciate the need for human connection. During a time period when we lack social interaction, I understand the appeal of love at first swipe. However, due to the instant gratification

one can receive through a dating app with minimal effort, it creates a negative feedback cycle where individuals are more likely to turn to the virtual world rather than the real world when desiring positive reinforcement. Furthermore, the act of swiping or scrolling through profiles minimizes the very complex development of human attraction into a petty game. Humans are becoming trained to desire that virtual “stamp of approval” through a like or mention on social media, rather than an in-person vocalized acknowledgement. When rejection occurs, which it does more frequently on dating apps than in real life (due to the sheer number of matches users make a day), it causes individuals to choose dating apps over face-to-face interactions. Rejection does not feel as personal in this environment. Utilizing technology as a crutch has strong ties with social anxiety and the inability to form complex in-person relationships.

We are all pressed for human connection right now, but before you decide to sit down and download Tinder or Bumble to satisfy your need for human validation and acceptance, ask yourself: do dating apps cause more harm than good? ■



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