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Review article

Infusing Developmental Neuroscience Into School-based Preventive Interventions: Implications and Future Directions

Catherine P. Bradshaw, Ph.D., M.Ed.[a,*], Asha Goldweber, Ph.D.[a], Diana Fishbein, Ph.D.[b], and Mark T. Greenberg, Ph.D.[c]

[a] *Johns Hopkins Center for the Prevention of Youth Violence, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland*
[b] *Transdisciplinary Science and Translational Prevention Program, RTI International, Baltimore, Maryland*
[c] *Prevention Research Center, Pennsylvania State University, University Park, Pennsylvania*

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A B S T R A C T

Purpose: Recent advances in developmental neuroscience have the potential to significantly impact the behavioral and academic outcomes of adolescents. By adopting a translational approach, we aim to promote the transfer of knowledge related to neurological, cognitive, and emotion regulatory factors that underlie youth's ability to respond to educational and prevention programming.
Method: This article synthesizes basic and applied research from the field of developmental neuroscience to highlight the significance of this work for the creation, evaluation, and tailoring of school-based preventive interventions designed to address aggressive behavior problems. We draw on research related to stress, social–cognitive factors, emotional perception and regulation, and executive functioning to identify potential neurodevelopmental mediators and moderators of prevention program impacts.
Results: Findings suggest that a high level of brain plasticity characterizes early childhood and adolescent stages of development, providing optimal windows of opportunity for intervention. The available research emphasizes the importance of executive functioning and related emotional regulatory factors as potential mechanisms for change in educational and risk prevention models.
Conclusions: Neuroscience research provides insights into underlying mechanisms that, when appropriately targeted, can help optimize the impact of social–emotional learning curricula. Recommendations are made for how to apply relevant findings from neuroscience and related disciplines to improve behavioral and academic outcomes for school-aged youth. Additional research areas are identified to inform the creation of neurodevelopmentally sensitive preventive interventions targeting aggressive behavior problems which, in turn, are expected to affect academic outcomes.

Recent advances in developmental neuroscience afford an unprecedented opportunity to translate and apply basic research findings to improve children's and youth's academic and social–emotional outcomes. This innovative line of translational neuroscientific research can also validate and clarify previous behavioral findings by exploring some of the neurocognitive mechanisms underlying previous research [1–3]. In particular, this article focuses on risk behaviors, which ultimately affect academic success and a range of behavioral and mental health outcomes. We draw on the growing body of research on neurodevelopmental mechanisms associated with the onset and course of behavioral problems (e.g., externalizing disorders, substance abuse) and highlight their implications for school-based prevention programming. Using a prevention science approach, we aim to promote the translation and dissemination of research on relevant aspects of

* Address correspondence to: Catherine P. Bradshaw, Ph.D., M.Ed., Johns Hopkins Center for the Prevention of Youth Violence, Johns Hopkins Bloomberg School of Public Health, 624 North Broadway, Room 831, Baltimore, MD 21205.
E-mail address: cbradsha@jhsph.edu (C.P. Bradshaw).

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developmental neuroscience to ultimately enhance youth's responsivity to educational and prevention program curricula and identify the specific mechanisms underlying these improvements. We begin by considering the role of stress in the development of both behavioral and mental health problems in childhood and adolescence, and the neurological and physiological mechanisms that play a role in these processes. We provide examples of ways in which neuroscience research has been infused into school-based programming and can be used to better understand the impacts of programs. We conclude with several recommendations for future translational research related to prevention during adolescence.

Relevance of Developmental Neuroscience for Preventive Interventions

Stress and the brain

Influenced by the emerging understanding of the dynamic interaction between genetic and environmental factors, brain functions and their behavioral outcomes are malleable. Compromised brain function and deleterious environmental conditions (e.g., deprivation, poverty, traumatic stress) may increase the risk for psychopathology, whereas environmental manipulation via intervention may buffer youth from developing such problems [4]. Although many researchers have focused on infancy and early childhood [5], the development and coalescence of neurobiological systems continue through adolescence until early adulthood [6,7]. Substantial brain plasticity in early adolescence makes this a sensitive epoch. Changes in structural and functional connectivity, as well as increased dopaminergic activity in pathways linking limbic, striatial, and prefrontal areas, have been associated with changes in reward-directed neural activity [8,9]. Developmental shifts in the activity of reward systems relative to cognitive controls during adolescence have implications for increases in risk taking [10]. These findings suggest that attention to differences in susceptibility during relatively distinctive neurodevelopmentally sensitive periods throughout childhood and adolescence is warranted to achieve the greatest preventive impact [4].

