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Emotional Development: A Field in Need of a (Cognitive) Revolution

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Abstract

The cognitive revolution of the 1970's and 80's brought with it an emphasis on cognitive processes involved in emotion. While a similar wave of cognitive research spread to the field of developmental psychology, it did so in a relatively affectively neutral way. While infancy research systematically whittled down developmental processes into their most basic cognitive underpinnings, the role of cognition in emotional development remains largely underrepresented in the literature. This chapter is a clarion call to researchers to devote equal theoretical and empirical efforts to the role of cognition in emotional development. We highlight three areas of research ripe for closer examination by researchers of emotional development: appraisal, executive functioning, and inference-based learning. By linking existing research methodologies and findings in these cognitively dominated domains with open questions relating to emotional development, we highlight how this research can help spur progress in the study of emotion.

Keywords: Cognition; appraisal; executive function; rational inference; statistical learning

Emotions are processes of managing one's relation with their perceived environment on matters of personal significance (Barrett & Campos, 1987). As such, studying their development necessitates understanding changes in how the developing individual appreciates and relates with their world. The cognitive revolution of the 1970's and 80's infused theoretical and empirical emotion research in the adult literature, yielding a wealth of research on how differences in individuals' goals and their perception of the environment correspond with differences in emotional experiences. In developmental psychology, the cognitive revolution sparked interest in the building blocks of cognition in infants and children. However, researchers of emotional development failed to make such similar conceptual and empirical progress. Thus, while much of developmental research has focused on identifying emotions in infants and young children, our understanding of how changes in constituent emotion processes (e.g., cognition, perception) impact emotional development remains limited. This chapter borrows from and extends findings from the cognitive development literature to spark novel research on emotional development. In doing so, we aim to inspire novel ways of considering how emotion and cognition develop in tandem – in essence, providing the complementary side of a developmental coin.

The Cognitive Revolution that Emotional Development Forgot

The field of emotional development is both old and new. Philosophers have pondered emotions and their development for centuries (e.g., Aristotle, 340BC/1999; Hume, 1739; Locke, Book II, 1690). Likewise, Darwin observed infants and young children (including his own) to inform his understanding of the emergence of expressive behaviors, such as blushing or tears while crying (Darwin, 1872). Interestingly, a common tension amongst the authors centered on those aspects of emotion that are innate and those that develop, and the distinction between passion (i.e., emotion) and reason (i.e., cognition).

Modern empirical inquiry of emotional development took hold in the 1970's and 1980's with the research by Campos, Izard, and others (e.g., Barrett & Campos, 1987; Izard, 1978, 1979; Klinnert et al., 1983). The human infant was not merely lost in a Jamesian "blooming, buzzing confusion" (James, 1890, pp. 462), she interacted with and related to the developmental context. Infants used emotions to engage with social partners (e.g., Field, 1982), sought out and used emotion to guide their interaction with the environment (e.g., Sorce et al., 1985), and were acutely sensitive when emotional interactions were disrupted (e.g., Tronick et al., 1978).

Concurrently, the broader field of emotion began integrating cognitive components into emotion theory (e.g., Clark & Fiske, 1982). In particular, the role of (cognitive) appraisal became central to many emotion theories (see Moors et al., 2013; Roseman & Smith, 2001). These theories emphasized the importance of how an individual perceives and appraises their environment across different dimensions (e.g., agency, certainty, novelty) for the elicitation of specific emotions. In doing so, emotion researchers studying adult populations successfully bridged cognition and emotion – even naming a journal accordingly (*Cognition and Emotion*).

However, despite the rich history of research seeking to understand the ontogeny of emotion and the leaps taken to understand adult emotion processes, the study of emotional development has struggled to keep pace. The lack of progress is clear when compared with the study of cognitive development. The cognitive revolution of the latter half of the 20th century brought forth grand theories on cognition and development (e.g., Chomsky, 1957; Gibson, 1969; Neisser, 1967). Moreover, empirical research accelerated in productivity in the 1980's with the advancement of novel methodological approaches (e.g., habituation and violation of expectation paradigms). The results were numerous breakthroughs that transformed our understanding of cognition and development. In stark relief to such headway is our understanding of basic

processes of emotional development, a topic of continued study (see Pollak et al., 2019) that remains mired in construct-level confusion (Walle & Dahl, 2020).

The role of cognition in the emotion process is firmly instantiated in emotion theory and empirical research with adults; it is time for researchers of emotional development to make similar conceptual and empirical leaps. By marrying current emotion theory with the methodological precision of studies of cognitive development, emotion researchers can expand our understanding of how emotional processes change across human development.

Examining the Co-development of Emotion and Cognition

Cognitive processes are central to many theories of emotion and are important to consider in the study of emotional development (see Fogel et al., 1992; Lewis, 2001). Although substantial overlap is apparent when one aligns research on emotional and cognitive development (see Reschke et al., 2017), explicit research linking these domains in the developmental literature is sparse. We do not seek to relitigate whether an emotion can be deconstructed and reconstructed with its requisite pieces; emotions are greater than the sum of their parts (see Camras, 2017; Coan, 2017; Lazarus, 1991). Rather, understanding the ontogeny of the component processes of emotion can elucidate the developmental interconnectedness of these processes and how they cohere to form an emergent process that, while related to its substrates, is qualitatively distinct. Below we highlight three cognitive processes likely to underlie emotional development: appraisal, executive functioning, and inference-based learning.

The Development of Appraisal Dimensions of Emotion

The role of appraisal is central to many views of emotion (see Lazarus, 1991a; Scherer et al., 2001). Conceptualizations of how many appraisal dimensions are utilized (e.g., Kitayama & Markus, 1990; Scherer, 1982; Smith & Ellsworth, 1985), how distinct dimensions cohere in the

generation of specific emotions (e.g., Roseman et al., 1996; Smith & Ellsworth, 1987), and their sequencing (e.g., Grandjean & Scherer, 2008; Lazarus, 1991b; Scherer, 1999) in the emotion process varies. However, there is general agreement that appraisals are involved in the emotion process (see Ellsworth & Scherer, 2003; Lazarus, 1993) and empirical research indicates discrete emotions are elicited by manipulating specific appraisal dimensions (e.g., Roseman & Evdokus, 2004).

