Why Inspiring Stories Make Us React: The Neuroscience of Narrative

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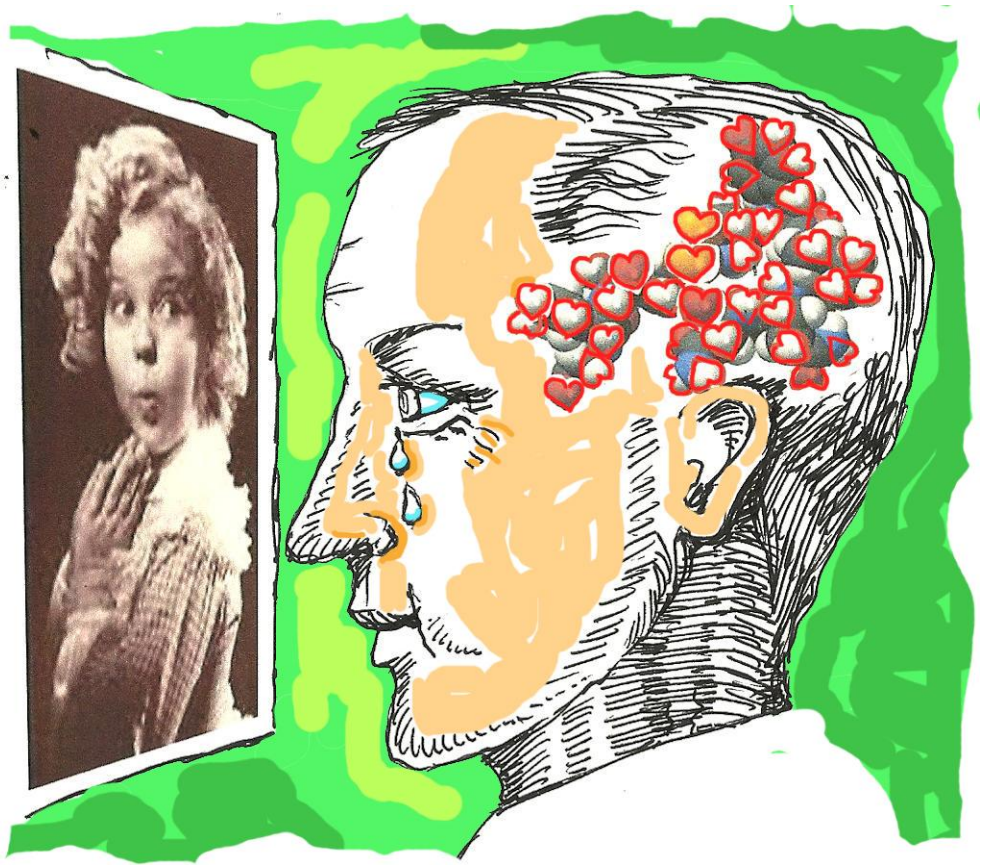

Illustration by William Hogan

Editor's Note: The man behind the discovery of the behavioral effect of a neurochemical in the brain called oxytocin wondered if the molecule might motivate people to engage in cooperative behaviors. In a series of tests using videos, his lab discovered that compelling narratives cause oxytocin release and have the power to affect our attitudes, beliefs, and behaviors.

During a night flight home to California after five days in Washington, D.C., I discovered that I am the last person you would want sitting next to you on a plane. Tired and unable to bang on my laptop in the turbulence at 40,000 feet, I decided to watch *Million Dollar Baby*. I hadn't seen it, but I figured a Clint Eastwood–directed film that had won the Oscar for Best Picture would be a deserved break for a hard week.

It is a wonderful film, and I became deeply absorbed in it. The narrative is circumscribed by a father-daughter story and concludes with an agonizing act. When the movie was over, the man next to me said, "Sir, is there something I can do to help you?" I was crying. Well, not really crying, more like heaving big sloppy sobs out of my eyes and nose and mouth. Everyone around could hear me but I could not suppress my sadness.

After I recovered, I began to wonder what had happened to me. I was cognitively intact, aware of my surroundings and who I was. And yet the story was so engaging that it caused my brain to react as if I were a character in the movie, as if one of my own daughters were the one suffering. I experienced heartache as the movie ended, but then it was only a story.

As a neuroscientist, I knew that movies changed our brain activity in some way, but how?

