Brain and Cognition 89 (2014) 61–69

Contents lists available at ScienceDirect

Brain and Cognition

journal homepage: www.elsevier.com/locate/b&c

Risk, adaptation and the functional teenage brain

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ARTICLE INFO

Article history:
Available online 24 January 2014

Keywords:
adolescence
risk
brain
adaptive
discourse
youth
evolution

ABSTRACT

Over the last decade, the propensity for young people to take risks has been a particular focus of neuroscientific inquiries into human development. Taking population-level data about teenagers' involvement in drinking, smoking, dangerous driving and unprotected sex as indicative, a consensus has developed about the association between risk-taking and the temporal misalignment in the development of reward-seeking and executive regions of the brain.

There are epistemological difficulties in this theory. Risk, the brain, and adolescence are different kinds of objects, and bringing them into the same frame for analysis is not unproblematic. In particular, risk is inextricably contextual and value-driven. The assessment of adolescent behaviour and decision-making as 'sub-optimal', and the implication that the developmental schedule of the teenage brain is dysfunctional, is also reassessed in terms of evolutionary development of the individual, the family and the human community. The paper proposes a view of adolescent development as adaptive, and a focus on young people's capacities in the profile of the needs of the community as a whole.

1. Introduction

A Thursday afternoon, the first warm afternoon of the spring. After months of a Scottish winter's grey confinement, it was time to take the motorcycle out for a long run. Just on sunset, with the Ducati's drumbeat exhaust reverberating off the walls, I pulled into the car park of a restaurant built into the dungeons of a thirteenth-century castle deep in the Campsie Fells.

The only other people in the restaurant left a few minutes after I arrived, leaving just me and the 18 year old waitress. We struck up a conversation, as you do, about motorcycles in the first instance. She did not like them. I asked if someone had frightened her, and she said yes – her dad. She had gone for a ride with him and he had gone fast and leaned over far and she got frightened and had not got on a motorcycle again.

She lived in the village. They had moved there when she was fourteen. She was on a gap year, out of school, working out what to do next. She wanted to move out of the village, to study in Glasgow, but was full of trepidation about leaving home and living on her own. 'You're not a risk-taker, are you?' I said. 'No' she laughed. 'I'm not. I mean, who has their gap year at home?'

Accounts of the neuroscience of adolescent risk often begin with a narrative like this, or more precisely, a narrative exactly the opposite of this (Dobbs, 2011; Landau, 2011; Steinberg, 2004b). According to researchers in this field, adolescence is 'characterised by suboptimal decisions' (Casey, Jones, & Hare, 2008) and risk-taking among adolescents is conventionally presented as high level, frequent, and typical. Opening paragraphs in articles about teenagers, risk and the brain repeatedly foreground drinking, or driving recklessly, or taking illegal drugs, or unprotected sex. This is cited as the typical teenage experience, and forms the context within which neuroscientific studies of risk and reward take place. While wide variability in risk taking behaviour is sometimes acknowledged (Samanez-Larkin, Kuhnen, Yoo, & Knutson, 2010), the general assumption of a high risk taking profile for adolescents nevertheless prevails.

However, clinical youth work experience finds that the timidity of my Highland waitress is not unusual among teenagers. Official statistics confirming that young people disproportionately drive drunk, take illegal drugs or engage in unprotected sex (Casey et al., 2008; Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Steinberg, 2008) obscure the equally valid statistical reality that most young people do none of these things (Romer, 2012). The adolescent of the musicals and the movies, the 'noisy, crazy, dirty, lazy loafers' of *Bye Bye Birdy* (Stewart & Adams, 1963), or the motorcycle daredevils of *Rebel Without a Cause* (Ray, 1955) might get the publicity and the attention, but the teenage world is full of boys and girls like her. There is an even larger number of young people who might like a bit of excitement, to challenge the otherwise suffocating domination that pervades their lives, but do not ever do anything that seriously threatens their lives or livelihoods. Even the most risk-prone adolescents are not taking risks most of the time. Most of the time, they are sitting in highly-controlled environments doing what they are told.

As population statistics indicate, young people are mostly competent about risk – the survival rate for teenage boys in the UK is

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http://dx.doi.org/10.1016/j.bandc.2014.01.001

around 99.96% (UK National Statistics 2012), despite the apparent prevalence of life-threatening sub-optimal decision-making. A number of commentators have argued that there is a danger of over-deterministic, over-simplified and over-generalised accounts of the mechanics of risk taking behaviour, and an understandable, but unbalanced *focus on the pathological*: on dangerous, deleterious, deviant risk-taking in the young (Ellis et al., 2012; Johnson, Blum, & Giedd, 2009; Moshman, 2011). Morality is not absent from the picture either: the fact that most analyses focus on drinking, smoking, taking drugs and having sex (rather than riding horses, for example (Nutt, 2009)) indicates that it is not merely a question of the highest risks for death or injury.

It may well be that young people have a greater propensity to take risks than older populations. There are a range of sociological and psychological reasons as to why the profile of risk taking among teenagers might be different to that of older people. Young people have fewer possessions, less of a stake in the status quo, they do not have positions of power and status to protect. Experience changes our approach to risk: in both directions. Indeed, we should expect differences in brain architecture between young people and older people on the grounds of neuroplasticity alone. Alongside the differential circuits resulting from different prior experiences, young people and older people also inhabit different ecological spaces, and would be expected to have different brains because of that. But it may also be, as current orthodoxies in neuroscience suggest, that in the biological trajectory of human development, the teenage brain deals differently with risk than others' brains do.

