Origins of Anhedonia in Childhood and Adolescence

Janani Prabhakar,

Section on Clinical and Computational Psychiatry, National Institute of Mental Health, Bethesda, MD, USA

Dylan M. Nielson,

Section on Clinical and Computational Psychiatry, National Institute of Mental Health, Bethesda, MD, USA

Machine Learning Team, National Institute of Mental Health, Bethesda, MD, USA

Argyris Stringaris

Division of Psychiatry and Division of Psychology and Language Sciences, University College London, London, UK

National and Kapodistrian University Athens, Athens, Greece

Abstract

Anhedonia reflects a reduced ability to engage in previously pleasurable activities and has been reported in children as young as 3 years of age. It manifests early and is a strong predictor of psychiatric disease onset and progression over the course of development and into adulthood. However, little is known about its mechanistic origins, particularly in childhood and adolescence. In this chapter, we provide a socio-cognitive model of the development of anhedonia. This model is substantiated by past literature presented in this chapter to account for how the individual trajectories of emotion knowledge, autobiographical memory, and self-concept representations contribute to the onset, persistence, and progression of anhedonia from early childhood through adolescence.

1 Introduction

Anhedonia symptoms are one of the most common presentations of depression across the lifespan (Pelizza and Ferrari 2009). They reflect a reduced ability to engage in activities that were previously pleasurable and/or a difficulty in feeling and expressing joy (Husain and Roiser 2018). In this definition, joy and pleasure reflect dimensions of positive emotion differentiated only by the experiential nature of pleasure and the internal feelings of joy (Mortillaro et al. 2011). Anhedonia may present early in life in depression (Luby et al.

janani.prabhakar@nih.gov .

2002, 2003, 2004, 2006) and is associated with worse disease course and treatment response in youth and adults (Luby 2010). Recent literature has indicated a high prevalence of anhedonia over the course of development. For example, in a relatively small sample of preschoolers, more than half of the depressed preschoolers presented with anhedonia (Luby et al. 2004). In adolescent population samples, anhedonia presents in approximately 10–15% of adolescence, with or without psychiatric illnesses (Pornpattananangkul et al. 2019; Stringaris et al. 2015). The large incidence of anhedonia in developmental populations underscores the importance of understanding the nature of anhedonia presentation from a developmental context.

This chapter will provide a developmental socio-cognitive account of mechanisms that may give rise to anhedonia and specifically, to the difficulty individuals face in feeling and experiencing joy. This account proposes that anhedonia and anhedonic behaviors are the outcome of an interactive relationship, over the course of development, of emotion knowledge (the set of emotion representations instantiated in a person's memory arsenal), autobiographical memory (one's memory for their own past, personal experiences), and self-concept representations (one's set of beliefs about who they were, are, and will be). This interactive relationship is a result of an individual's inherent desire to make choices and decisions that allow them to maintain a coherent sense of self, that is, remain internally consistent with their beliefs about who they are (Coughlin and Robins 2017; Howe and Courage 1997). As such, this account suggests that an ideal state is to ensure that the set of choices one allows for themselves overlaps with their self-concept beliefs (Fig. 1a). However, as the overlap between one's set of self-concepts and allowable choices diverge (Fig. 1b), individuals are placed in a position of discomfort to resolve the discrepancy. A resolution to reduce the distance between the sets of self-concept beliefs and allowable choices can be made through a process of discounting, either discounting the self-belief as not truly being reflective of self, or the choice as not relevant or of interest to the self. One's capacity to reduce this distance may, thus, be dependent on the strength of self-representations ingrained in one's memory (or, how well one has determined their own self-beliefs), and the extent to which one has made choices, over time, that are repeatedly consistent with these self-representations. In essence, self-concepts allow individuals to select or choose activities that maintain a level of coherence with who they are, and the choices individuals make help strengthen those self-concept beliefs. For example, prior work has shown that adolescents with higher self-concept clarity (i.e., notion of who they are) make personal choices about college and their future with greater confidence (van der Aar et al. 2019), suggesting that choices help reinforce one's personal views. This notion is supported by models of depression that suggest that pervasive negative processing of one's self-identity may generalize to influence how one processes incoming information and selects appropriate actions (Clark et al. 2000). We propose that anhedonia may be a means of avoiding the uncomfortable feeling of being incoherent with one's internal sense of self. A built sense of self can result from one's efforts to make meaning out of past experiences or find meaning in the present. Past experiences that reflect a high frequency of negative events or a low frequency of positive events may lead to self-concept representations that skew less positive and more negative. For example, repeated experience of social exclusion may result in an individual building a representation of self as "shy" or "awkward." This

self-concept representation provides an explanatory framework for negative experiences and supports choices, like avoiding social gatherings, that may cause undue distress. Continuing efforts to avoid these feelings lead to greater avoidance of social gatherings, strengthening self-concept representations as "shy" or "awkward."

These negative self-representations can also drive personal daily behaviors outside the context of social gatherings. A lack of motivation to engage in personally beneficial activities, such as routine activities like taking a hot shower or cooking a delicious meal, can result from a reduced capacity to derive positive satisfaction from these activities on a daily basis. Indeed, prior research indicates that individuals who report lower anticipation of pleasure also engage less frequently in usual, daily activities, and report lower positive self-concept and emotion (Rosebrock et al. 2021). These authors suggest that this relationship may result from individuals' perceived notions of difficulty engaging in routine activities and a lack of motivation, as a result, to do so. It is important to consider that the process of building self-concepts relies on meaning making (Conway and Pleydell-Pearce 2000) and when one lacks motivation or perceives activities as too burdensome, these activities may then hold lesser positive value within one's identity. As such, if decisions to engage in a routine activity are impacted by the perceived low emotional value it holds, then these activities will be routinely avoided.

Neurobiological data support this notion that individuals with anhedonia may place less value on personally rewarding activities. Individuals with anhedonia show a blunted neural response to future rewards in delay discounting tasks (Kang et al. 2020), suggesting that these types of typically rewarding items do not hold the same personal value in individuals who fail to derive satisfaction from them. In pre-adolescence, altered connectivity, specifically during reward anticipation, in children with anhedonia was reported between the ventral striatum and cingulo-opercular network, indicating a lack of intrinsic arousal to a potential reward (Pornpattananangkul et al. 2019). Other evidence in patients with Major Depressive Disorder (MDD) suggests that abnormal activation of structures within this network and in the subcortical-cortical midline system more broadly (e.g., the dorsomedial prefrontal cortex, the anterior cingulate cortex, and the precuneus) correlates with increased focus on negative self-related judgments as well as anhedonia (Grimm et al. 2008, 2009; Greicius et al. 2007; Phillips et al. 2003). These abnormalities in structures and networks typically involved in self-processing and reward anticipation suggest that anhedonia may reflect not only a diminishment of a potential reward but also an increased level of negative emotion to rewards or positive events, as well.

