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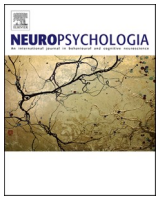

The art of film: Perspective on neural clues to repeated attraction to movie watching

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ABSTRACT

This article about possible neural underpinning of repeated attraction to watching movies is dedicated to the memory of Prof. Eran Zaidel, who made outstanding contributions to neuroscience (and loved watching movies). The film is an art form crafted by multiple artists from diverse fields, contributing specialized skills, talents, and creativity to the final product. Attention-attraction to all artworks has deep biological roots. Movies have been attracting audiences repeatedly ever since they were introduced over 100 years ago. Although countless studies analyzed the nature of the art, the neural underpinning of repeated attraction to viewing movies has been understudied. Here, clues gleaned from non-film findings are proposed. The perspective suggests that functions of the mesolimbic "reward pathway" associated with pleasure and joy, the brain regions responding to facial beauty, to pictorial art aesthetics, and to music listening with increased dopamine levels are all recruited in the repeated attraction.

1. Introduction

The art of film is an extension of storytelling, which emerged long before the film. The tradition of telling stories has deep roots in humans' distant evolutionary past (Smith et al., 2017). The practice is currently ubiquitous throughout the world. Early humans started out telling them aurally, possibly first around the base camp's fire hearth where they congregated to share food, warmth, light, and rehash experiences concerning their survival (D. Zaidel, 2005, 2019). Hundreds of thousands of years later, telling stories about real events and imaginary situations blossomed through literature and printed books. The art became a regular feature of the human cultural repertoire.

Enriching the narrative of stories by making them life-like through motion and light runs deep: There is a tantalizing speculation that pictorial animation was attempted about 15,000 years ago in the Lascaux cave, France, when humans still dwelled in caves, well before there was written language or movie cameras (Azéma and Rivère, 2012). By the time movies were created with advances in technology, and introduced in theaters over 100 years ago (Arnheim, 1958), audiences sitting in darkened theaters were culturally prepared to embrace animated stories on the screen, created not only by the director and cinematographer, but also by the work of multiple artists from diverse artistic fields. Their separate contributions intersect artistically, culminating in drawing the audience in to the story. Unlike narratives in aural stories, which leave a great deal to the listener's personal imagination and are bound by limitations in the imperfect communicative nature of words, movies are more explicit by comparison. They focus viewers' attention to the narrative graphically. In the perspective offered here, clues to the repeated attraction to movies lie in neural activity in separate as well as overlapping brain regions mediating pleasure, beauty, and self-identification.

The arts have been consistent cultural features of human societies in the past thousands of years. Their widespread practice attests to their adaptive survival value. They repeatedly engage our attention to their contents and subject matter through artistic displays of talent, skill, and creativity. Inherited traits passed on from humans' biological ancestors for the engagement have been suggested, "… Looking upon art as a system of communication reveals another key to its practice and value to humans, and therein lies the purpose of the esthetic reaction, namely to pull the viewer in to the artwork through attention-attraction" (D. Zaidel, 2015, p. 2). The communicative nature in the art of film is similar to the other arts in that it introduces ideas and reveals facts, expresses wishes, stirs shared emotions, and depicts human experiences, which together engage our attention, memory, cognition and thinking. With movies in particular, attentional mechanisms through activation of two major sensory modalities, vision and audition, aid consolidation of memory for explicit details (e.g., faces, scenes, action, music) and for deriving the plot.

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Importantly, repeated attraction to movie watching is observed regardless of *genre* and regardless of whether or not they are in color, depict true or fictional events, exhibit well-known or new actors, shaped by established directors or beginners, speak in familiar or foreign language, or leave spoken language out altogether. Some researchers have proposed that in part the attraction stems from cognitive and psychological considerations (Tan, 2018) and in part, from the sheer enjoyment of being absorbed in the story (Bilandzic and Busselle, 2011; Bálint and Tan, 2015). However, the neural bases in the brain for the motivated attraction has rarely been explored. Here it is proposed that considering the recruitment of the mesolimbic dopaminergic "reward system" pathway (involved in joy and pleasure), the neural networks active in pictorial aesthetics and facial beauty, and the neural underpinning of Theory of Mind (ToM), the socially-based cognition involved in self-identification with the story characters, is worthwhile. In the present view, all of these offer clues to repeated attraction to movie watching, albeit they are based on generalization from non-film studies.

