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Developing Mechanisms of Self-Regulation in Early Life

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Abstract

Children show increasing control of emotions and behavior during their early years. Our studies suggest a shift in control from the brain's orienting network in infancy to the executive network by the age of 3–4 years. Our longitudinal study indicates that orienting influences both positive and negative affect, as measured by parent report in infancy. At 3–4 years of age, the dominant control of affect rests in a frontal brain network that involves the anterior cingulate gyrus. Connectivity of brain structures also changes from infancy to toddlerhood. Early connectivity of parietal and frontal areas is important in orienting; later connectivity involves midfrontal and anterior cingulate areas related to executive attention and self-regulation.

Keywords

attention; connectivity; development; orienting

This article addresses the early development of emotion regulation within a temperament systems framework. By temperament we mean constitutionally based individual differences in reactivity and self-regulation in the domains of affect, activity and attention (Rothbart & Derryberry, 1981). Temperamental *reactivity* refers to responses to change in the external and internal environment, measured in terms of the latency, duration and intensity of emotional, orienting and motor reactions. *Self-regulation* refers to processes that serve to modulate reactivity, especially processes of executive attention and effortful control. One of the most important broad dimensions of temperament we have identified is effortful control, defined as the ability to voluntarily regulate behavior and attention, as seen in the inhibition of a dominant response and activation of a subdominant response (Rothbart & Rueda, 2005).

We recognize that the emotions are broadly integrative systems ordering feeling, thought and action (LeDoux, 1989), and representing the output of information processing assessing the meaning or affective significance of events for the person. Neural object recognition and spatial processing systems address the questions "What is it?" and "Where is it?," whereas

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emotion processing networks address the questions “Is it good for me?,” “Is it bad for me?” and “What shall I do about it?”. Emotional reactions thus include not only evaluations, but preparations for action and physiological support for those actions (Rothbart, 2011).

The emotion of fear is a primarily reactive temperamental system that potentiates withdrawal, attack or behavioral inhibition; positive affect potentiates rapid and energetic approach. These two processes are mutually inhibitory (Rothbart, 2011; Rothbart & Sheese, 2007). Attentional orienting early in life can be reactive, but it has regulatory consequences on the expression of infants' emotions (Harman, Rothbart, & Posner, 1997). A more pure form of self-regulation is seen in the executive attention processes that help to support temperamental effortful control, and can modulate reactivity (Rothbart & Rueda, 2005). In this paper, we review findings on the relation between orienting and executive networks of attention and emotion in the early years, and describe a longitudinal study investigating this development.

Orienting and Affect

The regulation of distress is an important goal of both caregiver and infant in the early months of life, and previous research suggests that orienting is important in state regulation. Although infants will habituate to repeated presentations of a stimulus before 3–4 months, younger infants show little control of orienting, and indeed appear to go through a period of “obligatory attention,” when disengagement from a visual stimulus is difficult and the infant's extended orienting may lead to distress (Ruff & Rothbart, 1996). By 4 months of age, infants have gained some control over their own orienting and are able to disengage attention from one location and move it to another. Greater flexibility of orienting in the laboratory at 4 months is associated with lower parent-reported negative emotionality and greater soothability in measures of infant temperament (Johnson, Posner, & Rothbart, 1991).

We have found that infants of 3 and 6 months of age can be soothed from distress induced by overstimulation by the presentation of novel objects (Harman et al., 1997). Infants were first shown a sound and light display that led to distress in about 50% of the infants. We then presented interesting visual and auditory distractors to the infants, for instance, sound-making toys. As infants oriented to the distractors, their facial and vocal signs of distress disappeared. As soon as their orienting stopped, (e.g., when the object was removed) however, the infants' distress returned to almost exactly the same level shown prior to the presentation of the distractor. We also demonstrated that this was not an effect of frustration at toy removal. In later studies, we found that infants could be quieted by distraction for as long as one minute, without affecting their level of distress once the orienting was ended (Harman et al., 1997).

This suggests that the orienting network might play an important role in early emotional control. Caregivers in Western societies use orienting as a means of helping their child to develop self-regulation (Harman et al., 1997). In a longitudinal study of infants from 3–13 months of age, we found a number of changes in the relation between orienting and negative emotion over the early months (Rothbart, Ziaie, & O'Boyle, 1992). Older infants increasingly looked to their mothers when arousing stimuli such as mechanical toys and masks were presented. At 13 months of age, the infants' disengagement of attention (looking away from the arousing stimulus) was also related to lower levels of negative emotion in the laboratory. Direct links have also been found by Stifter and Braungart (1995) between infants' disengagement of attention and lowered negative affect.