Taken together, the extent to which one's memory systems respond to emotionally laden input, construct self-beliefs, and use those self-beliefs to inform actions is dependent on the reciprocal and dynamic nature as well as the individual trajectories of emotion knowledge, autobiographical memory, and self-concept development. This chapter interprets prior literature in the context of how anhedonia may arise from disruptions in developing emotional concepts of positive emotion during infancy, in memory processes that build knowledge structures regarding joy-inducing experiences during childhood, and in developing a sense of self, during childhood and beyond, as (or not as) one who experiences joy. Altogether, the chapter will provide the foundation for an integrative model of how

conceptual development of positive and negative emotions, memory processes, and self-concept formation can perpetuate anhedonic symptoms and the avoidance of positive experiences through a need to maintain coherence with oneself and avoid feelings of distress.

2 Impact of Positive Caregiving During Infancy

Infancy is a highly flexible and dynamic period for emotion concept formation (Gelman and Kalish 2006). During this time, caregivers learn to identify infant cues to respond to their emotional and physiological needs. These interactions help children build emotion concepts that are functionally useful to signal a need to the caregiver. The foundations of this dyadic relationship between caregiver and infant come from early characterizations of attachment theory (Ainsworth and Bowlby 1991). In this theory, the strength of caregiver-infant attachment rests on the extent to which caregivers respond to infants seeking security and comfort. Infants seek attachment figures for safety and security, but caregiver response can reflect differing levels of maternal responsiveness to infant cues and needs that range from positive and emotionally responsive to negative and hostile. Lack of early attachment or maternal deprivation, as noted in early human (Bowlby 1965) and non-human primate development (Harlow and Zimmerman 1958), can result in significant detachment issues in infancy and childhood. Furthermore, other evidence shows that positive emotional synchrony between parent and child in early childhood contributes to less negative behaviors and greater self-regulation exhibited by the child later (Lunkenheimer et al. 2020; Meyer et al. 2014; Eisenberg 2020). As such, missing this early opportunity to instantiate emotion knowledge in one's representational arsenal impacts the extent to which infants can continue to their emotional growth outside of the home.

Caregiver response to emotion cues during the first few months to years of life helps build a social contract between parent and child. This social contract aligns with a rational constructivist approach to emotion learning (Barrett 2006; Hoemann et al. 2019), a scientific framework suggesting that infants begin with proto-conceptual primitives and end with domain-specific intuitive theories of emotion knowledge and expression by engaging learning processes. Critically, this framework hypothesizes that the expression of "joy" or "pleasure" results from a distributed and integrated network of neural connections drawn from across different brain states and processes, including motor, perceptual, affect, and memory states (Hoemann et al. 2019; Phan et al. 2004), that act on top-down and bottom-up cues. That is, the ad hoc emotion concept and expression is capable of being stored and retrieved through predictive or top-down activation processes. This section will provide an overview of the early influences of caregiver support (e.g., responsiveness) on building strong emotion representations and how the absence of these influences may impact socioemotional growth and limit positive emotion development, specifically.

In neonates, smiles are a primitive index of joy and pleasure that result from a relaxation of cognitive tension in response to a stimulus (Sroufe and Waters 1976; Camras et al. 2017). Over the first few 10–20 weeks of life, infants begin to dynamically shift attention to environmental stimuli and form connections between primitive forms of smiling behavior and the responses they elicit. Infant smiles engender parental caregiving and cognitive

processes help instantiate the functional role of infant smiles to elicit desired outcomes, thereby establishing strong social bonds between the parent and child (Camras et al. 2017; Oster et al. 1992; Holodynski and Friedlmeier 2006; Bridges 1932; Messinger and Fogel 2007; Fogel and Thelen 1987).

With experience, children display a repertoire of discernable expressions in response to parental communications (Oster et al. 1992; Messinger and Fogel 2007). As such, increasingly complex representations of positive emotion come with greater experience and engagement, wherein the expression of joy and pleasure expands beyond these states of arousal into other features, like laughing. Ultimately, these dynamic processes allow infants to learn that their smiles elicit warmth from parents and parents consolidate cues from infants to prompt caregiving behaviors, establishing a reciprocal relationship that solidifies parent–child bonds and further strengthens neural connections associated with "joy" and "pleasure" (Kärtner et al. 2013). A dynamic system such as this underscores that emotion responses reflect an interactive relationship between real-time expression of affect and the social context in which they occur. In early infancy, this social context is based on the relationship with the parent during which time social contingencies and contagion between infant expression and parental response are established (Mireault et al. 2015; Shultz et al. 2018; Mundy and Jarrold 2010).

The strength of the reciprocal nature between child and caregiver is predicated on the approach, style, and sensitivity in the caregiver response (Parsons et al. 2017; Dollberg et al. 2010; Granat et al. 2017). In one study, authors found that infants of depressed mothers exhibited greater self-regulatory (e.g., self-soothing behaviors, like thumb sucking, during interaction with mothers) behaviors during positive emotion expression (Granat et al. 2017), suggesting that a lack of a positive reciprocal relationship with the caregiver reduces positive emotion expression. Relatedly, parental depression and anxiety have negative influences on infant smiling, possibly mediated by dysfunctional amygdala connectivity with cortical regions (Phillips et al. 2021; Weinberg and Tronick 1998). This is supported by further evidence showing that maternal stress about one's own ability to provide appropriate parental care is negatively associated with reductions in infant smiling and laughter behaviors over time (Bridgett et al. 2013; Legerstee and Varghese 2001), suggesting that one's beliefs about their own parenting capability can impact their child's positive emotion growth. In addition, low maternal affect mirroring, or emotion contagion (i.e., the maternal emotional response of warmth, sensitivity, and responsiveness to infant behaviors), results in lower amount of smiling, vocalizations, and prosocial behaviors in the infants (Harker et al. 2016).

These drawbacks in parental caregiving and responsiveness hinder the adaptive functionalities of early expression and behaviors that are designed to build children's emotional repertoire. This hindrance has reciprocal properties such that parents of insecurely attached infants display more negative emotions that likely hinder emotional growth and perpetuate further the insecure attachment (Radke-Yarrow et al. 1985). This underdevelopment further hinders normative trajectories of development of neural networks, particularly in the frontoparietal regions, that are engaged to store, retrieve, express, and coordinate internal representations associated with emotion (Hanford et al. 2018). In

mothers, network connectivity in similar regions that provide a coordinated response to infant joy is also affected (Laurent and Ablow 2013).

Essentially, a dearth of positive caregiver approaches (i.e., a lack of approach-oriented positive emotion from caregiver and use of a broad range of facial expressions) results in impoverished attentional and learning environments that hinder the establishment of emotion concepts and expression. This is supported by other work showing that lack of caregiving support in early childhood mediates effects of impoverished environments (e.g., low-income households) on lower hippocampal volume in middle childhood (Luby et al. 2013). These results suggest that nurturing environments have meaningful and significant impacts on brain development and emotion development, with likely implications for child psychosocial and emotional well-being, as well.