This paper has been written in the context of a conversation about adolescence, the brain and risk: and from the perspective of a sociologist and youth worker. While supportive of the potential for contemporary neuroscience to add to our understanding of ourselves, I argue for more care in approaches to these questions, a clearer and cleaner epistemological approach. I am especially wary of the insertion of categories of value and morality into the science, and argue that a more consistent approach to the biology might mitigate against pathologising views of young people. Notwithstanding the occasional rare (and tragic) fatality, we would expect the primary assumption from within a biological perspective to suggest that if there is biologically-driven risk-taking at the population level, it is functional both for the individual and their community (Dobbs, 2011).

As a social theorist and as an advocate for young people, I have been concerned at the way that discourses of risk have the potential to feed into youth policy in ways that are restrictive and prejudicial (Ellis et al., 2012; Payne, 2012b). Young people need the neuroscience to be clean and clear, especially given its influence on parenting, education and public policy. Functional Magnetic Resonance Imaging (fMRI) is a powerful cultural instrument, and needs to be operationalised at the level of public discourse with great care (Racine, Bar-Ilan, & Illes, 2005).

2. Neuroscientific research on adolescents, risk and the brain

The empirical basis for our understanding of the neuroscience of risk in adolescence rests substantially on fMRI studies involving the subject being scanned while engaged in a simulation of risk-taking behaviour, typically playing a computer game that offers varying rewards according to the risk taken within the game. In reported studies (Chein, Albert, O'Brien, Uckert, & Steinberg 2011; Galvan, Hare, Voss, Glover, & Casey, 2006; Segalowitz et al., 2012; Somerville, Hare, & Casey, 2011; Steinberg, 2007, 2010), this work shows a different pattern of activation in various regions of the brains of young people compared to either children or young adults. Specifically, for teenagers engaged in risk-taking simulations, activation of the reward centres of the brain (the ventral striatum, especially the nucleus accumbens, Nacc) is focused and strong, and activation of the centres responsible for executive function (the pre-frontal cortex, PFC) more diffuse. These data receive corroboration from other work, like Beatriz Luna's saccade/anti-saccade testing (Luna, Garver, Urban, Lazar, & Sweeney, 2004; Luna, Padmanabhan, & O'Hearn, 2010; Luna et al., 2001), which also shows that a different pattern of response to stimulus can be seen in fMRI scans of the brain.

These data are aligned with behavioural and epidemiological studies of teenagers and risk taking to constitute a narrative regarding risk, the adolescent, and the brain: namely, that, as the adolescent brain develops over the teenage years into its adult configuration, a temporal disconnect occurs between the development of the reward centres of the brain and those responsible for executive function, including rational consideration and judgment (the pre-frontal cortex – see Ernst, this issue). This disconnect results in an increased tendency for young people to take risks. This has been expressed metaphorically in the literature as 'all gas and no brakes' (Casey, Jones, & Somerville, 2011; Payne, 2012a) and has been translated into a number of other epistemological spheres, including parenting (Feinstein, 2010; Landau, 2011; National Institute of Mental Health., 2011; Steinberg, 2011), pedagogy (Howard-Jones, 2008; NSW Department of Education, 2006), and the law (Haider, 2005; Steinberg, 2009; Steinberg, Cauffman, Woolard, Graham, & Banich, 2009).

There is some recognition that the actual practice of decision-making regarding risk for adolescents is unlikely to be simply a function of suboptimal pairing of the Nacc and the PFC. Monique Ernst's triadic theory suggests that the activation of the amygdala in decision-making about risk is also likely to be significant (Ernst, Pine, & Hardin, 2006). Intuitively, risk-taking involves more than the anticipation of a reward: serious decisions about risk will involve some anxiety and are likely to involve at least avoidance systems. In time, we are likely to identify a broad network of connections within the brain implicated in decisions about risk, in which the Nacc/PFC nexus may be important, but may not be determinative in every risk-decision event (Insel, 2010; McIntosh, 2000; Pfeifer & Allen, 2012; Shermer, 2008; Uttal, 2002). For the moment, however, it constitutes the dominant narrative about the adolescent brain and risk-taking behaviour.

3. The adolescent brain: liability or asset?

According to epistemologies that see adolescence as a biological feature of human development, the distinctive elements of adolescence are a product of evolutionary processes, specifically natural selection (Ellis et al., 2012; Hawley, 2011; Weisfeld & Berger, 1983). Presumably, from the point of view of evolutionary psychology, homo sapiens has survived *because* of adolescence (including the traits the neuroscience is trying to describe), not in spite of it. Biologist David Dobbs argues:

> Selection is hell on dysfunctional traits. If adolescence is essentially a collection of them—angst, idiocy, and haste; impulsiveness, selfishness, and reckless bumbling—then how did those traits survive selection? They couldn't...
>
> [Dobbs (2011)]

In an interview on NPR in September 2011, in conversation with B.J. Casey and David Dobbs, Jay Giedd argued that

> ...the teen brain is not a broken or defective adult brain. It's been exquisitely forged by the forces of our evolutionary history to be a very good teen brain. It's different than children, it's different than adult, but it's not broken.
>
> [Giedd, in Conan (2012)]