The International Encyclopedia of Media Psychology

Neuropsychological Underpinnings of Emotional Responsiveness to Media

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Abstract

Responding emotionally to a movie, video game, Instagram post, or a social robot is quite a common experience. Whereas the experience felt is real, the mediated encounter or message often is fabricated, just fiction, and involves artificial non-existent characters. An intriguing question is thus 'why does media use feel so real and how are emotions induced by processing media?' The current entry aims to answer that question by outlining the neuropsychological underpinnings of emotional responsiveness to media. We discuss how emotions and emotion regulation are processed in the brain and exemplify neuro-psychological models. Key is the fast processing of feelings and emotions, mostly operated in subcortical-limbic brain regions, relative to slower and more reflective processing through the prefrontal cortex, which dynamically interact as one system. Then, we outline the neural underpinnings of the rewarding and disturbing effects of (social) media use. Finally, we show how the parallel processing of emotions in neuropsychological models may explain the often-found emotion-bias in media use. In all, this entry aims to provide insights in the psychology behind media use and open new perspectives for relevant media psychological research.

Keywords

Emotional processing; Media-based emotions; Neuropsychology; Brain mechanisms; Emotion-bias; Media-based realism

Please cite as:

Konijn, E.A. & Achterberg, M. (2020). Neuropsychological underpinnings of emotional responsiveness to media. In: van den Bulck, J., Sharrer, E., Ewoldsen, D. & Mares, M-L. (Eds). *The International Encyclopedia of Media Psychology*. Wiley Publishers. See: https://blackwells.co.uk/bookshop/product/International-Encyclopedia-of-Media-Psychology-by-Jan-van-den-Bulck-author/9781119011064

Introduction

Observations show that most people regularly respond emotionally to media, whether a movie, video game, Instagram post, social media message, or toward a social robot. Whereas they are aware that media are just composed, fabricated, or plain fiction, individuals tend to respond as if the mediated encounter were real in activating our emotional system. This raises the question why does media use feel so real and how are emotions induced by media processed? In answering this question, the current entry takes a closer look into the underlying neural mechanisms. By outlining the neuropsychological underpinnings of emotional responsiveness to media, we aim to provide insights in the psychology behind media use and provide new hypotheses for relevant media psychological research.

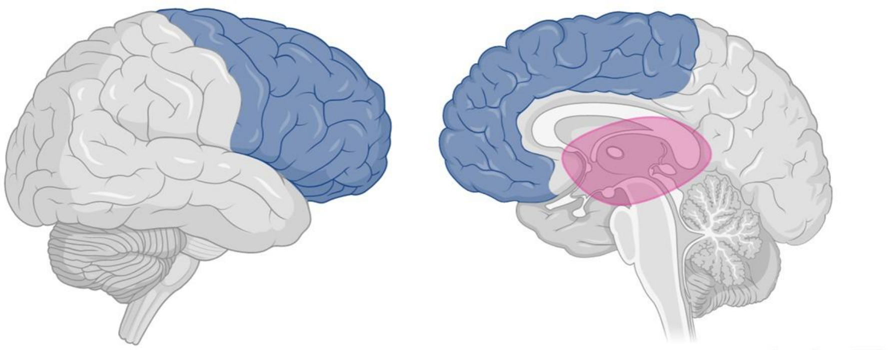
Studying emotions in general, and emotional responsiveness to media in particular, can be challenging as it is a complex form of behavior that is strongly intertwined with our day-to-day lives. In order to decompose these processes, researchers have often worked with experiments. The advantage of an experiment is to examine participants in a controlled setting, making it possible to study unique aspects of complex behaviors. Emotional responsiveness to (social) media has been studied in a variety of experimental settings, for example by manipulating Instagram likes (Sherman et al., 2018), by identifying with violent video game characters (Konijn et al., 2007), by simulating feedback on the participant's profile page (Achterberg et al., 2018), or (ostensible) peer feedback on media images (van der Meulen et al., 2017). An additional advantage of experimental paradigms is that they are very suitable to use in combination with neuroimaging methods, such as functional Magnetic Resonance Imaging (fMRI). In addition to studying behavior, neuroimaging methods can provide information about covert aspects of processing emotions.