And yet, research examining the ontogeny of appraisals remains scant. Although Izard (1993) provided a harsh assessment on the rising importance placed on cognition in studying emotion processes through the lens of appraisals, other notable researchers have indicated its importance. In considering laughter, Darwin noted that "a young child if tickled by a strange man, would scream from fear" (pp. 186), illustrating the important role of how the child appraises the context in generating the resulting emotional experience. The importance of developmental research has also been noted by appraisal researchers (e.g., Roseman & Smith, 2001). Indeed, Roseman (2001) emphasized that "appraisal-making may proceed with little or no consciousness, and it is likely that there are primitive (simple, rudimentary) versions of each appraisal… that can elicit these emotions (pp. 77)." Below we focus on two appraisal dimensions that may undergird early emotional development: agency and expectedness.

The Co-development of Emotion and Agency

Attributing responsibility is essential for the elicitation of numerous emotions. Indeed, according to Roseman (2001, Table 4.4), agency differentiates eight discrete emotions: surprise, joy, fear, anger, pride, guilt, shame, and disgust. Adults readily assign responsibility for others' actions – there is even a classic error named in its overuse (Ross, 1977)! However, what of the young infant who cannot complete goal-directed actions: is it reasonable to expect that she can

appreciate agency? Work by Woodward and colleagues has meticulously examined infants' perception of goal-directed action (see Woodward, 2009). Findings indicate that interventions providing young infants with experience grasping objects facilitates their appreciation of others' reaching as goal-directed (Sommerville et al., 2005). Thus, as the infant becomes more agentic and engages with others perceived as agentic, their appreciation of agency is likely to blossom and correspond with marked changes in their emotionality (e.g., Biringen et al., 1995).

Conversely, a child may misattribute agency in an emotional context. One can imagine a child believing that they are the cause of an outcome (e.g., their parent's divorce) or that fate brought a cache of December gifts. In one of the few studies to examine children's understanding of causal attributions and emotions, Thompson (1991) found that this appraisal dimension explained variability in emotion processing in young children. Moreover, erroneously attributing intentionality can lead children to unjustly punish an agent whose transgression was accidental (Killen et al., 2014). Extensive work by Dodge and colleagues provides insight on how misattribution of agency can result in different emotional responses (e.g., Dodge, 1980), as well as the long-term consequences of such misattributions (see Dodge et al., 2003). Thus, concepts such as the fundamental attribution error commonly used to make sense of adult behavior may be similarly useful for understanding seemingly irrational emotions in the developing child.

The Co-development of Emotion and Expectedness

An adult's wealth of experiences provides numerous examples and counterexamples to anticipate the likelihood of particular outcomes. Findings from the field of cognitive development demonstrate infants' propensity to detect probabilities and outcomes (e.g., Gopnik & Wellman, 2012); a skill undoubtedly relevant for emotional development. In fact, the violation of expectation paradigm, used widely by cognitive development researchers, is predicated on

infants' expectations for particular outcomes, and have recently been used to connect situational outcomes with emotional responses (Scott, 2017). Likewise, 20-month-old infants who observed an agent consistently select a statistically improbable object were more likely to give the agent that object, demonstrating that infants appreciated the preference of the agent and completed her, statistically improbable, goal (Kushnir et al., 2010). Thus, understanding the likelihood of particular goal-outcomes allows infants to anticipate and appreciate others' emotions.

More broadly, appreciating the potential for particular emotional outcomes could set the stage for enduring moral competencies. For example, THOMPSON (chapter, this volume) describes children's "premoral sensibilities" of right and wrong as an emerging appraisal essential for experiencing certain moral emotions (e.g., indignation, sympathy, empathy, vengeance). Thus, an infant testing whether their parent will persist in reprimanding a previously prohibited action (e.g., pp. 165, Dahl & Freda, 2017) may serve to build a degree of confidence that the act will be met with negative judgment, as well as transfer to other actions/contexts of similar relational significance (e.g., the destruction of property). The cultivation of such experiences in the developing child is likely fundamental to understanding emotional development.

The Role of Executive Functioning for Emotional Development

Emotions and executive functioning (EF) have important roles in the manifestation of human behavior. While emotion refers to processes that regulate the self and others in the environment in relation to one's goals (Barrett & Campos, 1987), EF refers to higher-order cognitive processes that enable us to act in a goal-directed manner (Anderson, 2002; Diamond, 2013). While cognitive processes associated with EF are plentiful, the core components include inhibitory control, working memory and cognitive flexibility (Carlson, 2005; Diamond, 2013;

Zelazo et al., 1997; Welsh et al., 1991; Miyake et al., 2000). There have been a concentrated wave of studies and theoretical accounts discussing and advancing our understanding of the reciprocal relationship between emotion and higher-order cognitive processes, such as EF.

EF has been associated with socio-emotional development (see Riggs et al., 2006 for a review). For example, children with poorer EF exhibit more negative emotion expressions, aggressive coping strategies, and impulsive behaviors, suggesting a link between executive function and emotion (Jahromi & Stifter, 2008). Furthermore, several studies have found that EF predicts performance on false belief tasks concerning the causes and goals of other's actions (Sabbagh et al., 2006; Carlson & Moses, 2001; for reviews, see Perner & Lang, 1999; Devine & Hughes, 2014). While prior research clearly demonstrates associations between emotions and higher-order cognitive processes, less is known regarding *how* emotions and EF interact (see chapter DeFRANCE, this volume).

