

Cognitive neuroscience to understand risk- taking in youths



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Adolescents are frequently described as risk takers. From a cognitive neuroscience perspective, What evidence exists to support or refute the claim?

Introduction

Adolescents are often portrayed in society as the riskiest age group and evidence from neuroscience to support this claim is slowly emerging with neuroimaging methods. The vast majority of research is supportive of the claim that adolescents have a proclivity for risk in comparison to older age groups. The papers below look at three key ideas which support different aspects of adolescent risk-taking propensities. The first is the popular idea of a Dual System Model during adolescent development (Leijenhorst et al., 2010). The second paper looks at how the neural response to reward and risk can be altered in social conditions (Chein et al., 2010). The final paper is a longitudinal study looking at the relationship between pubertal development and risk-taking. These research articles all support the claim that adolescents are risk takers, however, the papers demonstrate that risk-taking has numerous factors which contribute to the overall outcome. This area of cognitive neuroscience is important as research can identify biomarkers of risk, which in turn can identify risky developmental trajectories.

Dual System Model

A key concept which supports the claim is the Dual System Model (Steinberg, 2010). This proposes that cognitive control and the reward system of an adolescent are on divergent developmental trajectories. The reward system

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has a rapid nonlinear development, while the cognitive control has a slow linear maturation. Empirical evidence of this model was first seen in Casey et al. (2008). Researchers found that cognitive control areas, lateral prefrontal cortex and dorsal anterior cingulate cortex, had a slower rate of maturation. While there was an increase in response to reward from the ventromedial prefrontal cortex and ventral striatum (Casey, Jones & Somerville, 2011).

Leijenhorst et al. (2010) found fMRI evidence supporting the Dual System Model. The paper was researching activation in reward circuitry, looking at whether the activation would climax during the decision processing or at the outcome stage. The risk that participants were undertaking was a gambling task; participants would have to choose between Low-Risk or High-Risk choices which had different monetary rewards. Researchers used four age groups: prepubertal children, early adolescents, older adolescents, and young adults. The investigation found a reduction in response from the dorsal anterior cingulate cortex linearly correlated with age and risky decisions. The results suggest that the activation in reward circuitry and cognitive control networks permutate across development from prepubertal to young adults. These findings are consistent with the hypothesis of the Dual System Model.

However, a limitation of this study is the level of monetary reward to the Low or High-Risk scenarios. It is unknown whether value holds comparable across subjects from prepubertal children to young adults, in terms of reward and response reactions. An alternative explanation is that there may have been more of a peak in reward circuitry from adolescents because the monetary reward is more important to them than in children or adult age groups. The <https://assignbuster.com/cognitive-neuroscience-to-understand-risk-taking-in-youths/>

investigators assessed pubertal development by giving the participants a self-rating scale, which corresponded to the different Tanner Stages. Maturation of neurons in the dopamine system which can assess pubertal development in participants cannot be explicitly conducted in fMRI, and therefore the study had to rely on the Tanner Scale. The grouping of participants is missing a middle stage between prepubertal (8-10 years) to early adolescents (12-14 years). Although the focus of the research toward adolescents suggests that this group is unnecessary, Leijenhorst et al. (2009) used a group of 10-12-year-olds as their control when comparing adolescents to children. This omission of the middle age group is also reflected in a large change on the mean Tanner score between groups and may have some significance to the findings. These findings suggest further research should be conducted into how emotional situations affect adolescent risk-taking (Rudolph et al., 2015).

Altering of Neural Substrates in Social Contexts

This investigation into how the neural reward system can be modified in social contexts supports the claim that adolescents are riskier. Studies looking at adolescents and reckless driving, crime rates, and substance abuse have found that adolescents are more likely to part-take in these activities in the presence of peers (Simons-Morton et al., 2005).

Chein et al. (2010) found different responses in the ventral striatum (VS) and orbitofrontal cortex (OFC) across the different age groups that were tested. The activation in the reward circuitry was dependent on the social context a participant was experiencing. This is similar to findings which found an age-

dependent effect towards riskier behaviour in the presence of peers (Englund & Siebenbruner, 2012).

The research question looked at whether adolescent's disposition to risk-taking in the presence of peers is a consequence of the linear development of cognitive control systems and rapid maturing reward circuitry. This conjecture suggests that an adolescent's reward systems may be more sensitive to the potential benefits of risk-taking in the presence of peers. The researchers propose an alternative explanation that the presence of peers could be related to changes in cognitive control, and the different activations found could be related to impulse management. The risky scenario which participants undertook was a driving task in fMRI, where the participants were told to get from the start to the finish as quickly as possible, to gain monetary reward. During this task, participants would get stopped at a number of points, making the decision whether to risk a collision or wait. This task was completed twice; once on their own, and a second time where their peer would be watching their responses in another room. The researchers tested three age groups: adolescents, young adults, and adults. Each participant also completed a questionnaire to gauge their self-reported riskiness.

