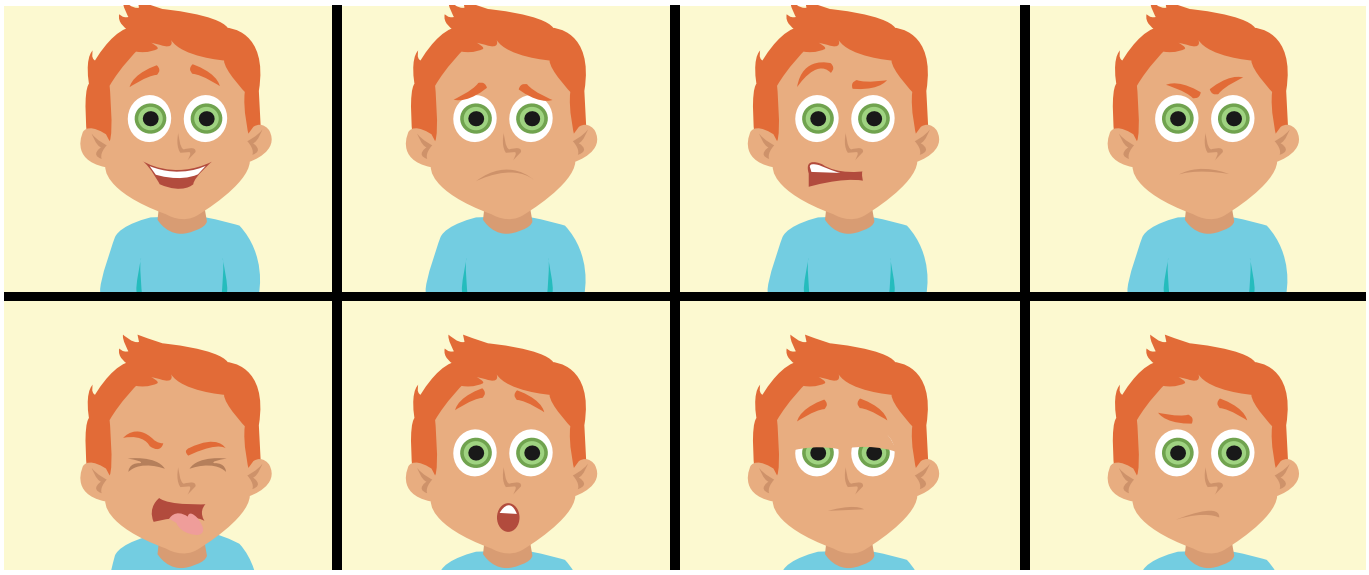
frontiers FOR YOUNG MINDS

NEUROSCIENCE
Published: 09 May 2018
doi:10.3389/frym.2018.00015



HOW MANY DIFFERENT KINDS OF EMOTION ARE THERE?

Alan Cowen*

Department of Psychology, University of California Berkeley, Berkeley, CA, United States

REVIEWED BY:

CAMPUS MIDDLE SCHOOL FOR GIRLS
AGE: 12–13

Throughout life, our feelings influence the choices that we make. We watch TV shows that make us laugh or cry. We avoid people that scare us. We eat until we feel satisfied. Even though these emotional feelings determine how we behave, psychologists have not figured out how many different *kinds* of emotions we feel. One theory is that we feel five or six different kinds of emotion, like anger and amusement, and that each emotion is completely different from all of the others. Another theory is that we feel two opposite emotions, like pleasure or displeasure and excitement or calmness, that are mixed together to form all of our emotional feelings. To study the number of different kinds of emotional feelings that people experience in response to different situations, we collected over 300,000 self-reported emotional responses to 2,185 emotional videos. We then used mathematical techniques to see how many different emotions were captured in people's responses. Our findings told us that there are at least 25 different kinds of emotion, and that many of them can be mixed together. To show what these different emotions are and how they can be blended together, we created an online interactive map. This map reveals that the emotions people report experiencing are more complex

than scientists had thought. Our results may help people who study emotional disorders and the way the brain represents emotion, and may also help to design phones and computers that react appropriately to the emotions we express.