Emotions and emotion regulation in the brain

Since its inception 1990, fMRI has been widely used to unravel brain mechanisms that are related to behavior, cognition, and emotions. fMRI is a measure of brain activity that is based on the magnetic properties of oxygen in blood (for a concise overview of MRI methodology, see Glover, 2011). Brain cells – neurons – do not have their own energy supply and therefore they need additional energy when they become more active, which is provided in the form of oxygen. Through a process called the hemodynamic response, blood travels to the active neurons and releases oxygen in a greater rate than it does to inactive neurons. As oxygenated blood has different magnetic properties than deoxygenated blood, fMRI can map out the neurons of brain regions that are using more oxygen, that is, are more active. When combined with experiments, scientists can study the difference in Blood Oxygen Level Dependent (BOLD) in one condition opposed to another and see which brain regions are more active. For example, one can compare which brain regions respond to romantic movie scenes versus violent scenes (Sege et al., 2017).

A wealth of neuroimaging research has provided insights in the neural underpinnings of emotions. For example, numerous studies have shown that brain activation within the subcortical-limbic system (see **Figure 1**) is associated with affective-motivational and emotional responses. These subcortical regions are deeply rooted in the brain and are very old in evolutionary terms. Folded over is the cerebral cortex, the outer layer of neural tissue of the brain. In contrast to the subcortical system, the cerebral cortex shows the large evolutionary variation and has evolved most recently. It plays a key role in attention, awareness, perception, and cognitive control. Specifically, the frontal part of the cerebral cortex, the prefrontal cortex (**Figure 1**) has been implicated in planning complex cognitive behavior, decision making, and emotion regulation. A better understanding of the interactions between brain regions that respond to emotions and emotional content, and brain regions that help to process and regulate these responses can help us understand how emotions induced by media are processed and shed light on the neuropsychological underpinnings of emotional responsivity to media.

Figure 1. *The subcortical-limbic region (pink) and the prefrontal cortex (blue). Figure created with Bio Render (www.biorender.c*



Neuropsychological models of emotions and emotion regulation

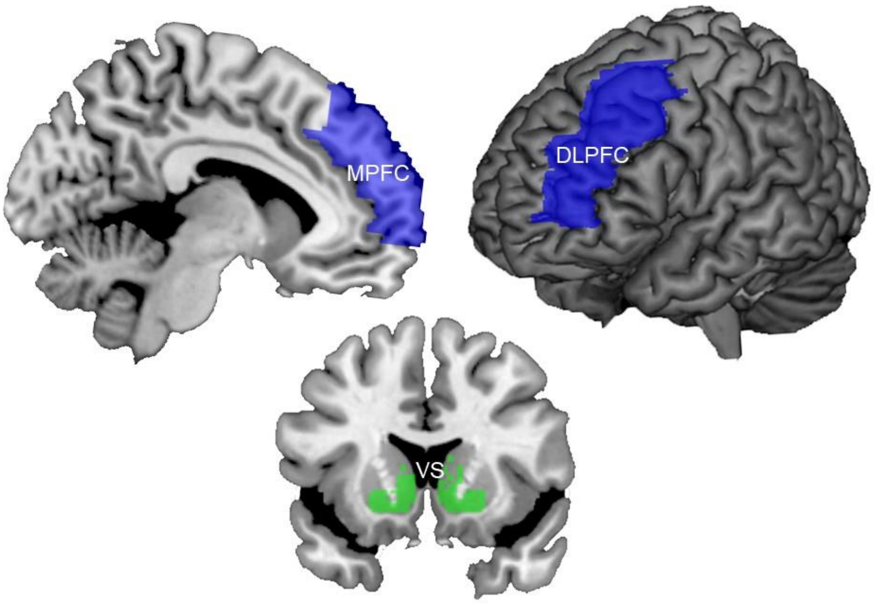
Important insights on the neural basis of emotions and emotion regulation come from studies that are focused on a developmental phase where emotions are particularly salient: adolescence. Adolescence is the transition period between childhood and adulthood and ranges from approximately 10-22 years (Crone & Dahl, 2012). Adolescent behavior is often driven by emotions: it is a phase marked by thrill seeking and shows the highest prevalence of mood disorders such as depression and anxiety. Adolescents also seem most susceptible to media influences compared to other age groups (Brown & Bobkowski, 2011), which might be explained accordingly. Several neurobiological models have been proposed to explain emotion-driven behavior in adolescents (Casey, 2015). These models are mostly formalized on dynamic interactions between two processes: a ‘hot’ or lower-order process that is emotionally driven by fears, desires, and reflexes, and a ‘cool’ or higher-order process that is emotionally neutral, strategic, and flexible (Casey, 2015). The lower-order process comprises the relatively fast processing of feelings and emotions, is often considered intuitive or subconscious, and is mostly operated by the subcortical regions (**Figure 1**). The higher-order process is relatively slow and more reflective and is mostly executed by the prefrontal cortex (**Figure 1**). The relatively slower and faster processes dynamically interact as one system (LeDoux & Brown, 2017).

