fMRI Outcomes of Emotional Regulation: A Feasibility Study

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*Thank you....*
* To discuss the development of the project from idea to implementation and analysis.
* To present the fMRI research
* To explore the research outcomes
* To review fMRI study strengths and limitations and
* To set future goals

* Objectives
* As a PMHNP, I engage in psychotherapy that is augmented, at times, with psycho-pharmacy.
* My main client intervention, however, is psychotherapeutic interventions.
  * Sensorimotor Psychotherapy
  * Cognitive Behavior Therapy
  * Brief Motivational Interviewing techniques
* My burning questions were -
  * How does the brain respond to cognitive dissonance, increased mindfulness, and the reframing of memories?
  * How can I provide some evidence related to the impact of sensorimotor psychotherapy?

* Why did this study mean so much to me?
• The threat does not have to be real, only perceived.
• It does not have to occur suddenly.
• Environments have their own emotional make up, and the people in the environments affect the group response.
• A memory, or personal story, can provide a back story and emotional charge to an event or image.
September 2012

Dr. John DeLuca,

Senior Vice President for Research at Kessler Foundation,
licensed psychologist

Professor in the Departments of Physical Medicine & Rehabilitation (PM&R) and Neurology and Neuroscience at Rutgers New Jersey Medical School

Research Interests: disorders of memory and information processing in Multiple Sclerosis, Aneurysmal Subarachnoid Hemorrhage, Chronic Fatigue Syndrome, and Traumatic Brain Injury
* Functional MRI Visiting Fellowship: A five-day intensive introduction
  * grounding in the fundamentals of fMRI.
    * basic physics of MR imaging, the biology and biophysics of the hemodynamic responses to neural activity, data analysis (including both exploratory and statistical analyses), stimulus presentation and response recording in the context of high magnetic fields and electromagnetic pulses, and the design of perceptual and cognitive experiments.
  * Emphasis on the design of fMRI-based experiments

*Introduction to fMRI...*
* Allows us to observe regions of interest (ROI) in the brain, which are active during a specific time (Raichle, ME. 2013).

* When Neurons fire they have to rely on the hemodynamic response to supply them with the needed energy: glucose and O₂.

* O₂ is carried in the hemoglobin, and the change of oxyhemoglobin and deoxyhemoglobin is detectable due to the differential magnetic susceptibility of heme (iron) in the blood.

* Statistical analysis can determine what areas of our brain (or other parts of the body as well) have the difference in oxygenated v deoxygenated hemoglobin, indicating which areas are most active when engaged in experience, action or even thought processes.

**BOLD:** Blood O₂-Level Dependent

http://www.talyarkoni.org/blog/2010/06/16/time-on-task-effects-in-fmri-research-why-you-should-care/
Steps to setting up an fMRI study

Opportunities, necessities, barriers, solutions
* September 2012  presentation on fMRI
* March 2013 fMRI visiting fellowship - Dr. Marshall
* September 2013 discussion with Dr. DeLuca about an idea...(fund raising begins...)
* 2013- 2014 work on IRB for Kessler and WPU
* 2014 apply for ART - continue literature search
* 2014 apply for CfR for summer of 2015
* 2015 Complete literature search and submit paper
* 2015 scan 11 volunteers
* 2016 publication of fMRI article
* April 2016  receive data from Dr. Akbar
* 2017 complete analysis and publication
This study actually began in 2013 with an idea and a question about neural processing of emotional regulation-

*Does a story, attached to a picture, change the way the brain processes the picture?*

*And the need to review what was already done....*

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*In the beginning there was the Literature Review*
* Many studies had examined the context impact on the fMRI
* Many studies had examined the picture impact on the fMRI
* A couple of studies had examined the impact of a picture and a story...

    BUT

* None had examined the emotional impact of a changing story with a static repeating picture....

* Complexity of the issue
This study sought to examine the brains of 10 healthy volunteer subjects in an fMRI machine.

What we had: A Nurse, a Librarian, an undergraduate nursing student, and an idea....

What we Needed:

- An fMRI
- Money
- Neuroscientists
- fMRI experts
- Willing, healthy, volunteers
- Knowledge of parameters of safety for fMRI imaging
- Ability to identify what we were doing, what we needed, what we wanted to accomplish and getting it all by two IRB’s!
The Purpose of this Study

* Evaluate neuronal responses to emotional regulation in healthy adults exposed to repeating static faces accompanied by changing contexts.

* This project investigated, through the use of a functional Magnetic Resonance Imaging (fMRI), the impact of stories on visual cues, and associated brain activity in the areas of the brain devoted to memory and thoughtful consideration.
Emotional regulation is the array of automatic and controlled strategies that either attaches meaning to, or directs attention away from, an event (Foti & Hajcak, 2008).

Limbic: anterior cingulate
Paralimbic: anterior insula
Ventral frontal

Our mirror neuron networks are found in the inferior parietal, inferior frontal lobes.

* Emotional states like pain, disgust, fear) are found in the anterior insula

* The mirror neurons provide an internal replication of the actions and emotions of others linking the “I” and “thou” experience.

