ScAAN.net

Scientific support for raising the age of criminal responsibility

This report summarizes psychological and neuroscientific evidence from over 20 peer-reviewed studies. Compiled by the Scientist Action and Advocacy Network. For questions or comments, email info@scaan.net.

March 2017

Summary

Developmental neuroscience research shows that brain areas (e.g., the prefrontal cortex) that are involved in deliberative decision-making and the regulation of emotions and impulses are among the last to develop,[1] continuing to mature into young adulthood.[2,3,4]

Because their brains are under construction and malleable,[1] adolescents have a unique ability to learn new behavioral patterns.[5,6] **Whether the adolescent develops in a prosocial or an antisocial direction depends strongly on the adolescent's environment and experiences.**[5,6,7,8]

This malleability means that incarceration can leave a lasting and traumatic mark[9,10,11] on adolescents as they are separated from friends, parents, and loved ones, and deprived of the opportunities to practice prosocial behavior.[12] Conversely, this malleability means that the adolescent brain may be particularly amenable to rehabilitation.[6] In adolescents demonstrating risk for criminal or antisocial behavior, interventions that provide opportunities for prosocial interactions may bolster healthy development.[8]

Incarceration hinders the social and emotional development of adolescents.[13] Juvenile justice policy should instead be designed to reduce recidivism, promote rehabilitation, and implement interventions during this formative window of brain malleability.

The choice between these two approaches is particularly important because the cognitive and social skills that develop during adolescence may persist into adulthood.[13,9] Therefore, how correctional programs use this unique window of opportunity will likely have lasting impacts on the rest of the affected individuals' lives.

1 Brain areas involved in decision-making and regulation of emotions are not fully developed in adolescents.

Developmental neuroscience research shows that brain areas (e.g., the prefrontal cortex) that are involved in deliberative decision-making and the regulation of emotions and impulses are among the last to develop,[1] continuing to mature into young adulthood.[2,3,4]

- **Response to threat (Figure 1).** In one experiment, people were presented with a series of faces which they had to classify as quickly as possible. They were instructed to push a button for calm faces, and withhold button presses for fearful faces. Adolescents had a significantly higher rate of false alarm reactions for fearful faces than adults, suggesting that they react more impulsively to threatening stimuli. Correspondingly, these situations of perceived threat produced a stronger response in the adolescent brain than in the adult brain.[14]

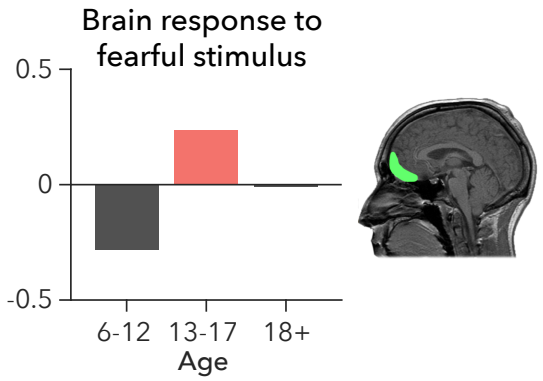

Figure 1: *Green area indicates the orbitofrontal cortex, a brain region associated with decision-making and reward processing. The adolescent orbitofrontal cortex response to fearful stimuli is significantly higher than that of other age groups. Adapted from Dreyfuss et al., 2014.[14]*

- **Response to reward.** The adolescent brain responds to rewards differently than the adult brain, making adolescents more prone to impulsive decision-making. For instance, in a gambling game experiment with real monetary rewards, adolescents made far riskier decisions; these decisions corresponded with heightened activity in reward centers of the brain.[15,2]
- **Suppressing emotional information.** During a computer game, participants viewed distracting background images. When presented with distracting images that were emotionally negative, teenagers were less capable of staying focused on the task, compared to adults aged 20-25. This study, among others, suggests that adolescents have relatively poor control of involuntary emotional reactions.[16]
- **Peer influence and risk-taking (Figure 2).** Adolescents and adults played a "traffic light" video game, either alone or while being watched by friends. In the game, they could choose to stop in front of a yellow light or try to drive through it before it turned red. Driving through the yellow light was a risky decision, putting the driver at risk of crashing. The study found that adolescents drove through the yellow light much more often when they knew they were being watched by their friends, and that they had relatively high activity in reward-related areas of the brain.[17,18,19]