Interestingly, the subcortical regions and the prefrontal cortex do not develop with the same pace (Casey, Jones, & Hare, 2008). The mismatch in developmental trajectories of subcortical brain regions and the prefrontal cortex can provide a neuropsychological perspective of emotion regulation (Casey, 2015). Specifically, because the gradual linear increase of prefrontal cortex maturation is slower than the non-linear increase of affective-limbic regions, there is an imbalance between bottom-up limbic regions and top-down control regions, which is most pronounced during adolescence. This imbalance between subcortical and cortical maturation hinders emotion regulation and can result in risky or reward driven behavior, which is commonly seen in adolescence. Nowadays, adolescent risk seeking behaviors seem to occur more often online than in ‘real-life’ (e.g., sexting). Although in general, these networks are efficiently developed by early adulthood, large individual differences remain in the ability to have top-down cognitive control over bottom-up limbic regions. These individual differences might act as an underlying neuropsychological mechanism for why some individuals are more emotional responsive to (social) media use and why others might be more capable of regulating (social) media induced emotions.

Neural underpinnings of (social) media use

Neuroimaging research has started to unravel the neural mechanisms of emotional responsiveness to media. Social media, for example, has been studied using experiments that manipulate social feedback (Crone & Konijn, 2018). These studies showed that social acceptance is associated with increased activity in striatal regions, specifically in the ventral striatum (VS, **Figure 2**), part of the subcortical system associated with emotional responses (Achterberg et al., 2016; Sherman et al., 2018). That is, participants showed more activity in the VS while viewing their Instagram pictures with many ‘likes’ compared to their pictures with few ‘likes’. As numerous studies have shown that activation of the VS is associated with reward processing (Sescousse et al., 2013), this heightened activation could reflect the rewarding value of positive feedback on social media.

Figure 2. *Brain regions implicated in emotions and emotion regulation. MPFC: medial prefrontal cortex, DLPFC: dorsolateral prefrontal cortex; VS: ventral striatum. Figure adapted with permission from Achterberg (2019).*



Studies using real-life social media have also pointed to the striatum: individuals that spend more time on Facebook showed smaller gray matter volumes of the nucleus acumens, a region within the VS (Montag et al., 2017). Smaller gray matter volume of the VS has previously been related to higher sensitivity to rewards and higher impulsivity (Tschernegg et al., 2015). Possibly, these individuals are more sensitive to the positive emotions associated with Facebook use, and therefore are more inclined to spend time using such platforms. The fast processing of subcortical reward systems might be more pronounced than the lower processing prefrontal control, making it difficult to downregulate the urge to engage in (social) media. Indeed, longitudinal evidence has shown that individuals with stronger brain connectivity between the VS and the prefrontal cortex are better able to regulate impulses. That is, participants with stronger brain connectivity were better able to choose a delayed larger reward over a smaller, immediate reward (Achterberg et al., 2016). Such neurological rewarding mechanisms may also underlie the enslaving nature of playing video games. For some individuals it might be difficult to choose a larger reward in the future, say eight hours of sleep, over the immediate reward of enjoyment when playing a video game or binge-watching. These individual differences in behavior might arise from individual differences in neural mechanisms and subcortical-cortical brain connectivity.

Indeed, by using real-life (social) media use, it was recently shown that individuals who spend more time using media had stronger structural brain connectivity between the VS and the medial prefrontal cortex (MPFC, **Figure** 2) and weaker brain connectivity between the VS and the dorsolateral PFC (DLPFC, **Figure 2**) (Wilmer et al., 2019). Put otherwise, these individuals showed stronger networks between social cognition (MPFC) and reward regions (VS), than between cognitive control (DLPFC) and the VS. This is in line with neuroimaging studies reporting that the extent to which individuals are able to regulate aggressive behavior after social rejection is associated with neural activation in the DLPFC (Achterberg et al., 2016; Achterberg et al., 2018).