THE EXPERIENCE OF EMOTION

Consider the last time you felt angry at a classmate, anxious over a presentation, or overwhelmed with awe at the beauty of your surroundings—perhaps during the solar eclipse last August. **Emotions** color both our inner world and the world around us, telling us where to look, what to remember, what to think about, and what to do next. These ideas about emotion are backed up by science, including important research by Keltner at the University of California, Berkeley, and were famously put to life through the film *Inside Out*, which Dr. Keltner helped create [1, 2]. In the animated film, which takes place inside the mind of a child, memories are depicted as glass orbs, literally colored by emotion. But how many "colors" of emotion are there? If you saw *Inside Out*, you might remember that it showed five different emotions, each one with an animated character: anger, disgust, fear, happiness, and sadness. These happen to be the emotions that scientists have focused on the most [2]. However, while these five emotions are very important, recent evidence indicates that we also experience many other emotions in our everyday lives.

WHAT IS AN EMOTION?

The concept of emotion may seem simple, but scientists often have trouble agreeing on what it really means. Most scientists believe that emotions involve things other than just **feelings**. They involve bodily reactions, like when your heart races because you feel excited. They also involve expressive movements, including facial expressions and sounds—for example, when you say "woah" because you are fascinated by something. And emotions involve behaviors, like yelling at someone when you are angry.

Although there are many different parts of an emotion, feelings are usually considered the most important part [3]. The majority of scientists who study emotion measure it by asking people what they are feeling. Of course, we cannot know whether a person is telling the truth about what he or she is feeling. It is also worth noting that terms like "angry" and "amused" might mean different things to different people. Despite these limitations, however, self-reported experience, meaning what a person says about what he or she is feeling, is the most direct way to measure emotional feelings.

EMOTION

Scientists do not always agree on what makes up an "emotion," but they usually agree that it is more than just a feeling. Emotions can also involve bodily reactions, like when your heart races because you feel excited, and expressive movements, including facial expressions and sounds—for example, when you say "woah" because you are fascinated by something. And emotions can involve behaviors, like yelling at someone when you are angry. These bodily reactions, expressive movements, and behaviors are often included in scientists' definitions of "emotion."

FEELING

The way that someone experiences an emotion. A feeling is something that you experience internally, in your own mind, and that other people can understand based on your behavior. You can help other people understand how you feel using emotion terms, like "anger" or "sadness"—the subject of this study—or by using analogies, like "I feel the way a kid would feel if her dad took away her Halloween candy."

THE STRUCTURE OF EMOTION

People use many different words to describe the emotions that they feel. We wanted to study how many different emotions these words actually refer to, and how these emotions relate to each other. This is the question of how emotion is *structured*. Different scientists believe in competing theories of the structure of emotion.

For many years, most psychologists (scientists who study the mind, and why we do the things that they do) believed that emotions could be boiled down to five or six types [2]. The most widely studied types of emotion—anger, disgust, fear, happiness, and sadness—are the main characters in the film *Inside Out*. Scientists who support this view of emotion consider each type to be a family of emotions that contains closely related emotions, such as anger, frustration, and rage.

Other scientists believe that there are just two properties that make us experience emotion in any situation and they are called valence and arousal. Valence means the degree to which a person feels good or bad, and arousal means the degree to which a person feels calm or excited. Scientists who support this view usually also believe that the differences between emotions like anger and fear, which are both negative (low valence), highly excited (high arousal) states, come from our interpretations of the actual events that are going on, rather than from specific emotional feelings like those in *Inside Out* [4].

The evidence for the valence-and-arousal view of emotion came from mathematical analyses of how people report feeling [4]. These mathematical techniques told us that negative emotions like fear and sadness often happen together, as do positive emotions like amusement (humor) and awe. That is, emotions that are similar in valence tend to happen together. So do emotions that are similar in arousal. In other words, certain emotions are **correlated**—meaning they often rise and fall together—because people tend to report feeling them at the same time or in similar situations. But these mathematical analyses have not always been able to tell us when two emotions are different. We do not know whether fear is truly distinct from sadness, and amusement from awe, beyond their similarities and differences in valence-and-arousal levels.

CORRELATION

A measurement of the degree to which two things tend to rise and fall together. For instance, height is correlated with weight, because taller people are usually heavier.

In our study, we wanted to discover how many emotions people really have. When people say what they are feeling, can what they tell us be boiled down to how good or bad, excited or calm they feel? Do we need five emotions, like the ones from *Inside Out*? Or do we need a lot more? To determine how many emotions people have, we first gathered some of the darkest and brightest moments of life caught on video, including over 2,000 films of wedding proposals, animals, art, births, nature, warfare, sports, accidents and close

calls, and many other deeply emotional scenes. Then, we had people watch these videos over the Internet and gathered hundreds of thousands of reports of how the videos made people feel. Finally, we developed a new mathematical technique to find out how many different dimensions of emotion we need to explain how people said the videos made them feel. Our technique tells us whether, when people use a word like "awe," they mean something different from when they use a different word, like "happiness."