Further, the neurodevelopment–behavior link occurs within a social context. Patterns of synaptic growth, pruning, and gene expressions may vary by sociocontextual factors (e.g., exposure to community violence, child maltreatment) [11]. The degree to which this is the case and the amount of variability in the link between brain function and experiential learning are areas ripe for research aimed toward enhancing intervention effects. Recent research indicates that environmental stress during childhood and adolescence has substantial effects on the operation of the neuroendocrine system and that these effects are likely to have a long-term impact on both cognitive and social–emotional functioning [6]. By improving children's social ecologies (e.g., responsive parenting, caring and welcoming schools) and by supporting children's emotion regulation and coping abilities, empirically informed interventions have the potential to prevent a range of untoward outcomes in adolescence and adulthood.

Some of the goals of school-based prevention interventions are to mitigate the impacts of early stress, modulate stress reactivity, and promote effective coping with stress. Therefore, the specific physiological mechanisms involved in the stress response are a topic of growing interest to prevention researchers. Functioning of the hypothalamic-pituitary-adrenal (HPA) axis, which is activated in response to a perceived threat [5,12], has been the focus of considerable inquiry. The hypothalamus, pituitary gland, and adrenal gland all act in concert to produce the stress hormone cortisol. Studies have consistently linked dysregulation in cortisol functioning with behavioral and mental health problems [13,14]. A recent study highlights the relevance of an anticipatory stress reaction in relation to bullying; sixth graders who had previous exposure to bullying experienced dysregulation in cortisol functioning in anticipation of being bullied at lunch time [15].

Related research has focused on allostasis, defined as the complex interaction of physiological processes seeking to maintain equilibrium between bodily systems [12,16]. Allostasis represents the body's attempt to continually adjust to changing environmental and biological conditions to reach a homeostatic operating range. The process of maintaining that balance and adapting to adverse experiences and environmental stress increases the allostatic load [17]. Expanding on Rutter's (1989) [18] theory of cumulative risk, Evans (2003) [12] reported an association between cumulative risk and a number of physiological changes (e.g., self-regulatory behavior, cardiovascular and neuroendocrine functioning, and a composite index of total allostatic load) in rural youth. Evans' work also highlighted the potential psychological and physiological impacts of stress and the developmental timing of stress exposure on adjustment, both in the short term and across the life course. This research underscores the significance of addressing the stress process in the designing of preventive interventions and their developmental timing. Several school-based prevention programs aim to promote effective coping to modulate youths' stress reactivity [19], as additional research suggests that changes in cortisol functioning may mediate the impact of prevention programs on children's aggressive behavior [20].

Social–cognitive mechanisms

Numerous studies have examined youths' perception of social interactions to better understand potential social-cognitive factors that may fuel aggressive behavior [21]. Studies indicate that youth with higher rates of aggression tend to be hypersensitive to cues of threat, to selectively attend to aggressive cues, and to overlook other situational factors that may have influenced the behavior of others [21,22]. They are more likely to show a hostile attribution bias, which influences their interpretation of social interactions, such that they infer greater hostility in other people's ambiguous behavior. They also tend to have a large repertoire of aggressive responses and believe aggressive responses to be more effective at obtaining the desired goal than prosocial ones. Therefore, several preventive interventions target social information processing in an effort to reduce aggressive behavior. Different patterns of physiological and neurological activation have been implicated in these information biases [21].

An important aspect of social information processing is accurately identifying emotional cues, a skill that is deficient in many aggressive youth. These deficits may be related to adverse childhood experiences, such as maltreatment. For example, Pollak and Tolly-Schell [23] have shown variation in children's cognitive and physiological sensitivity to emotionally salient social cues based on previous maltreatment. Compared with nonmaltreated children, abused children tend to display increased sensitivity toward the detection of angry facial expressions, as indicated by reactivity of the central nervous system [23]. This research is consistent with behavioral data linking maltreatment and hypersensitivity to interpersonal threat. Correlational studies also suggest that individuals who display a tendency toward reactive or affective aggression are generally low in constraint and likely to respond aggressively to a wide range of potentially threatening stimuli [24]. However, there is research suggesting that reactive aggression is associated with high autonomic reactivity [24], whereas proactive aggression is associated with callous unemotional traits and low autonomic arousal [13,25]. Reactively aggressive youth tend to be hypersensitive to perceived threats and respond when emotionally dysregulated, whereas proactively aggressive youth may aggress to obtain items and social goals; this suggests that reactively and proactively aggressive youth may respond differently to preventive interventions. This line of research also highlights the importance of emotions and related physiological systems as targets for preventive interventions.