Behavioural results found participants responded similarly when completing the test alone, but adolescents became riskier in the social condition. The researchers were able to control for peer pressure by having the peers watch the participant's performances in another room. The fMRI data found the VS and OFC were more active during the peer condition for adolescents, compared to the other two groups. These regions are confirmed as <https://assignbuster.com/cognitive-neuroscience-to-understand-risk-taking-in-youths/>

biomarkers for reward estimation by the large response found during the task. The study discovered more activation in the lateral prefrontal cortex (LPFC) for the adult group, which is used as an alternative hypothesis to explain increased activation in the VS and OFC in adolescents. They suggest that the adult group are able to activate these LPFC regions when making risky decisions to control the influence of reward circuitry.

The investigators concluded that the activation in the ventral striatum and orbitofrontal cortex was due to reward circuitry. An alternative explanation for the response is hesitancy on decision making elicited by the peer condition, or adolescents having a greater disposition to distraction (Park et al., 2004). The limitation of the study was a lack of consideration to a participant's prior driving experience. The study did not ask participants whether they had ever been in an accident or had previous negative driving experiences as this would have influenced behaviourist risk-taking results (Ivers et al., 2009). In addition, participants were also not asked about their experience with driving games. As the setup of the task may be more comparable to that of a driving video game than a real-life risk decision task. A participant who has significant usage of driving video games may be predisposed to dangerous behaviour and expecting no consequences.

Longitudinal Data

Longitudinal data is important to research in risk-taking as predicting developmental trajectories could forestall future deviant behaviour (Pettigrew, 1990). Heightened activity in the nucleus accumbens (NAcc) is an

important article in reward circuitry, with suggestions that it corresponds to participants self-reported risk-taking tendencies (Galvan, 2007).

The following article supports the claim that adolescents are more prone to risk-taking behaviour than adults. Braams et al. (2015) report significant findings which indicate that pubertal development is a key trait that relates to risk-taking tendencies with adolescents. The study looked at the correlation between activity in the NAcc and reward; including factors such as pubertal development and risk-taking behaviour to more accurately anticipate behavioural tendencies.

The study used a Balloon Analog Risk Task (BART) to measure risk-taking (Lejuez et al., 2002), as well as having participants rate their risk-taking tendencies with behavioural inhibition and activation system questionnaires (Taylor and Eitle, 2015). The researchers also took measurements of testosterone from any participant under the age of 17 (controlling for abnormal testosterone values) and asked adolescents to complete the Pubertal Development Scale (PDS). The data was measured from two-time points with a two year age gap, and a total of 217 participants had fMRI scans while completing the tasks. The regions of interest for the fMRI analysis was the bilateral ventral striatum which included the NAcc in both time points. The investigators used mixed-models to determine the trajectory of the data; looking at the change of time, independent starting points, and the gradient of each model.

The result of the investigation found the same peak in NAcc activity in rewards and risk-taking for adolescents, which had previously been reported.

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Participants who had increased activity in NAcc also had an increased BIS/BAS score in comparison to their earlier test point, and there was a correlation between this activity and self-reported risk-taking tendencies.

The investigators tested the correlated factors of age and puberty separately with the activation in NAcc to investigate individual effects. From this, they found that self-reported pubertal development was linearly correlated with NAcc activity. This has a dramatic contrast to the findings between age and NAcc activity to rewards, which had a quadratic effect with a peak in mid-puberty. Testosterone measurements were also linearly related to the increased response in NAcc, suggesting that individuals with higher testosterone levels had higher activation in NAcc in response to reward.

The author suggests a correlation between higher testosterone level and risk-taking. These results have been found previously in Herman et al. (2010), where testosterone was given to women and a higher activation was measured in the ventral striatum in response to reward. Previous presumptions of a riskier group in society have led to discrimination on the bases of sex. However, as this study demonstrates the individual rate of risk-taking fluctuates dramatically between participants, and therefore any societal implications are unjust. The investigator concluded that the self-reported pubertal development was linearly correlated with NAcc activity. However, an alternative explanation may be a causation effect, rather than correlation. As a participant who reports advanced pubertal development may have other effects that cause activation in NAcc, such as self-doubt and longer processing times to risk, or other underlying mental processes (Uddin et al., 2006). A limitation of this study is the lack of manipulation between

reward and losses in the BART task design. The study could include a baseline factor to NAcc activation to better distinguish between response to outcomes.

Conclusion

In conclusion, evidence from cognitive neuroscience suggests that adolescents have higher risk-taking tendencies than adults. This predisposition to risk can be described through the rapid development of the reward circuitry in comparison to the linearly developing cognitive control as seen in Leijenhorst et al. (2010). Evidence for the Dual System was presented through a gambling task with a monetary reward and alludes to possible further research in pubertal development and emotional factors which may contribute to risk. The Chein et al. (2010) paper looked at risk-taking with adolescents in a social condition. The investigators found that adolescents had higher risk-taking tendencies in the presence of peers, with activation of the ventral striatum and orbitofrontal cortex. Braams et al. (2015) longitudinal study looked at pubertal development through testosterone measurements in participants in comparison to reward and risk-taking behaviour. The investigators found an association between higher testosterone levels and risk-taking. The area of adolescent risk-taking is a large field, however, the key points raised by these papers illustrate that risk is a multi-fascinated condition and there is a multitude of things which affect a person's frequency to take risks.

[WORD COUNT: 1979]

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