

# The Role of Quantifiable Affordances in Adolescents' Neural Sensitivity to Social Evaluation and Self-Esteem: A Narrative Literature Review

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The rise of social media in recent years has led to increased usage, particularly among adolescents, who represent key users of these platforms. Because adolescence is a critical period for neurodevelopment, social media exposure during this time may influence developmental processes that shape cognitive and behavioral outcomes. These developmental patterns have been associated with increased vulnerability to neuropsychiatric conditions. Among social media affordances, quantifiable features such as likes, comments, and views may uniquely influence neural sensitivity to social evaluation, yet remain underexamined. This narrative literature review examines evidence for associations between quantifiable social media feedback and differential activation of neural circuits involved in affect regulation and social self-evaluation through the synthesis of evidence from adolescent neurodevelopmental, social-behavioral, and neuroimaging research. Articles were identified through searches of academic databases including PubMed and Google Scholar. Searches were made with keyword combinations under themes of adolescent development, social feedback, neural activity, and social evaluation. Included studies addressed neural mechanisms related to adolescent neurodevelopment, social evaluation, and social feedback processes. Neuroimaging findings suggest associations between quantifiable affordances and differential activation across the prefrontal cortex (PFC), amygdala, and nucleus accumbens (NAcc)—all regions central to social evaluative neural circuits. The quantity, social meaning, and intensity of feedback—whether positive or negative—are associated with distinct patterns of activation across these regions. Positive, socially salient feedback preferentially engages reward and self-referential circuits, while negative feedback is more strongly associated with affective and evaluative processing. Over time, repeated engagement of these circuits during adolescence may contribute to externally driven patterns of social evaluation and self-monitoring, potentially increasing reliance on quantifiable metrics for self-assessment. Overall, understanding these potentially harmful behaviors associated with quantifiable feedback highlights the need to make digital environments healthier for adolescents, by avoiding such concepts.

**Keywords:** Neurodevelopment, Neuroplasticity, Social Media, Quantifiable Affordances, Self-Referential Cognition, Neuropsychiatric Conditions

## Introduction

From birth, the brain undergoes significant maturation, characterized by both progressive and regressive changes that refine brain circuits<sup>1</sup>. However, while brain development begins at birth, adolescence is a period characterized by high brain plasticity, during which the brain has a heightened capacity to change, adapt, and reorganize its neural connections, leading to functional changes. Such periods of heightened brain plasticity are critical for an individual's development, as the roots of social cognition and quotidian behaviors are shaped by both internal and external factors, including hormones, social environment, and culture<sup>2</sup>. Such brain development is non-linear and region-specific<sup>3</sup>. During the period of adolescence, re-

gions dealing with reward systems, such as the ventral striatum, are hyperactive, while the prefrontal cortex, which is responsible for executive functions—judgement, impulse control, and risk evaluation—matures later<sup>4</sup>. While such an imbalance in development has been associated with behavioral aspects, including increased risk-taking, sensation-seeking, and vulnerability to substances, these neural imbalances have also been linked to the onset of certain neuropsychiatric conditions. These vulnerabilities align with global mental health data; according to the World Health Organization, globally, one in seven 10-19 year-olds experiences a mental disorder, with depression and anxiety being the leading causes of illness<sup>5</sup>. In today's environment, dominated by the use of social media, it is increasingly recognized that such a social environment may play a major role in adolescent brain development. What was

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once a minor part of adolescents' social environment has now become a primary context.

With the prevalence of environmental factors, and given the growing influence of social media on the development of adolescents, examining the variety of social media affordances is crucial, as they tend to have different impacts—emotional, behavioral, and cognitive. These affordances typically include association, personalization, and quantifiability<sup>6</sup>. Quantifiable affordances of social media refer to the measurable aspects of how users interact with platform features, primarily to achieve goals, such as the number of likes, comments, shares, and follower growth. In turn, these quantifiable affordances—alongside the heightened neuroplasticity of adolescents, especially in reward, social cognition, and stress-related regions<sup>4,6,7</sup>—may vastly increase sensitivity to social evaluation and influence self-esteem regulation. This may be driven by the curated, idealized content of social media, which may contribute to constant feedback and potentially shape self-esteem and neural sensitivity to social approval<sup>8</sup>.