Of course, one cannot talk about the environment without discussing genetic and heritable features that may also disturb maternal reciprocation to infant emotion expression. Prior literature suggests that while negative emotion has a substantial heritable component, positive emotion is much more strongly dependent on the environment (Zheng et al. 2016; Baker et al. 1992; Luby et al. 2004). This notion is further supported by evidence showing that genetic attributes that result in anhedonia may be more connected to negative emotion and personalities than positive emotion and trait features (Luby et al. 2004). In several overlapping studies, authors found that a melancholic subtype or anhedonic depressed subtype in preschoolers was characterized by greater depression severity, alterations in stress cortisol reactivity, increased psychomotor retardation, and increased melancholic symptoms (Luby et al. 2004, 2009). Critically, the authors found that anhedonic preschoolers appeared "slowed down" or "restless," and these preschoolers compared to healthy controls showed greater negative overall affect. In another study, preschool-aged boys who exhibited lower trait sociability were more likely to exhibit anhedonia symptoms in middle childhood (Mumper et al. 2021). These data suggest that the dependency on a positive environment underscores the development of positive emotion and expression in infants and may serve as a protective and manipulable feature against the development of anhedonia.

Animal models align with these findings, showing a unique molecular profile of anhedonia specific to mice who are intrinsically vulnerable to chronic environmental stress (Couch et al. 2013). Vulnerability to stress was captured by measures of susceptibility (e.g., floating versus swimming during a forced swim task) or negative bias (e.g., providing more negative than positive responses to an ambiguous cue). These data suggest that inherent trait features may moderate the extent to which environmental stress is a risk factor for anhedonia, and that these traits may promote greater negative processing of environmental cues (Couch et al. 2013). Taken together, this evidence points to the role of trait by environment interactions in determining who is most susceptible (Rygula et al. 2013). These results are particularly important to consider in the context of the model presented in this review. If certain trait features predict an infant's susceptibility to anhedonia, then these features may also impact the quality of early caregiver interactions (e.g., how the infant negatively processes cues from the caregiver). Our model underscores the importance of these interactions for positive emotion development and later positive self-concept formation. As such, early

identification of inherent trait features associated with anhedonia and their influence on early environmental exposures would open the possibility for early intervention.

3 Impact of Memory Processes and Social Engagement During Early and Middle Childhood

Memory systems emerging in early childhood aid in establishing robust representations of emotion concepts (Nelson 2000). Children's experience of and response to positive experiences, such as positive feedback from caregivers or social engagement with the outside world, are encoded into memory. With repeated exposure, not only are these encoded representations strengthened within the memory system, but they are also more readily accessible for retrieval. As such, repeated exposure to positive input during early childhood, inside and outside the home, allows children opportunities to instantiate and strengthen representations of positive emotion knowledge and expression. In this section, we establish how memory processes provide the foundation upon which emotion representations are stored, retrieved, and used.

From early childhood onward, children experience a greater level of agency and control over their own behaviors. This occurs with the onset of language as well as greater interaction with individuals outside the home. The development of language during this time motivates a rapid emergence of concept development and as children engage to a greater extent with the environment, their own sense of agency within it allows them to make connections between new experiences and subjective feelings (Meltzoff and Kuhl 2016). The process rests on furthering the reciprocal nature of positive expression and positive feedback, and social engagement during early childhood allows children to build emotion representations and regulate them based on peer feedback and social response (Holodynski and Friedlmeier 2006; Marshall and Meltzoff 2011). While early displays of this reciprocal behavior between mother and child allows for the prototypical concepts of positive affect, dynamic engagement with the outside world allows children to exercise these concepts flexibly and engage in a more significant way with individuals outside their immediate context (Meltzoff and Kuhl 2016). These dynamic interactions lead to construction of schematic representations of affect expression, including joy and pleasure.

Schemas are cognitive frameworks that allow children to organize and categorize events and experiences in memory based on commonalities between them and can be used to make meaning of the world and select actions (Nelson 2019; Holodynski and Seeger 2019). Schematic representations of emotions developed during early childhood include feelings of anger, fear, joy, disgust, amusement, and guilt (Conway and Pleydell-Pearce 2000). The ontogenesis of these emotions that include the dynamic relationship between the environment and internal cognitive processes reflects the significance of emotions as social cues and ways to engage with the social environment. Establishing schematic representations of emotion knowledge and expression allows for flexible and efficient use of these representations to reflect internal processes to the external world and guide behaviors within a social setting.

Functionally, establishing schematic representations occurs from a complex combination of attentional, memory, and control processes. As toddlers engage with their environment, they attach valence to events and stimuli they encounter, and these emotional features are encoded into memory. Repeated exposure to these valenced stimuli allows for repeated retrieval, re-consolidation, and strengthening of these stored emotional concepts in memory such that they develop into robust representations of emotion knowledge that can be accessed as semantic structures (or, schemas) when similar events are encountered once again (Weinberg and Tronick 1998). The more readily and frequently these are accessed through control processes that regulate the child's present motivations and drives, the stronger these emotion schemas are reflected within one's memory architecture. This interplay reflects the foundation of the relationship between the hippocampus and the amygdala, wherein increased attention to emotionally laden stimuli through amygdala activation prioritizes hippocampal encoding processes toward such stimuli and events (Holodynski and Seeger 2019; Phelps 2004; Barch et al. 2019).

Alison Gopnik's characterization of toddlers as social beings (Gopnik 1996) has value in establishing the functional role of schematic representations of emotions, particularly positive ones. The prevalence of positive experiences in childhood through play and exploration serves as the foundation for the establishment of robust representations of positive affect that has utility. When these opportunities for play and exploration are hindered, so then are the establishment of long-term, readily accessible schematic representations. Children signal intent and goal through display of emotion, but if they don't have the context within which these emotion displays are received and reciprocated, they do not build robust representations that can be retrieved later. That is, joyful activities no longer have predictive cues for an affect-based response (Alwaely et al. 2021).

Acknowledging the value of social engagement in positive emotion development, its availability or quality is highly affected by community and neighborhood factors (Cutrona et al. 2005; Ewing et al. 2019). Evidence shows that neighborhood factors and household support play a critical role wherein adverse home and neighborhood environments (including but not limited to economic or perceived stress, parental psychopathology, parenting techniques, and empathy) increase susceptibility to depression and anhedonia (Ewing et al. 2019; Simons and Steele 2020). Economic deprivation results in a disrupted ability to establish a social contagion within which schematic representations of emotions can be dynamically and reciprocally utilized (Gao and Han 2016; Bolger and Patterson 2001; Cicchetti and Aber 1998; Raver 2004). This serves as a potential opportunity for intervention in providing access to peer interaction within under-resourced environments.