Related, the protracted development of adolescents' social brain regions implicated in perspective taking (Blakemore & Mills, 2014) hampers reappraisal and emotion regulation. This can explain the vicious cycle found in cyberbullying behavior. Cyberbullying peaks during adolescence and being a victim is highly correlated with acting as a cyberbully oneself. Research showed that the frustration and anger of being victimized led these adolescents to seek media with antisocial media content, which eased the path to become a cyberbully oneself (den Hamer & Konijn, 2015). Furthermore, it was shown that adolescents who applied reappraisal strategies to regulate their anger, were less inclined to bully in cyberspace than those applying 'other-blame' strategies (den Hamer & Konijn, 2016). In a similar vein, adolescents with peer-induced anger were morally more lenient toward media portraying antisocial behaviors than those not angered (Plaisier & Konijn, 2013).

Neural underpinnings of emotion-bias in media use

Various media studies have shown that emotions tend to color our perceptions of media content, resulting in an emotion-bias. For example, discrete emotions were shown to frame information in media messages, with an anger frame resulting in a more retributive approach and a fear frame resulting in a more protection-oriented approach against an undesirable activity (Nabi, 2003). Other media studies showed that viewers' emotional state led to recall errors (Brosius, 1993; Lang, 2000) and favored emotional material in recall (Zillmann, Knobloch, & Yu, 2001). Doré et al. (2019) showed that amygdala activity predicted the impact of anti-smoking messages, which was mediated by the ventromedial prefrontal cortex and moderated by neural mechanisms of emotion regulation. In applying the neuropsychological model discussed above, we can better understand how emotion-arousing media content is processed. The fast processing of emotions associated with engagement, sensation-seeking, and emotional responsivity may then take control precedence over more reflective and relatively slower processes, such as reappraisal and emotion regulation.

Konijn et al. (2009) applied this line of thought in explaining such emotion-bias in media processing by arguing that the faster processing of emotion cues resonates with how emotions are experienced in real life. Emotions lend realness to the object of emotion because it signifies to the user that something of “real” importance is going on. Physiological sensations accompanying emotions are felt as *proof of reality* and ultimately color the object of emotion (Frijda, 1988; LeDoux & Hofmann, 2018). For example, if a newscaster raises disgust, upon repeated exposure the disgust becomes an inherent part of the newscaster. After all, emotions and sensations as experienced by the user *are* real, even if they are experienced in response to fiction, media or something non-real (e.g., robots, VR). Hence, when media encounters are emotionally gripping, the subcortical brain structures have difficulties discerning fact from fiction and may explain why people may process information from media as if real – ‘it just feels real’ (Konijn et al., 2009).

This emotion-bias has been demonstrated first in experimental studies contrasting video footage presented as fiction-based to the same footage presented as reality-based with participants who were either in an emotional state or neutral (Konijn et al., 2009). Those in an emotional state attributed significantly higher levels of realism to the fiction-based footage than those in a neutral state. Likewise, such emotion-bias has recently been found in comparing fake-news with and without emotional appeals (de Jonge et al., 2020). Participants responding emotionally perceived the fake news as more real than the non-emotional participants. However, the emotional appeal in the message boomeranged among those with political preferences against the message’s appeal. Thus, our neuropsychological approach may explain how emotion-arousing, sensationalist, or populist media messages and “fake news” can be taken for real.

Finally, the neuropsychological model may explain why people are inclined to treat humanoid robots as if they were real human beings. This has been observed in particular in those high in affective needs, such as for lonely elderly and children with autism spectrum disorder. This aligns with earlier research showing that children with impaired attachment styles showed higher needs for bonding with a TV character than those with secured attachment styles (Cohen, 2004). A recent study showed that observers responded with empathy to a maltreated robot and attributed more feelings onto the robot with more detailed facial articulacy than to a facially static robot (Konijn & Hoorn, 2018). Emotional responsivity to social robots is important in establishing socio-affective bonding to social robots. Depending on the relevance and urgency of one’s emotional needs (e.g., loneliness), affective bonding with a social robot may take precedence over the awareness that it is just a media figure or a robot. Such awareness may then disappear into the background. Illustrative is the painful loneliness of the old ladies featured in the documentary *Alice Cares* (2015), that may have driven them to become friends with the humanoid robot *Alice*.