The connection between social media and adolescent neurodevelopment is complex as both contain vast bodies of literature. Hence, the acknowledgement of specific connectivities between certain affordances of social media and particular behavioral outcomes is scarce. There is available research regarding the neurodevelopment of adolescents, which is strong in its analysis of neural processes, but weaker in addressing the real-world digital context<sup>1–3,9,10</sup>. In contrast, there is also a strong base in research regarding social evaluation and self-esteem, which primarily focus on behavioral aspects, but lack the analysis of neural mechanisms<sup>11–14</sup>. There appears to be a lack of research that discusses the integration of these two topics, connecting digital social metrics to brain-based self-esteem regulation and social evaluation. This paper aims to address this gap by comparing the two fields of neurodevelopment and social evaluation behaviors, ultimately bridging neural and social perspectives. We hypothesize that social media quantifiable affordances—such as likes, comments, and follower metrics—are associated with increased neural sensitivity in reward and social-evaluative circuits during adolescence, thereby significantly influencing self-esteem regulation.

## Neurodevelopment

Critical periods are intervals during neurodevelopment, activated during major hormonal shifts, that exhibit heightened plasticity enabling the formation and stabilization of neural circuits<sup>15</sup>.

During adolescence, the hormonal changes of puberty reactivate many developmentally critical brain regions, and the heightened plasticity during this period may make adolescents more susceptible to external influences—such as sensory input and behavioral experiences—which contribute significantly to

the proper development of neural circuits<sup>16</sup>. To examine such broad and complex concepts, it is necessary to consider the functionality of neurodevelopment at a regional level. Connections between a variety of regions lead to various neural networks—the default mode network, the salience network, and the fronto-parietal network, which also undergo activity variations during adolescence. While the study of such networks is important for better understanding, for the scope of this research, this review will primarily focus on regions that change during adolescence, specifically the prefrontal cortex, the amygdala, and the nucleus accumbens.

Similarly, to understand the influences of quantifiable affordances on social evaluation and the self-esteem of individuals, it is necessary to explore how adolescent brain development has been studied and characterized, specifically referring to regions involved with social aspects such as the prefrontal cortex, the amygdala, and the superior temporal sulcus.

## Premises of Neurodevelopmental Studies

To grasp an understanding of the effects of environmental input—specifically social media—on the social brain alterations of the adolescent brain, it is necessary to investigate the anatomical and functional changes during adolescent neurodevelopment. Knowledge of adolescent brain development has been structured through a range of research methods, from preclinical animal models to non-invasive human neuroimaging. Preclinical studies, such as those examining social experiences in adolescent rodents, provide evidence for the major role of environmental input in neural development, as rodents with environmental enrichment displayed increased cognitive capacity, such as enhanced synaptic plasticity<sup>17</sup>. Environmental enrichment for rodents can consist of running wheels, tunnels, or wood, which has been found to enhance neurogenesis, known to enhance learning<sup>18</sup>.

Such processes in preclinical studies suggest that environmental input may have a significant influence on synaptic pruning and connectivity in brain regions, similar to those involved in human social cognition. This principle suggests that the types of experiences adolescents engage with—ranging from offline hobbies to social interactions—may shape their neurodevelopment. This foundational concept has provided a basis for investigating further similar processes in humans regarding the influence of environmental enrichment.

Environmental input on development, however, varies depending on duration, intensity, type, and the social value of the experience. For humans, digital experience—social media—can provide beneficial inputs such as supportive interactions or opportunities for learning that lead to improved self-perception. Social media can also have harmful effects, as negative feedback may lead to stress, comparison, or evaluative pressure. This duality is important as it suggests that

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social media is neither coherently beneficial nor harmful for the maturation of a person, but rather dependent on the specific type of affordance. The type of social media affordance may be associated with varying effects that can impair or increase maturation of the adolescent brain. Hence, examining how different social media affordance exposure may attribute to differences across varying neural regions is vital.

Different approaches to social media will leave the individual with differing effects. Understanding this duality, adolescents would benefit from conscious social media use to guide more positive impacts on brain maturation, while also avoiding use that may impair maturation. Such conscious use, supported by practices that promote awareness—such as reflection, meditation, and mindfulness—could contribute to healthier patterns of social media engagement.

## Methods for Analyzing Neurodevelopment

Following this, scientists utilize non-invasive neuroimaging, such as functional magnetic resonance imaging (fMRI), which assesses neural activity in specific regions during certain experiences or experiments. This is possible through the measurement of blood flow in the brain and is widely utilized among researchers, as it remains non-invasive, offers clear spatial resolution, and demonstrates specificity in engaged regions during specific tasks<sup>19,20</sup>.