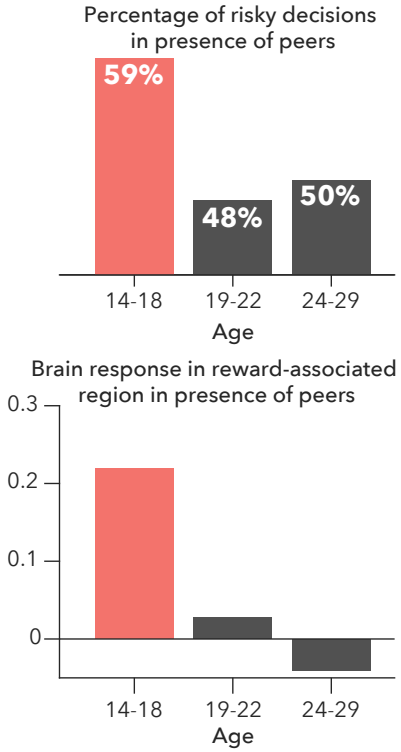

Figure 2: *Top plot shows the rate at which players in each age group chose to drive through a yellow light. Bottom plot shows left orbitofrontal cortex response to these decisions. Adapted from Chein et al., 2011.[17]*

A related study used questionnaires to determine the ability of adolescents to resist peer influence. The researchers found that resistance to peer influence continues to increase until after the age of 17 (Figure 3).

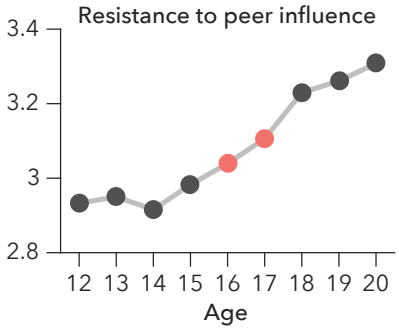

Figure 3: *Higher scores on the Resistance to Peer Influence measure indicate greater resistance to peer influence. Adapted from Steinberg and Monahan, 2007.*[19]

Another study showed that adolescents make more prudent decisions if they are in the presence of a single slightly older adult instead of in a group consisting only of peers.[20]

- **Exploratory behavior.** Adolescents show increased exploratory and experimental behavior during this transitional period of development, relative to other periods of life.[21]
- **Future-oriented thinking.** In experiments where people are asked to imagine themselves or their circumstances in the future, adolescents tend not to project as far into the future as adults.[21]

2 The adolescent brain is malleable and can be shaped positively or negatively by environment and experiences.

Because their brains are under construction and malleable,[1] adolescents have a have a unique ability to learn new behavioral patterns.[5,6] **Whether the adolescent develops in a prosocial or an antisocial direction depends strongly on the adolescent's environment and experiences.**[5,6,7,8]

Incarceration and trauma leave lasting marks on adolescents and promote antisocial behavior.

Incarceration places teens in an environment where they lack the opportunities to practice prosocial behavior and to learn to regulate their emotions and impulses. Such facilities further stunt adolescents' emotional and social development, separating them from friends, parents, and loved ones, while employing forceful punitive tactics which themselves may become lasting traumatic experiences.

- **Incarcerated adolescents experience disproportionate use of force by prison staff (Figure 4).** The first report of the Nunez Independent Monitor[12] found that, each month, 27% of the incarcerated 16- and 17-year-old population experienced the use of force by correctional staff. This rate was 9 times that of their adult counterparts.

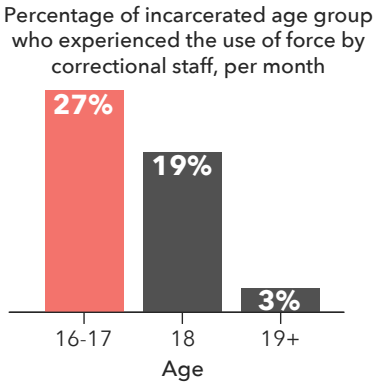

Figure 4: *Data collected from the New York City Department of Corrections, November 1, 2015 to February 29, 2016. Adapted from the First Report of the Nunez Independent Monitor.*[12]

Exposure to the traumatic experiences endemic to jails and prisons may be particularly detrimental to teens' long-term outcomes. Neuroscientific evidence suggests that trauma experienced in adolescence has a lasting impact on behavior and brain development.