2. Neural clues

It is logical to suppose that the attraction to the "reward" obtained from movie watching is a response to the intersection of all the contributing artistic fields. Musical scores, actors with attractive faces, and pictorial beauty are the focus here.

The mesocortical-limbic dopaminergic system is considered a neural pathway associated with gratification and positive experiences in which there are enjoyable consequences (Berridge and Kringelbach, 2015; Kringelbach and Berridge, 2017). Neuroanatomically, from the ventral tegmental area (VTA) in the midbrain dopaminergic neurons project to the nucleus accumbens in the ventral striatum where the nucleus regulates amount of dopamine released to the medial prefrontal cortex (mPFC) and the orbital prefrontal cortex (OFC) (Lewis et al., 2021; Starkweather et al., 2018; Tzschentke, 2000). Being an excitatory neurotransmitter, dopamine levels are also known to play a major role in other behaviors, notably in addiction ("uncontrolled attraction" with physiological bodily response) to food, drink, sex, recreational drugs, smoking, and social interactions (Zuckerman and Neeb, 1979; Berke, 2018).

Memory for the pleasureful experience itself is part of the neural mechanism underlying repeated attraction to movie watching. The critical structure in the brain for memory consolidation is the hippocampus. Remembering salient events interact with more-of-the-same experiences. Dopamine plays a role in memory for highly motivated, goal-directed behavior based on past behavior (Shohamy and Adcock, 2010), and in repetition of the pleasureful experience in both animals (see Chen et al., 2021) and humans (see Cohen et al., 2019). Pathways functionally connecting the hippocampus and the ventral tegmental area have been found in functional magnetic resonance imaging (fMRI) studies in humans (Cohen et al., 2019), consistent with the role of memory in pleasureful events of the kind proposed here, namely the repetition of movie watching.

Music has a dominant role in focusing attention and following the narrative in movies. It shapes expectations, resolves anticipation, arouses emotions, and, in general, helps tie (remember) the narrative together (Ansani et al., 2020). Of all the arts, dopamine levels have been studied mostly in music listening, independently of movies, showing that increased release is associated with pleasure (Zatorre, 2015; Mavridis, 2015; Salimpoor et al., 2015; Ferreri et al., 2019).

Actors with highly attractive faces are a source for repeated attraction to movie watching. The positive response of viewers to human facial beauty has been suggested to stem from attention-attraction traits inherited from our biological ancestors where genetic and fitness qualities are exhibited in animal mate selection displays (D. Zaidel, 2015). The biological roots associated with attraction to beauty are consistent with universal high beauty ratings across cultures for the same faces, young infants selective response to beautiful faces, ease of job attainment and high positive character ratings for people with beautiful faces (see, Little et al., 2011). In fMRI studies of facial beauty, maximal consistent activation has been reported for the mPFC, which is part of the mesolimbic "reward" system (O'Doherty et al., 2003; Ishai, 2007) as well as for the face processing areas in the right anterior occipital lobe and right fusiform gyrus (Yang et al., 2022). Moreover, investigations of the role of makeup in facial beauty confirmed maximal activation of these frontal lobe regions (Ueno et al., 2014; Arai and Nittono, 2022). Increased activation upon viewing beautiful faces in the nucleus accumbens have also been reported (Aharon et al., 2001; Covey and Cheer, 2019). Memory for beautiful faces, which are remembered better than non-beautiful faces, maximally activates the OFC, and, as would be expected, the hippocampus as well (Tsukiura and Cabeza, 2011).

Neural activation in response to pictorial aesthetics is measured with stimuli consisting of artworks, mostly photographed paintings. Meta-analyses of neuroimaging studies revealed widely spread activated brain regions, which include the OFC as well as brain regions specializing in perceptual, cognitive, motor, and affective functions (Nadal, 2013; Vartanian and Skov, 2014; Vartanian, 2015; Boccia et al., 2016). Given multiple intersecting sources of beauty in film (faces, scenery, music, story) we would similarly expect widely spread brain activation across several regions upon viewing movies.