* What is happening to you (her/him) is happening to me.

http://wisance.com/6-ways-to-read-someones-mind-easily/
* Funding was applied for and received from multiple foundations.
* A collaboration was entered in between William Paterson University and Kessler Foundation for use of the fMRI facilities and support for the taking, processing and analysis of the images.
* All researchers and assistants attended and passed the fMRI safety courses.
* IRB’s were attained at both institutions.
The IRB helped us to develop the proper wording for the flyers and outreach to secure healthy subjects appropriate for an fMRI study.

The Interview:
* Claustrophobia?
* Implants?
* Piercings that can’t be removed
* Dental work...

Dr. Helen Genova, and Nadine Akbar, PhD, from Kessler Foundation, worked with the team in the design and analysis phases of this study.

Summer 2015 - Fall 2017
The design for this experiment was developed in the visiting fellowship program in functional MRI at the MGH NMR Center and Athinoula A Martinos Center for Biomedical Imaging.

The design sheet, by Dr. Savoy was employed, and Dr. Savoy provided ongoing support.

Block design: Ten participants were scanned as they were exposed to first repeating neutral (25) and then surprised (25) faces (Radboud Faces Database) that were coupled with changing contexts of happy stories or scary stories.
* Neutral + no story
* Surprised + no story
* Surprised + happy story
  * The faces you are about to see just won the lottery.
* Surprised + Fearful story
  * The faces you are about to see just witnessed a murder.

* Contrasts of interest
* The settings were:
  * Initial Interviews were conducted at William Paterson University in Wayne, New Jersey, USA
  * Secondary interviews, and the scans, were conducted at the Kessler Foundation Neuroimaging center, South Orange, NJ USA
  * Sample: 20 volunteers were interviewed, 13 were identified fit for scanning, 11 were available during the hours of scanning, and 10 were scanned.
  * 5 Males, 5 Females - between the ages of 21-39. Ethnicities included, Asian, African American, Caucasian, and Hispanic.
If we knew what it was we were doing, it would not be called research, would it?

— Albert Einstein
* Just opening our eyes....
* Posterior Cingulate Process
* Occipital fusiform gyrus,
* Precuneus,
* Cingulate gyrus and
* Intra calcarine cortex.
* Amygdala

*ROI* - Regions of interest
No significant activation noted

*The Control: Neutral story neutral faces vs neutral story surprised face
Surprised faces
Fearful story v happy story

Same 25 surprised faces: changing story
The faces you are about to see have
1) just witnessed a murder
2) have just won a 20 million dollar lottery
Mean activation map of contrast 4 where there was higher activation in fearful surprised compared to happy surprised.

Peak of activation was located in the left intracalcarine cortex (z= at cluster peak, MNI coordinates = -12, -88, 2, p<.001, indicated by crosshair) and included the right intracalcarine cortex, left lingual gyrus, left intracalcarine cortex, and left cuneal cortex.

Identified Regions of Activation
*Fearful v Happy Stories with Surprised faces*

Images are displayed in radiological convention (subject’s right side shown on the left).
*Fearful story SF vs Happy story SF*

Thresholded activation images

2.3                      3.9

zstat1: max Z stat of 3.92145 at voxel (51 18 35)
*the left occipital pole, lingual gyrus, and occipital fusiform gyrus (z=3.92 at cluster peak, MNI coordinates=-12, -90, -2, p<.01)

*Fearful and Happy stories SF y no story
No story SF vs HSSF + FSSF

Thresholded activation images

2.3 3.9
* Activation in the bilateral posterior cingulate (z=3.08 at cluster peak, MNI coordinates=8, -38, 26, p=.0342).

* Fearful story SF after HS surprised face
* Some of the participants (n=7) reported that the faces were kind of silly, and that they really didn’t see fear or surprise in them.
* All of the participants reported that the faces when by too fast.
* None of the participants felt that the experiment was too long.
* Four of the participants complained that the faces were too bright.
* Eight of the participants reported wondering whether the story was real, “if I should believe the story” since the faces reappearing seemed to be the same.
The activation of the posterior cingulate cortex was not surprising given that the cues for the fearful stories included threat-related wording (“the faces you are about to see just witnessed a murder”).

The faces without a story, neutral and surprised, although slightly activating, did not meet the threshold set for activation.

The repeat of the faces +stories after initial run, engaged the participant in consideration of veracity.

*Discussion*
* Only 10 participants
* Use of a free face base, which was identified as not particularly believable, by the participants.
* Limited access to analysis explanation, academic collaborators, secondary review of the scans.
* Very limited budget
* This was one of the most exciting, engaging, rewarding, astonishing, and frustrating experiences of my 30 years of nursing.
* What we say, the words we choose, and the faces we make when talking to our patients can make all the difference in whether they hear us or defend against us.
* I now believe, more than ever, that
  * Nurses need to be a part of the informed team doing evaluation of brain-based responses for improving mental health, utilizing advanced evidence-based technologies.
  * Nursing education should be focused on expanding to include cutting edge evaluation technologies, so that we can evaluate the impact of our interventions.
  * Nurses must be sitting at the interdisciplinary table, as a full partner, when determining patient interventions.
  * Nurses and other health care providers will soon be able to demonstrate the ability of all kinds of therapies to impact the emotional well being and capacity of our patients.
* I hope to find nurses and others interested in this kind of research to collaborate with and grow with over the coming decade.

*My Take Away*


*reference*
*Thank you for your attention - the future beckons....