I soon realized I had stumbled on a potentially useful way to extend my studies of the social brain. My lab was the first to discover that the neurochemical oxytocin is synthesized in the human brain when one is trusted and that the molecule motivates reciprocation.[1] [2] [3] We found that the human oxytocin response was similar to that found in social rodents,[4] signaling that another person (or rodent) is safe and familiar. Perhaps most surprising, we found that in humans, this "you seem trustworthy" signal occurs even between strangers without face-to-face interactions.

Oxytocin is an astonishingly interesting molecule. It is a small peptide synthesized in the hypothalamus of mammal brains. It is made of only nine amino acids and is fragile. Oxytocin is classically associated with uterine contractions and milk-letdown for nursing. Animal studies have shown that under physiologic stress oxytocin is released in both brain and body.[5] [6] This is unusual

for a brain-derived neurochemical, but it provides a powerful way to study oxytocin: After a stimulus, changes in oxytocin in blood reflect changes in the brain's oxytocin.

For more than a decade, I have run human experiments measuring the endogenous release of oxytocin during social interactions. My colleagues and I have studied oxytocin release in the laboratory as well as in field studies spanning religious rituals, folk dances, weddings, and a traditional war dance by indigenous people in the rainforest of Papua New Guinea.[7] I also have demonstrated the causal effect of oxytocin on prosocial behaviors by safely infusing synthetic oxytocin into hundreds of people's brains through their noses.[8] [9] [10] Oxytocin infusion increases prosocial behaviors. It's like turning on a garden hose and watching the water spray out.

Provoking the Brain

Studies that only infuse oxytocin into participants and then make claims about human behavior are suspect. This approach does not identify what the brain itself is doing during social interactions, including neurochemical promotion and inhibition of oxytocin synthesis and dose-response relationships between oxytocin and behavior. The key question is whether the brain produces its own oxytocin during the behavior being studied; if so, the causal relationship between oxytocin and a particular behavior can be demonstrated via an infusion study. But the reverse is not true: Infusing oxytocin or any drug into the brain and observing a change in behavior does not mean that this is how the brain works—it simply means that a drug has changed behavior, as many drugs do. My studies complete the causal circle by measuring what the brain does naturally and then intervening in this system pharmacologically to show that the behavior can be provoked.

After years of experiments, I now consider oxytocin the neurologic substrate for the Golden Rule: If you treat me well, in most cases my brain will synthesize oxytocin and this will motivate me to treat you well in return. This is how social creatures such as humans maintain themselves as part of social groups: They play nice most of the time. (Why people do not play nice is a fascinating story we also have studied; see Zak, 2012 for evidence). But I'm a skeptic at heart, so I always want to measure the behavioral effects of oxytocin rather than simply ask people's opinions about how they feel.

The experience I had watching *Million Dollar Baby* caused me to wonder if movies, in addition to direct personal interactions, would cause oxytocin release. To test this, my colleague Jorge Barraza edited a set of a short video clips that we obtained with permission from St. Jude Children's Research Hospital. One version shows a father talking to the camera while his 2-year-old son, Ben, who has terminal brain cancer, plays in the background. The story has a classic dramatic arc in which the father is struggling to connect to and enjoy his son, all the while knowing that the child has only a few months to live. The clip concludes with the father finding the strength to stay emotionally close to his son "until he takes his last breath."

We also developed a video of the same father and son spending a day at the zoo. This version does not mention cancer or death, but the boy is bald (from his chemotherapy) and is called "miracle boy" once during the clip. This video lacks the tension induced by the typical story form but includes the same characters. This version was used as a control story to see what the brain does when any video is being watched.

In our first study of narratives, we took blood before and after participants watched one of the two versions of the video.[11] We found that the narrative with the dramatic arc caused an increase in cortisol and oxytocin. Tellingly, the change in oxytocin had a positive correlation with participants' feeling of empathy for Ben and his father. Heightened empathy motivated participants to offer money to a stranger who was in the experiment. We connected a story to a feeling and then to a prosocial behavior. The "flat" narrative of Ben and his father at the zoo did not increase oxytocin or cortisol, and participants did not report empathy for the story's characters.

These findings suggest that emotionally engaging narratives inspire post-narrative actions—in this case, sending money to a stranger. But maybe this result only applied to videos of dying children. Also, we did not know for sure that oxytocin was the reason participants cared about the people in the video, just that oxytocin and empathy were correlated. So we rolled up our sleeves and ran more experiments.