Later in childhood and in adulthood, the executive network and effortful control are important in control of negative emotion. For example, temperament questionnaire data has consistently found that high effortful control is related to low negative emotionality

(Rothbart, 2011), and effortful control has been consistently related to laboratory measures of executive attention (Rothbart & Rueda, 2005). Studies using neuroimaging have shown that the anterior cingulate cortex in adults is important in the control of both cognition and emotion (Bush, Luu, & Posner, 2000).

Anatomy and Development of Executive Attention

The executive attention network is one of three neural attention networks. These networks are distinct in that they serve different functions, have different neural anatomies, and involve different neuromodulators (Posner & Fan, 2008; Rueda, Posner, & Rothbart, 2011). The first two networks, the alerting and orienting networks, are involved in achieving and maintaining the alert state and orienting to sensory events. The alerting network involves the brain's norepinepherine systems arising in the midbrain and making contact with frontal and parietal areas. The orienting network involves both inferior and superior parietal areas as well as the frontal eye fields (Posner & Fan, 2008). The third, the executive attention network, functions to monitor and resolve conflict between other brain networks (Botvinick, Braver, Barch, Carter, & Cohen, 2001). A key aspect of self-regulation is the ability to detect errors, and the anterior cingu-late has also been reported to be central to this capacity (Gehring, Goss, Coles, Meyer, & Donchin, 1993; Holroyd & Coles, 2002).

Executive Attention, Effortful Control, and Emotion

There are important connections between effortful control, executive attention and emotion expression, beginning in the preschool period and extending to adulthood. These involve inhibition of a dominant response in order to activate a sub-dominant response and the ability to plan. Effortful control (EC) shows considerable development in the toddler and preschool years (see reviews by Posner & Rothbart, 2007; Rothbart, Posner, & Kieras, 2006; Rothbart & Rueda, 2005). High effortful control is consistently related to low negative emotion in questionnaire and laboratory studies, and effortful control has been consistently related to the measures of executive attention (Rothbart, 2011; Rothbart & Rueda, 2005). Conflict tasks can be used with children and provide a measure of the executive attention. These tasks include the use of incongruent flankers surrounding a target, or having a child respond to a target, on one side of the screen with a response on the opposite side (Rothbart & Rueda, 2005).

At later ages it is likely that control by orienting remains present but occupies a secondary role. The executive network interacts with the limbic system to adjust responses to negative and positive affect in accord with cultural norms (Rothbart & Sheese, 2007). However, orienting can still be summoned by environmental change, and in some situations may even replace executive control. Thus orienting and executive networks both appear to serve regulatory functions, with orienting being dominant earlier and executive control later in life. This may be one example of the general trend in development for more sensory or external influences in the early years being replaced by more motivational and internal influences later in childhood. We now turn to recent findings on brain and connectivity changes with development that are supportive of this developmental hypothesis.

Brain Connectivity in Early Development

Studies of human brain development have begun to reveal important changes during childhood. One of these changes involves focalization of brain activity during the performance of cognitive tasks (Durston & Casey, 2006). As children develop, cognitive-task performance is associated with smaller patterns of neural activation and with activation in fewer brain areas. It is as though task performance becomes more finely tuned with development. Some of these effects are similar to what has often been found in adults with practice, with practice reducing the number and size of brain activations (see Kelly & Garavan, 2005, for a review). On the other hand, studies of resting fMRI (Fair et al., 2009) show changes in connectivity during development that progress from predominantly local connections to more global connections.

These two effects suggest two seemingly opposite views of development. The activation data suggest that increasing age produces more focal activity, while connectivity studies suggest more distributed activity in older children and adults. Another way to view these changes, however, is that the computations become more focal as fewer neurons are needed to carry them out, and as fewer areas are activated, more global connections are used to connect them. Thus changes in activation and connectivity may work together to produce more efficient networks, showing both smaller and more tuned local activity as well as broader and more diffuse connectivity.