RESULTS: A BETTER UNDERSTANDING OF THE STRUCTURE OF EMOTION

To study how people's emotional responses to the videos were structured, we first asked people to rate each video they saw by choosing one or more categories from a list of 34 categories of emotion, such as "amusement," "awe," and "sympathy." We collected 27,660 of these responses. Next, we asked people to freely respond to each video with their own words, describing how the video made them feel. We collected 19,710 of these responses. Finally, we asked people to rate each video along dimensions, including valence and arousal. We also included other dimensions that people think might be fundamental to emotion, in addition to valence and arousal, like how safe people feel. Each dimension was rated on a 9-point scale (with 1 being very low, for example, very unsafe, and 9 being high, for example, very safe). We collected a total of 276,696 of these responses. Collecting these three different types of responses is important because they capture different ways that people can describe their emotions.

By analyzing the relationships between the different types of responses that we collected, we found that people reliably reported feeling at least 25 different kinds of emotion when they watched the videos. We did this using a mathematical technique that calculates the number of dimensions that are required to explain the different types of responses we received. It turns out that we needed at least 25 dimensions, or patterns, to explain the data we collected.

The patterns of emotion that we found corresponded to 25 different categories of emotion: admiration, adoration, appreciation of beauty, amusement, anger, anxiety, awe, awkwardness, boredom, calmness, confusion, craving, disgust, empathic pain, entrancement, excitement, fear, horror, interest, joy, nostalgia, relief, sadness, satisfaction, and surprise.

Finally, we found that even though most of the videos were just around 5 s long, many of them caused people to feel more than one category of emotion. In fact, a lot of the categories were blended together for many videos. This challenges the view that emotions are totally separate, like the characters in *Inside Out*. Instead, emotions are more like colors. Just as there are many

FIGURE 1

FIGURE 1

The structure of reported emotional experience: smooth gradients connect 25 distinct categories of emotion.
The map shows how people's emotional responses to each of the 2,185 videos map onto the 25 dimensions of emotion that we uncovered. Each video is represented as a small letter in the map. Using mathematical techniques, the videos are placed near other videos that made people feel similar emotions. Each video is colored by blending together the colors corresponding to each dimension of emotion that it evoked. The map reveals how distinct categories are connected by smooth gradients of intermediate emotions, such as the gradients from anxiety to fear to horror to disgust. To see the videos, you can visit the interactive version of this map at https://s3-us-west-1.amazonaws.com/emogifs/youngminds.html. Within the interactive map, you can hover over each number with your mouse to watch each video. However, parental discretion is advised.

different colors in between red and green—like yellow, orange, brown, laser lemon, electric lime, and so on—there seem to be many different emotions in between fear and disgust.

To visualize the 25 different dimensions of emotion and the blends between them, we developed a technique to build an interactive map of the emotions caused by each video, using a new kind of mathematical technique [5]. In the map, each video is represented by a letter corresponding to the emotion it causes the most, a color corresponding to the exact blend of emotions that it causes, and a location near other videos that caused similar emotions. You can think of each letter as similar to one of the glass orbs from the movie *Inside Out*, where the color of each glass orb represents the emotion associated with the memory it contains. The difference here is that there are 25 colors instead of 5, and there are also blends between colors. In other words, a video that causes a blend of "anxiety," which is a burnt yellow, and "fear," which is a deep pink, may appear as an intermediate, orange color. Hovering over each letter allows you to watch the video that it corresponds to. Be careful, though—the "disgust" videos may gross you out, and the "fear" and "horror" videos may scare you. You can find the interactive map here: https://s3-us-west-1.amazonaws.com/emogifs/youngminds.html. Figure 1 shows a non-interactive version of the map.

WHAT THIS MEANS FOR SCIENCE AND SOCIETY

We found that the structure of emotion is more complex than many scientists thought. Scientists who believed emotional experiences existed as just five or six basic categories, like the characters in *Inside Out*, were half correct. They were right in thinking that emotions are best represented as categories, like anger and fear. But they underestimated the number of distinct categories. Also, they were wrong in thinking that these categories were completely independent, like the characters in the movie. Instead, many emotions can be blended together.