Narrative Immersion

Our previous study pointed to oxytocin as the biological instrument that puts people in thrall to a story. To assess the causal impact of oxytocin on narrative immersion, we ran a study using public service announcements (PSAs) in which participants received intranasal infusions of synthetic oxytocin or a placebo. This time around, we decided to test a larger set of video narratives. We wanted stories that most people would not have seen before and ones that could elicit a prosocial action at a cost (such as a donation). This would allow us to measure objectively whether the story "got to you."

We found a rich trove of public service announcements from the United Kingdom that are well-produced and engaging. The experiment used sixteen PSAs that ran for thirty or sixty seconds on four topics: smoking, drinking to excess, speeding, and global warming. To incentivize people to pay attention to the videos, each of the participants was paid five dollars if they could correctly answer a factual question about the ad immediately after watching it. For example, "Was there a car in the video?" Then, our software asked participants if they would like to donate some of the five dollars they had just earned to a charity associated with the cause shown in the PSA. None of the PSAs solicited donations, they simply told stories about social issues. Computer software presented all the videos and post-video questions and we used random participant identifiers so that one's donation behavior was kept private.

Forty people received either 40 IU of oxytocin or an equivalent amount of normal saline (placebo). Neither the experimenters nor the participants knew what substance had been administered. Participants started watching the videos after an hour-long period during which the synthetic oxytocin diffuses from the sinuses into the brain.

We found that those who received oxytocin donated, on average, 56 percent more money to charity compared with participants who received the placebo.[12] This confirmed the causal role of oxytocin on post-narrative prosocial behavior. But why did this happen? We discovered that participants who were given oxytocin showed substantially more concern for the characters in the

PSAs. This increased concern motivated them to want to help by donating money to a charity that could alleviate the suffering these stories depicted.

If you think about it, the donations are quite odd. The narrative is over, but the effects linger. It is as if the brain is lazy and is using a "monkey see, monkey do" approach to assess appropriate social behaviors. (Indeed, the brain seeks to conserve energy by using default pathways—a kind of "laziness.") The PSAs seemed to persuade viewers that (for example) nowadays the humans are very concerned about drinking too much, so as a human, I, too, should be concerned. And I should demonstrate that concern by donating money to charity. Such responses are what social creatures with social brains do. And yet, participants understand that the stories are fictional and are portrayed by professional actors. The money donated to charity cannot help these actors out of their fictional binds. The money might help prevent the harm depicted in the PSAs from happening to an unknown other person, but this is a big "if." Nevertheless, oxytocin makes people want to help others in costly and tangible ways.

In another experiment,[12] we sought to replicate our earlier study by taking blood samples before a group of forty-two participants (who were not in the oxytocin infusion study) watched one of the UK PSAs. We measured the change in oxytocin and in a fast-acting arousal hormone with a long name that is abbreviated ACTH.

When the PSA elicited an increase in both ACTH and oxytocin, donations were 261 percent higher than when one or both of these biomarkers did not rise. The change in ACTH correlated with the amount of attention people paid to the story. This finding makes sense: If we do not attend to a story, it will not pull us into its narrative arc. Attention is a scarce neural resource because it is metabolically costly to a brain that needs to conserve resources. If a story does not sustain our attention, then the brain will look for something else more interesting to do.

We also found that the change in oxytocin was associated with concern for the characters in the story, replicating our earlier finding. If you pay attention to the story and become emotionally engaged with the story's characters, then it is as if you have been transported into the story's

world. This is why your palms sweat when James Bond dodges bullets. And why you stifle a sniffle when Bambi's mother dies.

Attention-getting

Narratives that cause us to pay attention and also involve us emotionally are the stories that move us to action. This is what a good documentary film does. More generally, stories with a dramatic arc fit the requirements for high-impact narratives. This structure sustains attention by building suspense while at the same time providing a vehicle for character development. The climax of the story keeps us on the edge of our neural seats until the tension is relieved at the finish.

Theorists including Aristotle (*Poetics*, 335 BCE), Gustav Freytag (*Die Technik des Dramas*, 1863), and Joseph Campbell (*The Hero with a Thousand Faces*, 1949) have contended that the rising and falling tension of dramatic performances facilitate the audience's emotional connection to the characters. Hollywood writers call this creating "surprising familiarity." Every story is different but somehow the same.

Now let's get down to brass tacks: Why are there so many dreadful movies? Humans have known about the three-act structure and mythos, pathos, and ethos for 2,500 years. This is where the neuroscience hits the flickering screen.