Targeting executive functioning

Emerging research has underscored the important role of executive functions (EF) [26] in aggressive behavior problems [27]. EF is an interrelated set of cognitive abilities that are important for adaptive functioning, including working memory, inhibitory control, attention set shifting, and planning. Relevant to processing social information, EF skills are regulatory abilities that develop and organize the emotional arousal systems associated with behavioral inhibition and approach, as well as reactivity to threat and stress. EF skills support planning (generating and following mental guides, sequencing actions), problem solving (evaluating, flexibly altering strategies for goal attainment), and intentional learning (sustained attention, resistance to interference) [28]. The triadic model [29] of motivated behavior provides a neurodevelopmental framework for understanding the development of EF skills. During adolescence, the reward-driven system (ventral striatum [nucleus accumbens]) may be stronger, whereas the harm-avoidant (amygdala) and regulatory control systems (medial/ventral prefrontal cortices) may be weaker [29]. This imbalance may relate to risky decision making and the development of psychopathology. As these systems interact substantially, it is important for interventions to address them collaboratively.

The development and refinement of EFs throughout childhood and adolescence manifest in the increasing ability to focus and engage in goal-oriented behavior that supports cognitive learning, and the management of emotion regulation and increasingly complex interpersonal relationships [30]. Delays in EF development have been associated with exposure to environmental stressors, which undermine connections between the neural systems mentioned earlier in the text [31]. Poor EF has been reported in youth with conduct problems, as low EF capacity dampens one's ability to interpret social cues, generate socially acceptable responses, and exercise avoidance or coping strategies [32]. Given the EF deficits characteristic of high-risk youth and the related constellation of comorbidities, it follows that preventive interventions targeting EF would potentially impact a range of behavioral problems [33]. Additionally, preventive strategies that foster more responsive and nurturing environments (e.g., less chaotic/disorganized classrooms, positive school climate) might affect EF. Taken together, these findings have the potential to influence the creation and targeting of effective educational and prevention programs to promote academic achievement and to reduce behavioral problems.

Neurodevelopmentally Informed Prevention Programming

Despite EF being related to school readiness, academic success, and positive behavioral outcomes [27], few interventions are expressly designed to affect neurodevelopment (for an exception, see the article by Greenberg and Rhoades) [30]. As such, interventionists should examine neurodevelopmental mediators of program effects [33] and refine programs to target EF (and socioemotional and physical development) [27]. A high level of brain plasticity characterizes early childhood and adolescent stages of development, providing an optimal windows of opportunity for intervention, although it remains important to understand the underlying mechanisms by which change occurs in prevention models. Neuroscience may provide insights into underlying mechanisms in individual-level differences in the ability to respond to school and prevention program curricula. Although some youth exhibit long-term improvements across multiple domains, a heterogeneous group of "nonresponders" evinced poor progress and an escalation of conduct problems and drug initiation. As suggested earlier in the text, youth with proactive aggressive behavior problems may vary in program responsiveness, such that youth with callous/unemotional traits may be less amenable to interventions [25]. Further investigation of the neuropsychological mechanisms of preventive interventions may help us better target and tailor programs to optimize outcomes and to reduce the rates of nonresponders. Prevention trials might use theory-based biobehavioral variables to explore moderating conditions (e.g., neurocognitive functioning [34], baseline stress reactivity, classroom context) that promote or hinder program outcomes.

School-based programs informed by neuroscience are likely to lead to evidence-based practices with significant population-level improvements in academic achievement and reductions in risk behaviors (e.g., externalizing disorders and substance abuse). This, in turn, would constitute an important milestone in establishing the legitimacy of educational and programmatic innovations. Currently, there is insufficient basic research on the developmental neuroscience of learning, how to facilitate and remediate neuro-modulated skills, and how to improve outcomes via neuroscience-informed models of prevention and promotion.

One especially important finding from the neuroscientific literature is that recruiting motivational and reward systems in the brain can enhance the salience and intrinsic reward of learning. This finding is particularly relevant when applied during the pubertal period when reward-driven behavior and appetitive behavior changes [35]. Adolescence is characterized by greater reward anticipation, sensitivity, and novelty or sensation seeking—particularly social rewards (e.g., peer regard, gains in social status). Reward regions of the brain are more strongly activated when youth make risky decisions in the company of peers rather than alone [36]. That this pattern of findings did not occur for adults suggests that adolescence may be a particularly unique time to leverage reward-based preventive interventions that take into consideration not only neurocognitive functioning but also the related role of the peer group and sociocontextual conditions. Youth's impulse control also should be considered, as research demonstrates that impulse control is relatively low at the same time that reward sensitivity is high (i.e., pre- and midadolescence) [37].