Emotion, Neurological Functioning, and EF

Research from cognitive neuroscience supports the intricate bond between cognition and emotion through shared neural mechanisms (Bell & Wolfe, 2004; Blair, 2002; Zelazo & Cunningham, 2007; Bush et al., 2000). Likewise, work focused on the development of emotion and cognition in early childhood has found instances in which emotional control and cognitive control are dynamically dependent (Blankson et al., 2012; Carlson & Wang, 2007; Ferrier et al., 2014). For example, Blankson and colleagues (2013) found that emotional control at age 3 supports cognitive control at 4 years of age. Furthermore, Rhoades et al. (2009) found that preschoolers who performed better on inhibitory control measures were rated lower on internalizing problems and higher in social skills – outcomes infused with emotion. Studies among infants complement these findings, with emotional reactivity and regulation in infancy

predicting EF at 4 years (Urasche et al., 2013). Thus, it appears that cognitive capabilities in infancy, such as attention and reactivity, correspond with later self-regulation abilities (Blair, 2002; Urasche et al., 2013).

While these studies have advanced our understanding of the relationship between emotional development and cognitive development, further emotion research including complementary cognitive processes would provide a dynamic view of emotion and cognition during child development (Bell & Wolfe, 2004). Indeed, there are a variety of standardized attention and EF measurements that would be fruitful in this endeavor (Mahone, 2005; Carlson, 2005). Specifically, some tasks require motoric inhibition, verbal inhibition, flexibility between competing rules, or working memory demands – all processes likely related to emotion regulation. Thus, the inclusion of standardized EF tasks into studies on emotional development would offer emotion researchers a peak at the intertwined nature of emotion and cognition in early childhood.

Considering "Hot" and "Cool" Contexts

Given the nature of many EF studies, research on this construct has primarily been studied within relatively "cool", decontextualized, and non-emotional contexts (Zelazo & Müller, 2002; Zelazo & Carlson, 2012), such as the regulation of arbitrary rules in a task with low stakes (Zelazo & Cunningham, 2007). For instance, in an antisaccade inhibitory control task, infants must inhibit looking to peripheral distracter cues (Holmboe et al., 2008; Johnson, 1995). Similarly, in a delayed-memory search that measures inhibitory control and working memory, infants must find an object in one of multiple locations after a delay and restrain from searching in locations that were previously rewarded (Diamond 1985; Cuevas & Bell, 2010). If EF and attention skills are truly at the core of how one begins to control one's behavior in relation to

one's goal (Cuevas et al., 2017), then these skills may inform the development of emotion regulation and the influence of emotion's on self-regulatory abilities. Rhoades et al. (2009) found that a task designed to capture children's ability to inhibit a motor response was the best measure for predicting social-emotional development. Consequently, the ability to inhibit certain action tendencies of emotions (Frijda, 1986) may be important for socio-emotional development.

Contrary to cool tasks, hot EF tasks require regulation in contexts where the outcomes are of greater personal significance, such as completing a task to earn a desirable prize (e.g., Hongwanishkul et al., 2005; Kerr & Zelazo, 2004). Interest in studying executive function within 'hot' motivational emotional contexts is gaining traction in the literature. Such studies include examining the regulation of one's own social behavior or decision-making involving punishment and reward (see Bechara, Damasio, Damasio, & Lee, 1999; Damasio, 1995). Relatedly, research has begun to distinguish between hot and cool EF abilities in children and adolescents (e.g., Poon, 2018; Zelazo & Carlson, 2012), further supporting the notion that these processes may be uniquely informative for emotional development. For example, Zelazo and Cunningham (2007) proposed a reciprocal relationship between emotion and EF based on the problem's motivational significance (i.e., hot or cool). In this model, emotion and EFs are inseparable. Increased precision in using the term "hot" EF, effortful control, self-regulation, or cognitive control would improve comparisons of "hot" and "cool" executive processes (Zhou et al., 2012) and provide clarity of their role in emotional development.

Inference-based Learning and Emotional Development

Human beings are often considered natural Bayesian learners, using prior experience to inform their understanding of the world. A theoretical view in developmental psychology that champions this position is rationalist constructionism. From this perspective, infants use the

natural cooccurrence of events in their environment to construct and support domain general categories that help them make sense of the world (Xu, 2019). Rational constructivist approaches have traditionally been utilized when examining the development of infant causal theories (Gopnik & Wellman, 2012), knowledge of conceptual categories (Baillargeon et al., 2015), and language learning (Yurosky et al., 2013). Only recently has this perspective been applied to the study of emotional development, such as the construction of emotion categories (Hoemann et al., 2020; chapter PLATE, this volume). Below we demonstrate how emotion-related information can influence these rational learning processes to facilitate emotional development.

Statistical Learning

While statistical learning is relevant for various developmental domains, it has traditionally been studied in relation to infant language development. However, there are at least two ways that infants' propensity to learn the probable contingencies of environmental input is likely relevant for emotional development. First, infants keep track of co-occurring environmental stimuli. For example, 8-month-old infants can identify novel words by tracking the statistical regularities of various phonemes in a speech stream following only 2-minutes of auditory exposure (Saffran et al., 1996). Likewise, infants link contingent elements of emotion-related information, such as facial expressions, vocalizations, and goal-directed actions (e.g., Wu et al., 2017). A growing body of research indicates that infants have expectations of events likely to elicit particular emotions (see chapter PLATE, this volume). For example, infants have expectations for events likely to elicit joy and sadness at 12-months (Reschke et al., 2017), surprise at 18-months (Wu et al., 2018), and even distinct positive emotions in the second year of life (Wu et al., 2017). Nonetheless, just as learning the transitional probabilities of phonemes to identify words does not necessarily mean that the infant understands its meaning, the infant

forming associations between emotion-related elements does not necessarily indicate that the infant appreciates their communicative or relational significance.