An additional form of commonly utilized neuroimaging would be structural magnetic resonance imaging (sMRI), which, rather than function, reveals detailed images of brain anatomy, including, gray matter, white matter, and cerebrospinal fluid, and with sMRI researchers are able to analyze the size, volume, and shape of different regions such as the prefrontal cortex or the hippocampus. This is made possible by the use of a strong magnetic field and radio waves<sup>20</sup>. sMRI remains a popularized method among researchers as it provides high-resolution images of brain structure, is non-invasive, and allows precise measurement of brain regions.

High-resolution imaging of the living body, however, can be challenging, as there are many limiting factors of an MRI scan, such as resolution, scan time, the power of the magnet within the scanner, and modality. For instance, for a higher signal-to-noise ratio (SNR), high-field MRI systems should be utilized for the acquisition of data with higher spatial resolution<sup>21,22</sup>. These two methods—fMRI and sMRI—are often and most likely utilized in combination in order to connect structure with function, facilitating the understanding of changes to the adolescent brain that may occur as a result of environmental influence<sup>2,3,9,10</sup>.

## Brain Structures Involved in Self-esteem and Social Cognition

Building on these neuroimaging methods, researchers have identified several brain regions that exhibit high plasticity and, therefore, undergo significant changes during adolescent development. Among these are the prefrontal cortex (PFC), the amygdala<sup>1</sup>, and the nucleus accumbens (NAcc)<sup>23</sup>. Each of these regions contributes to key aspects of adolescent social cognition and self-perception, which may be influenced by social media exposure. Understanding the distinct roles of these regions facilitates the connections with the impact of social media.

### Prefrontal Cortex

A key region implicated in social cognition is the PFC, which is anatomically complex, with sub-regions that all have their own unique functions, receiving and sending instructions to cortical and subcortical regions. While the range of the PFC functions is vast, it ultimately generates internal cognitive frameworks that coordinate the body's behavior in an organized, timely manner<sup>24</sup>. Such frameworks hold information within the brain even when the stimulus is gone, essentially a working memory. This assists in thinking ahead, which is why the PFC is often linked with functions such as response inhibition<sup>24</sup>. The PFC is known to be the last brain region to develop, ultimately finishing development at around the age of 25 years<sup>2</sup>. However, the critical period remains during adolescence, and as such, adolescents are especially sensitive to social feedback, reward, and impulse decision-making, which may also be shaped by social-media related experiences. With the usage of MRI scans, studies have analyzed the effects of positive and negative social feedback from social media, demonstrating significant activation within several areas of the PFC, including the middle frontal gyrus ( $t = 4.41$ ), as well as the medial PFC and ventromedial cortex ( $P = .04$ )<sup>25–27</sup>. All three take part in self- and other-referential processes. Behavioral studies have shown that negative feedback is associated with decreased mood ( $b = 1.00$ ,  $SE = 0.11$ ,  $t = 9.22$ ), whereas positive feedback is associated with improved mood ( $b = 1.20$ ,  $SE = 0.13$ ,  $t = 9.04$ )<sup>27</sup>. Corresponding fMRI studies have also demonstrated activity within several PFC regions during social feedback processing<sup>25,27</sup>.

### Amygdala

Another region of interest would be the amygdala. The amygdala is involved in assigning emotional value—whether positive or negative—to sensory environmental information. It drives the appropriate physiological, behavioral, and affect-

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tive responses, such as stress responses or avoidance<sup>28,29</sup>. The amygdala also includes evaluating pain as threatening or aversive, coordinated specifically by the central nucleus of the amygdala (CeA) which serves as the main output hub of the amygdala. Rather than determining the sensory location, the CeA contributes to the affective and emotional responses, which include anxiety, aversive learning, emotional memory, and fear-like responses, all of which correspond to pain. The CeA is able to perform this function because it modulates pain control systems, projecting to the periaqueductal gray, parabrachial nucleus, hypothalamus, and various brainstem monoamine nuclei<sup>28</sup>. Through this, in certain contexts, the CeA can either suppress or amplify pain. In particular, during acute stress or pain, the CeA induces analgesia, while during chronic pain, the CeA becomes sensitized and enhances hyperalgesia, anxiety-like states, and avoidance behaviors. These serve as some of the specific emotional processing circuits<sup>28,29</sup>. Given the amygdala's responsiveness to socially salient stimuli<sup>26</sup>, social media similarly may play a similar role, much like real-life social rewards. As it holds responsibility in encoding social value, positive social feedback, such as "likes" on social media, has been associated with an increase in activity in the amygdala<sup>30</sup>. And adolescents' amygdala responses are particularly sensitive to reduction of "likes", suggesting a link between neural activation of the amygdala to mood changes tied to social feedback sensitivity<sup>31</sup>. Studies have shown the varying intensities of amygdala activation for larger amounts of positive or negative social feedback as well, suggesting that not only does the amygdala encode the presence of social reward, but also the intensity of it. The reward of "likes" or other positive social feedback correlates with the reward-seeking behavior that stems from the amygdala, potentially contributing to repeated behavior for reward reinforcement. Contributing to habits such as habitual checking of social media, as the brain may begin to anticipate social rewards.