Recent studies have examined the brain activity of infants and young children at rest using fMRI (Fair et al., 2009; Fransson et al., 2007; Gao et al., 2009). Resting fMRI has an advantage for developmental studies because it does not require tasks that can be used across large age differences. Studies of functional connectivity have shown sparse connectivity between brain structures during infancy, and a strong increase in connectivity at 2 years of age (Gao et al., 2009) and later (Fair et al., 2009). Results also indicate changes from more local to longer range connectivity during development. In studies of neonates, the parietal areas, prominent in the orienting-attention network, showed strong connectivity to lateral and medial frontal areas, areas that would later be connected to executive attention. Even at the age of 2, the anterior cingulate, implicated in executive attention, showed stronger connections to frontal areas and to lateral parietal areas, but connectivity continues to increase during childhood. These findings suggest that control structures related to executive attention and effortful control may be present in infancy but do not exercise their full control over other networks until later.

In accordance with this view, we have reported that error detection activates the midfrontal and/or cingulate areas at 7 months of age (Berger, Tzur, & Posner, 2006), although the ability of the infant to take action based on errors seems not to be present until later in development (Jones, Rothbart, & Posner, 2003). During adulthood there is clear evidence for the parallel operation of orienting and executive networks (Dosenbach et al., 2007). According to the views of Dosenbach et al. (2007), the orienting network (which they call the parietal frontal network) deals with control at short time scales, for example within a particular trial in a cognitive task, while the executive network (also called the cingulo-opercular network) deals with longer and more strategic control over the entire task. Tradeoffs between executive attention and orienting can also be seen in hypnotism. We (Posner & Rothbart, in press) have speculated that the hypnotist with the cooperation of the subject places the brain in a state where orienting assumes control over behavior. The executive networks and the usual goal-directed control are suspended and instead control passes to the instructions provided externally by the hypnotist.

Can Executive Attention be Measured in Infancy?

Do children younger than 2 years possess a brain system related to their ability to resolve conflict? There has been little behavioral evidence concerning the executive network during infancy. Parent reports of their children's ability to regulate emotions and cognitions are not used in infancy, and the voluntary tasks that allow measurement of the efficiency of the executive attention network cannot be carried out before the preschool age (Gerardi-Caulton, 2000). There is evidence, however, that at least one aspect of the executive network, error detection, is present at 7 months of age. Wynn (1992) presented infants with puppets which were hidden behind a screen. A hand reached in and either added or subtracted a puppet. Infants looked longer when the screen was lifted to show the wrong number of puppets than when the correct number reflecting the addition or subtraction was shown.

Berger et al. (2006) repeated Wynn's experiment and used 128 scalp electrodes to measure brain activity. Infants of 7 months of age showed the identical scalp pattern to errors over frontal midline electrodes found in adults. This scalp activity has been shown to arise in the anterior cingulate, the same brain area used by adults in tasks involving executive attention and error detection (Berger et al., 2006). The authors concluded that the frontal anatomy responsible for error detection in adults and involving the anterior cingulate could be observed at 7 months of age. However, the connectivity data suggest that the cingulate is not connected to other networks to influence actions until later (Fair et al., 2009).

We have completed a longitudinal study to test whether the orienting network is the chief method of regulating emotion during infancy and over development loses dominance to the executive network. During infancy, the natural tendency to orient to novelty provides a means of soothing, often with the aid of the caregiver, and is under the child's control later in infancy. Orienting to novelty in adults has been shown to recruit the anterior cingulate (Shulman et al., 2009). During infancy this could allow the caregiver to influence the development of self-regulation by bringing their child's attention to novel events. In later childhood and adulthood the executive network becomes the dominant means of self-regulation, with the orienting network remaining present but in a secondary role (Rothbart & Sheese, 2007).

In the longitudinal study, we observed children as infants (6–7 months), toddlers (18–20 months) and during the preschool period (3–4 years) (Sheese, Rothbart, Posner, White, & Fraundorf, 2008; Sheese, Voelker, Rothbart, & Posner, 2007; Voelker, Sheese, Rothbart, & Posner, 2009). At each age we examined tests thought appropriate for assessing reactive and regulatory functions in both emotion and attention. One major innovation was to use a sequential looking task to assess attention starting in infancy. We hoped that this task would measure separately the orienting and executive networks. Our thinking was that anticipatory looks to objects would be influenced by executive function since they were more voluntary, while reactive looks that occurred after the object was presented would involve orienting.