A prevention strategy for reducing aggression extending from this program of research would entail potentiating neurological development for greater self-regulation. Research has established that self-regulation is related to academic success [38]; thus, building self-regulatory skills (behavioral and emotional) should improve educational outcomes. Lasting benefit across domains may come from program components directed at: strengthening recognition of social cues, regulation of emotional responses, judgment and decision making based on consequences, scripted practice to provide structured settings for skill development, support to enhance self-monitoring and skill refinement, continual performance feedback, imagery to focus on cue salience and language internalization, and modulation of stress reactivity, each of which has a neurologic substrate [39]. These psychosocial approaches can teach and reinforce self-regulatory skills subserved by prefrontal-limbic circuitry in ways that produce measurable change in the brain and corollary physiological processes that may be more sustainable than conventional approaches.

Explicitly promoting EF skills, verbal processing, and emotional awareness may enhance program outcomes, especially during the critical period of neurocognitive development in adolescence. Computer-based interventions focused on explicit EF practice on cognitive tasks have shown some evidence for gains in EF skills and behavioral control [40,41]. There is also promising evidence from Tools of the Mind, a preschool intervention model based on Vygotsky's emphasis on play; preschoolers exposed to Tools of the Mind evinced higher rates of working memory and inhibitory control than children who were not [42]. Laboratory studies also indicate that practice enhances EF; when youth repeat cognitive self-regulation exercises, their performance improves [43].

Promoting Alternative Thinking Strategies (PATHS)

There is a growing evidence base for the effectiveness of neuroscience-informed preventive interventions—particularly programs aimed at reinforcing self-regulatory skills. Recent research has demonstrated that inhibitory control, as measured by the Stroop Task, partially mediated the impact of the PATHS social–emotional learning (SEL) curriculum on teacher-rated aggression [44]. The PATHS program is conceptually grounded in developmental models of neuroscience; it was created based on the goals of developing neurocognitive control both vertically (i.e., frontal control of emotion and arousal) and horizontally (i.e., language use in the service of emotion regulation). Teachers receive basic training on core aspects of developmental neuroscience during the PATHS training to help them understand the rationale for the different program activities and elements.

A related study, combining the preschool version of PATHS with an interactive reading program through Head Start, demonstrated an impact on SEL by fostering self-regulatory skills [45]. Findings highlight the importance of developing specific program components to activate neurocognitive pathways associated with various aspects of SEL. Research by Fishbein and Greenberg is currently under way to further investigate the specific neuropsychological mediators of the PATHS program. Using a randomized controlled trial (RCT) design, they are examining the extent to which social–emotional skills (emotion recognition, social problem solving), basic cognitive skills (language, IQ), executive function skills (attention, self-regulation), and physiological stress reactions (heart rate variability, skin conductance) serve as both mediators and moderators of PATHS outcomes.

Mindfulness programs

Another approach to promoting regulatory processes comes from research on contemplative practices, such as mindfulness with children and youth [46,47]. One goal of mindfulness practices is to increase youth's ability to develop awareness of and capacity for dealing with stress via meditation, yoga, and emotion-regulation techniques [48]. Although mindfulness-based approaches clearly predate neuroscientists' inquiry, a series of recent intervention studies have yielded positive results with adults; however, additional research is needed using RCT designs with adolescents [49]. Initial mindfulness-based interventions have demonstrated increases in optimism [47] and decreases in depression, anxiety, and emotional and behavioral reactivity in adolescents and children [50]. For example, a recent RCT of a school-based mindfulness and yoga intervention for urban youth indicated that the program was feasible, appealing to schools, and showed promise in reducing problematic response patterns to stress that are prodromal to anxiety and depression (e.g., rumination, intrusive thoughts, and emotional arousal) [46].

Implications and Future Research Directions

The available neuroscience research suggests several implications for prevention and future research. However, it is important to note that neuroscience should not be given the credit, for example, for establishing that decision making and self-regulation are critical to academic and social success [51]. A long line of social science research has been dedicated to these areas, and the applied neuroscience research has helped to validate these findings [1]. In fact, several researchers [1–3] have stressed that it is erroneous to privilege the neuroscientific evidence over the behavioral evidence; researchers are urged to be cautious in not misattributing or misapplying the brain-based approaches [2,3]. Rather, neuroscience research can both explicate social science findings and extend on them by asking new questions about meditational processes and informing the refinement of behavioral approaches. It is also possible that the neuroscience research can further "legitimize" behavioral research in the minds of the public.