Thus, when media encounters are emotionally moving, the emotional response seems to blur the borders between fact and fake; the imbalanced processing of the instantaneous emotional response and accompanying sensory feedback takes control precedence over cognitive reflection and biases subsequent information processing (perhaps only temporarily). This may explain why people may take (fake) information from media as real – 'it just feels real'. In all, these suggestions call for further empirical testing, specifically also comparing adolescents and adults.

Closing remarks and future directions

Clearly, individuals differ in how they respond to media content, especially when these evoke emotional responses or are evaluated in an emotion-aroused state. We argue that the regulating role of the prefrontal cortex is important to control immediate emotional responses to mediated (social) rewards, rejection, fake news, (violent) video games, appealing ideals, and emotion appeals. We coin the neuropsychological underpinnings of emotional responsiveness to media as explanatory model with imbalanced and dynamically intertwined faster emotion-based processing and slower cognitive-based processing structures in the brain. We presented how these neuropsychological insights align with many observations and research findings of how people emotionally respond to media: the rewarding and disturbing effects of social media use, seemingly irrational and biased perceptions of (fake) media contents, affective bonding to non-existent or artificial media figures, that can be explained by placing them within such a neuropsychological framework.

Current media technology opens possibilities to understand sensitivities to media and social contexts in adolescence and adulthood. For example, YouTube, Facebook, and Instagram provide excellent environments to study combined media content and peers' feedback (Konijn et al., 2013; van der Meulen et al., 2017). An intriguing question for future research is whether regulation or control of media-generated emotions can be trained. Video games and immersive virtual environments might then provide useful training environments (Constantinidis & Klingberg, 2016). These enrichment and training programs are especially important as they can provide insights in the causality of results. That is, by moving beyond correlational studies towards longitudinal intervention studies, we can shed light on whether media behavior affects the brain, or if specific brain mechanisms result in different media behaviors (Crone & Elzinga, 2015). By taking into account the neuropsychological mechanisms, new hypotheses can be formulated and further insights on individual differences in emotional responsiveness to media can be generated.

SEE ALSO: IEMP0291 (Cognitive Functional Model of the Effects of Discrete Negative Emotions); IEMP0169 (developmental changes in fright reactions through the lifespan); IEMP0055 (Excitation

Transfer Theory); IEMP0055 (Guilt and media use); IEMP0128 (Involvement); IEMP0287 (media use and fear of crime); IEMP0176 (parasocial relationships and affective and emotional character engagement); IEMP0177 (moral foundations emotions); IEMP0286 (video games, virtual reality, and fear responses); IEMP0255 (Mood Management Theory); IEMP0175 (Affective Disposition Theory); IEMP0261 (automatic and controlled processes); IEMP0066 (Cognitive Biases and Heuristics); IEMP0202 (Heuristic-Systematic Model (HSM); IEMP0121 (Limited Capacity Model of Motivated Message Message Processing, LC4MP); IEMP0234 (Developmental Changes in Perceptions of Media Reality); IEMP0315 (Event-related Potential Measures (ERPs) and Processing Media); IEMP0305 (Neurocinematics); IEMP0013 (Psychophysiological Methods: Options, Uses, and Validity); IEMP0252 (Self-control, self-regulation, impulse control); IEMP0317 (Robots in Healthcare); IEMP0211 (Media Use and Socio Emotional Learning)

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Contributor Bio

Elly A. Konijn is full professor in Media Psychology at the Department of Communication Science, VU University Amsterdam. Building on her multidisciplinary background in psychology, media studies, and computer science, she initiated and developed the unique graduate and research program in Media Psychology Amsterdam. Her research focuses on three interconnected lines: 1) Relating to media figures, virtual humans, and social robots; 2) Emotions and media-based reality perceptions; 3) Media use among adolescents. Konijn's research work has been published in major scientific journals in the field, books and edited volumes, and was presented in professional documentaries, invited lectures, and media appearances. She served as chair of the *Information Systems* division of the *ICA* and editor of *Media Psychology*.

Michelle Achterberg is a post-doctoral researcher in the Brain and Development Research Center at the Dept. of Developmental psychology at Leiden University. Her research focuses on brain development across childhood and emerging adolescence and how brain maturation is related to emotion regulation. She published relevant studies in *Neuroimage* and in *Human Brain Mapping*. She is particularly interested in how social media influences the developing brain and tries to unravel these associations using longitudinal experimental MRI research.