## Nucleus Accumbens

The final brain region to discuss is the NAcc, which is part of the ventral striatum, sitting at the heart of the brain's reward circuitry, mediating reward sensitivity and addictive behaviors<sup>32</sup>. Neurons within the NAcc receive major inputs from other regions of the brain, then integrate signals of the value, effort, and outcome of reward-predicting actions, serving as reward processing for goal-directed behavior<sup>32,33</sup>. Similarly to the amygdala, however, the NAcc is not only involved in reward processing, but also in aversion and avoidance processing, assisting in the processing of both positive and negative outcome-valued stimuli. Such registration of positive and negative feedback means the NAcc not only registers rewards and risks, but also drives action in response. This can be linked to

how the NAcc is highly dopaminergic<sup>32,33</sup>, reinforcing behaviors that lead to rewards. The constant gratification stemming from rewards is processed by various regions of the brain—including the NAcc—which may drive behaviors seeking similar rewards. This most likely will apply to social media use. Positive social media feedback, such as "likes" and other aspects resembling acceptance, has been linked to heightened activation within the NAcc, with greater bilateral activation observed when adolescents viewed their own images receiving many rather than few likes ( $n = 32$ )<sup>34,35</sup>. In one fMRI study, self-generated images receiving many likes elicited greater bilateral NAcc activation, including significantly greater right NAcc activation than with neutral images ( $t(31) = 2.34$ ,  $P = .026$ ) and risky images ( $t(31) = 2.45$ ,  $P = .020$ )<sup>34</sup>. The activation within this region has been positively correlated with the intensity of social media use, as it plays a key role in motivating behavior towards positive social gains. This means the response and activation vary depending on the feedback quantity, and these activation patterns between NAcc responses to "likes" have been found similar to responses to gambling rewards—which may help explain the repetitive and potentially addictive behavior to social media.

## Role of Regions in Neural Circuits

These findings underscore the role of different brain regions—the PFC, the amygdala, and the nucleus accumbens—in shaping the sensitivity to social feedback, including social media interactions. These regions are highly malleable to environmental inputs during adolescence, as it is a critical period of heightened plasticity. Overall, the PFC handles self-perception and planning, the amygdala manages emotional valuation of social rewards and punishments, and the NAcc integrates reward signals and reinforces addiction-like responses, all working in conjunction with one another. These neural mechanisms may help explain why adolescents are particularly sensitive to social media feedback, why they seek positive reinforcement, and how these mechanisms may contribute to habitual or addictive usage. These functional sensitivities are paralleled by structural changes in the same regions, suggesting a potential association between social media use and variations in adolescent brain development and function. Understanding and considering the developmental sensitivity of these neural mechanisms is important when evaluating the impact of social media on adolescents.

## Social Media Quantifiable Affordances - Self-esteem and Social Evaluation

Having established the neural basis of adolescents' heightened sensitivity, it is important to recognize that the PFC, the

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amygdala, and the NAcc play a significant role in responses to reward, threats, and self-referential processes. While understanding the overall influence of social media on adolescents' evaluative behaviors is useful, it is also critical to examine how specific affordances—particularly quantifiable ones—map onto neural circuits and relate to behavioral responses, to clarify how these two areas connect. To clarify these links, the following section outlines how quantifiable affordances engage neural circuits involved in emotional and threat processing, how these circuits are involved with behavioral responses, and how those responses ultimately intersect with adolescent self-esteem.

Quantifiable affordances such as 'likes' may engage neural regions involved in emotional processing—namely the PFC, amygdala, and NAcc—as they function as a form of reward signal<sup>30</sup>.

