ENCYCLOPEDIA on Early Childhood Development

Executive Function and Emotional Development

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Introduction

Emotional development involves increased ability to feel, understand and differentiate progressively more complex emotions, as well as the ability to self-regulate them in order to adapt to the social environment or to accomplish present or future goals. Often, children face situations where they must select among competing options, such as finishing homework before playing or eating a snack now as opposed to saving room for a healthier meal. In making such decisions, they need to reconcile the conflict between competing choices available in the context with a specific set of expectations and rules, as well as to regulate impulses for immediate gratification in the service of a choice that is less immediate and automatic. This sort of behavioural and cognitive control is related to the concept of executive functions. Executive function refers to multidimensional cognitive control processes that are characterized by being voluntary and highly effortful. They include the ability to evaluate, organize and achieve goals, as well as the capacity to flexibly adapt behaviour when confronted with novel problems and situations. Evidence from cognitive development and developmental cognitive neuroscience has shown that the development of emotion regulation is strongly supported by several core executive functions, such as attention control, inhibition of inappropriate behaviours, decision

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making and other high cognitive processes that take place in emotionally demanding contexts.[1,2]

Subject

As humans are predominantly social, understanding emotions in oneself and others is an important skill to have, and a good part of the brain is devoted to that effort.[3] Basic emotions, such as happiness or fear differ from the so-called moral emotions (e.g., shame, guilt, pride, etc.), that arise in social interactions, where a normative or ideal behaviour is either explicitly or implicitly established. Understanding and managing moral emotions requires internalization of norms and moral principles shared by the community. It is also necessary to perceive and understand other people's emotions (empathy) and make attributions of their mental states (theory of mind), including understanding of their beliefs and attitudes. As such, emotional and social development are tightly linked to one another. Another key component of emotional development, namely emotion regulation, is not less crucial to socialization. In social activities (e.g., being at school), it is often necessary to control emotional reactions, either positive (e.g., excitement) or negative (e.g., frustration) in order to accommodate to norms and goals. Therefore, the development of executive control is central to emotion regulation.

Problems

Executive function is often considered a domain-general of cognitive function. This means that it is involved in regulating all sorts of behaviours, such as those involving language, memory, reasoning, etc. However, some authors have suggested that emotional, social and motivated behaviour (e.g., deciding whether to eat a piece of cake or to hug someone we love) may be harder to control and might even require a different kind of mechanism as compared to emotionally-neutral conditions (e.g., deciding whether five is an even or odd number). Some authors have established a distinction between "cool" (purely cognitive) and "hot" (affective) aspects of executive function.[4] Thus, in goal-directed problem-solving, executive function and emotion regulation bear a reciprocal relation. However, the particular requirements for emotion regulation will depend on the motivational significance of the problem and whether the problem itself is hot or cool.[1]

Research Context

The multidimensional nature of the executive function construct contrasts with the absence of a specific agreement on a gold-standard test of executive functions despite the highly structured

nature of the tasks typically used to examine different functions separately. A variety of laboratory tasks are thus used to measure different executive functions, some of which have been adapted from those used with adults. A general distinction can be made between cool executive function and hot executive function tasks, depending on whether the task involves dealing with emotionally-relevant information or not.[5] Within this general categorization, tasks can be also divided according to the particular function they target, for example, working memory, inhibitory control or mental flexibility. However, given the protracted development of executive function throughout childhood, a wide variety of tasks are available which are appropriate for children of a given age range or ability level.[6]

Key Research Questions

1. Is emotional development supported by maturation of executive function skills? How is the development of key aspects of emotional development (e.g., empathy, theory of mind, internalization of moral principles, etc.) related to maturation of the *prefrontal cortex*?
2. What factors determine the development of executive function skills?
3. Are individual differences in the development of executive function and emotion regulation determined by genes, or are they rather related to experience?
4. Is it possible to foster the development of executive function by means of educational interventions? If so, would enhanced executive function turn into better emotion development?