Like all experiments, we had to start small.

To answer these questions, we needed to measure attention and oxytocin responses rapidly—second by second, or even faster. Blood draws would not do. At the same time, the U.S. Department of Defense wanted to know why narratives are persuasive and supported our research and that of other labs as well. Attention is easy to measure rapidly, via a quickened heartbeat or sweat coming from eccrine glands in the skin. But was there a way to measure oxytocin rapidly? Nature provided a solution. While we were mostly interested in oxytocin in the brain, the stimulus-induced co-release of oxytocin in the brain and blood meant we could measure changing activity in regions with densities of oxytocin receptors. The vagus nerve (the longest cranial nerve, which innervates the heart and gut) is chock-full of oxytocin receptors. With a bit of algorithmic fiddling,

scientists can measure the activity of the vagus using an electrocardiogram (ECG). We confirmed that the change in oxytocin in blood correlates with changes in vagus nerve activity. Voilà, we had a measurement technique. But would it predict behavior?

We returned to the story of the dying child Ben because it is a reliable way to stimulate oxytocin release. This time we measured cardiac activity using an ECG and sweat using an electrodermal sensor on the fingers. Because we were developing a system that might be used in a war zone, we built in redundancies. Attention was measured using both heart rate and skin conductance changes from sweat on the fingers; emotional resonance was quantified using two measures of changes in the brain's relaxation response driven by the vagus nerve. The exciting part was that we could measure both effects up to one thousand times a second with off-the-shelf wireless technologies.

But it is not so simple to isolate the effects of a story from everything else the brain is doing to keep you upright, breathing, and conscious. All neuroscience studies need to extract the neurologic signal produced by a stimulus during an experiment from the background noise of all other neural activity. To give you a sense of the scope of this problem, for every thirty people we test for an hour each, we collect a terabyte of peripheral neurologic data. Most of this data is not relevant to understanding why people respond to stories, but the faint traces that are relevant must be extracted and processed with extraordinary care. Once we did all this, the data told us several interesting things.[13]

First among them is that the brain does not work like the hypothetical story structure known as Freytag's pyramid, in which strictly rising action leads to a climax, and then strictly falling action occurs as the story resolves. Even for the one-hundred-second "Ben" video, one's attention waxes and wanes. The brain is attending to the story and then doing a quick search of the rest of the environment, and then refocusing on the story as the tension rises. Nevertheless, the peak attentional response occurs in the climax, when Ben's father reveals that Ben is dying. That's a bombshell to which people pay attention.

The oxytocin response lags behind the attentional spike as the story begins. After about thirty seconds, vagal activity begins to increase as viewers get to know and then begin to empathize with

Ben and his father. Attention to the story provides a reason viewers should care about the characters.

Not only were we able we track what the brain is doing millisecond by millisecond during a story, we used the neurologic data to build a predictive model of donations to a childhood cancer charity—our measure of story impact. The statistical model we built predicts whether a participant would donate money with 82 percent accuracy. That is, by measuring how your peripheral nervous system responds to a story, we can almost perfectly predict what you'll do before you do it.

The participants who, for whatever reason, either lost interest in the video or didn't form an emotional connection to Ben and his father almost never donated money to charity. But we are still left with a mystery: Why donate money at all? The money will not save Ben and it won't offer relief to his father. It seems that once we are attentive and emotionally engaged, our brains go into mimic mode and mirror the behaviors that the characters in the story are doing, or might do. As social creatures we are biased toward engaging with others, and effective stories motivate us to help others.

Truth be told, Ben's story is as near to a perfect high-impact narrative as there is. We wondered if neurologic data could identify bad stories, too. And what about stories that may be distasteful but that are still desirable to watch? I watched Steven Spielberg's Holocaust movie *Schindler's List* once. I'm glad I did, but I don't have much desire to watch it again. It was just overwhelming emotionally.

Our next study tested stories about "hot-button" issues to see how people reacted to potentially disagreeable topics. We used first-person narratives from StoryCorps, a nonprofit that collects and distributes personal stories. We choose six stories on racism, gun control, and the terrorist attacks of September 11. Each anecdote lasted from two to four minutes. For our "narrative impact" measure, we invited participants to donate some of their earnings to a charity associated with the topic of the story.

These stories were challenging to analyze because they varied substantially in structure and content. The peripheral neurologic data we collected reflected these variations. Just as in the "Ben"

story, we confirmed that stories that sustain attention and generate emotional resonance produce post-narrative donations—even stories on difficult topics. To the brain, good stories are good stories, whether first-person or third-person, on topics happy or sad, as long as they get us to care about their characters.

