The International Young Researchers' Conference
DOI: 10.34614/iyrc2021f11

Brain Reactions to Film Watching

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Abstract

This systematic review sought to uncover the mechanisms through which films induce certain emotions and the ways in which people's brains respond to those stimuli through the lens of neuroscience. Films vary in composition, though many make use of motion, both through characters and the camera, to elicit emotions. They also use previously successful scene setups and actor castings for a similar effect. Brain regions have differential reactions to films, especially in response to film duration, category, and context. Brain hemispheres generally differ from each other in their responses as well, such as in response to positive versus negative stimuli. People's characteristics, such as empathy levels and age, can also influence the level to which the brain responds to films and the differences between activation levels of different regions. Substance abuse alters the brain's chemistry; it can also increase the activation of specific brain regions. Several studies utilize electroencephalography and functional magnetic resonance imaging; their limitations are discussed. Future research could also explore other possible measures of emotional response to films.

Keywords: Emotional induction, Film, Movie, Brain regions

Introduction

Countless films have been produced since cinema began in the late 1800s (O'brien, 2015). There are several genres, production companies, and distributors that are well-known to the public, with respective examples being fantasy, the Walt Disney Studios, and Columbia Pictures. Another familiar aspect of films is their ability to elicit certain emotions at specific times. People might cry, laugh, feel anger, or feel frightened, depending on the scene. Their facial expressions might also change unintentionally (Fanti et al., 2015). There are databases containing films meant to induce particular emotions, though it is not always specified how those films successfully complete the task, and some studies partly or mostly base the effectiveness of the films on ratings from their participants (Gabel et al., 2019; Zupan & Eskritt, 2020). This review attempts to uncover the ways in which films influence people's emotions and affect the brain.

Methods

A systematic review was conducted by searching the PubMed database for papers on emotional induction through films. Two separate searches were completed with the following phrases: "'film' and 'emotion'" and "'movie' and 'emotion.'" A total of (n = 696) papers were present at the start of the review. Date of publication and location of research were not of concern to this review and no papers were excluded based on these criteria. The titles of the papers were reviewed manually. Any paper not pertaining to films affecting emotions or the way in which the brain processes emotions was excluded. After this first screening, (n = 223) papers remained. Another group of (n = 88) papers was removed because they contained neither the word "film" nor the word "movie" in their titles. There were (n = 12) duplicates, which were also removed. The abstracts of the

remaining (n = 123) papers were downloaded and individually reviewed for relevance. Papers were removed if they only spoke of creating a database of films for eliciting certain emotions without giving concrete data for their effectiveness or if they did not focus on cerebral responses to films. Afterwards, (n = 26) papers remained. An attempt was made to retrieve the full text for each paper, but (n = 3) were unavailable. After screening the full texts of the papers, (n = 16) were included in the review. Figure 1 depicts the overall screening process.