We found that 6–7-month-old infants who showed higher levels of anticipatory looking to locations in a repeated sequence were also more likely to regulate approach tendencies when presented with novel toys, and to show self-soothing when presented with frightening stimuli (Sheese et al., 2008). If we had succeeded in measuring executive attention in the sequence task, these results would suggest early links between emotion regulation and executive attention. However, we needed to test whether these measures in infancy were related to performance on the children's Attention Networks Test (ANT) at 3–4 years of age. The ANT allowed us to assess efficiency of executive attention, alerting and orienting. Our goal was to examine the relation between early orienting, executive attention and performance on the ANT to identify precursors of executive attention. Our sample size involved 50 or more infants at each age (Sheese et al., 2007, 2008; Voelker et al., 2009).

Anticipatory looking procedures—The presentation of visual stimuli in a repeating pattern of locations was used to examine reactive and anticipatory looking. In brief, the child was shown a repeating sequence of stimuli at three positions on a screen. Each trial began with the child looking at a central fixation stimulus. After one second a stimulus was presented at one of the three positions. After the infant oriented to that event, a new position was used for the target, again with a 1-second delay, and this was repeated for the third location. If the child moved to the target before it was presented, it was called an anticipation; if they oriented only after the stimulus was presented, it was seen as a reactive move. The measures extracted from these procedures were the total number of anticipations and percentage of correct anticipations at each age.

Behavioral responses to novel and threatening stimuli—The presentation of novel toys and animal masks were used to assess aspects of reactivity and regulation in the infants. In the toy segment, a series of toys was individually presented on the high-chair table and the child was allowed to interact with each toy. In the mask segment, a series of somewhat frightening masks was presented one at a time immediately in front of the child. The child's coded reactions included looks away and intensity of distress. The mask procedure was repeated for toddlers. Measures discussed here include looking away from both masks and toys at T1, duration of distress in infancy and peak distress to masks in the toddlers. We also used the time of fixation before moving toward the toys in infancy as a measure of caution.

Temperament questionnaires—The Infant Behavior Questionnaire Revised (IBQ-R) (Gartstein & Rothbart, 2003) and the Early Childhood Behavior Questionnaire (ECBQ) (Putnam, Gartstein, & Rothbart, 2006) were used for parent reports of child temperament in infancy and toddlerhood. The Children's Behavior Questionnaire (CBQ) (Rothbart, Ahadi, Hershey, & Fisher, 2001) was used for parent-reported temperament in the preschool children. In this study we used factor scores for orienting, surgency/positive affect and negative affect for the infants; and at both toddler and preschool assessments, factor scores for effortful control, surgency/positive affect and negative affect.

Planning and error detection—The nesting cup procedure developed by DeLoache, Sugarman, and Brown (1985) was used to examine children's correct nesting moves, error detection and correction in the toddlers as an assay of executive attention. In this procedure children are videotaped performing three successively more difficult cup-stacking trials. Successful completion of the later trials required the children to recognize which cup constructions should be left intact and which (if any) should be disassembled (error detection and correction). Videos were coded for each move (cup combination) the child made, as well as error-correction strategies and attempts at forcing together nonfitting cups. We used measures of correct moves and error detection as surrogates for executive attention in toddlerhood.

Child Attention Network Test (ANT)—The child ANT was a version adapted from Rueda et al. (2004). The Child ANT presents five fish in a horizontal row that appear above or below the fixation point. Children were instructed to press a key indicating in which direction the central fish was pointing and to ignore the flanker fishes. Completion of the task allows calculation of three scores related to the efficiency of attentional networks (as in Rueda et al., 2004). Alerting is measured by the additional time required to respond with no cue, compared to a double cue that does not give information about location but does inform the child that a target will occur shortly. Orienting is measured by the time taken to respond to a cue at the target location minus reaction time to a central cue. Executive attention is measured as interference by the flanker fish on the child's score. Larger interference scores (incongruent–congruent flankers) indicated less efficiency in resolving conflict. Each child participated in extensive practice and then most completed 2 blocks of 72 trials each.

