Functional MRI Brain Scan

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Introduction

- Magnetic resonance imaging (MRI) is a noninvasive procedure that creates cross sectional images of the body. Images are created by magnetic fields and radio frequency energy reacting with biologic tissues (Mayo Clinic Staff, 2021, para. 1)
- There are different types of pulse sequences used in MRI "to measure the difference between oxygenated and deoxygenated blood" (Long, Rollins, & Smith, 2019, p. 270)
- The ability for an MRI to measure the difference between blood makes a functional magnetic resonance scan (fMRI) scan important
- "The use of oxygenated and deoxygenated blood as a contrast agent is known as blood oxygen level-dependent (BOLD) imaging"(Long et al., 2019, p. 270)

Purpose of fMRI Brain Scan

- Guide the planning for surgery
- Help assess the effects of different disorders
- Explain functional anatomy of the brain
- Monitor the growth and function of brain tumors

(Mayfield Clinic Staff, 2018a, para. 6)

Contraindications

- Patient motion (Power, 2020, pp. 337-339)
- Claustrophobic patient
- Expensive procedure
- Metallic implants that are not MRI compatible
- Kidney or liver problems

(Mayo Clinic Staff, 2021, para. 11)

Functional MRI (fMRI)

- "Functional MRI (fMRI) records active areas of the brain during certain activities or after the introduction of stimuli, such as visual or auditory stimuli" (Long et al., 2019, p. 270)
- The different magnetic properties of blood flow are used to look at the dynamic areas of the brain (Salem et al., 2021a, pp. 139-150)
- "It is used to determine precisely which part of the brain is handling critical functions such as thought, speech, vision, movement and sensation" (Mayfield Clinic Staff, 2018a)
- Takes about one to two hours to complete
- A head coil is placed over the patient's head to transmit the radiofrequency (RF) pulse

Figure 1. Head MRI (Harkin, 2017, para. 59)

What Happens After an fMRI?

Many patients are scheduled for a fMRI prior to surgery. If they do not have a surgery scheduled, doctors will assess the images with their patient and decide how to proceed. For example, if a patient has a tumor that overlaps with certain motor-skills, surgery may be scheduled to remove part of it to correct the problem. (Mayo Clinic Staff, 2021, para. 24)

Methods of fMRI Scan

Task- based fMRI T-fMRI)

- In T-fMRI , a patient is told to perform a particular task that activates a specific part of the brain
- It is based on the BOLD signal fluctuation between task-stimulated states and controlled states
- When a task is performed, oxygenated blood rushes to the area of the brain activated

(Power et al., 2019, pp. 141- 149)

Resting State fMRI (rs-fMRI)

- In rs-fMRI, images are acquired in the absence of a task and the patient can rest
- As with the task- based fMRI, the rs-fMRI is also based on the BOLD signal fluctuation. However, rs-fMRI only focuses on spontaneous BOLD signal changes
- Rs-fMRI is especially appealing to patients who struggle with task instructions because the signal will still relate to the spontaneous neural activity (Cash et al., 2020, pp. 337-339)
- More susceptible to motion artifact from patient moving

(Power et al., 2019, pp. 141-149)

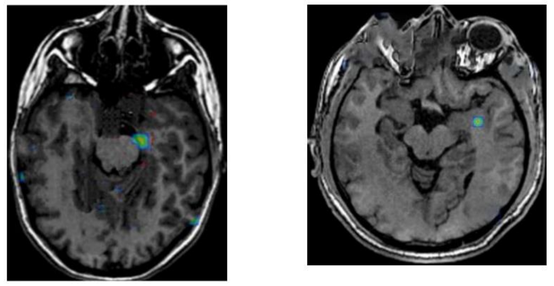

Figure 2. Comparison between degree of activation of amygdala in patients and control (Salem et al., 2021b, p. 145)

Common Tasks Performed During a fMRI

Sentence completion

- Patient will see a sentence and think of a word that completes it

Finger tapping

- Patient will be told to tap thumb and finger together in one or both hands

Verb generation

- Patient will see a noun and think of a verb that is related without saying it out loud

Word Generation

- Patient will see a letter and think of a word that starts with that letter but will not say the word out loud

(Mayfield Clinic Staff, 2018a, para.12)

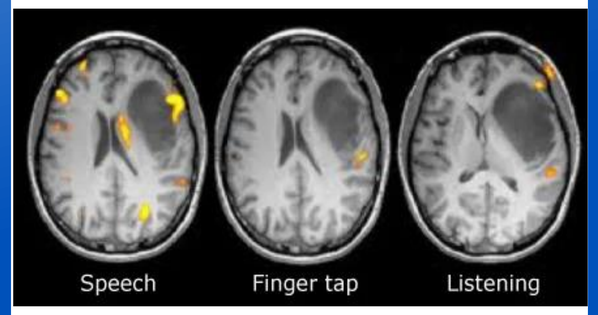

Figure 3. In functional MRI, brain areas "light- up" when performing certain tasks (Mayfield Clinic Staff, 2018b, para. 5)

Conclusion

- fMRI "holds future promise not only as a diagnostic tool but as a predictor of future behaviors & disease processes" (Long et al. 2019, p. 270)
- Because of these high-quality images, better diagnoses can occur
- Further studies are needed for improved outcomes to benefit in diagnoses and surgery preparation

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