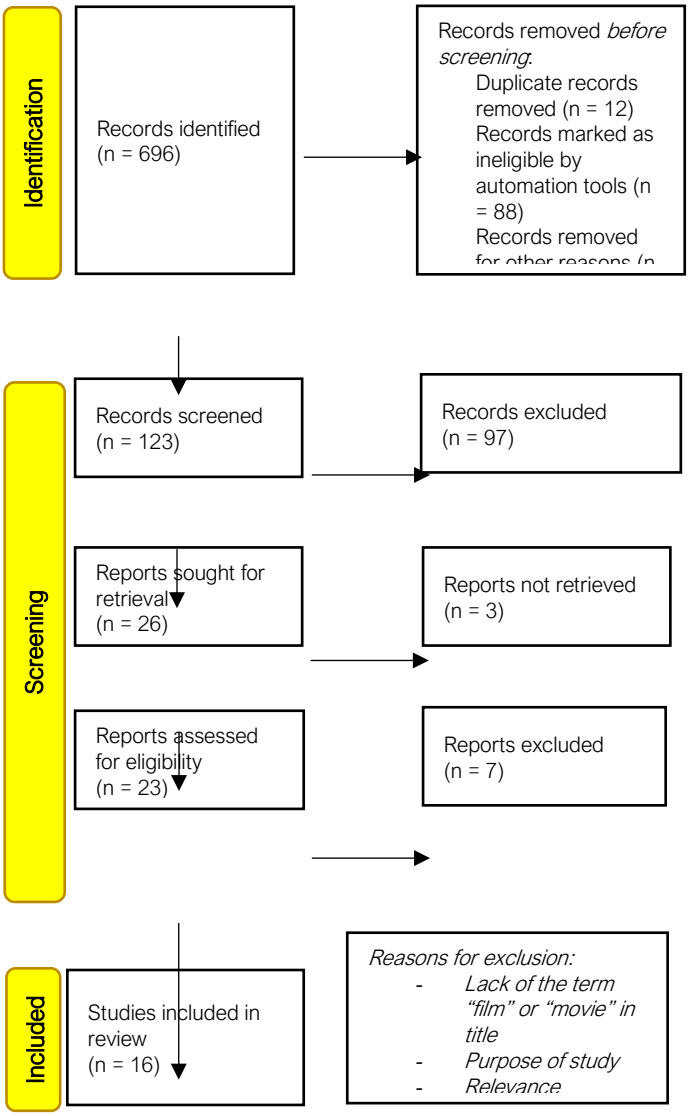

FIGURE 1: PRISMA flow diagram depicting the process for choosing the papers included in the review.

Film Techniques for Influencing Emotions

One of several ways in which films may emotions is through the use of motion (Dayan et al., 2018). Local motion concerns the movement of objects and humans whereas global motion concerns the camera. The latter tends to influence emotion more strongly than the former. Motion can convey information that might describe the emotions of characters, the movement of the plot, or other key factors that play in a film's storytelling, thus influencing the viewer (Dayan et al., 2018).

Once a particular setup has been used and is deemed effective, it tends to show up again in future films. For instance, several films depict romantic separation scenes by using a couple standing together, some close-ups, the physical separation of the couple, and a crescendo of sad music (Schlochtermeier et al., 2017). The use of certain actors can also influence people's emotions. Zhu & Wu (2021) found that people were more willing to watch films with skilled actors (those with recognized acting abilities) than publicity actors (those chosen based on their physical appearance) and that they were more engaged emotionally when skilled actors were present.

Brain Reactions to Films

Brain regions and chemical secretions

The brain is composed of several regions, such as the dorsal anterior cingulate cortex and the dorsomedial prefrontal cortex, which communicate with each other and have different functions (Anderson et al., 2013), although many be activated in conjunction to process stimuli from films (Karama et al., 2011). Several experiments show the diversity of brain regions that are involved in the processing of audiovisual information and the emotions that come with them. Schlochtermeier et al. (2017) used functional magnetic resonance imaging (fMRI) in order to determine anterior and posterior cortical responses to sad romantic separation scenes. Three forms of the scene were used: one was the original scene from the film, one had a replaced

segment, and one had a random order. The anterior and posterior cortical midline regions were activated more when presented with the original scene and the scene with the replaced segment while the temporal gyri were activated less. The anterior and posterior cortical midline regions are part of the default mode network, which is associated with intrinsic processing, while the temporal gyri process external stimuli, such as sound (Schlochtermeier et al., 2017). Longer scenes also promote greater activation of brain regions (Schlochtermeier et al., 2017). In another study, global motion in emotional film clips revealed significantly stronger blood oxygenation level dependent responses to emotional relative to neutral clips of regions like the right inferior frontal gyrus, right precuneus, and left interior occipital gyrus (Dayan et al., 2018).

Different brain regions are activated in response to different stimuli. For instance, traumatic films tend to activate fear processing regions of the brain, such as the amygdala and insula, and activation of those regions can be influenced by the production of hormones in the endocrine system (Miedl et al., 2018). Amusing films activate the temporal cortex and bilateral temporo-parieto-occipital cortex whereas erotic films activate areas like the amygdala and prefrontal cortex (Karama et al., 2011). Domain-general brain networks can also work together to promote different emotional outputs. One finding from Raz et al. (2016) was that stronger connectivity between the dorsal salience network and medial amygdala network was associated with greater emotional ratings in all film categories (anger, fear, and sadness) examined.