4 Role of Self-Concept Development During Childhood and Adolescence on Anhedonia

Self-concept reflects a set of representations or knowledge base that encompass one's beliefs, desires, and goals (Conway 2005). These concepts emerge from a dynamic interaction between inherent traits and external experiences, wherein one's experience of the world is driven by knowledge of themselves ("what would I want to do?") and one's

knowledge of themselves is influenced by their experience of the world ("how did that make me feel?"). This drive to know more about oneself is supported by memory processes that privilege self-related information.

Self-concept formation begins in middle childhood as children begin to generate self-beliefs by integrating across their own past experiences (Conway and Pleydell-Pearce 2000). The self-memory system (SMS) emphasizes the interconnectedness between the self and memory (Conway and Pleydell-Pearce 2000; Ross et al. 2020). This model defines the active construction of a self-concept as the "working self" that is comprised of one's present actions, goals, and self-images, and serves as the foundation upon which memory and regulatory processes emerge. The working-self coordinates and modulates control and memory systems in order to maintain consistency between one's past self, present self, and future self. Access to semantic knowledge structures, including schemas of emotion concepts, allows individuals to control how the working self operates within the world. A more effortful, top-down search (a generative search) can probe autobiographical memory structures for evidence from one's past that allows one to establish coherence with present drives and motivations (e.g., "I was shy when I went to that party, so I will avoid this party"). This interplay between control and memory systems allows individuals to make meaning of who they were and incorporate that into their knowledge base to regulate and coordinate present-day actions, thereby substantiating and perpetuating self-concept representations over time (Conway and Pleydell-Pearce 2000).

With a dearth of positive experiences instantiated into memory during early development, self-concept formation capacities are likely built on few examples of positive experiences. As such, integrating across a dearth of positive experiences may result in fewer positive self-concepts that, ultimately, influence the kind of choices children believe they have. Over time, fewer choices that elicit positive emotion or positive sense of self may result in general avoidance of pleasureful activities, or anhedonia. This section will provide an overview of how self-concept beliefs are built and can shape the extent to which a child may engage in pleasure-seeking activities.

Prior evidence shows that the SMS is active in preschool-aged children. In one study, authors found that preschoolers with a strong self-concept knowledge base showed stronger source memory for self-referential information and that this relationship was mediated by the quality of their autobiographical memory reports (Scheuplein et al. 2021; Ross et al. 2020). That is, children's ability to remember personal aspects of their own past (i.e., their autobiographical memory) explained their ability to use knowledge about the self to guide encoding and retrieval of self-referential information in the present. This study underscores the foundational relationships between oneself and memory, and the extent to which a robust relationship between the two guides present behaviors and actions (Higgins 1987). Furthermore, normative development shows heightened sensitivity and memory bias to self-related information in adolescents, with this heightened sensitivity decreasing into adulthood, suggesting that childhood and adolescence is a particularly vulnerable period in which self-concepts shape goals and behaviors, as well as memory and identity (Ross et al. 2020).

While a primary role of the working self is to maintain consistency with one's sense of self, discrepancies can occur within this system wherein individuals perceive their current self to be different from their ideal self (Barry et al. 2006). This notion is reflected in the distance model we introduced at the beginning of this chapter (Fig. 1) wherein individuals strive to maintain consistency with who they are and reduce the distance between one's set of self-concept beliefs and the possible choices one considers. In the context of depression, reduction in the number of choices that provide positive outcomes can negatively impact the extent to which children both build and are motivated to retrieve positive self-perceptions (Jacobs et al. 2003). Furthermore, in order to return to a state of coherence in a void of positive social input, individuals with depression may be biased to negative past experiences and self-perceptions from memory and as a result, make choices that cohere with these negative self-beliefs, thereby perpetuating them in the present and future, and maintaining a close distance between choices and self-beliefs.

In the context of anhedonia, this may be manifest as a lack of desire or an unwillingness to engage in pleasureful or joyful activities (Jacobs et al. 2003). In the context of development, when children are still building an integrated self-concept, discrepancies can be more difficult to reconcile. Insufficient top-down regulatory processes may promote negative drives and input, and an emerging memory system may be unable to flexibly identify those self-beliefs that counteract the negative input, leaving children confused and distressed (Burrows et al. 2017). In support, prior work suggests that children with a strong self-concept, or knowledge of who they are, exhibit lower levels of internalizing symptoms and higher positivity biases (i.e., notions that the future will hold positive outcomes) (Hsieh and Stright 2012; Kraus et al. 2011). In essence, this work aligns with our hypothesis that a strong internal self-representation can help an individual maintain a sense of individual and personal authenticity, positive or negative (Cunningham et al. 2014).

An aspect critical to self-referential processing is that it is built on the combination of personal and social identities. Daily engagement and interaction with the social world help shape one's identity, and input from the external world helps individuals determine how they feel about themselves and how they want others to see them. As young as 3 years of age, children engage in social comparisons to inform their self-evaluations, resulting in dynamic changes and opportunities for disruption in the formation of a positive self-view (Ruble and Frey 1991; Calheiros et al. 2020a). Not surprisingly, positive youths' perceptions of their social images were associated with their positive self-representations, and negative youths' perceptions of their social image were associated with youth's negative self-representation (Pfeifer et al. 2009). In adolescence – when social inputs become far more relevant a part of one's social experience, greater network activity is seen in the adolescent than adult brain in areas relevant to self-perception (medial prefrontal and parietal cortices) and social cognition (dorsomedial prefrontal cortex, temporal-parietal junction, subgenual anterior cingulate cortex, and posterior superior temporal sulcus). These latter findings suggest adolescent self-construal may rely more heavily on others' perspectives about the self and on the need for self-acceptance (Golde et al. 2019; Masten et al. 2009). As such, self-evaluation and an adolescent's evaluation of the world are tightly linked, supported further by evidence showing that perceived loneliness is associated with reduced neural

processing in areas implicated in self-processing, including the vmPFC, and in reducing self-related processing (Van der Cruijsen et al. 2018).

These deficits in self-referential processing align with similar evidence from depressed adolescents, as well. For example, in one study, depressed female adolescents endorsed more negative than positive views of the self. These results were substantiated by neural evidence showing greater P1 amplitudes (i.e., early ERP modulation over parietal-occipital sites) in response to these negative self-views, suggesting that depressed adolescents may exhibit early and strong biobehavioral response to negative self-referential information (Auerbach et al. 2015). In the context of anhedonia, individuals actively dampen responses to statements that are positively self-focused (e.g., think about high achievement) and positively emotion-focused (e.g., think about happy feelings), potentially rooted in overactive self-regulatory processes associated with the frontostriatal system (Werner-Seidler et al. 2013; Joormann and Stanton 2016). These results suggest that individuals with anhedonia struggle to regulate appropriate responses to positive self-information. These deficits may be particularly felt in adolescence considering the high instance of social inputs and relationships prompting more frequent self-appraisals. It is, thus, not surprising that the prevalence of anhedonia and MDD increases through the course of adolescence (Bennik et al. 2014). In recognition of these challenges in the context of anhedonia, recent work has suggested utilizing metacognitive interventions to improve self-esteem and attenuate negative self-views (McLeod et al. 2021).