- **Adolescence is a unique period of vulnerability.** Adolescents are particularly vulnerable to social stress, trauma, and drug use. Psychiatric illnesses related to stressful events often begin during this time window.[10,11,22,23,24]
- **Adolescents are susceptible to lasting trauma (Figure 5).** In one experiment, people were trained to associate the presentation of a square with an unpleasant noise. Upon seeing the square, they began to produce an unconscious fear response, which was measured by sensors on the surface of the skin. Subjects were then trained to dissociate the square from the unpleasant noise. After this training, the fear response remained high in adolescents but not in other groups, suggesting that adolescents have a uniquely low ability to forget fearful memories. This finding suggests that traumatic memories and associations acquired during adolescence are more difficult to unlearn than those acquired during childhood and adulthood.[9]

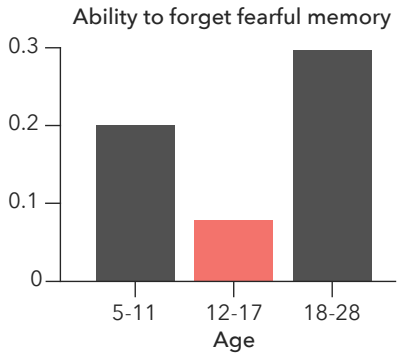

Figure 5: *After being trained to learn a fearful association, children and adults, but not adolescents, were able to unlearn it. Ability to forget memory was determined via skin conductance, a physiological measure of fear. Adapted from Pattwell et al., 2012.*[9]

- **Incarceration stunts social development.** Psychosocial maturity includes the ability to curb aggressive behavior, to consider other people's perspectives, and to function autonomously. For adolescents, punishment-oriented facilities have been shown to stunt the development of psychosocial maturity, more so than rehabilitation-oriented facilities. This effect was especially strong for incarcerated adolescents who reported feeling unsafe in their facility.[13]

Conversely, the adolescent brain may be particularly amenable to rehabilitation.

The heightened sensitivity and malleability of the adolescent brain present a window of opportunity for behavioral change. In adolescents demonstrating risk for criminal or antisocial behavior, interventions that provide opportunities for prosocial interactions may bolster healthy development.[8]

- **Brain architecture is drastically reshaped during adolescence.** In the frontal cortex, adolescents can have up to twice as many connections between brain cells compared to adults. As adolescents grow into adults, these connections are selectively pruned in a way that depends on learned memories and experiences. These changes may last well into adulthood.[1,25]
- **Personality development is sensitive to experiences during adolescence.** The rapid development of brain networks during adolescence means that the adolescent brain is particularly sensitive to both positive and negative influences. Experiences during adolescence may have a much larger impact on development than the same experiences during adulthood.[5,6]
- **Self-control develops during adolescence.** An important developmental milestone is the ability to make controlled decisions in emotionally heightened, high-stakes situations. Brain areas related to self-control are especially sensitive during adolescence. Accordingly, cognitive training during childhood and adolescence may be able to enhance self-control.[7]

3 Conclusion

Experimental evidence suggests that the adolescent brain is under development in a variety of psychological domains. Because the adolescent brain is malleable, the effects of trauma during adolescence may be particularly acute. Conversely, for this very reason, adolescents should be even more receptive to behavior-reforming programs than adults.

Incarceration hinders the social and emotional development of adolescents.[13] Juvenile justice policy should instead be designed to reduce recidivism, promote rehabilitation, and implement interventions during this formative window of brain malleability.

The choice between these two approaches is particularly important because the cognitive and social skills that develop during adolescence may persist into adulthood.[13,9] Therefore, how correctional programs use this unique window of opportunity will likely have lasting impacts on the rest of the affected individuals' lives.

References

[1] Zdravko Petanjek et al. “Extraordinary neoteny of synaptic spines in the human prefrontal cortex”. In: *Proceedings of the National Academy of Sciences* 108.32 (2011), pp. 13281–13286.

[2] Alexandra O Cohen et al. “When is an adolescent an adult? Assessing cognitive control in emotional and nonemotional contexts”. In: *Psychological Science* (2016), pp. 549–562.

