



# Teacher–student relationships and adolescent behavioral engagement and rule-breaking behavior: The moderating role of dopaminergic genes☆

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## ARTICLE INFO

### Article history:

Received 13 May 2015

Received in revised form 18 November 2015

Accepted 17 February 2016

Available online xxxx

### Keywords:

Gene–environment interaction

Teacher–student relationships

School engagement

Dopamine

DAT1

DRD4

## ABSTRACT

This study examined whether the dopamine transporter *DAT1* and the dopamine receptor *DRD4* genes moderate the effect of student-reported teacher–student relationship affiliation or dissatisfaction on parent-reported adolescent rule-breaking behavior and behavioral engagement. The sample included 1053 adolescents (51% boys,  $M_{age} = 13.79$ ) from grades 7 to 9. Regression analyses were conducted using Mplus while controlling for multiple testing and nested data. Adolescents who experienced stronger affiliation with their teachers were more engaged in school, whereas greater dissatisfaction predicted more rule-breaking behavior. In addition, a significant gene–environment interaction was found for both genes examined. The link between low teacher–student affiliation and low engagement was more pronounced for *DAT1*-10R homozygotes. The link between high teacher–student dissatisfaction and more rule-breaking was stronger for *DRD4* non-long carriers. Implications for understanding the role of teacher–student relationships in adolescence and suggestions for future research are outlined.

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## 1. Introduction

The bio-ecological model of human development (Bronfenbrenner & Morris, 2006) assumes that adolescent development is shaped by adolescents' social environments, as well as by biological factors such as genes, and the interactions between genes and environments (i.e., GxE interactions). The GxE interactions take place when the genotype's effect is moderated by the social environment or, conversely, when the effect of exposure to a social–environmental factor on behavior is conditional upon a person's genotype (Moffitt, Caspi, & Rutter, 2006). Regarding social environments, most GxE research focuses on (negative) aspects of parenting such as maltreatment or negative aspects of the social context as a whole such as stressful life events. However, for several domains of child and adolescent development, including externalizing behaviors such as rule-breaking behaviors and behavioral school engagement, teacher–student relationships are important as well (e.g., O'Connor, Dearing, & Collins, 2011).

☆ Funding was provided through grant GOA/12/009 ('STRATEGIES' project) of the 'BOF' (Bijzonder Onderzoeksfonds), KU Leuven–University of Leuven.

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ACTION EDITOR: Kathy Rudasill.

Despite the fact that school is a central context of child and adolescent development (Roeser, Eccles, & Sameroff, 2000), teacher–student relationships have been largely overlooked in GxE research. Not only does the study of the interplay of genes with teacher–student relationships contribute to the GxE literature, it also adds significantly to the current knowledge base on the developmental significance of teacher–student relationships. Indeed, previous research has suggested that teacher–student relationships are particularly influential for vulnerable students (Sabol & Pianta, 2012). These vulnerabilities, however, have only been assessed at the behavioral level, raising the question as to whether students with certain genetic markers of vulnerability are also more susceptible to the quality of teacher–student relationships.

The present study is the first GxE study on specific genes (also referred to as a molecular genetics study) that includes teacher–student relationships as a social environmental factor. The dopamine transporter or *DAT1* and the D4 receptor or *DRD4* genes were selected, because they have been associated with aspects of externalizing behavior and behavioral engagement such as concentration problems (e.g., Dmitrieva, Chen, Greenberger, Ogunseitan, & Ding, 2011; Gordon, Stollstorff, Devaney, Bean, & Vaidya, 2012). We sought to investigate whether *DAT1* and *DRD4* moderate the effect of perceived teacher–student relationship quality on adolescents' rule-breaking behavior and behavioral engagement. In other words, we examined whether adolescents with certain genotypic variants of *DAT1* and *DRD4* differ in their sensitivity to the effects of teacher–student relationships.