Our results suggested that during infancy, the orienting network serves as a regulatory system, both in reducing negative affect and increasing surgency/positive affect. There were a number of significant relations between orienting and emotion in infancy. Infants reported by their mothers as showing higher orienting, for example, showed more surgency/positive affect and less negative affect, a finding reported in other studies using the IBQ-R (e.g., Gartstein & Rothbart, 2003). This finding is also in keeping with our previous experimental result that orienting modulates emotion (Harman et al., 1997). The findings were also consistent with the idea that infant orienting and state regulation have modulatory influences on both positive and negative emotion. Infants with higher negative affect in infancy also looked away more from novel toys; here emotion may be driving orienting, or greater looking away may be a sign of greater self-regulation of negative emotion. The latter interpretation is in keeping with our finding that looking away from the masks in infancy predicted less peak distress to the masks in the toddler period.

Better sequence learning was also related to less looking away from the masks in infancy. While this finding could indicate that more regulation was related to better orienting performance, infants with better sequence learning may have experienced less negative affect and thus had less need to regulate. Looking away from novel toys in infancy was related to better sequence learning in the toddlers. More rapid habituation in infancy may have predicted better learning, or the relation might be due to infants' better orienting skills in general.

Our data in the toddler and preschool periods showed first the appearance and later the involvement of effortful control in emotion regulation. In the toddlers, we had expected that nesting-cup performance and detection of errors would both be positively related to effortful control (EC), and this was the case. Nesting-cup performance and detection of errors also both predicted EC in the preschool period. Although we must be very careful about null findings given the study's sample size, no relations between either orienting or effortful control measures and positive or negative affect were found in the toddlers. EC in the toddlers, however, predicted both EC and lower surgency/positive affect during the preschool period, suggesting that early executive attention may contribute to later emotion regulation.

At the preschool age, the orienting measures continued to be unrelated to negative affect (however, only a parent report of fearfulness was assessed at this age) and positive emotion, but effortful control (EC) was now related to lower surgency/positive affect. Toddler EC also predicted lower surgency/positive affect at the preschool age. Although once again there are questions about the null findings, 3–4 years is the first age at which effortful control appeared to be modulating the expression of emotions. Surgency/positive affect was also negatively related to fear, as has been previously found (Rothbart, 2011). Just as attention systems modulate emotion, emotional systems appear to mutually inhibit one another (Rothbart & Sheese, 2007).

We have been interested in whether our measures of orienting, sequence learning and regulation in infancy and toddler-hood might be related to later performance on the ANT task executive attention, alerting and orienting tests. We found some continuity for orienting. Both looking away from toys and from masks in infancy were positively related to children's orienting score on the ANT at 3–4 years of age. Instead of predicting later executive attention, however, looking away from masks in infancy was negatively related to executive attention efficiency at the preschool age. There are some predictions from earlier emotion to ANT performance: distress to masks in the toddlers predicted ANT orienting, and surgency/positive affect in toddlers predicted ANT alerting. However, the relation of infant fixation time without movement to later efficient executive attention on the ANT suggests that early inhibitory control of movement (caution) may be a precursor to later executive control.

One additional goal of our study was to determine whether anticipations (voluntary looks) in the sequential looking task would offer a measure of executive attention in early life. However, it appeared from our data that this task measured chiefly orienting and alerting, and not executive attention as measured by the ANT at 3–4 years of age. Thus we did not find the expected positive relationships between orienting in infancy and later effortful control; instead, our findings suggest that orienting is initially a separate system from executive attention.

Our longitudinal study results can be related to studies of resting fMRI connectivity. In infancy, the parietal lobes, which are important for orienting, show strong connectivity to frontal and other areas. While there is evidence that midline anterior cingulate cortex (ACC) and frontal areas are active in infancy, at least for the detection of errors (Berger et al., 2006), resting fMRI offers no evidence that they are strongly connected to other areas (Gao et al., 2009). The connectivity found in the adult data occurs only later in development. In behavior we do see evidence of a controlled reaching and caution during infancy which predicts later executive attention, but this limited regulation may either be supplied by the orienting network or be an early sign of a still incompletely connected executive system at this age. In our longitudinal study that followed children from infancy to 7 years, we found that the only predictor of later effortful control was the measure of controlled reaching and caution during infancy (Rothbart, Derryberry, & Hershey, 2000).