Second, the communicated goal-relevance inherent to emotional signals likely drives infant attention to attend to relevant contextual features (see chapter CLEMENT, this volume. Recent language learning research indicates that infants actively generate efficient contexts for statistical learning. For instance, infant sustained attention and manipulation of objects predicts language learning outcomes (Pereira et al., 2014; Slone et al., 2018), by narrowing the amount of environmental information, and thereby simplifying the statistical learning process (Yurosky et al., 2013). So, too, do emotions influence infant attention to their environment. For example, infants increase visual attention towards disgusting and fearful stimuli and faces expressing anger (Hoehl, 2014; LoBue & Rakison, 2013). Thus, the infant's disposition to attend to emotionally salient objects and events may increase the likelihood that statistical regularities in the emotional environment are detected and retained. Additionally, the infant's own emotional interest in particular objects or events may improve their receptiveness to adult input about such stimuli. Indeed, language learning is improved when parents follow-in on what their infant is already attending to (e.g., Yu & Smith, 2012). Thus, the infant's own interest in emotionally relevant stimuli may increase the likelihood that they successfully form relationally significant associations communicated by a caregiver.

Rational Inferences

Beyond the statistical regularities with which emotions occur in the environment, emotions communicate agents' intentions, goals, and preferences (Reschke et al., 2017). Rational inference is a powerful tool used to infer others' mental states (Wu et al., 2017) and is related to reverse engineering of appraisal dimensions (Hareli & Hess, 2010). An emerging body of

research has attempted to bridge paradigms from cognitive development to study how rational inferences correspond with emotion understanding. For example, multiple studies have shown that an agent's repeated persistence towards a goal communicates their intention and preference (Baillargeon et al., 2015). In such paradigms, researchers go to great lengths to ensure that the experimenter remain expressively neutral – so as to remove the potential "confound" of emotion. However, a recent study compared infant's attribution of intention to the experimenter's actions when she was expressively neutral versus frustrated when failing to complete an action. As predicted, the findings indicated that the experimenter's expression of frustration heightened infants' understanding of her goal-directed actions (Reschke et al., 2020).

Infants also infer intentions and preferences from probability distributions governing the likelihood of a particular outcome (see Denison & Xu, 2019). For example, infants who observe an experimenter repeatedly select a minority object from a distribution of objects infer that the experimenter has a preference for the minority object over the majority object (Diesendruck et al., 2015; Kushnir et al., 2010; Ma & Xu, 2013; Wellman et al., 2016). Interestingly, many of these studies include the agent's expression of joy following the selections, and recent work suggests that such emotional expressions act as an additional preference cue. For example, young children expect agents to be surprised after receiving a low probability item and happier when receiving a preferred item that was improbable (Doan et al., 2018, 2019). Thus, the child integrates the present context with prior emotional experiences to generate emotional expectations, and these experiences, in turn, guide future predictions.

Considerations for Studying Emotional and Cognitive Development

We have focused primarily on basic processes underlying emotional development, with an emphasis on cognitive processes likely to undergird such development. However, the

potential of our perspective is broader than what we have reviewed. We conclude by pushing this perspective further in four ways.

Exploring How Processes Function and Change, Not Their Presence or Absence

A particular ability or understanding need not necessarily be present or absent; rather, it can take various forms across development (see Mascolo & Fischer, 2015, 1995) and demonstrate non-linear trajectories. Identifying the synchronous, and also heterochronous (see Fogel & Thelen, 1987), trajectories of underlying cognitive processes is crucial for understanding emotional development (see chapter DeFRANCE, this volume). Moreover, the presence of a cognitive ability does not necessarily mean that it can be utilized in emotional contexts. For example, while young infants may know that others' have agency, it is not until 7-months that they appreciate who is blocking their goal and express anger toward the agent accordingly (Stenberg & Campos, 1990). Thus, the integration of various cognitive aspects of emotion may not necessarily be present when the capacity to appreciate each distinct ability in isolation exists. Lazarus (1991) rightly stated that breaking down water into its atomic parts resulted in no longer studying the water molecule itself. The reverse is equally true: the mere presence of particular atoms is insufficient to assume the existence of the bonds required to create the molecule. Development entails the integration of more basic processes into more complex skills; so, too, is this case for emotional development.

Contextual factors may also promote or inhibit the utilization of specific appraisal dimensions in the emotion process. An example of this may be when a particular appraisal dimension is so overwhelmingly salient as to obscure for the child so as to obscure attention from other relevant dimensions, akin to the classic conservation errors observed by Piaget (1952). Conversely, a child may understand the certainty of particular outcomes in the home but

be less attuned to this dimension in novel or ambiguous contexts, and thus misappraise the context. Conversely, children may overgeneralize a particular dimension, as seen with overextension of a word or grammatical rule. For example, lacking a proper delineation of agency could result in an only-child who always wins at home needlessly blaming herself when failing in contexts that, to an objective observer, are out her control. Such errors may be reasonably expected and help to explain emotional functioning of the infant and child.

Bidirectional and Interactive Influences

Emotional development undoubtedly influences the development of cognition. A visceral response to a situation, such as startling at the unexpected barking of a dog, may facilitate subsequent appraisals of threat upon future canine encounters. Changes in what is relationally significant to the child will necessarily change contexts from "cool" to "hot," and the ability to regulate attention in such situations. Emotional communication may also serve an important function in communicating value to the infant, thereby increasing attention to the object and label and facilitating word learning.