## Prefrontal Cortex

Studies have shown that quantifiable affordances modulate activity throughout different regions of the PFC. In an fMRI study of 30 participants, positive feedback, such as receiving many 'likes', was associated with increased activation in the vmPFC<sup>26,34</sup>, whereas feedback that may be perceived as negative—such as dislikes or receiving few likes—activates the vlPFC and the mPFC<sup>25,27</sup>. The mPFC, which is heavily correlated with social cognition and self-referential processing, is particularly activated when viewing highly liked photos<sup>34</sup>, indicating how quantifiable social signals may shape adolescents' social cognitive behaviors. Moreover, likes modulate self-referential thought in the mPFC, suggesting that the quantity and relevance of social feedback influence adolescents' social evaluation and perceptions of their own social standing. Identifying differing sections of the PFC that deal with a multitude of aspects—the vmPFC for reward valuation, the vlPFC for emotional regulation and conflict monitoring, and the mPFC for self-referential processes<sup>30</sup>—shows how quantifiable affordances, such as likes, simultaneously and contrastingly engage different PFC subregions. However, studies found that positive feedback produced stronger and more consistent activation patterns, suggesting that platforms may be biased toward reward processing and that the PFC disproportionately encodes positive social reinforcement.

Additionally, the magnitude of PFC activation is not dependent on like-count alone. Studies have shown that the social identity of the people giving the likes may also have an impact. Stronger PFC reward responses occur when likes come from high-status individuals, attractive peers, or opposite sex peers. This indicates the extent of the role that quantifiable affordances play—beyond reward networks—also interacting with social evaluation circuits, as the vmPFC and mPFC are reacting not only to the quantity but also the social relevance

of the feedback<sup>30</sup>. Aside from the influences of outer identity perspectives, individual differences also vary the PFC sensitivity to likes. Those that spend more time on social media showed greater PFC reward activation in response to the same quantity and type of like. Stronger PFC responses to likes were also seen in adolescents with low resistance to peer influence<sup>30</sup>. Therefore, PFC modulation varies depending on social vulnerability traits that the individual has, suggesting that modulation is not constant. And as reward activation in PFC regions increases with the quantity of likes and social relevance of likers, the PFC circuits begin calibrating reward expectations around inflated social signals, which may shape future behaviors.

Importantly, quantifiable affordances may also be linked to alternations in cognitive control. When adolescents were exposed to risky photos that nevertheless received a high "like" count, there was decreased activation within PFC-based cognitive control networks<sup>34</sup>, suggesting reduced inhibition in socially charged situations. Likes further influence decision-making by shifting PFC-mediated strategies—concluded by the increase in beta activity along high-like images—potentially biasing adolescents towards prioritizing social conformity over risk assessment in decision-making contexts.

Namely, "likes" not only function as rewards, but are important in shaping decision-making and sensitivity to peer approval. As higher numbers of "likes" were connected to adolescents adjusting themselves accordingly to perceived group norms, this suggests that quantifiable affordances may strengthen motivations for social approval, reinforcing the plausible impact quantifiable affordances have on social evaluation and self-esteem in a self-referential context.

## Amygdala

The amygdala appears particularly sensitive to both the social relevance and hierarchical value of feedback received<sup>26,30</sup>, with "likes" from high-status peers eliciting significantly greater left amygdala activation ( $P = .03$ ), while corresponding vmPFC activation was also observed ( $P = .04$ )<sup>26,30</sup>. This responsiveness aligns with developmental models indicating that the adolescent amygdala is especially reactive to socially salient cues, particularly signals of peer approval or social standing<sup>8</sup>. Because the amygdala encodes emotional significance, quantifiable affordances function as rapid social-evaluation cues. As a result, adolescents presumably become highly sensitive to feedback embedded in like-counts, with the amygdala showing robust engagement in response to positive social feedback<sup>26,30</sup>.

Importantly, self-generated content further amplifies this activation, especially when paired with a high-like count. This pattern suggests the amygdala's sensitivity to self-referential

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popularity cues, intensifying both reward encoding and the emotional salience attributed to one's own content. Additionally, research suggests that the emotional weight adolescents assign to peer approval is moderated by the functional connectivity between the amygdala and the ventral striatum during social reward processing<sup>36</sup>.