Psycholinguists have shown that effective stories induce "transportation" into the narrative.[14] Transportation happens when one loses oneself in the flow of the story—just like I did while watching *Million Dollar Baby*. To understand the psychological effects of stories, we included surveys of narrative transportation and concern for story characters in the StoryCorps study. Both narrative transportation and concern predicted post-story donations. This shows why stories affect behavior after the story has ended: we have put ourselves into the narrative. Even a week after the experiment, accurate story recall was predicted by a single measure: narrative transportation.

Do We Know a Good Story When We See One?

You may be thinking that we have a money-centric approach to assessing when people are moved by a story. Fair enough. Let's try a different approach: We'll have thousands of people rate stories instead. The stories we used were TV commercials. Conveniently, this is just what *USA Today* asks readers to do on Super Bowl Sunday: vote for the commercials they like the best. About five thousand people voted for their favorite commercials in 2014, and the style and content of these short narratives vary from the unusual to poignant to just plain silly. This gave us a chance to further refine our algorithms and test them against what people say they like.

USA Today does not simply provide a ranking of commercials; it has its readers rate them on a one to ten scale. Good idea! My group derived a quantification of narrative engagement using neurologic data so we, too, could rate story quality. We estimated the relative contribution of attention and emotional resonance on story impact from our corpus of studied stories. We call this measure a story's ZEST (for Zak Engagement STatistic). By estimating each Super Bowl ad's ZEST, we could compare the *USA Today* readers' ad likability with the ZEST measure of brain activity.

Three days after the 2014 Super Bowl, sixteen participants watched the top ten Super Bowl commercials in random order in my lab while we measured their peripheral neurologic activity. The

results were astounding. There was no correlation at all between what *USA Today* readers said they liked and a commercial's ZEST. Either we had made a big mistake, or we had discovered something important. So we ran another study using *USA Today's* top ten 2013 Super Bowl commercials and found exactly the same thing: zero correlation.

These findings suggest that people are unable to articulate what they like and do not like. But their brains reveal what is engaging for them to watch. Perhaps this should not surprise us. In a classic study, psychologist and economics Nobel laureate Daniel Kahneman found that people's preferences for things they have not experienced are largely unformed.[15]

Watching the Super Bowl commercials myself, I sensed why it is hard to articulate what one likes. The best Super Bowl commercial in 2014, according to *USA Today* readers, was called "Puppy Love," produced for Budweiser beer. In the first ten seconds, one sees a puppy nuzzling the nose of a Clydesdale horse. One immediately recognizes the Clydesdale as the Budweiser icon, and this tells viewers what they can expect from the ad. The suspense is gone, and our neurologic measures show that people's attention wanders starting fifteen seconds into the commercial. Without attention, the hoped-for emotional resonance with the ad's characters (and presumably the brand) fails to occur.

But ask people what they like and, gosh, they see puppies and horses and wide open country and, well, of course we love these images. But the brain does not lie. The commercial is dull.

In all our studies we ruled out effects that might influence ZEST, including movement, cars, buildings, attractive men and women, and many other factors. They don't matter; it all comes down to story.

The U.S. Department of Defense's funding of the emerging science of narrative jump-started the field.[16] [17] Storytellers have always known that attention and emotion are important to develop during a narrative, but now we have ways to measure these responses directly rather than rely on incohate impressions such as "entertaining" or "fascinating." Yet, even with millennia of practice, creating a great story is difficult. The emerging science of narrative can guide the art, but it cannot

replace it. Humans are just too complex for an algorithm to generate art. And this is where the artist comes in. The narrator in *Million Dollar Baby* describes the heroine, Maggie's, desire to be a boxer as "... the magic of risking everything for a dream that nobody sees but you." Artists who create worlds we cannot help but enter do the same.

Bio

Paul J. Zak, Ph.D., is a scientist, author, and public speaker. His book *The Moral Molecule: The Source of Love and Prosperity* was published in 2012 and was a finalist for the Wellcome Trust Book Prize. He is the founding director of the Center for Neuroeconomics Studies and Professor of Economics, Psychology and Management at Claremont Graduate University. Zak also serves as Professor of Neurology at Loma Linda University Medical Center. He has degrees in mathematics and economics from San Diego State University, a Ph.D. in economics from University of Pennsylvania, and post-doctoral training in neuroimaging from Harvard. He is credited with the first published use of the term "neuroeconomics" and has been a vanguard in this new discipline. He organized and administers the first doctoral program in neuroeconomics. Zak's lab discovered in 2004 that the brain chemical oxytocin allows us to determine who to trust. His current research has shown that oxytocin is responsible for virtuous behaviors, working as the brain's "moral molecule."