Hemisphere asymmetry

Several papers discussed whether there is a difference between the left and right hemispheres in the processing of films and emotions. Two stated that the effects are not different between the two hemispheres (Dennis & Solomon, 2010; Kaviani et al., 2010), while three did find differences (Costa et al., 2006; Tomarken et al., 1990; Wittling & Pflüger, 1990), which are summarized in Figure 2. Costa et al. (2006) found differences in the electroencephalographic (EEG) synchronization of different brain regions. For instance, sadness was more synchronized in the left while happiness was more synchronized in the right hemisphere (Costa et al., 2006). Wittling & Pflüger (1990) found that the right hemisphere had more control over cortisol secretion compared to the left hemisphere. Tomarken et al. (1990) showed that frontal asymmetry was associated with increased differences in positive and negative reactions. Other research seems mainly to back up the claim that the brain hemispheres do differ in their responses to stimuli, such as by controlling the heart during film watching (Wittling et al., 1998) or by influencing response inhibition to different faces (Schrammen et al., 2020).

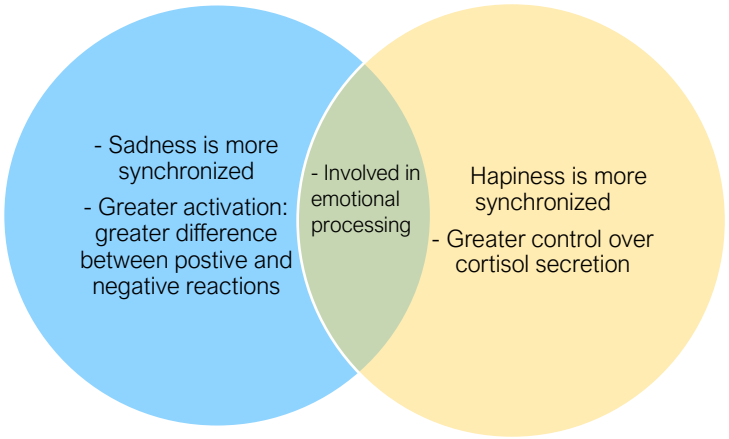

FIGURE 2: Venn diagram comparing the two hemispheres of the brain.

EEG findings

Electroencephalography can be used in order to measure electrical brain activity with electrodes (Müller-putz, 2020). Particular frequencies correspond to different mental states and functioning of different brain regions (Krause et al., 2000). For instance, Krause et al. (2000) found that there was greater synchronization

while watching aggressive versus sad and neutral films in the 4-6 Hz band, which might reflect theta EEG activity and activation of hippocampal-cortical pathways. One finding from Costa et al. (2006) was that frontal regions were more synchronized than others and that sadness was more synchronized than happiness.

Physical measure of attentiveness

Some automatic physical processes, such as blinking, can reflect the brain's response to external stimuli. Having greater blink rate inhibition reflects greater attention to visual stimuli so less information is lost. In a study conducted by Maffei & Angrilli (2019), it was found that people blink less while watching films containing erotic, scenic, or compassionate elements, whereas they blink more while watching films containing threatening elements that elicit fear and sad elements. The erotic and scenery categories in the study were rated as the most pleasant, therefore it follows that people would pay more attention to them and blink less often. Compassion clips were rated as unpleasant, but they contained prosocial elements that would move the viewer to want to help the characters. Fear and sadness clips made people want to reject the information and formulate a plan for defense.

Personal characteristics affect emotional responses to films

People with certain personality traits, such as different levels of empathy, can have different neural responses to films. A study by Maffei et al. (2019) shows that higher levels of empathy are associated with greater activation of brain regions involved in the processing of other people's pain and greater cortical gamma secretion in response to several film categories whereas lower levels of empathy are associated only with an increase in cortical gamma secretion in response to negative films. A survival instinct is activated by the negative films while other films presenting appetitive material may be less arousing because they are not as ingrained biologically (Maffei et al., 2019).