Recent Research Results

Evidence from multiple studies indicates that maturation of aspects of executive functioning, such as inhibitory control and executive attention, are strongly related to increased emotional understanding (in oneself and others) and regulation. Preschool children's performance on laboratory tasks measuring inhibitory control significantly correlates with their ability to regulate their emotions.[7,8] Also, children with higher attention control abilities tend to cope with anger by using non-hostile verbal methods rather than overt aggressive methods.[9] Higher effortful control also correlates positively with empathy.[10] To display empathy toward others requires interpretation of their signals of distress or pleasure. In fact, the ability to distinguish between mental states of oneself and others (Theory of Mind, ToM), which is another central cognitive component of empathy,[11] is strongly associated with individual differences in effortful

and inhibitory control.[12] However, whether ToM is directly associated with more general emotion regulation skills during early development is still under debate.[13] Additionally, individual differences in executive control are associated with the development of conscience, which involves the interplay between experiencing moral emotions and behaving in a way that is compatible with rules and social norms.[14] In this context, internalized control of behaviour is greater in children high in effortful control.[15] The common interpretation is that effortful control provides the attentional flexibility required to link moral principles, feelings and actions.

In addition to these studies, current lines of research are investigating the factors, both educational and constitutional, that influence the development of executive function. Training studies of different executive functions in preschool and school-aged children have showed direct benefits on the trained abilities, including executive attention,[16,17] fluid reasoning,[18,19,20] working memory[21,22,23] and cognitive control.[24]

Research Gaps

There are future research avenues that have the potential to shed further light on executive functions and emotional development. Although cross-sectional studies can be very informative, longitudinal research is needed to rule out possible effects due to individual variance across age groups. Thus, longitudinal studies can provide important insights regarding typical and atypical cognitive and emotional development.[25] Another important but still unresolved question is to what extent educational interventions designed to foster executive function can produce stable changes in the efficiency of this system, both at the structural and functional levels, throughout development. Some studies have shown benefits of executive function training at the level of brain function during development,[16,17,22,23] which are still observable a few months later without further training.[16] However, more research is needed to further characterize the benefits of training over time, and whether benefits of executive function training transfer to emotion regulation skills.

Conclusions

Emotional development involves increased understanding of emotions in oneself and others as well as increased ability to regulate emotions based on current goals and socially-shared rules. Changes in emotional function are recognized as playing a critical role on social adjustment and school competence.[26,27] Adaptive development of emotion is linked to child well-being, whereas

difficulties with emotion regulation are related to mood disruptions and behavioural problems.[27,28] Emotional development is constructed from a variety of cognitive skills, including the ability to flexibly regulate behaviour in a voluntary, effortful, mode (executive function), which strongly depends on maturation of the frontal lobes.[29] Cognitive and emotion regulation appear to develop in concert, showing a strong development during the preschool period and a more protracted developmental course during late childhood and adolescence.[30]

Implications for Parents, Services and Policy

Increasing evidence suggests that executive function can be enhanced through cognitive training and that such interventions have the potential to enhance the efficiency of brain systems underpinning behavioural and emotional regulation skills in children[16] as well as in adults.[23,31,32] Recent research also shows that the development of executive control is affected by environmental factors, such as parenting and education. The quality of parent-child interactions during early childhood appears to promote the development of executive function later on. Parental attitudes such as warmth, responsiveness and gentle discipline, which are related to secure parent-child attachment and positive mutuality, are related to advanced executive function skills in the child.[33] Likewise, classroom curricula that focus on teaching regulation skills are shown to significantly increase the development of executive control at preschool ages.[24] Plasticity of the neurocognitive system underlying cognitive and emotional regulation could be related to its extended maturation during the first two decades of life. Importantly, the susceptibility of this neurocognitive system to be influenced by a wide range of experiences provides multiple opportunities to promote children's social and emotional competence. Research-based data of the type summarized in this paper must encourage policy makers to promote the use of educational programs that include curricula directly addressing socio-emotional competence.

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