5 Conclusions and Future Directions

Altogether, this points to the important role of self-cohesion in driving positive actions and feelings throughout childhood. While there is generally a decrease in positive traits during adolescence (Calheiros et al. 2020b), a dearth of positive experience or input in the context of anhedonia can increase negative traits because of socially driven negative self-evaluations, resulting in children disengaging from social and pleasureful activities. A disrupted social environment can have multiple avenues of influence on anhedonia. First, a lack of social engagement could reduce the extent to which children engage in self-referential processing, resulting in a less defined self-knowledge base. As a result, a self-memory system would struggle to identify relevant aspects of one's past self that might guide present choices and regulatory functions may struggle to identify a coherent path forward. For example, children with little social input may not readily know what to expect from themselves in a social event and avoid it altogether, thereby perpetuating feelings of loneliness and avoidance of typically pleasureful activities. Second, increased negative or decreased positive social engagement can increase negative traits that are perpetuated through the iterative self-memory system to maintain coherence. For example, negative self-evaluations such as "I am shy" may be used to protect against the possibility of negative social evaluations. It is also important to note that environmental and social inputs are constantly in flux. As such, self-evaluations are dynamic and shift over time based on changes in positive or negative experiences or feedback, potentially resulting in the present avoidance of what was previously pleasureful activities.

This is particularly critical when thinking about an adverse life event that may set children on a path toward negative self-representation and the cyclical nature in which this

perpetuates avoidance of joyful activities. Prior work shows that maltreatment in the form of sexual abuse increases negative self-representations in youth, and physical and psychological abuse, emotional maltreatment, and neglect decrease positive self-reflections (Rygula et al. 2013). In this context, negative self-representations serve as protective factors in reducing externalizing symptoms because of physical and psychological abuse.

It is also important to note that the relationship between negative self-representations and memory, as outlined in this paper in the context of anhedonia, may also play a role in maintaining other psychiatric disorders, including social anxiety disorder (Anderson et al. 2008; Hulme et al. 2012; Aymerich-Franch et al. 2014), obsessive compulsive disorder (Aardema and O'Connor 2007; Aardema et al. 2013), and eating disorders (Amianto et al. 2016). Neurobiologically, prior work has shown abnormalities in the adolescent hippocampal volume because of current and past depression, deficits in emotion regulation and episodic memory processes, and early childhood adversity, suggesting a strong link between development of memory systems, deficits in cognitive functions, early environment, and a host of psychiatric outcomes (Meyer et al. 2014).

Altogether, the model presented here delineates a dynamic, interactive relationship between the central role of self-concept in regulating and moderating emotionally laden choices. The overview of prior literature outlines the value of early experience in establishing emotion representations in memory. It further outlined the role of memory processes in maintaining representations of emotionally laden memories and concepts for flexible retrieval and use. Finally, it establishes how emotion representations and memory processes interact to establish a self-concept that drives what choices individuals believe they have and what choices they make. In particular, the work presented here provides a possible developmental perspective of how a dearth of positive experiences and emotion concepts in early memory might impact, over time, the extent to which an individual makes choices that appear pleasure-seeking and joyful. To validate this perspective, future work would benefit from longitudinal designs that can account for how early exposures impact the development of emotion memory processes and how the type of meaning making that must occur to generate one's set of self-beliefs might draw from impoverished memory networks related to positive content. Future work would also benefit from focusing on treatment and intervention. Parent–child interactions in early development are important for emotion development, and a focused intervention on parental caregiving and emotion expression may help scaffold emotion learning during this vulnerable period. Reappraisal, regulation, and metacognitive strategies later in adolescence may help alter the persistence of negative self-concept beliefs in defining one's identity and actions.

References

Aardema F, O'Connor K (2007) The menace within: obsessions and the self. J Cogn Psychother 21(3):182–197

Aardema F, Moulding R, Radomsky AS, Doron G, Allamby J, Souki E (2013) Fear of self and obsessionality: development and validation of the fear of self questionnaire. J Obsess-Compuls Relat Disord 2(3):306–315

Ainsworth MS, Bowlby J (1991) An ethological approach to personality development. Am Psychol 46(4):333

Alwaely SA, Yousif NBA, Mikhaylov A (2021) Emotional development in preschoolers and socialization. Early Child Dev Care 191(16):2484–2493

Amianto F, Northoff G, Abbate Daga G, Fassino S, Tasca GA (2016) Is anorexia nervosa a disorder of the self? A psychological approach. Front Psychol 7:849 [PubMed: 27378967]

Anderson B, Goldin PR, Kurita K, Gross JJ (2008) Self-representation in social anxiety disorder: linguistic analysis of autobiographical narratives. Behav Res Ther 46(10):1119–1125 [PubMed: 18722589]

Auerbach RP, Stanton CH, Proudfit GH, Pizzagalli DA (2015) Self-referential processing in depressed adolescents: a high-density event-related potential study. J Abnorm Psychol 124(2):233–245 [PubMed: 25643205]

Aymerich-Franch L, Kizilcec RF, Bailenson JN (2014) The relationship between virtual self similarity and social anxiety. Front Hum Neurosci 8:1–10 [PubMed: 24474914]

Baker LA, Cesa IL, Gatz M, Mellins C (1992) Genetic and environmental influences on positive and negative affect: support for a two-factor theory. Psychol Aging 7(1):158 [PubMed: 1558701]

Barch DM, Harms MP, Tillman R, Hawkey E, Luby JL (2019) Early childhood depression, emotion regulation, episodic memory, and hippocampal development. J Abnorm Psychol 128(1):81–95 [PubMed: 30628810]

Barrett LF (2006) Solving the emotion paradox: categorization and the experience of emotion. Personal Soc Psychol Rev 10:20–46

Barry ES, Naus MJ, Rehm LP (2006) Depression, implicit memory, and self: a revised memory model of emotion. Clin Psychol Rev 26(6):719–745 [PubMed: 16111794]

Bennik EC, Nederhof E, Ormel J, Oldehinkel AJ (2014) Anhedonia and depressed mood in adolescence: course, stability, and reciprocal relation in the TRAILS study. Eur Child Adolesc Psychiatry 23(7):579–586 [PubMed: 24154568]

Bolger KE, Patterson CJ (2001) Developmental pathways from child maltreatment to peer rejection. Child Dev 72(2):549–568 [PubMed: 11333084]