Moreover, various cognitive abilities likely interact with one another in the emotion process. Likewise, statistical regularities may influence appraisal dimensions and EF. For example, a child who is told repeatedly to wait for dessert may associate their physiological state in these instances with frustration or anger, but they could also associate these feelings with goal blockage (appraisal dimension) and the need for inhibitory control (a component of EF). In this way statistical regularities in the environment may not simply add to particular emotion schemas, but also to related appraisal dimensions and EF related to coping. Viewing emotional development as intertwined with, rather than separate from or predicated by, cognitive development opens a range of research opportunities. Furthermore, while beyond the scope of

this chapter, the bidirectional interaction of emotional development with other domains is similarly likely (see Camras & Witherington, 2005), such as motoric development (e.g., Campos et al., 1992), caregiver relationships (e.g., Kochanska, 2001; Laible & Thompson, 1998), and neurological functioning (e.g., Bunge et al., 2002; Johnson et al., 2014; Lewis, 2005).

Exploring Individual and Group Differences

While we have emphasized basic research examining emotional and cognitive development, this perspective is also readily amendable to exploring individual differences. For example, selective attention to the outcome of an event (e.g., being hit by a ball on the playground) over its possible causes (e.g., intentional, accidental) in concert with poor inhibitory control (e.g., pausing to assess the context) may exacerbate a child's predilection to attribute hostile intent in socially ambiguous contexts and consequently respond with aggression (see Dodge, 1991, 1980). Rather than simply isolating a particular cognitive skill (e.g., behavioral inhibition), such research could shed light on ways to ameliorate problematic behavior by examining the functioning of that skill in the emotion process.

This approach may also provide greater understanding of developmental and group differences in emotion. Consider the growing acceptance that emotions differ across cultures due to varying life experiences, socialization practices, and how aspects of the environment are appraised (e.g., Markus & Kitayama, 1991), and even that distinct emotions may exist in some cultures but not others as a function of such cultural differences (Kitayama & Markus, 1990). Why could this not also be true for the infant or the child? More concretely, comparing the emotions of a child to an adult may be as invalid as the emotional experience of a New Yorker with that of a person native to rural Mongolia, or a typically developing child and a child with Autism Spectrum Disorder. While there are no doubt commonalities in the emotions of each of

these samples, there may also exist qualitative differences in their emotional experiences (see Mascolo & Fischer, 1995). Understanding the underpinnings of emotions and their development can enlighten researchers to the manifold differences of emotions across populations (see chapter BROESCH, this volume), evolutionary periods (see chapter HOLBROOK, this volume), and even non-human species (see chapter CLAY, this volume).

The Importance and Potential for Bridging Cognitive and Emotional Development

Capturing the spirit of the cognitive revolution has the potential to transform the study of emotional development and our understanding of emotion more broadly. It is laudable that cognitive development researchers have begun to explore the role of emotion in their paradigms (e.g., Doan et al., 2018; Wu et al., 2018). The risk for emotion research, however, is that studies insufficiently grounded in emotion theory could lead to findings that fail to capture the complexity of the construct. Thus, it should be the responsibility of emotion researchers to take the lead in bridging emotional and cognitive development. Researchers of emotional development are well-positioned to elucidate such aspects of emotion.

References

Anderson, P. (2002). Assessment and development of executive function during childhood. *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence, 8*, 71-82.

Aristotle (2019). *Nicomachean Ethics* (3rd ed.), (T. Irwin, Trans.). Hackett Publishing Company (Original work published in tablet form).

Baillargeon, R., Scott, R. M., He, Z., Sloane, S., Setoh, P., Jin, K.-s., Wu, D., & Bian, L. (2015). Psychological and sociomoral reasoning in infancy. In M. Mikulincer, P. R. Shaver, E. Borgida, & J. A. Bargh (Eds.), *APA handbook of personality and social psychology, Vol. 1. Attitudes and social cognition* (p. 79-150). American Psychological Association.

Barrett, K. C., & Campos, J. J. (1987). Perspectives on emotional development II: A functionalist approach to emotions. In J. D. Osofsky (Ed.), *Wiley series on personality processes. Handbook on infant development* (p. 555–578). John Wiley & Sons.

Bechara, A., Damasio, H., Damasio, A. R., & Lee, G. P. (1999). Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *Journal of Neuroscience, 19*, 5473-5481.

Bell, M. A., & Wolfe, C. D. (2004), Emotion and cognition: An intricately bound developmental process. *Child Development*, *75*, 366-370.

Biringen, Z., Emde, R. N., Campos, J. J., & Appelbaum, M. I. (1995). Affective reorganization in the infant, the mother, and the dyad: The role of upright locomotion and its timing. *Child Development, 66*, 499-514.

Blair, C. (2002). School readiness. integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *The American Psychologist, 57*, 111–27.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology*, *20*, 899-911.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78*, 647-663.

Blankson, A. N., O'Brien, M., Leerkes, E. M., Marcovitch, S., Calkins, S. D., & Weaver, J. M. (2013). Developmental dynamics of emotion and cognition processes in preschoolers. *Child Development*, *84*, 346–360.

Bunge, S. A., Dudukovic, N. M., Thomason, M. E., Vaidya, C. J., & Gabrieli, J. D. E. (2002). Immature frontal lobe contributions to cognitive control in children: evidence from fMRI. *Neuron, 33*, 301-311.

Bush, G., Luu, P., & Posner, M. I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences, 4*, 215-222.

Campos, J. J., Bertenthal, B. I., & Kermoian, R. (1992). Early experience and emotional development: The emergence of wariness of heights. *Psychological Science, 3*, 61-64.

Camras, L. A. (2010). Emergent ghosts in the developmental machine. *Emotion Review, 2*, 290-291.

Camras, L. A., & Witherington, D. C. (2005). Dynamical systems approaches to emotional development. *Developmental Review*, *25*, 328-350.

Carlson, S. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology, 28*, 595-616.

Carlson, S., & Moses, L. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*, 1032-1053.

Carlson, S. M., & Wang, T. S. (2007). Inhibitory control and emotion regulation in preschool children. *Cognitive Development*, *22*, 489-510.

Castro, V. L., Camras, L. A., Halberstadt, A. G., & Shuster, M. (2018). Children's prototypic facial expressions during emotion-eliciting conversations with their mothers. *Emotion*, *18*, 260-276.