With these caveats in mind, the current article aimed to highlight what neuroscience offers in terms of exploring some of the unobserved neurocognitive mechanisms underlying behavioral interventions and findings. This research is particularly applicable to high-poverty neighborhoods where high levels of stress, trauma, and adversity abounds; exposure to stressors has a cumulative impact on child brain development, functioning, and HPA activity [5,6]. Further research is needed to explore the profound effects of adversity and chronic stress on child brain development, which could be attenuated or remediated by preventive interventions. Additional research should also aim to identify changes that occur in youth's brain development in response to educational and programmatic innovations (e.g., mediation).

Future research is also needed to determine the types of interventions and specific program components that normalize or improve neurodevelopment in ways that lead to desirable outcomes (e.g., reductions in psychopathology, school failure, and drug abuse). For example, additional work should focus on developing curricula informed by neuroscience findings on emotional and behavioral self-regulation, which are integrated with behavioral techniques to promote academic and social success. Such programs should be created and evaluated to determine their impact on various behavioral and social needs of youth and neurodevelopmental markers of successful outcomes.

Studies on the underlying mechanisms that may mediate the effects of such interventions are sorely needed. With the conscious collaboration of prevention scientists and developmental neuroscientists, the field can gain greater understanding of what works, for whom, why, and under what conditions. Future research should aim to identify neurobiological underpinnings for differential susceptibility to environmental stressors or, conversely, differential responsivity to educational and prevention programming. Determining the mechanistic effects of prevention programs and interventions may also provide an evidence base to guide efforts to select, refine, and improve program components. For example, a multimethod approach (e.g., functional magnetic resonance imaging [fMRI], positron emission tomography, electroencephalography [EEG] event-related potentials) would allow for a more fine-grained understanding of whether performance on neurocognitive tasks maps onto parallel changes in brain function and structure and could isolate specific neurological correlates of interventions. As Greenberg (2006) [52] noted, behavioral changes might lead to greater activation in the anterior cingulate gyrus and dorsolateral prefrontal cortex that could be measured via EEG event-related potentials assessments. Likewise, if an intervention is expected to impact activity in the frontal lobe of the brain and stress reactivity (HPA axis), it may, over time, affect overall health, which could be assessed by immunological functioning [52]. Further, Gunnar et al (2006) [53] called for preventive interventions to include assessments of changes in the ratio of dehydroepiandrosterone to cortisol, changes in frontal EEG asymmetry, and alterations in cortisol and PEP (cardiac preejection period) or increased sympathetic-cortisol coregulation to psychosocial stressors. By targeting patterns of relations among measures, these suggested approaches may elucidate neurobiological changes related to functioning.

Additionally, as deficits in EF may have a substantial genetic component, the role of genetics in moderating prevention program impact (gene environment interaction) should be considered [54]. Specifically, salivary samples would need to be collected to extract deoxyribonucleic acid and selectively genotype markers based on their biological plausibility for deficits in EF. For instance, the DAT1 gene, which codes for the dopamine transporter, and a variant of this gene (associated with attention deficit hyperactivity disorder [ADHD]) have been associated with compromised response inhibition and error monitoring in children [55]. As the dopamine system plays an important role in response inhibition—with typically developing children homozygous for the 10-repeat allele of DAT1 performing less well on test of response inhibition [56]—future research should also collect psychophysiological data. For instance, one fMRI study investigated the role of dopaminergic genetic variation on EF by comparing how activation related to inhibition (both successful and unsuccessful) and differed based on DAT1 genotype and ADHD [57].

Given the emergence of evidence that negative and positive environments may differentially affect gene expression [58], a range of environmental risk and protective factors should be assessed with regard to school climate and other socio-contextual factors (e.g., student–student relationships and teacher–student relationships). Given the dynamic interplay between genetic and environmental systems and the costs and complexities of conducting neuroscientifically sensitive research, crosscutting collaborations based on a transdisciplinary translational model are crucial. Moreover, collecting buccal samples for DNA extraction may be more feasible and cost-effective in a school setting than obtaining fMRI data.