Bowlby J (1965) Attachment. Basic Books, New York

Bridges KMB (1932) Emotional development in early infancy. Child Dev 3:324–341

Bridgett DJ, Laake LM, Gartstein MA, Dorn D (2013) Development of infant positive emotionality: the contribution of maternal characteristics and effects on subsequent parenting. Infant Child Dev 22(4):362–382

Burrows CA, Usher LV, Mundy PC, Henderson HA (2017) The salience of the self: self-referential processing and internalizing problems in children and adolescents with autism spectrum disorder. Autism Res 10(5):949–960 [PubMed: 27868365]

Calheiros MM, Patrício JN, Silva CS (2020a) Social support as a moderator of associations between youths' perceptions of their social images and self-representations in residential care. Child Youth Serv Rev 119:105667

Calheiros MM, Silva C, Patrício JN (2020b) Maltreatment and youth self-representations in residential care: the moderating role of individual and placement variables. Child Youth Serv Rev 116:105230

Camras LA, Castro V, Halberstadt A, Shuster M (2017) Facial expressions in children are rarely prototypical. In: Russell JA, Fernandez-Dols JM (eds) The psychology of facial expressions, 2nd edn. Cambridge University Press, New York, pp 279–296

Cicchetti D, Aber JL (1998) Contextualism and developmental psychopathology. Dev Psychopathol 10(2):137–141 [PubMed: 9635218]

Clark DA, Beck AT, Alford BA, Bieling PJ, Segal ZV (2000) Scientific foundations of cognitive theory and therapy of depression. J Cogn Psychother 14(1). 10.1891/0889-8391.14.1.100

Conway MA (2005) Memory and the self. J Mem Lang 53(4):594–628

Conway MA, Pleydell-Pearce CW (2000) The construction of autobiographical memories in the self-memory system. Psychol Rev 107(2):261 [PubMed: 10789197]

Couch Y, Anthony DC, Dolgov O, Revischin A, Festoff B, Santos AI et al. (2013) Microglial activation, increased TNF and SERT expression in the prefrontal cortex define stress-altered behaviour in mice susceptible to anhedonia. Brain Behav Immun 29:136–146 [PubMed: 23305936]

Coughlin C, Robins RW (2017) Self-concept development. The Sage encyclopedia of abnormal and clinical psychology. Sage, Thousand Oaks

Cunningham SJ, Brebner JL, Quinn F, Turk DJ (2014) The self-reference effect on memory in early childhood. Child Dev 85(2):808–823 [PubMed: 23888928]

Cutrona CE, Russell DW, Brown PA, Clark LA, Hessling RM, Gardner KA (2005) Neighborhood context, personality, and stressful life events as predictors of depression among African American women. J Abnorm Psychol 114(1):3–15 [PubMed: 15709807]

Dollberg D, Feldman R, Keren M (2010) Maternal representations, infant psychiatric status, and mother–child relationship in clinic-referred and non-referred infants. Eur Child Adolesc Psychiatry 19(1):25–36 [PubMed: 19543936]

Eisenberg N (2020) Findings, issues, and new directions for research on emotion socialization. Dev Psychol 56(3):664–670 [PubMed: 32077732]

Ewing ESK, Herres J, Dilks KE, Rahim F, Trentacosta CJ (2019) Understanding of emotions and empathy: predictors of positive parenting with preschoolers in economically stressed families. J Child Fam Stud 28(5):1346–1358

Fogel A, Thelen E (1987) Development of early expressive and communicative action: reinterpreting the evidence from a dynamic systems perspective. Dev Psychol 23(6):747

Gao M, Han ZR (2016) Family expressiveness mediates the relation between cumulative family risks and children's emotion regulation in a Chinese sample. J Child Fam Stud 25(5):1570–1580

Gelman SA, Kalish CW (2006) Conceptual development. In: Kuhn D, Siegler RS (eds) Handbook of child psychology: cognition, perception, and language, vol 2, 6th edn. Wiley, pp 687–733

Golde S, Romund L, Lorenz RC, Pelz P, Gleich T, Beck A, Raufelder D (2019) Loneliness and adolescents' neural processing of self, friends, and teachers: consequences for the school self-concept. J Res Adolesc 29(4):938–952 [PubMed: 30019816]

Gopnik A (1996) The scientist as child. Philos Sci 63(4):485–514

Granat A, Gadassi R, Gilboa-Schechtman E, Feldman R (2017) Maternal depression and anxiety, social synchrony, and infant regulation of negative and positive emotions. Emotion 17(1):11–27 [PubMed: 27441576]

Greicius MD, Flores BH, Menon V, Glover GH, Solvason HB, Kenna H, Reiss AL, Schatzberg AF (2007) Resting-state functional connectivity in major depression: abnormally increased contributions from subgenual cingulate cortex and thalamus. Biol Psychiatry 62:429–437 [PubMed: 17210143]

Grimm S, Beck J, Schuepbach D, Hell D, Boesiger P, Bermpohl F, Niehaus L, Boeker H, Northoff G (2008) Imbalance between left and right dorsolateral prefrontal cortex in major depression is linked to negative emotional judgment: an fMRI study in severe major depressive disorder. Biol Psychiatry 63:369–376 [PubMed: 17888408]

Grimm S, Ernst J, Boesiger P, Schuepbach D, Hell D, Boeker H, Northoff G (2009) Increased self-focus in major depressive disorder is related to neural abnormalities in subcortical-cortical midline structures. Hum Brain Mapp 30(8):2617–2627 [PubMed: 19117277]

Hanford LC, Schmithorst VJ, Panigrahy A, Lee V, Ridley J, Bonar L et al. (2018) The impact of caregiving on the association between infant emotional behavior and resting state neural network functional topology. Front Psychol 9:1968 [PubMed: 30374323]

Harker CM, Ibanez LV, Nguyen TP, Messinger DS, Stone WL (2016) The effect of parenting style on social smiling in infants at high and low risk for ASD. J Autism Dev Disord 46(7):2399–2407 [PubMed: 27007726]

Harlow HF, Zimmerman RR (1958) Affective responses in the infant monkey. Science 12(13):431–432

Higgins ET (1987) Self-discrepancy: a theory relating self and affect. Psychol Rev 94(3):319–340 [PubMed: 3615707]

Hoemann K, Xu F, Barrett LF (2019) Emotion words, emotion concepts, and emotional development in children: a constructionist hypothesis. Dev Psychol 55(9):1830 [PubMed: 31464489]

Holodynski M, Friedlmeier W (2006) Development of emotions and emotion regulation. Springer, New York

Holodynski M, Seeger D (2019) Expressions as signs and their significance for emotional development. Dev Psychol 55(9):1812 [PubMed: 31464488]

Howe ML, Courage ML (1997) The emergence and early development of autobiographical memory. Psychol Rev 104(3):499 [PubMed: 9243962]

Hsieh M, Stright AD (2012) Adolescents' emotion regulation strategies, self-concept, and internalizing problems. J Early Adolesc 32(6):876–901