Chomsky, N. (1957). *Syntactic structures*. Mouton & Co.

Clark, M. S. & Fiske, S. T. (1982). *Affect and cognition*. Lawrence Erlbaum Associates.

Coan, J. A. (2010). Emergent ghosts in the emotion machine. *Emotion Review, 2*, 274-285.

Cuevas, K., & Bell, M. A. (2010). Developmental progression of looking and reaching performance on the A-not-B task. *Developmental Psychology*, *46*, 1363-1371.

Cuevas, K., Rajan, V., & Bryant, L. J. (2017). Emergence of executive function in infancy. In S.A. Wiebe & J. Karbach (Eds.), *Executive function: Development across the life span.* (pp. 11-28). Routledge.

Dahl, A., & Freda, G. F. (2017). How young children come to view harming others as wrong: A developmental analysis. In J. A. Sommerville & J. Decety (Eds.), *Frontiers of developmental science. Social cognition: Development across the life span* (p. 151–184). Routledge/Taylor & Francis Group.

Darwin, C. (1872). *The expression of the emotions in man and animals*. Harper Collins.

Devine, R. T., & Hughes, C. (2014). Relations between false belief understanding and executive function in early childhood: a meta-analysis. *Child Development*, *85*, 1777–1794.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64,* 135-68.

Diesendruck, G., Salzer, S., Kushnir, T., & Xu, F. (2015). When choices are not personal: The effect of statistical and social cues on children's inferences about the scope of preferences. *Journal of Cognition and Development, 16*, 370-380.

Denison, S., & Xu, F. (2019). Infant statisticians: The origins of reasoning under uncertainty. *Perspectives on Psychological Science*, *14*, 499-509.

Diamond, A. (1985). Development of the ability to use recall to guide action, as indicated by infants' performance on AB. *Child Development, 56*, 868-883.

Doan, T., Friedman, O., & Denison, S. (2018). Beyond belief: The probability-based notion of surprise in children. *Emotion*, *18*, 1163-1173.

Doan, T., Friedman, O., & Denison, S. (2020). Young children use probability to infer happiness and the quality of outcomes. *Psychological Science*, *31*, 149-159.

Dodge, K. A. (1980). Social cognition and children's aggressive behavior. *Child Development*, *51,* 162-170.

Dodge, K. A. (1991). Proactive Aggression. In D.J. Pepler & K. H. Rubin (Eds.). *The development of treatment of childhood aggression.* (pp. 201-218). Psychology Press.

Dodge, K. A., Lansford, J. E., Burks, V. S., Bates, J. E., Pettit, G. S., Fontaine, R., & Price, J. M. (2003). Peer rejection and social information-processing factors in the development of aggressive behavior problems in children. *Child Development, 74*, 374-393.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C.

(2007). School readiness and later achievement. *Developmental Psychology*, *43*, 1428–1446.

Ekman, P. (1998). Universality of emotional expression? A personal history of the dispute. In C. Darwin, *The expression of the emotions in man and animals* (3rd ed., pp. 363-393). Oxford University Press.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion review*, *3*, 364-370.

Ellsworth, P. C., & Scherer, K. R. (2003). *Appraisal processes in emotion*. In R. J. Davidson, K. R. Scherer, & H. H Goldsmith (eds.), *Series in affective science. Handbook of affective sciences* (pp. 572-595). Oxford University Press.

Ferrier, D. E., Bassett, H. H., & Denham, S. A. (2014). Relations between executive function and emotionality in preschoolers: exploring a transitive cognition-emotion linkage. *Frontiers in Psychology*, *5*, 487–487.

Field, T. (1982). Affective displays of high-risk infants during early interactions. In T. Field & A. Fogel (Eds.), *Emotion and early interaction* (pp. 101-125). Lawrence Erlbaum Associates.

Fogel, A. & Thelen, E. (1987). Development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. *Developmental Psychology, 23*, 747-761.

Frijda, N. H. (1986). *The emotions*. Cambridge University Press.

Gibson, E. J. (1969). *Principles of perceptual learning and development*. Appleton-Century-Crofts.

Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, Bayesian learning mechanisms, and the theory theory. *Psychological Bulletin*, *138*, 1085-1108.

Grandjean, D., & Scherer, K. R. (2008). Unpacking the cognitive architecture of emotion processes. *Emotion*, *8*, 341-351.

Gross, J. J. (1998). Antecedent-and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, *74*, 224-237.

Hareli, S. & Hess, U. (2010). What emotional reactions can tell us about the nature of others: An appraisal perspective on person perception. *Cognition and Emotion, 24* (1), 128-140.

Hoehl, S. (2014). Emotion processing in infancy. In K. H. Lagattuta (ed.), *Children and emotion* (Vol. 26, pp. 1-12). Karger Publishers.

Hoemann, K., Xu, F., & Barrett, L. F. (2019). Emotion words, emotion concepts, and emotional development in children: A constructionist hypothesis. *Developmental psychology*, *55*, 1830-1849.

Holmboe, K., Fearon, R. P., Csibra, G., Tucker, L. A., & Johnson, M. H. (2008). Freeze-Frame: A new infant inhibition task and its relation to frontal cortex tasks during infancy and early childhood. *Journal of Experimental Child Psychology, 100*, 89-114.

Hongwanishkul, D., Happaney, K. R., Lee, W. S., & Zelazo, P. D. (2005). Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology*, *28*, 617-644.

Hume, D. (1739). *A treatise on human nature*. Clarendon Press.

Izard, C. E. (1978). On the ontogenesis of emotions and emotion-cognition relationships in infancy. In M. Lewis & L. A. Rosenblum (eds.), *The development of affect* (vol. 1, pp. 389-413). Springer.