However, it is important to note that these neuroscientific approaches do not replace the need for additional research on environmental effects (e.g., quality of student–teacher relationships, school climate). In fact, an enhanced understanding of the dynamic interaction between genetic and environmental factors across the life span is an important step toward clarifying the mechanisms through which phenotypes are created. This knowledge base may inform the type and timing of interventions to maximize long-term effects. This approach also allows us to more fully understand the cognitive and neural mediators and moderators of change. As such, research should further explore neural correlates of sex differences in emotional reactivity and regulation (e.g., EEG asymmetry) and identify when sex-specific, indicated, preventive intervention programs are needed.

Neuroscience-informed prevention programs may be further refined in several ways. When implementing this neuroscientific approach, caution should be taken to ensure that theories and techniques are developmentally appropriate [59] and feasible (for conceptual and methodological challenges to interpreting fRMI findings on younger children see Peterson, 2003 [60]). Developmentally sensitive and somewhat distinctive periods of plasticity in childhood and adolescence provide opportunities to improve social, behavioral, and cognitive outcomes. Additional research is needed to identify critical windows during childhood and adolescence that may produce the greatest effects for specific types of curricula and program components. For example, interventions targeting the middle schoolers should be exceptionally beneficial, given the neurological reorganization that occurs in adolescence, the increasing stress that occurs in middle school, and the powerful hormonal changes that affect peer relations, sexuality, and risk taking. Many mental health problems have their onset in adolescence; therefore, intervening during middle school may equip youth with the skills to better cope with chronic stress that might have otherwise prompted the onset of psychopathology.

There is a great need to support ongoing strategies for the translation and implementation of relevant research findings to applied settings, such as schools and families. Detailed and theory-driven examinations of innovative social– emotional prevention programs are warranted. The ultimate goal of this line of research is to identify underlying conditions that may serve to both mediate and moderate program effects in youth at particularly high risk (e.g., those in high-poverty neighborhoods). Further research in this area could help identify underlying bases for individual differences in program responsivity and help tailor preventive approaches to specific needs of subgroups of youth, thereby enhancing efficiency, cost-effectiveness, and maximization of impact. Important, especially for youth at risk for problems by virtue of their environment, is accounting for the way in which individual-level characteristics (e.g., neurological, cognitive, and emotional regulatory factors) interact with the environment (social and physical) to portend developmental pathways and amenability to school programming.

Despite the increasing number of promising neuroscientifically infused approaches, it is important to remember that our knowledge base for the link between brain structure/development and individual behavior remains limited. Much of the research uses animal models that are not directly translatable to school-aged youth. Furthermore, some of the methodologies (e.g., fMRI) are perhaps better suited for adults than children. When attempting to move beyond basic methodologies (e.g., salivary cortisol sampling), research may become invasive (e.g., blood sampling), which may limit school, parent, and student involvement.

Finally, truly transdisciplinary collaborations are necessary. We need more opportunities to connect educators and practitioners with developmental neuroscientists who can facilitate the incorporation of neuroscience findings into educational and risk prevention programs. Neuroscientists, developmental psychologists, psychophysiologists, prevention scientists, and so forth will need to work together with educators and practitioners to develop and test theoretical models and to translate the knowledge generated. Indeed, there is a call for substantial investment by school districts, state and local governments, and federal agencies to implement evidence-based prevention programs in schools. A collaborative effort between schools and researchers would enhance our investigation and understanding of neurocognitive pathways in the promotion of social competence and academic success. This line of collaborative, interdisciplinary, translational research may also help maximize the effectiveness and efficiency of the available prevention programs and lead to the creation of new programs that are neurodevelopmentally sensitive.

Conclusions

The translation of developmental neuroscience has not been adequately emphasized. Neuroscientific research has the potential to give SEL and behavioral-based prevention programs a legitimacy and importance they have not previously enjoyed. It may also help to optimize these programs to improve effectiveness—especially for nonresponders. We call for developmental and neuroscientifically sensitive school-based prevention research to lead the charge in thoughtfully infusing the latest findings from developmental neuroscience into the education and prevention sciences. This line of translational research has the potential to enhance the development and refinement of science-based programs to improve youth behavioral and academic outcomes. It also offers several compelling advantages to conventional research approaches. Perspectives and methodologies from neurosciences can be informative both in evaluating and optimizing programs designed to strengthen cognitive development, behavioral self-regulation, and academic success. Accumulating research suggests that such an approach is likely to produce compelling evidence that well-designed and targeted preventive interventions have potential to alter developmental trajectories (behavioral and brain) that will ultimately buffer or prevent effects of adversity and other disadvantages [4].

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