### 1.1. Rule-breaking behavior and behavioral school engagement: Importance of teacher–student relationships

During early adolescence (i.e., ages 10 to 14), there is a general increase in adjustment problems, including an increase in externalizing behaviors (e.g., Reitz, Dekovic, & Meijer, 2005) and a decrease in behavioral school engagement (e.g., Li & Lerner, 2011). Externalizing behaviors involve conflicts with other people or with society as a whole and are clearly noticeable in overt behaviors such as aggression and rule breaking (Achenbach & Rescorla, 2001). The present study focuses on rule-breaking behavior especially (i.e., not abiding by the rules at home, at school, or anywhere else by means of stealing, lying, hanging out with deviant peers, using drugs, skipping classes) (Achenbach & Rescorla, 2001). As studies including rule-breaking behaviors are rather scarce, relevant studies including other aspects of externalizing problems are discussed as well. Behavioral school engagement (e.g., Li & Lerner, 2011) involves participation in academics by means of effort, concentration, and doing homework (Birch & Ladd, 1997). Age-related changes in behavioral school engagement and externalizing behaviors are common (e.g., Reitz et al., 2005), but they may have detrimental consequences, both concurrently and in the long term. For some adolescents, externalizing behaviors continue into adulthood, expressed by antisocial behavior (Schaeffer, Petras, Jalongo, Poduska, & Kellam, 2003), addiction, and criminal activity (Reef, Diamantopoulou, van Meurs, Verhulst, & van der Ende, 2011). A lack of behavioral engagement is associated with increased academic failure (e.g., Johnson, McGue, & Iacono, 2006), higher dropout rates (e.g., Alexander, Entwisle, & Horsey, 1997), and more psychosocial problems (e.g., Li & Lerner, 2011).

A growing body of literature suggests that school is a central context for early adolescents' development (e.g., Roeser et al., 2000) and that teacher–student relationships make a unique contribution to early adolescents' academic and social–emotional development, including externalizing behavior (e.g., O'Connor et al., 2011; Roland & Galloway, 2002) and behavioral school engagement (e.g., O'Farrell, Morrison, & Furlong, 2006). For example, a meta-analysis by Roorda, Koomen, Spilt, and Oort (2011) (with medium to large effect sizes ranging from  $r = .25$  to  $.40$ ) revealed that positive aspects of affective teacher–student relationships, such as teacher–student support and caring, are related to higher participation in learning and more on-task behavior, whereas negative aspects of teacher–student relationships are related to lower school engagement. Drawing from this work, the present study included adolescent rule-breaking behavior and behavioral engagement as outcomes, and examined the contribution of both positive (i.e., teacher–student affiliation) and negative (i.e., teacher–student dissatisfaction) aspects of teacher–student relationships. Distinguishing between positive and negative relationship dimensions is considered important, as it allows examining differential effects on students' school adjustment (e.g., Birch & Ladd, 1997).

Recent research shows that students with behavioral markers of risk are affected more by the quality of the relationship with their teachers compared to other students (Sabol & Pianta, 2012). For example, research has indicated that child temperamental inhibition/disinhibition moderates the effect of early teacher–student relationships on student mental health in early adolescence (Essex, Armstrong, Burk, Goldsmith, & Boyce, 2011) and that shy students seem to benefit more from close teacher–student relationships (Arbeau, Coplan, & Weeks, 2010). Based on this research, it seems plausible that students with vulnerability markers at the genetic level (instead of the behavioral level), may also be more susceptible to the quality of teacher–student relationships. To our knowledge, only one study has investigated teachers in a GxE framework (Taylor, Roehrig, Hensler, Connor, & Schatschneider, 2010). However, this study focused on teaching quality as operationalized by reading skills of the whole class rather than on (the affective quality of) teacher–student relationships. Moreover, this study was conducted in a twin-based study design in which overall genetic and environmental influences are estimated based on comparisons of siblings with varying degrees of genetic relatedness. No published study has investigated the joint impact of teacher–student relationships and genes on adolescents' academic or social–emotional development, neither in a twin-based study, nor in a molecular genetics design, in which specific measured gene variants are identified.

### 1.2. Dopaminergic genes *DAT1* and *DRD4*, externalizing behavior and behavioral school engagement

In prior GxE interaction research, externalizing behavior and behavioral engagement have been investigated in relation to dopaminergic genes such as the dopamine transporter gene *DAT1* and the dopamine receptor gene *DRD4*. These genes code for chemical substances or proteins that regulate the functioning of the neurotransmitter dopamine in the brain. Both genes contain

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