People with substance abuse disorder have different activation of brain regions in response to films. Park et al. (2016) explored the effects of alcohol dependency on the experience of anger through fMRI scans. Alcohol-dependent and non-alcohol-dependent participants were found to experience anger to a similar extent, though the alcohol-dependent group had significantly greater activation of the bilateral dorsal anterior cingulate cortex, right cuneus, and right precentral gyrus.

Age has also been shown to impact emotional responses, especially since the brain is constantly changing and developing as people grow up. Gruskin et al. (2020) found that children's brain responses were unrelated to depressive symptom severity whereas adolescents with greater depressive symptom severity had atypical fMRIs.

Discussion

Films may use various techniques in order to elicit specific emotional responses, such as by utilizing motion to convey information, making use of previously successful setups, and using well-known actors. As the brain is composed of several regions, there is differential activation of those regions based on film category, presented context, and the length of the film, and some regions may be activated together to generate the appropriate emotional response. The amygdala is frequently mentioned in studies of emotional processing as it is generally associated with the processing of fear- and anxiety-inducing stimuli (Davis, 1992).

It is likely that the left and right hemispheres of the brain react to stimuli in different ways as evidenced by studies specifically based on films and studies based on other things like facial expressions. EEG studies also showed the different amounts of synchronization in response to different film categories, thus confirming that different brain regions react to different film categories.

Spontaneous blink rate demonstrates a level of attention, and it generally increases when a person is presented with unpleasant and threatening information while it decreases when there is pleasant imagery or a need for greater analysis of scenes.

Having higher levels of empathy is generally associated with greater activation of pain-processing brain regions and greater cortical gamma secretion compared to people with lower levels of empathy. Substance abuse and age also influence the brain. The former increases activation of specific brain regions, whereas the latter changes the relation between depressive symptoms and brain responses. Other personality traits and mental conditions likely influence the brain's responses to films as well.

Limitations

As this study was conducted under a time constraint, it was difficult to perform multiple searches, thus there was a limited number of papers to review. The researcher looked through all of the papers, so there was also a limit to the number of papers that could be read. Some full-text papers could not be accessed because of paywalls and other obstacles. There could also be a lack of research in some areas of how films elicit certain emotional. The majority of papers included in this study discussed the responses of specific brain regions and differences between them, but only Dayan et al. (2018), Schlochtermeier et al. (2017), and Zhu & Wu (2021) described some of the mechanisms behind how films can influence audiences.

Another limitation could come from the methods of the papers included in this study. EEGs can only detect synchronous brain activity at the scalp, so some information might be lost (Müller-putz, 2020). Neither EEGs nor fMRIs are invasive, which means that both are indirect measures of brain activity, and their findings rely on inferences (Hall et al., 2014). The findings from these studies might not be conclusive because of unknown confounding factors and the limitations of non-invasive technology.

There were also limitations to the selection criteria. The researcher only included papers with the word "film" or "movie" in the title, which might have eliminated papers of interest. The papers included mainly analyzed people's emotions in response to film clips or scenes rather than full films, which could impact emotions and brain regions.

Future research

Future research could take into account other physiological responses people might have to films, such as salivary cortisol levels, heart rate, and skin conductance levels. Other databases, such as EBSCO, JSTOR, and ProQuest, and other keywords could be used to obtain a greater variety of papers and information. More specific searches could be conducted to find other ways in which films induce specific emotional responses. Searches could also be conducted on the influence of mental conditions on the emotional reception of films.

Conclusion

In conclusion, films employ various methods that are translated into differential activations of brain regions, including the left and right hemispheres, and brain responses can be influenced by a person's characteristics and substance use. Films are often used as a source of enjoyment, but many neural processes are involved in generating the specific emotions felt while watching films. They can be a source of inspiration and can be used for scientific experiments.

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