And such activation of the amygdala is associated with social-reward processing, coordinating both emotional and behavioral responses to socially relevant cues<sup>37</sup>. This may drive behaviors such as heightened sensitivity to social evaluation, peer-approval seeking, and conformity. These amplified amygdala responses in most likelihood leave adolescents more emotionally reactive to social feedback, potentially contributing to social anxiety or mood variability in online contexts<sup>37</sup>. Thus, vulnerability to problematic social media use—particularly when positive reinforcement is exaggerated—may be mediated by the amygdala and its associated circuits.

Interactions with other brain regions also play a significant role in social evaluation, as co-activation with the vmPFC during positive feedback suggests an integrated emotional-reward signal<sup>26</sup>. This social-evaluative circuit likely supports decision-making based on social rewards, such as selecting content to post or adjusting online behavior to maximize positive feedback.

Heightened amygdala-ventral striatum connectivity during positive social feedback may provide a neural pathway through which quantifiable affordances can intensify emotional reactivity, increase attentiveness to peer judgment, and heighten sensitivity to social evaluation. These mechanisms may contribute to fluctuations in adolescents' self-esteem, increased conformity, and greater vulnerability to anxiety within a digital social environment context<sup>36</sup>.

## Nucleus Accumbens (NAcc)

As with other neural regions, social relevance most likely influences the magnitude of activation within the NAcc. Its activity is modulated not only by the number of likes but also by characteristics of the individual providing the feedback, including social status, sex, and perceived attractiveness<sup>26,30</sup>. "Likes" consistently elicit significant activation across multiple subregions of the NAcc, each associated with distinct behavioral outcomes. Broadly, NAcc activation corresponds with positive feedback, with the quantity of likes playing a central role. In an fMRI study of 32 adolescents, photos receiving many likes elicited greater NAcc activation than those receiving few likes<sup>34</sup>. This activation—similar to patterns observed in the PFC—positively correlates with the intensity of social media use, as heavier users exhibit stronger NAcc responses<sup>35</sup>. More specifically, viewing images with high-like counts reliably elicits greater activation in the left NAcc, consistent with its involvement in emotional processing and

decision-making. These findings collectively demonstrate the likelihood that increases in like-count are closely linked to increases in reward processing.

While left NAcc activation is most consistently reported in response to social feedback, self-generated stimuli with high-like counts evoke robust bilateral NAcc activation<sup>30</sup>. Because self-relevant popularity appears to amplify reward encoding, these findings underscore a substantial association between quantifiable feedback and self-referential processing<sup>25,38</sup>. Greater activation across NAcc subregions has been linked with increased motivation to engage with social media<sup>13,35</sup> and to modify online behavior in ways that maximize positive feedback, reflecting the region's core role in reward-driven behavioral reinforcement<sup>30,35</sup>. Finally, NAcc activation in response to social feedback is often accompanied by concurrent activity in the ventral tegmental area (VTA) and other striatal regions, highlighting its central position with dopaminergic reward circuitry<sup>30,38</sup>.

## Discussion

This literature review aimed to bridge adolescent neurodevelopment with the quantifiable affordances of social media and analyze the mechanisms that possibly play a major role in shaping adolescents' social evaluation and self-esteem. The review revealed variations across the neural regions examined, the types of social feedback, and the behavioral outcomes measured within studies. Individual studies often focused predominantly on one area—either neurodevelopment or social media and adolescents' social evaluative behaviors. Neurodevelopmental studies tended to emphasize neural regions, the neural circuits they form, and their functional mechanisms, but frequently lacked integration with behavioral outcomes related to social evaluation and self-perception<sup>1-3,9,10</sup>. Conversely, studies focused on social behavior primarily examined actions and cognitive partners but provided limited insight into underlying neural mechanisms<sup>11-14</sup>. Across both types of studies, however, three neural regions consistently emerged as central—the PFC (mPFC, vIPFC, vmPFC), the amygdala, and the NAcc. These three regions are significantly involved in social evaluative processes<sup>4,6,9,28,29,32</sup>, interacting with one another, and other regions to form such circuits.

As the PFC experiences delayed maturation, its limited regulatory capacity may make adolescents more susceptible to external evaluation<sup>1,2,8</sup> when forming their self-concepts. When developing self-referential judgments, the mPFC integrates social information, in which quantifiable affordances become emotionally loaded stimuli that ultimately serve as a rapid "shortcut" for interpreting self-worth and social value for adolescents<sup>26,30</sup>. A simple increase in like-count could be interpreted as meaningful social approval, potentially contributing to temporary boosts in self-esteem<sup>25,26,38</sup> and rein-

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forcing metric-based social-evaluation.

