

The role of testosterone in aggressive and non-aggressive risk-taking in adolescent boys

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Abstract

While there exists increasing evidence of a relationship between testosterone (T) and risk-taking (RT), many issues remain unsolved. This paper tries to address two main-questions: (i) does T influence aggressive risk-taking (ART) and/or non-aggressive risk-taking (NART) behavior and (ii) is this relationship stable throughout age and pubertal development and how is the relationship affected by affiliations with peers that are highly involved in RT, referred to as differential association (DA)? For a sample of 301 third-grade adolescent boys (mean age 14.4 years), we assessed the relationship between serum levels of T and estradiol (E2), DA and ART/NART. Significant effects of SHBG (Beta = -0.15; $p < 0.029$) and free testosterone (FT) (Beta = 0.23; $p < 0.003$) on NART were shown. No significant effects were found with respect to ART. Further analyses showed that the FT-NART and the FT-ART relations differed as to age but not as to pubertal development (PD) and that the relationship between FT and RT is mediated by DA as such that individuals with higher levels of FT have friends that are more involved in RT and their influence contributes to increased levels of RT. Our results indicate that hormone-related interests and predispositions may influence the development of affiliations with risk-taking peers, a factor which is crucial in understanding adolescent RT.

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Introduction

Referring to Irwin (1993), we define adolescent risk-taking behavior (RT) as a behavior which may be rewarding in itself, however, has an unpredictable outcome given the possibility of an identifiable negative health outcome or social sanction. The concept of adolescent RT behavior defined as such is related to, but may be more broad than, other concepts as 'problem behavior', 'antisocial behavior', 'deviant behavior', 'delinquent behavior' or 'criminal behavior'. A broad definition – that includes vandalism, aggression, substance abuse as well as more mild indicators like cheating on exams, playing truancy at school or challenging authority – may be desirable (Byrnes et al., 1999) because it gives a common label to indicators that, as most studies show (Jessor and Jessor, 1977; Irwin, 1993), may be

strongly associated with each other without being 'deviant', 'delinquent' or 'antisocial' in the strict sense of these words. In addition, the concept of RT allows for the study of this behavioral phenomenon in younger adolescents that are less likely to be involved in more serious offenses (Byrnes et al., 1999).

In explaining adolescent RT and the fact that boys surpass girls in nearly all indicators of RT (Byrnes et al., 1999; Steffensmeier and Allan, 1996), biologists and behavioral scientists have focused on the role of sex steroids and, more particularly, on androgens. In spite of strong evidence of the activational role of T in the behavior of different animal species obtained from correlational (Harding, 1983; Rada et al., 1976) as well as experimental (Vom Saal, 1983) studies, research into the activational role of androgens in indicators of RT behavior in humans has remained inconclusive and studies with respect to adolescents remain scarce (Booth et al., 2003). The fact that studies differ substantially in sample size, target group and method of T assessment (use of serum versus saliva samples) may at least partially explain inconsistent outcomes in results.

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However, several additional aspects of the T-RT relationship that may be relevant to inconsistencies in outcomes have received little or no attention. Firstly, most studies have focused on aggressive risk-taking (ART) or have failed to differentiate between aggressive and non-aggressive risk-taking (NART). Given the fact that T and ART are closely associated according to the general public, it should come as no surprise that this association has received much attention over the last several decades (Aromaki et al., 1999; Ehlers et al., 1980; Olweus et al., 1980, 1988; Rada et al., 1976; Tremblay et al., 1998). However, results have been inconsistent: meta-analyses performed by Archer et al. (1998, 2005) and Book et al. (2001), have confirmed the existence of only a marginal relation. This is further supported by experimental evidence on healthy men to whom T was administered in a randomized placebo-controlled crossover trial (Pope et al., 2000). In this study, positive effects of T administration on mania scores and aggression scores were limited to one subgroup, whereas no effects were found in the general sample. Moreover, the administration of T as a treatment for delayed puberty in boys (Finkelstein et al., 1997) increased ART to some extent. However, the association between T and aggression is by no means as significant as was formerly assumed, and some have argued that estradiol (E2), the product of aromatization of T, rather than T is causally related to ART (Finkelstein et al., 1997). This hypothesis has not, to our knowledge, been assessed by means of a non-experimental research design in boys. Given the evidence that some differences may exist as regards to the etiologies of ART and NART, it has been argued that they should be studied together, but analyzed both on a separate and a comparative basis (Rowe et al., 2004). Studies that compared the effect of T on ART and NART in adolescents presented inconclusive results. Rowe et al. (2004) and Maras et al. (2003) have found that T was a less significant predictor of ART than of NART. Brooks and Reddon (1996), however, have found higher levels of T in violent offenders than in non-violent offenders. The possibility that T is related differently to ART and NART warrants further research.