Jahromi, L. B., & Stifter, C. A. (2008). Individual differences in preschoolers' self-regulation and theory of mind. *Merrill-Palmer Quarterly, 54*, 125–150.

James, W. (1890). *The principles of psychology.* Holt and Company.

Johnson, M. H. (1995). The inhibition of automatic saccades in early infancy. *Developmental Psychobiology, 28*, 281-291.

Johnson, E. L., Munro, S. E., & Bunge, S. A. (2014). Development of neural networks supporting goal-directed behavior. In P. D. Zelazo & M. D. Sera (eds.), *Minnesota symposia on child psychology: Developing cognitive control processes: Mechanisms, implications, and interventions* (pp. 23-54). Wiley.

Kerr, A., & Zelazo, P. D. (2004). Development of "hot" executive function: The children's gambling task. *Brain and Cognition, 55* (1), 148-157.

Killen, M., Mulvey, K. L., Richardson, C., & Jampol, N. (2014). The accidental transgressor: Morally relevant theory of mind. *Cognition, 119*, 197-215.

Kitayama, S., & Markus, H. (1990). *Culture and emotion: The role of other-focused emotions*. Paper presented at the 98th Annual Convention of the American Psychological Association, Boston.

Klinnert, M. D., Campos, J. J., Sorce, J. F., Emde, R. N., & Svejda, M. (1983). Emotions as behavior regulators: Social referencing in infancy. In R. Plutchik & H. Kellerman (eds.), *Emotions in early development* (pp. 57-86). Academic Press.

Kochanska, G. (2001). Emotional development in children with different attachment histories: The first three years. *Child Development*, *72*, 474-490.

Kushnir, T., Xu, F., & Wellman, H. M. (2010). Young children use statistical sampling to infer the preferences of other people. *Psychological Science*, *21*, 1134-1140.

Laible, D. J., & Thompson, R. A. (1998). Attachment and emotional understanding in preschool children. *Developmental Psychology*, *34*, 1038-1045.

Lazarus, R. S. (1993). From psychological stress to the emotions: A history of changing outlooks. *Annual Review of Psychology, 44*, 1-21.

Lazarus, R. S. (1991a). Cognition and motivation in emotion. *American Psychologist*, *46*, 352-367.

Lazarus, R. S. (1991b). *Emotion and adaptation*. Oxford University Press.

Lewis, M. D. (2005). Self-organizing individual differences in brain development. *Developmental Review, 25*, 252–277.

Lewis, M. D. (2001). Personal pathways in the development of appraisal: A complex systems/stage theory perspective. In K. S. Scherer, A. Schorr, & T. Johnstone (eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 205-220). Oxford University Press.

LoBue, V., & Rakison, D. H. (2013). What we fear most: A developmental advantage for threat-relevant stimuli. *Developmental Review*, *33*, 285-303.

Locke, J. (1690). *Human Understanding*.

Ma, L., & Xu, F. (2013). Preverbal infants infer intentional agents from the perception of regularity. *Developmental Psychology*, *49*, 1330-1337.

Mahone, E. M. (2005). Measurement of attention and related functions in the preschool child. *Mental Retardation and Developmental Disabilities Research Reviews*, *11*, 216-225.

Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review*, *99*, 587-604.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, *98*, 224-253.

Mascolo, M. F., & Fischer, K. W. (1995). Developmental transformations in appraisals for pride, shame, and guilt. In J. P. Tangney & K. W. Fischer (Eds.), *Self-conscious emotions: The psychology of shame, guilt, embarrassment, and pride* (p. 64–113). Guilford Press.

Mascolo, M. F., & Fischer, K. W. (2015). Dynamic development of thinking, feeling, and acting. In W. F. Overton, R. M. Lerner, & P. Molenaar (Eds.), *Handbook of child psychology and developmental science: volume 1* (pp. 114-161). John Wiley & Sons.

Miyake, A., Friedman, N., Emerson, M., Witzki, A., Howerter, A., & Wager, T. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 4*, 49-100.

Moors, A., Ellsworth, P. C., Scherer, K. R., & Frijda, N. H. (2013). Appraisal theories of emotion: State of the art and future development. *Emotion Review, 5*, 119-124.

Morrison, F. J., Ponitz, C. C., & McClelland, M. M. (2010). Self-regulation and academic achievement in the transition to school. In S. D. Calkins & M. A. Bell (Eds.), *Child development at the intersection of emotion and cognition* (p. 203–224). American Psychological Association.

Neisser, U. (1967). *Cognitive Psychology*. Appleton-Century-Crofts.

Perner, J., & Lang, B. (1999). Development of theory of mind and executive control. *Trends in Cognitive Sciences*, *3*, 337-344.

Piget, J. (1952). *The child's conception of number*. Norton.

Pollak, S. D., Camras, L. A., & Cole, P. M. (2019). Progress in understanding the emergence of human emotion. *Developmental Psychology*, *55*, 1801-1811.

Poon, K. (2018). Hot and cool executive functions in adolescence: development and contributions to important developmental outcomes. *Frontiers in Psychology*, *8*, 2311-2329.

Reschke, P. J., Walle, E. A., & Dukes, D. (2017). Interpersonal development in infancy: The interconnectedness of emotion understanding and social cognition. *Child Development Perspectives*, *11*, 178-183.

Reschke, P. J., Walle, E. A., & Dukes, D. (2020). Did you mean to do that? Infants use emotional communication to infer and re-enact others' intended actions. *Cognition and Emotion*, 1-7.

Reschke, P. J., Walle, E. A., Flom, R., & Guenther, D. (2017). Twelve-month-old infants' sensitivity to others' emotions following positive and negative events. *Infancy, 22*, 874-881.

Riggs, N., Jahromi, L., Razza, R., Dillworth-Bart, J., & Mueller, U. (2006). Executive function and the promotion of social-emotional competence. *Journal of Applied Developmental Psychology, 27*, 300-309.