During adolescence, the heightened responsiveness of the amygdala towards social relevance of feedback received<sup>8</sup> suggests that quantifiable affordances not only serve as “rewards” —which the amygdala takes part in evaluating—but are also socially focused emotional stimuli<sup>26,30,37</sup>. High engagement from those of high social status or desirable peers was associated with increased emotional weight, assigned from the amygdala<sup>26</sup>, increasing its salience. Likewise, low engagement may be interpreted as social rejection and or a “threat”<sup>26,30</sup>. Because quantifiable affordances provide countable markers for social acceptance or rejection<sup>6,7</sup>, they most likely exaggerate the emotional intensity of social evaluation. In turn, adolescents who already experience intense reactions to social threats or rewards, may experience stronger emotional swings as a result of digital quantifiable feedback. The amygdala’s strong response to positive or negative feedback can explain adolescents’ fixations with quantifiable metrics of social evaluation, serving as meaningful social cues. These mechanisms in all probability lead to heightened socially conscious behaviors of adolescents, such as comparison, fear of missing out, hypersensitivity to peer judgment, and self-reflection in online performance<sup>36</sup>.

Judging by the robust activation of the NAcc to social quantifiable feedback, it suggests that quantifiable affordances may recruit the same dopaminergic circuits involved in reward prediction, incentive motivation, and reinforcement learning<sup>30,32,35,38</sup>. Adolescents also experience strong motivational drives towards social rewards while prefrontal regulatory systems are still maturing, a pattern that has been associated with earlier maturation of the NAcc relative to the PFC<sup>4,36</sup>. This circumstance may allow quantifiable affordances to have a stronger influence over behaviors, and these countable metrics on social media become a variable reward schedule<sup>6,35</sup>. Quantifiable affordances are not just affirmations for self-perception but may function as neurological reinforcers that shape behavior. The stronger the NAcc activation that stems from this social feedback, the more adolescents may begin to associate posting, checking, and scrolling on social media with reward<sup>30,38</sup>. This interpretation may help explain the heightened socially evaluative behaviors of adolescents, such as curating content optimized for social engagement in order to chase the drive of positive social feedback that most likely leads to boosted self-esteem<sup>7,13,18</sup>.

Rather than functioning separately, the prefrontal cortex, the amygdala, and the nucleus accumbens operate as an interconnected system mediating motivated behavior, emotional regulation, and reward-seeking<sup>29,33</sup>. As the amygdala detects the social salience of feedback, the nucleus accumbens assigns reward value to that feedback through dopaminergic reinforcement. Finally, the PFC contributes to regulatory control, but because it is still developing during adolescence, this

results in weaker modulation of emotion and reward-driven responses. This process is further amplified by social media quantifiable affordances, as the design characteristics of these platforms introduce immediacy, visibility, and countability of feedback<sup>6,7,38</sup>. While this is a simplified way to understand the brain process, brain regions must be seen with an integrative framework that puts them together. These regions, functioning within an integrated circuit, may heighten sensitivity to social evaluation, contributing to the reinforcement of feedback-driven behaviors and instability in self-esteem among adolescents.

To review, experiences during adolescence may shape long-term circuits and habits because of the periods’ high plasticity<sup>1–3</sup>. And as circuits like mPFC-amygdala-NAcc are still developing, exposure to quantifiable social metrics have the possibility of altering self-evaluation processes permanently<sup>8,26,36,37</sup>. Implying that, patterns formed in adolescence—reward sensitivity, social comparison habits—could persist into adulthood.

Thus, patterns formed in adolescence that are based on social evaluative and self-referential behaviors may continue to adulthood. And as judged before, quantifiable feedback may have become a sort of anchor for self-worth, potentially making adolescents increasingly more reliant on “likes” and social engagement metrics to gauge social value. As these external validation behaviors become a habit, this may make internal self-esteem regulation weaker<sup>13,14,25</sup>. More specifically, the PFC processes self-referential information<sup>30,34</sup>, the amygdala assigns emotional weight<sup>26,30,36</sup>, and the NAcc reinforces certain behaviors<sup>30,35</sup>, and these circuits essentially may contribute to adolescents linking social approval to neural rewards, making it highly desirable.