Scientists who viewed emotional experiences as dimensions like valence and arousal were also half correct. They were right in doubting that there are rigid boundaries between emotions. Instead, we see that emotions can be blended together. But they were wrong in thinking that only two dimensions, like valence and arousal, can explain the emotions people report feeling. These emotions are actually made up of at least 25 different dimensions.

Beyond inspiring animated films like *Inside Out*, this research is important for a number of reasons. These findings might influence how scientists study various things, such as mood disorders (like anxiety or depression), the way emotions are produced in the brain, and the design of machines that react appropriately to our emotional needs.

Scientists who study mood disorders, like anxiety and depression, can use this research to understand the range of different emotions these patients feel in their everyday lives. It might turn out that two patients with the same diagnosis, like depression, actually experience different patterns of emotion, and respond to different kinds of treatment.

Scientists who study how the brain generates emotion can use this research to understand how different emotions could be represented in different brain regions. For example, one brain region that is known to be involved in emotion, especially in states of fear, is called the amygdala, a small structure lodged deep within each side of the brain, between the ears. The amygdala helps us learn to be afraid of dangerous things and to rapidly respond to those things based on our past experiences [6]. Brain scientists could study whether different parts of the amygdala are involved in emotional responses that are related to fear, such as anxiety, horror, relief, and surprise. Such studies could help us understand the role of brain regions like the amygdala in emotion.

Finally, scientists and engineers who develop machines that interact with humans, such as social media apps, iPhones, cars, and customer-service robots, can use this research to make sure their machines respond appropriately to our emotions. These machines could give us tools for coping with negative emotions, like anxiety and fear, and promoting positive emotions, like adoration and awe.

ORIGINAL SOURCE ARTICLE

Cowen, A. S., and Keltner, D. 2017. Self-report captures 27 distinct categories of emotion bridged by continuous gradients. *Proc. Natl. Acad. Sci. U. S. A.* 114 (38), E7900–E7909. doi:10.1073/pnas.1702247114

REFERENCES

1. Keltner, D., and Ekman, P. 2015. *The Science of 'Inside Out'*. The New York Times p SR10. Available at: https://www.nytimes.com/2015/07/05/opinion/sunday/the-science-of-inside-out.html (Accessed: April 13, 2018).
2. Dudd, J. W. 2015. *A Conversation with the Psychologist Behind 'Inside Out'*. Pacific Standard. Available at: https://psmag.com/social-justice/a-conversation-with-psychologist-behind-inside-out (Accessed: April 13, 2018).
3. LeDoux, J., Phelps, L., and Alberini, C. 2016. What we talk about when we talk about emotions. *Cell* 167, 1443–1445. doi:10.1016/j.cell.2016.11.029
4. Russell, J. A. 2003. Core affect and the psychological construction of emotion. *Psychol. Rev.* 110, 145–172. doi:10.1037/0033-295X.110.1.145
5. Maaten, L. V. D., and Hinton, G. 2008. Visualizing data using t-SNE. *J. Mach. Learn. Res.* 9, 2579–2605.
6. Pessoa, L., and Adolphs, R. 2010. Emotion processing and the amygdala: from a 'low road' to 'many roads' of evaluating biological significance. *Nat. Rev. Neurosci.* 11(11), 773–83. doi:10.1038/nrn2920

SUBMITTED: 10 September 2017; **ACCEPTED:** 27 March 2018;
PUBLISHED ONLINE: 09 May 2018.

EDITED BY: Sabine Kastner, Princeton University, United States

CITATION: Cowen A (2018) How Many Different Kinds of Emotion Are There? Front. Young Minds 6:15. doi:10.3389/frym.2018.00015

CONFLICT OF INTEREST STATEMENT: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REVIEWED BY

CAMPUS MIDDLE SCHOOL FOR GIRLS, AGE: 12–13

We are a group of 7th grade students who worked with our teacher and science mentor to discuss a new paper about emotions. Reviewing this paper helped us to better understand our own emotions and the emotions of others.

AUTHOR

ALAN COWEN

Alan Cowen is an emotion scientist at the University of California, Berkeley (USA). His research focuses on how people express their emotions, how emotions are represented in the human brain, and how we can program computers to recognize our emotions. In his free time, he seeks out positive emotions like excitement, interest, and awe by traveling the world, climbing rocks, cooking delicious food, and reading books. *alan.cowen@berkeley.edu