Rhoades, B. L., Greenberg, M. T., & Domitrovich, C. E. (2009). The contribution of inhibitory control to preschoolers' social-emotional competence. *Journal of Applied Developmental Psychology, 30*, 310–320.

Roseman, I. J. (2001). A model of appraisal in the emotion system. In K. S. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 68-91). Oxford University Press.

Roseman, I. J., Antoniou, A. A., & Jose. P. E. (1996) Appraisal Determinants of Emotions: Constructing a More Accurate and Comprehensive Theory. *Cognition and Emotion*, *10,* 241-277.

Roseman, I. J. & Evdokas, A. (2010). Appraisals cause experienced emotions: Experimental evidence. *Cognition & Emotion, 18*, 1-28.

Roseman, I. J. & Smith, C. A. (2001). Appraisal theory. In K. S. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 3-19). Oxford University Press.

Ross, L. (1977). The intuitive psychologist and his shortcomings: Distortions in the attribution process. *Advances in Experimental Social Psychology, 10,* 173-220.

Sabbagh, M., Moses, L., & Shiverick, S. (2006). Executive functioning and preschoolers' understanding of false beliefs, false photographs, and false signs. *Child Development*, *77*, 1034-1049

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science*, *274*, 1926-1928.

Scherer, K. R. (1999). Appraisal theory. In T. Dalgleish & M. J. Power (eds.), *Handbook of cognition and emotion* (pp. 637–663). Wiley

Scherer, K. R. (1997). The role of culture in emotion-antecedent appraisal. *Journal of Personality and Social Psychology*, *73*, 902-922.

Scherer, K. R., Schorr, A., & Johnstone, T. (eds.) (2001). *Appraisal processes in emotion: Theory, methods, research*. Oxford University Press.

Scott, R. M. (2017). Surprise! 20-month-old infants understand the emotional consequences of false beliefs. *Cognition, 159*, 33-47.

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology*, *48*, 813-838.

Smith, C. A., & Ellsworth, P. C. (1987). Patterns of appraisal and emotion related to taking an exam. *Journal of Personality and Social Psychology*, *52*, 475-488.

Sommerville, J. A., Woodward, A. L., & Needham, A. (2005). Action experience alters 3-month-old infants' perception of others' actions. *Cognition*, *96*, B1-B11.

Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: its effect on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21*, 195-200.

Stenberg, C. R. & Campos, J. J. (1990). The development of anger expressions in infancy. In N. Stein, B. Leventhal, & T. Trabasso (Eds.), *Psychological and biological approaches to emotion* (pp. 247-282). Lawrence Erlbaum Associates.

Thompson, R. A. (1991). Causal attributions and children's emotional understanding. In C. Saarni & P. L. Harris (Eds.), *Children's understanding of emotion* (pp. 117-150). Cambridge University Press.

Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *American Academy of Child Psychiatry, 17*, 1-13.

Ursache, A., Blair, C., Stifter, C., & Voegtline, K. (2013). Emotional reactivity and regulation in infancy interact to predict executive functioning in early childhood. *Developmental Psychology, 49*, 127-137.

Walle, E. A., & Dahl, A. (2020). Definitions matter for studying emotional development. *Developmental Psychology*, *56*, 837–840.

Walle, E. A., Reschke, P. J., Camras, L. A., & Campos, J. J. (2017). Infant differential behavioral responding to discrete emotions. *Emotion*, *17*, 1078-1091.

Wellman, H. M., Kushnir, T., Xu, F., & Brink, K. A. (2016). Infants use statistical sampling to understand the psychological world. *Infancy*, *21*, 668-676.

Welsh, M., Pennington, B., & Groisser, D. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7*, 131-149.

Woodward, A. L. (2009). Infants' grasp of others' intentions. *Current Directions in Psychological Science, 18,* 53-57.

Wu, Y., Baker, C. L., Tenenbaum, J. B., & Schulz, L. E. (2018). Rational inference of beliefs and desires from emotional expressions. *Cognitive Science, 42*, 850-884.

Wu, Y., Haque, J., & Schulz, L. (2018). Children can use others' emotional expressions to infer their knowledge and predict their behaviors in classic false belief tasks. In *Proceedings of the 40th Annual Meeting of the Cognitive Science Society* (pp. 1193-1198).

Wu, Y., Muentener, P., & Schulz, L. E. (2017). One-to four-year-olds connect diverse positive emotional vocalizations to their probable causes. *Proceedings of the National Academy of Sciences*, *114*, 11896-11901.

Wu, Y., Schulz, L., & Saxe, R. (2018). Toddlers Connect Emotional Responses to Epistemic States. In *Proceedings of the 40th Annual Meeting of the Cognitive Science Society (pp. 2711-2716)*.

Xu, F. (2019). Towards a rational constructivist theory of cognitive development. *Psychological Review*, *126*, 841–864.

Yu, C., & Smith, L. B. (2012). Modeling cross-situational word–referent learning: Prior questions. *Psychological Review*, *119*, 21-39.

Yurovsky, D., Smith, L. B., & Yu, C. (2013). Statistical word learning at scale: The baby's view is better. *Developmental Science*, *16*, 959-966.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives, 6*, 354–360.

Zelazo, P., Carter, A., Reznick, J., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology*, 1, 198-226.

Zelazo, P. D., & Cunningham, W. A. (2007). Executive Function: Mechanisms Underlying Emotion Regulation. In J. J. Gross (ed.), *Handbook of emotion regulation* (p. 135–158). Guilford Press.

Zelazo, P. D., & Müller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Handbook of childhood cognitive development* (pp. 445– 469). Blackwell.

Zhou, Q., Chen, S. H., & Main, A. (2012). Commonalities and differences in the research on children's effortful control and executive function: A call for an integrated model of self-regulation. *Child Development Perspectives*, *6*, 112-121.