It has been suggested that identifying with the characters and the storyline is a major attraction factor to movie watching (Gallese and Guerra, 2022). The identification draws on ToM processes, explained in terms of imagining, inferring, assuming the other's beliefs, emotions, and intentions (C. Frith and U. Frith and Frith, 2006; U. Frith and Happé, 1994). Research has shown that when ToM is absent, as is the case in autism, there is lack of meaningful social interaction (Happé and Frith, 2014). A cognitive aspect of ToM and an affective aspect of ToM have been identified (Kalbe et al., 2010; Sebastian et al., 2011). With the cognitive ToM the other's beliefs and intentions are inferred, while with affective ToM, the other's feelings and emotions are understood and empathized. Neuroimaging studies of participants viewing short movie segments (entire movies in such investigations are rarely used) revealed widely distributed regional brain activation and functional connectivity spanning the frontal (including the OFC), parietal, and temporal lobes, the hippocampus and parts of the limbic system in both cerebral hemispheres (Coëgnarts, 2017; Tikka et al., 2018; Cohn, 2020; Meer et al., 2020; Jääskeläinen et al., 2021). Good memory depends on attentional focus whose functions are represented in the frontal and parietal lobes, both found to be activated in these studies, and the fact that the hippocampus is activated highlights the role of memory for previous experiences in identifying with portrayals of others in movies. Clearly the neural recruitment of multiple cognitive and affective functions is evidenced by these neuroimaging studies.

Film makers are fascinated by the attraction to their art. Notably, repeated movie watching has been portrayed artistically in the film, *The Purple Rose of Cairo*, by Woody Allen et al. (1985). Two major ideas relevant to the discussion here are portrayed: One is repeatedly watching movies in the theater, and the second is ToM, identifying with the movie characters and the storyline. Allen uses an artistic technique known as "breaking the fourth wall" to blur the boundary between the film projected on the screen and the audience when a character "steps out" of the screen, and strikes reciprocally animated conversation with the protagonist sitting in the theater. The technique highlights ToM, reciprocal identification between portrayed characters and movie spectators.

3. Possible future clues

Social cues, emotional reactions, and self-concept (consciousness of the self) interact with viewers' reactions to movies (Tikka, 2008). Future explorations into the attraction to movie watching could benefit from innovative hemispheric specialization approaches pursued by Eran Zaidel, first at Caltech (E. Zaidel, 1975, 1976, 1978, 1987) and

subsequently with UCLA graduate students working in his laboratory. Together the lab published countless studies (albeit not of movies) on both functional symmetries and asymmetries as well as their integration through the corpus callosum, using neuroanatomical morphological methods (Aboitiz et al., 1992; Aboitiz et al., 1995; see review Mooshagian, 2008), neuroimaging, and hemi-field techniques. Of particular relevance here is tackling hemispheric asymmetry issues in attentional eye-gaze cues (Greene et al., 2009; Greene and E. Zaidel, 2011), anxiety in attentional focus (Crump et al., 2013), self-face recognition in both hemispheres in complete commissurotomy (Uddin et al., 2005a) confirming earlier reports (Sperry et al., 1979), and right hemisphere superiority in recognizing others, importantly in healthy participants, in autism, and mirror-neurons systems (Uddin et al., 2005; Uddin et al., 2006; Uddin et al., 2008). Such empirical hemispheric approaches (eye-gaze, social cues, self-recognition), particularly with functional neuroimaging, could shed promising light into some of the components (not all are currently known) of movies that intersect with the neural underpinning of repeated attraction to movie watching.

4. Concluding remarks

Unlike narratives in aural or read stories, which leave a great deal to the listener's personal imagination and are limited by imperfect communication through words, movies are more explicit by comparison. Films graphically depict specific personal actions and myriad self-identifying events that shape viewers' imagination, socio-cultural norms, and behavior, and satisfy intellectual curiosity. In this way, the art of film, through the work of the director and cinematographer, as well as of multiple artists, beckons us to use our cognition to distill the meaning of the story, influence issues not otherwise contemplated, and re-visit familiar experiences presented in new perspectives. Moreover, their plot is easier to remember than aural or read stories because two sensory modalities are used, the visual and auditory, which together optimize memory permanence. Without a neural underpinning for the memory of the pleasure and joy as "reward", the repeated attraction is less likely to be indulged.

Credit author statement

This manuscript was conceived and written solely by the author, D. W. Zaidel

Data availability

My article is a perspective/review of published papers, and reflects my opinion.

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