A second issue is the possibility that the effects of T are different at different levels of development. Besides the evidence of direct activational influences of T, the partially T-induced evidence of maturity may affect behavioral expectations, so that mature-looking boys experience pressure, motivations and opportunities at an earlier age (Udry, 1990). As a result, pubertal development (PD) and/or age may interact with T and may increase its effectiveness. Referring to the fact that research into ART in boys at a younger age yielded rather inconsistent results, Ramirez (2003) has argued that T might reach levels that are sufficient enough to have an activational influence only at later stages of adolescence. However, the meta-analysis performed by Archer et al. (2005) has not found any differences as to the effects in males among the age groups 13–21 and 21–35. Little research has focused on T-PD interactions in NART.

While the relationship between hormones and behavior may be affected by developmental factors, it may depend equally on the social contexts that influence adolescent RT. One classic criminological theory that may be particularly relevant in this

respect is differential association (DA) theory (Sutherland, 1993; Akers et al., 1979). DA theory is a social learning theory that argues that adolescents learn motivation, drives and attitudes favorable to RT through direct interaction with others highly involved in RT. One of the most important affiliations that may play a role in these social learning processes may be the adolescent's affiliation with delinquent or risk-taking peers (Akers et al., 1979). Having peers that are highly involved in delinquency or RT appears to be associated with aggression (Capaldi et al., 2001), self-reported delinquency (Vitaro et al., 2000), arrests (Patterson et al., 2000) and drug abuse (Dishion et al., 1995), and with a change in attitudes towards delinquency and substance abuse over time (Henry et al., 2000; Krohn et al., 1996). While being involved with risk-taking peers may be one of the most proximal correlates of adolescent RT (Henry et al., 2001), DA theory does not explain why some adolescents become affiliated with peers that are highly involved in RT and others do not. DA may be relevant to hormone behavior relationships if (i) individuals choose friends according to their predispositions and interests – “birds of a feather flock together” – and if (ii) T is related to these predispositions and interests. As such, one may expect that DA may, at least in part, mediate the association between T and RT. Alternatively, like the suggestion of the analyses of Rowe et al. (2004), it may be that the effects of T on RT are dependent on peer group affiliations and as such that these affiliations increase existing hormone-related predispositions toward RT.

The aim of this study was to explore, in a sample of healthy adolescent boys, the relation between T and NART and ART, to examine whether the relationship is equally evident at the different levels of development, as measured by PD and age and how DA affects the relationship between T and NART and ART. In addition, given the hypothesis that E2 is more important than T in relation to ART, we assessed the effects of E2 in comparison with the effects of T on ART and NART.

Methods

Subjects

Data presented in this paper are part of ADORISK, a larger study on the social and biological determinants of the sex gap in adolescent RT. The target group of this study was the population of third-grade students (average age between 14 and 15 years). The project was set up in collaboration with the Flemish Centres for Pupil Coaching (CPCs). CPCs are government-funded institutions that follow pupils through their school career, advising them on issues of health, psycho-social well-being and study-related problems. CPCs, where Flemish third-grade adolescents must submit to a medical consultation, compulsory by law, were screened for their willingness to participate and their capacity to host the data collection.

CPCs – which are associated with both public authority schools and private schools that virtually cover the whole educational landscape – in four small to large cities agreed to participate. All students attending the medical visit on selected dates were given the opportunity to participate in the research project. After an oral presentation on the goals of the study, informed consent letters were distributed to both students and their parents. Only students who had given their full written consent and whose parents had given their full consent, were allowed to participate. In exchange for their participation, students were given an incentive.

Seventy-one percent of the eligible students participated, making up a total sample of 599 third-grade adolescents, namely 301 boys and 298 girls. All project data – including questionnaires, serum samples and biometrical

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