In infancy there is clear evidence of regulation through use of the orienting network. This is supported by the questionnaire factor of orienting showing significant correlations with positive and negative affect. It also fits with the relations between sequential looking and virtually all aspects of mask behavior. There is little evidence for regulation via the executive network at this early age, although caution (fixation before movement) in infancy predicts later efficiency of executive attention. It has also been reported that infants' reactive inhibition to novelty (measured as fearfulness) predicts later effortful control (Aksan & Kochanska, 2004). The authors suggest that because fear is associated with the inhibition of action, fearful-ness may give the child the time needed to develop planfulness and effortful control. Fear may also provide children with the motivation for being good and following rules to avoid punishment. It is also possible that measures of fear and caution are confounded at this age, with the inhibited approach that predicts later effortful control reflecting either or both of these processes (see also Rothbart et al., 2000).

At 18–20 months there is the beginning of evidence for regulation by effortful control. Questionnaire measures of effortful control are correlated with the number of trials performed in the sequential looking tasks, but do not moderate mask performance. Nevertheless, effortful control at 18–20 months of age is related to both effortful control and modulated surgency/positive affect at 3–4 years of age. Effortful control shows links with decreased rather than increased surgency/positive affect, suggesting that voluntary control of positive impulsivity by attention is coming into play with development.

Parenting and the Transition between Orienting and Executive Attention

We have argued for a transition between two attentional control networks during the early years. According to this view, during infancy control is principally exercised by the orienting network, but by 3–4 years of age and later, this control involves the executive network. If this is correct, how might the transition take place? One possibility is that the transition is mediated through the exercise of the orienting network producing increased connectivity for the executive network. Support for this view comes in part from a study of adults (Shulman et al., 2009) in which the presentation of a novel object recruits the executive network (cingulo-opercular network in their terms) to supplement the orienting network (ventral parietal frontal network in their terms). If this mechanism is present in infancy, it could mean that caregivers provide impetus for the development of self-regulation when they exercise executive systems through the presentation of novel objects, which could be objects or other people. Reading to the child may be another source of this kind of stimulation. Cultures where observation is the chief activity of the infant may also prepare the executive attention network through infants, orienting to novel objects. Individual and cultural differences in these activities may be important in understanding different types of socialization.

Research by Bernier, Carlson, and Whipple (2010) shows that maternal sensitivity, mindfulness and autonomy support at 15 months of age are related to children's later executive functions at 18–20 months, suggesting the role of mothers in the development of self-regulatory activities. Our data at 18–20 months of age have previously shown that parental quality interacted with the 7-repeat allele of the DRD4 gene to influence the temperamental dimensions of impulsivity, high intensity pleasure and activity level, measures of sensation seeking (Sheese et al., 2007). Parenting made a strong difference for children with the 7-repeat allele in being related to sensation seeking. Those with poorer quality parenting were far more impulsive and sensation seeking than those with high-quality parenting. Parenting quality made no difference for children without the 7-repeat allele. At 3-4 years the DRD4 gene in interaction with parenting was related to children's effortful control, with higher quality parenting related to greater effortful control for children with the 7-repeat allele, but not for those without the 7-repeat allele.

The Catechol-O'-Methyltranseferase (COMT) gene also interacted with parenting to influence attention as measured by anticipatory looks at 18–20 months (Voelker et al., 2009). Those toddlers with high-quality parenting and one version of the COMT gene showed far more correct anticipations than any of the other groups. COMT later in childhood and in adulthood has shown a strong influence on aspects of executive attention (Blassi et al., 2005; Diamond, Briand, Fossella, & Gehlbach, 2004). These findings suggest that aspects of parenting as reported and observed at ages 1–2 years influence the developing child's attention networks and behavior. Although these findings indicate that the effect of parenting is dependent on individual differences in genetic variation, they also show that parents can play a role in shaping the child's behavior. An additional study found that only those children with the 7-repeat of the DRD4 showed the influence of a parent-training intervention (Bakersman-Kranenburg, van IJzendoorn, Pijlman, Mesman, & Juffer, 2008), suggesting that at least some of the genetic effects are directly influenced by parenting. These data suggest that both genetic and parental influences may be important in the shift between orienting and executive control networks.

In summary, our study and related research provide evidence of a shift in the self-regulation of infants during early development. Control during infancy works predominantly through the frontal eye field and parietal areas related to orienting. Parents can use this network to soothe the infant with novel objects. The presentation of novel objects may influence the connectivity of this network to the executive network, thus providing a vehicle for stronger self-regulation over the larger time scales that characterize later development. We hope future studies will test and elaborate this dual control story.

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