Hulme N, Hirsch C, Stopa L (2012) Images of the self and self-esteem: do positive self-images improve self-esteem in social anxiety? Cogn Behav Ther 41(2):163–173 [PubMed: 22439697]

Husain M, Roiser JP (2018) Neuroscience of apathy and anhedonia: a transdiagnostic approach. Nat Rev Neurosci 19(8):470–484 [PubMed: 29946157]

Jacobs JE, Bleeker MM, Constantino MJ (2003) The self-system during childhood and adolescence: development, influences, and implications. J Psychother Integr 13(1):33–65

Joormann J, Stanton CH (2016) Examining emotion regulation in depression: a review and future directions. Behav Res Ther 86:35–49 [PubMed: 27492851]

Kang MS, Wolf D, Kazinka R, Lee S, Ruparel K, Elliott M et al. (2020) Decision value signals in the ventromedial prefrontal cortex and anhedonia across mood and psychotic disorders. bioRxiv. 10.1101/2020.12.01.407197

Kärtner J, Holodynski M, Wörmann V (2013) Parental ethnotheories, social practice and the culture-specific development of social smiling in infants. Mind Cult Act 20(1):79–95

Kraus MW, Chen S, Keltner D (2011) The power to be me: power elevates self-concept consistency and authenticity. J Exp Soc Psychol 47(5):974–980

Laurent HK, Ablow JC (2013) A face a mother could love: depression-related maternal neural responses to infant emotion faces. Soc Neurosci 8(3):228–239 [PubMed: 23330663]

Legerstee M, Varghese J (2001) The role of maternal affect mirroring on social expectancies in three-month-old infants. Child Dev 72(5):1301–1313 [PubMed: 11699672]

Luby JL (2010) Preschool depression: the importance of identification of depression early in development. Curr Dir Psychol Sci 19(2):91–95 [PubMed: 21969769]

Luby JL, Heffelfinger AK, Mrakotsky C, Hessler MJ, Brown KM, Hildebrand T (2002) Preschool major depressive disorder: preliminary validation for developmentally modified DSM-IV criteria. J Am Acad Child Adolesc Psychiatry 41(8):928–937 [PubMed: 12162628]

Luby JL, Mrakotsky C, Heffelfinger A, Brown K, Hessler M, Spitznagel E (2003) Modification of DSM-IV criteria for depressed preschool children. Am J Psychiatr 160(6):1169–1172 [PubMed: 12777277]

Luby JL, Mrakotsky C, Heffelfinger A, Brown K, Spitznagel E (2004) Characteristics of depressed preschoolers with and without anhedonia: evidence for a melancholic depressive subtype in young children. Am J Psychiatr 161(11):1998–2004 [PubMed: 15514399]

Luby JL, Sullivan J, Belden A, Stalets M, Blankenship S, Spitznagel E (2006) An observational analysis of behavior in depressed preschoolers: further validation of early-onset depression. J Am Acad Child Adolesc Psychiatry 45(2):203–212 [PubMed: 16429091]

Luby JL, Belden AC, Pautsch J, Si X, Spitznagel E (2009) The clinical significance of preschool depression: impairment in functioning and clinical markers of the disorder. J Affect Disord 112(1–3):111–119 [PubMed: 18486234]

Luby J, Belden A, Botteron K, Marrus N, Harms MP, Babb C et al. (2013) The effects of poverty on childhood brain development: the mediating effect of caregiving and stressful life events. JAMA Pediatr 167(12):1135–1142 [PubMed: 24165922]

Lunkenheimer E, Hamby CM, Lobo FM, Cole PM, Olson SL (2020) The role of dynamic, dyadic parent–child processes in parental socialization of emotion. Dev Psychol 56(3):566 [PubMed: 32077725]

Marshall PJ, Meltzoff AN (2011) Neural mirroring systems: exploring the EEG mu rhythm in human infancy. Dev Cogn Neurosci 1(2):110–123 [PubMed: 21528008]

Masten CL, Eisenberger NI, Borofsky LA, Pfeifer JH, McNealy K, Mazziotta JC, Dapretto M (2009) Neural correlates of social exclusion during adolescence: understanding the distress of peer rejection. Soc Cogn Affect Neurosci 4(2):143–157 [PubMed: 19470528]

McLeod HJ, McGuire N, Gumley A (2021) The recovery of sense of self while coping with negative symptoms. In: The recovery of the self in psychosis. Routledge, pp 135–149

Meltzoff AN, Kuhl PK (2016) Exploring the infant social brain: What's going on in there. Zero to three 36(3):2–9

Messinger D, Fogel A (2007) The interactive development of social smiling. Adv Child Dev Behav 35:327–366 [PubMed: 17682330]

Meyer S, Raikes HA, Virmani EA, Waters S, Thompson RA (2014) Parent emotion representations and the socialization of emotion regulation in the family. Int J Behav Dev 38(2):164–173

Mireault GC, Crockenberg SC, Sparrow JE, Cousineau K, Pettinato C, Woodard K (2015) Laughing matters: infant humor in the context of parental affect. J Exp Child Psychol 136:30–41 [PubMed: 25897958]

Mortillaro M, Mehu M, Scherer KR (2011) Subtly different positive emotions can be distinguished by their facial expressions. Soc Psychol Personal Sci 2(3):262–271

Mumper EE, Finsaas MC, Goldstein BL, Gooding DC, Klein DN (2021) Developmental antecedents of social anhedonia: the roles of early temperament and sex. Dev Psychopathol 33(1):363–371 [PubMed: 32375907]

Mundy P, Jarrold W (2010) Infant joint attention, neural networks and social cognition. Neural Netw 23(8–9):985–997 [PubMed: 20884172]

Nelson CA (2000) Neural plasticity and human development: the role of early experience in sculpting memory systems. Dev Sci 3(2):115–136

Nelson K (2019) Explaining the emergence of autobiographical memory in early childhood. In: Theories of memory. Psychology Press, pp 355–385

Oster H, Hegley D, Nagel L (1992) Adult judgments and fine-grained analysis of infant facial expressions: testing the validity of a priori coding formulas. Dev Psychol 28:1115–1131

Parsons CE, Young KS, Stein A, Kringelbach ML (2017) Intuitive parenting: understanding the neural mechanisms of parents' adaptive responses to infants. Curr Opin Psychol 15:40–44 [PubMed: 28813266]

Pelizza L, Ferrari A (2009) Anhedonia in schizophrenia and major depression: state or trait? Ann General Psychiatry 8:22

Pfeifer JH, Masten CL, Borofsky LA, Dapretto M, Fuligni AJ, Lieberman MD (2009) Neural correlates of direct and reflected self-appraisals in adolescents and adults: when social perspective-taking informs self-perception. Child Dev 80(4):1016–1038 [PubMed: 19630891]