[3] Laurence Steinberg. “A social neuroscience perspective on adolescent risk-taking”. In: *Developmental Review* 28.1 (2008), pp. 78–106.

[4] Sarah-Jayne Blakemore. “Imaging brain development: the adolescent brain”. In: *Neuroimage* 61.2 (2012), pp. 397–406.

[5] Suparna Choudhury, Tony Charman, and Sarah-Jayne Blakemore. “Development of the teenage brain”. In: *Mind, Brain, and Education* 2.3 (2008), pp. 142–147.

[6] Ronald E Dahl. “Adolescent brain development: a period of vulnerabilities and opportunities”. In: *Annals of the New York Academy of Sciences* 1021.1 (2004), pp. 1–22.

[7] Philip David Zelazo and Stephanie M Carlson. “Hot and cool executive function in childhood and adolescence: Development and plasticity”. In: *Child Development Perspectives* 6.4 (2012), pp. 354–360.

[8] Adriana Galván. “Insights about adolescent behavior, plasticity, and policy from neuroscience research”. In: *Neuron* 83.2 (2014), pp. 262–265.

[9] Siobhan S Pattwell et al. “Altered fear learning across development in both mouse and human”. In: *Proceedings of the National Academy of Sciences* 109.40 (2012), pp. 16318–16323.

[10] Susan L Andersen and Martin H Teicher. “Stress, sensitive periods and maturational events in adolescent depression”. In: *Trends in Neurosciences* 31.4 (2008), pp. 183–191.

[11] Delia Fuhrmann, Lisa J Knoll, and Sarah-Jayne Blakemore. “Adolescence as a sensitive period of brain development”. In: *Trends in Cognitive Sciences* 19.10 (2015), pp. 558–566.

[12] Steven J Martin. *First Report of the Nunez Independent Monitor*. 2016.

[13] Julia Dmitrieva et al. “Arrested development: The effects of incarceration on the development of psychosocial maturity”. In: *Development and Psychopathology* 24.03 (2012), pp. 1073–1090.

[14] Michael Dreyfuss et al. “Teens impulsively react rather than retreat from threat”. In: *Developmental Neuroscience* 36.3-4 (2014), pp. 220–227.

[15] Leah H Somerville and BJ Casey. “Developmental neurobiology of cognitive control and motivational systems”. In: *Current Opinion in Neurobiology* 20.2 (2010), pp. 236–241.

[16] Julia E Cohen-Gilbert and Kathleen M Thomas. “Inhibitory control during emotional distraction across adolescence and early adulthood”. In: *Child Development* 84.6 (2013), pp. 1954–1966.

[17] Jason Chein et al. “Peers increase adolescent risk taking by enhancing activity in the brain’s reward circuitry”. In: *Developmental Science* 14.2 (2011), F1–F10.

[18] Margo Gardner and Laurence Steinberg. “Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study.” In: *Developmental Psychology* 41.4 (2005), p. 625.

[19] Laurence Steinberg and Kathryn C Monahan. “Age differences in resistance to peer influence.” In: *Developmental Psychology* 43.6 (2007), p. 1531.

[20] Karol Silva, Jason Chein, and Laurence Steinberg. “Adolescents in Peer Groups Make More Prudent Decisions When a Slightly Older Adult Is Present.” In: *Psychological Science* 27.3 (Mar. 2016), pp. 322–330.

[21] Laurence Steinberg and Elizabeth S Scott. “Less guilty by reason of adolescence: developmental immaturity, diminished responsibility, and the juvenile death penalty.” In: *American Psychologist* 58.12 (2003), p. 1009.

[22] Ronald C Kessler et al. “Age of onset of mental disorders: a review of recent literature”. In: *Current Opinion in Psychiatry* 20.4 (2007), p. 359.

[23] Ronald C Kessler et al. “Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication”. In: *Archives of General Psychiatry* 62.6 (2005), pp. 593–602.

[24] Elizabeth S Ver Hoeve et al. “Short-term and long-term effects of repeated social defeat during adolescence or adulthood in female rats”. In: *Neuroscience* 249 (2013), pp. 63–73.

[25] Brie Ann Linkenhoker, Christina G von der Ohe, and Eric I Knudsen. “Anatomical traces of juvenile learning in the auditory system of adult barn owls”. In: *Nature Neuroscience* 8.1 (Dec. 2004), pp. 93–98.