As these behaviors of comparison, conformity, and hyper-vigilance to peer evaluation increase<sup>7,8</sup>, adolescents may have begun to internalize social hierarchies, status, or popularity as central to identity. Social media may further magnify this effect because quantifiable feedback tends to be constant, immediate, and public<sup>6,31,35</sup>. And the variable reward schedules that reinforce frequent checking and posting, could set life-long patterns of engagement with feedback-based platforms. This may lead to the prioritization of online validation over intrinsic motivation or offline social experiences.

However, it is crucial to note that not all adolescents will be affected equally. While it is true that the development of neural regions differs in similar orders, and how these can be affected by external factors and therefore affect functionality, individual and contextual differences also serve a role in shaping behaviors. Individual differences of baseline self-esteem, social anxiety, and susceptibility to peer influence<sup>6,13,14</sup>, matter just as much as contextual differences like peer relations, cultural norms, and platform-specific features<sup>7,31</sup>.

Despite the considerable insight provided from this study,

limitations must be considered, particularly with the lack of variety in methods from interpreted studies. Neuroimaging studies are susceptible to ongoing concerns regarding replicability; therefore, they should be interpreted with caution, as there are possible limitations concerning consistency and generalizability of the observed effect<sup>19,21</sup>. Future research examining the connection between quantifiable social feedback and adolescents' social evaluative behavior may benefit from integrating longitudinal behavioral studies to provide more consistent and ecologically valid insight. Furthermore, much of the neurodevelopmental-heavy studies included in this review utilized fMRI or sMRI scans, which each have their own strengths and weaknesses. While fMRI scans can provide excellent spatial resolution—allowing for distinct identification of regions activated—they lack temporal resolution, which is needed to capture the fast nature of neural activity<sup>19,21</sup>. Meanwhile, sMRI can provide highly detailed anatomical images, it can not capture functional or real-time activity, limiting its ability to show how the brain actually functions during certain tasks<sup>20</sup>.

Overall, the relationship between social media's quantifiable affordances and adolescents' social evaluative behaviors appears to have mostly negative associations, as these features may provide a rapid and highly salient means of self-comparison during a period of heightened vulnerability<sup>8,13,25,30,36,38</sup>. To mitigate these potentially harmful effects, the social media industry could approach a more developmentally informed design, such as allowing users to opt out of visible metrics or reducing their prominence. By reducing constant exposure to rapid evaluative cues, adolescents may engage less in comparison-based judgments and form a more stable sense of self.

## Conclusion

Adolescence is a critical period, and many behaviors formed during this period can extend into adulthood<sup>1,5,15</sup>. Behavioral patterns such as seeking constant approval, heightened sensitivity to evaluation, and frequent social comparison—behaviors that may be reinforced by quantifiable metrics of social media—can persist over time. Persistent reliance on external evaluation may shape long-term patterns of self-perception, potentially contributing to difficulties in emotional regulation and self-evaluative stability, which may undermine self-esteem, and over time, increase vulnerability to neuropsychiatric conditions such as anxiety and depressive disorders<sup>5,6,25</sup>.

These behaviors rely on interconnected social evaluative neural circuits, rather than the isolated functions of regions involved. The PFC supports processing and regulatory control<sup>24</sup>, influencing how adolescents interpret and respond to quantifiable metrics. The amygdala assigns emotional signif-

icance<sup>28,29</sup>, which may heighten the evaluative value of features such as likes and comments. The NAcc may reinforce certain behaviors that feel socially rewarding<sup>32,33,35</sup>, strengthening evaluative habits over repeated exposure. Although each region serves many roles beyond social evaluation, together they form circuits—along with additional regions—that collectively contribute to evaluative processes influencing adolescents' self-perception.

Because reward sensitivity is heightened during adolescence<sup>1,4,31</sup>, quantifiable feedback may amplify comparison and evaluation-based behaviors<sup>25,30</sup>. To help reduce the repetitive and potentially addictive cycle of these self-evaluative habits, the social media industry could reconsider how prominently they display the quantifiable metrics of social feedback. Metrics such as like-counts provide social feedback and judgment that is instant, public, and numerical, creating a rapid 'short-cut' for self-evaluation. Offering options to opt-out of utilizing such metrics, limiting their visibility, or reducing their placement within the interface may help lessen the immediacy of evaluative cues. Such design adjustments have the potential to reduce compulsive checking and comparison pressure, supporting healthier patterns for self-evaluation as adolescents develop into adulthood. Promoting such intentional and healthier engagement with social media may support adolescents in developing a more conscious relationship with social-media feedback, which may help foster more stable patterns of self-evaluation.

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