Phan KL, Wager TD, Taylor SF, Liberzon I (2004) Functional neuroimaging studies of human emotions. CNS Spectr 9:258–266 [PubMed: 15048050]

Phelps EA (2004) Human emotion and memory: interactions of the amygdala and hippocampal complex. Curr Opin Neurobiol 14(2):198–202 [PubMed: 15082325]

Phillips ML, Drevets WC, Rauch SL, Lane R (2003) Neurobiology of emotion perception II: implications for major psychiatric disorders. Biol Psychiatry 54:515–552 [PubMed: 12946880]

Phillips ML, Schmithorst VJ, Banihashemi L, Taylor M, Samolyk A, Northrup JB et al. (2021) Patterns of infant amygdala connectivity mediate the impact of high caregiver affect on reducing infant smiling: discovery and replication. Biol Psychiatry 90(5):342–352 [PubMed: 34130856]

Pornpattananangkul N, Leibenluft E, Pine DS, Stringaris A (2019) Association between childhood anhedonia and alterations in large-scale resting-state networks and task-evoked activation. JAMA Psychiat 76(6):624–633

Radke-Yarrow M, Cummings EM, Kuczynski L, Chapman M (1985) Patterns of attachment in two-and three-year-olds in normal families and families with parental depression. Child Dev 56(4):884–893 [PubMed: 4042751]

Raver CC (2004) Placing emotional self-regulation in sociocultural and socioeconomic contexts. Child Dev 75(2):346–353 [PubMed: 15056189]

Rosebrock LE, Waite F, Diamond R, Collett N, Bold E, Chadwick E et al. (2021) Anticipatory pleasure in current psychosis: cognitive and emotional correlates. Psychiatry Res 297:113697 [PubMed: 33465523]

Ross J, Hutchison J, Cunningham SJ (2020) The me in memory: the role of the self in autobiographical memory development. Child Dev 91(2):e299–e314 [PubMed: 30644537]

Ruble DN, Frey KS (1991) Changing patterns of comparative behavior as skills are acquired: a functional model of self-evaluation. In: Suls J, Wills TA (eds) Social comparison: contemporary theory and research. Lawrence Erlbaum Associates, pp 79–113

Rygula R, Papciak J, Popik P (2013) Trait pessimism predicts vulnerability to stress-induced anhedonia in rats. Neuropsychopharmacology 38(11):2188–2196 [PubMed: 23660704]

Scheuplein M, Chierchia G, Ahmed S, Foulkes L, Griffin C, Blakemore SJ (2021) Adolescents display distinct self-referential biases in memory and perspective taking. PsyArxiv. 10.31234/osf.io/qywts

Shultz S, Klin A, Jones W (2018) Neonatal transitions in social behavior and their implications for autism. Trends Cogn Sci 22(5):452–469 [PubMed: 29609895]

Simons LG, Steele ME (2020) The negative impact of economic hardship on adolescent academic engagement: an examination parental investment and family stress processes. J Youth Adolesc 49(5):973–990 [PubMed: 32166653]

Sroufe A, Waters E (1976) The ontogenesis of smiling and laughter: a perspective on the organization of development in infancy. Psychol Rev 83:173–189 [PubMed: 188058]

Stringaris A, Vidal-Ribas Belil P, Artiges E, Lemaitre H, Gollier-Briant F, Wolke S et al. (2015) The brain's response to reward anticipation and depression in adolescence: dimensionality, specificity, and longitudinal predictions in a community-based sample. Am J Psychiatr 172(12):1215–1223 [PubMed: 26085042]

van der Aar LE, Crone EA, Peters S (2019) What characterizes adolescents struggling with educational decision-making? The role of behavioral and neural correlates of self-concept and self-esteem. Mind Brain Educ 13(3):184–197

Van der Cruijsen R, Peters S, Van der Aar LPE, Crone EA (2018) The neural signature of self-concept development in adolescence: the role of domain and valence distinctions. Dev Cogn Neurosci 30:1–12 [PubMed: 29197726]

Weinberg MK, Tronick EZ (1998) Emotional characteristics of infants associated with maternal depression and anxiety. Pediatrics 102(Supplement E1):1298–1304 [PubMed: 9794973]

Werner-Seidler A, Banks R, Dunn BD, Moulds ML (2013) An investigation of the relationship between positive affect regulation and depression. Behav Res Ther 51(1):46–56 [PubMed: 23178678]

Zheng Y, Plomin R, von Stumm S (2016) Heritability of intraindividual mean and variability of positive and negative affect: genetic analysis of daily affect ratings over a month. Psychol Sci 27(12):1611–1619 [PubMed: 27729566]
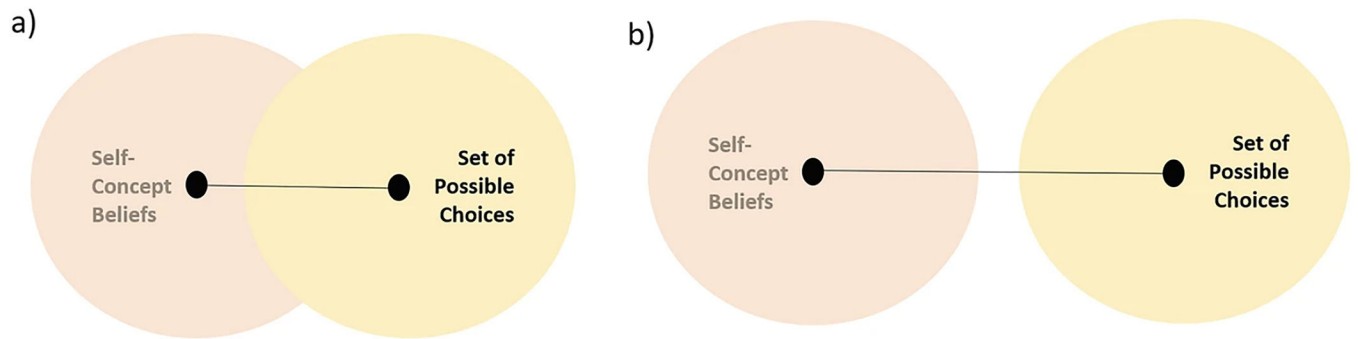
a)

b)

Fig. 1.
This figure represents a graphical depiction of the socioemotional hypothesis of anhedonia proposed in this manuscript. Individuals strive to select choices from what is possible (yellow circle) that cohere with their self-concept beliefs (red circle). The length of the lines in these figures reflects the degree of discordance one might feel when their choice or choices are not consistent with their self-concept beliefs. As such, an ideal place is when the distance between one's self-concept beliefs and set of possible choices is not exceedingly distant (**a**). When choices begin to diverge from one's set of beliefs and the distance between them begins to increase (**b**), the discrepancy may generate feelings of discomfort and unease. To reduce this distance, one needs to either alter their set of beliefs to overlap with the choice that was made or select options that are more in line with one's self-beliefs