References

1. P.J. Zak, R. Kurzban, and W.T. Matzner, "The Neurobiology of Trust," Annals of the New York Academy of Sciences 1032(2004): 224-227.
2. P.J. Zak, R. Kurzban, and W.T. Matzner, "Oxytocin is Associated with Human Trustworthiness," Hormones and Behavior 48(2005): 522-527.
3. V. B. Morhenn, J. W. Park, E. Piper, and P.J. Zak, "Monetary Sacrifice Among Strangers is Mediated by Endogenous Oxytocin Release after Physical Contact. Evolution and Human Behavior 29(2008): 375–383.
4. C.S. Carter, and E.B. Keverne, "The Neurobiology of Social Affiliation and Pair Bonding," in Hormones, Brain and Behavior, ed. Donald Pfaff, (San Diego: Academic Press, 2002): 299–337.
5. C. T. Wotjak, J. Ganster, G. Kohl, F. Holsboer, R. Landgraf, and M.Engelmann, "Dissociated Central and Peripheral Release of Vasopressin, but not Oxytocin, in Response to Repeated Swim Stress: New Insights into the Secretory Capacities of Peptidergic Neurons," Neuroscience 85(1998): 1209–1222 doi: 10.1016/S0306-4522(97)00683-0.
6. I. D. Neumann, "Brain Oxytocin: A Key Regulator of Emotional and Social Behaviours in Both Females and Males," Journal of Neuroendocrinology 20(2008): 858–865 doi: 10.1111/j.1365-2826.2008.01726.x.
7. P.J. Zak, "The Moral Molecule: The Source of Love and Prosperity," (New York: Dutton, 2012).
8. Zak, P. J., Stanton, A. A. & Ahmadi, S. 2007. Oxytocin increases generosity in humans. *Public Library of*

Science ONE, 2(11).
9. M. Kosfeld, M. Heinrichs, P. J. Zak, U.Fischbacher, and E. Fehr, "Oxytocin Increases Trust in Humans," Nature 435:2(2005): 673-676.
10. P.J. Zak, and J.A. Barraza, "The Neurobiology of Collective Action," Frontiers in Neuroscience. 7(2013):211 doi: 10.3389/fnins.2013.00211.
11. J. A. Barraza, and P. J. Zak, "Empathy Toward Strangers Triggers Oxytocin Release and Subsequent Generosity." Annals of the New York Academy of Sciences 1167(2009): 182-189.
12. P-Y. Lin, N.S. Grewal, C. Morin, W.D. Johnson, and P.J. Zak, "Oxytocin Increases the Influence of Public Service Advertisements," PLoS ONE 8:2(2013) doi: 10.1371/journal.pone.0056934.
13. J.A. Barraza, V. Alexander, L.E. Beavin, E.T. Terris, E.T., and P.J. Zak, "The Heart of the Story: Peripheral Physiology During Narrative Exposure Predicts Charitable Giving," Biological Psychology (2015): in press.
14. R.J. Gerrig, "Experiencing Narrative Worlds: On the Psychological Activities of Reading," (New Haven: Yale University Press, 1993).
15. D.Kahneman, and R.H. Thaler, "Anomalies: Utility Maximization and Experienced Utility," Journal of Economic Perspectives 20:1(2006):221–234.
16. B.K. Bracken, V. Alexander, P.J. Zak, V. Romero, and J.A. Barraza, "Physiological Synchronization is Associated with Narrative Emotionality and Subsequent Behavioral Response," in Foundations of Augmented Cognition. Advancing Human Performance and Decision-Making through Adaptive Systems: 8th International Conference,, eds., D.D. Schmorrow and C.M. Fidopiastis (Berlin: Springer, 2014) 3–13.
17. S. Gimbel, J. Kaplan, M. Immordino-Yang, Tipper, C. A. Gordon, M. Dehghani, S. Sagae, H. Damasio, A. Damasio, "Neural Response to Narratives Framed with Sacred Values," Abstract, Annual meeting of the Society for Neuroscience, (San Diego, 2013).