Depression in Early Adolescence:

Contributions from Relational Aggression and Variation in the Oxytocin Receptor Gene

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Abstract

Interpersonal stress arising from relational aggression (RA)—the intentional effort to harm others via rejection and exclusion—may increase risk for depression in youth. Biological vulnerabilities related to the hormone oxytocin, which affects social behavior and stress responses, may exacerbate this risk. In a community sample of 307 youth (52% female; age range = 10-14 years), we tested whether (1) the association between RA and subsequent depressive symptoms was mediated through social problems, and (2) a single nucleotide polymorphism (rs53576) in the oxytocin receptor gene (*OXTR*) moderated this indirect association between RA and depression, where GG homozygotes are hypothesized to be more sensitive to the effects of social problems than A-allele carriers. Youth-reported RA and depressive symptoms were measured using a structured interview and a questionnaire, respectively. DNA was extracted from saliva collected with Oragene kits. Consistent with the interpersonal theory of depression, the association between relational aggression and subsequent depressive symptoms was mediated by social problems. This indirect effect was further moderated by rs53576 genotype, such that GG homozygotes showed a stronger mediation effect than A-carriers. These results suggest that rs53576 variants confer vulnerability for depression within the context of interpersonal risk factors, such that youth with the GG genotype may be particularly sensitive to the social consequences resulting from RA.

Keywords: Depression; Interpersonal Stress; Relational Aggression; Oxytocin Receptor Gene; *OXTR*; rs53576

Depression in Early Adolescence:

Contributions from Relational Aggression and the Oxytocin Receptor Gene

Relational aggression (RA)—the intentional effort to harm others via rejection and exclusion—may represent a behavioral catalyst for youth depression (Kawabata, Tseng, Murray-Close, & Crick, 2012). Specifically, perpetrators of RA may generate interpersonal problems that increase their own risk for depression. Biological vulnerabilities related to the neuropeptide oxytocin, which affects both social behaviors and physiological responses to stress (Heinrichs, Chen, & Domes, 2013; Kumsta & Heinrichs, 2013), may further influence sensitivity to interpersonal problems, thereby partially accounting for the prospective effects of RA on depressive symptoms. Here we examined whether a single nucleotide polymorphism (SNP; rs53576) in the oxytocin receptor gene (*OXTR*) moderates the association between RA and depression in a community sample of youth.

Interpersonal stress, relational aggression, and depression

Stressful interpersonal experiences represent potent risk factors for depression (Hammen, 2005; Vrshek-Schallhorn et al., 2015). Among children and adolescents, several behavioral catalysts of interpersonal stressors have been identified, including solicitations of negative feedback (Borelli & Prinstein, 2006), excessive reassurance-seeking (Prinstein et al., 2005; Shih et al., 2009), co-rumination (Hankin, Stone, & Wright, 2010), and ineffective stress coping (e.g., disengagement; Flynn & Rudolph, 2011). Surprisingly, few studies have examined the influence of externalizing behaviors (e.g., aggression, rule breaking) on the occurrence of interpersonal stressors (Gibb & Hanley, 2010; Kawabata et al., 2012), despite research suggesting that exposure to interpersonal problems and stressful life events is highest among youth with

comorbid depression and externalizing psychopathology (Jensen, Shervette, Xenakis, & Richters, 1993; Rudolph et al., 2000).

Given its interpersonal nature, RA is a type of externalizing behavior that may particularly contribute to youth depression (Card, Stucky, Sawalani, & Little, 2008; Tackett, Daoud, De Bolle, & Burt, 2013). Meta-analytic evidence shows a robust cross-sectional association between RA and internalizing psychopathology, including depression and anxiety (Card et al., 2008). Longitudinally, RA predicts increases in internalizing problems in general (Murray-Close, Ostrov, & Crick, 2007), and depressive symptoms more specifically (Kawabata et al., 2012). RA is likely to provoke conflict in social contexts (Kawabata et al., 2012; Rose & Swenson, 2009; Rudolph et al., 2000), which may mediate the relationship between RA and depression. Nevertheless, RA shows considerable heterogeneity in trajectories and psychosocial consequences (Côté, Vaillancourt, Barker, Nagin, & Tremblay, 2007; Vaillancourt, Miller, Fagbemi, Côté, & Tremblay, 2007), raising the likelihood that other factors underlie vulnerability to RA-linked depressive symptoms (i.e., moderated mediation). No prior research has examined potential biological mechanisms accounting for the prospective associations between RA and depression.

Variation in the oxytocin receptor gene, social salience, and depression

The oxytocin system may play an important role in the connection between social experiences and psychopathology (Lucas-Thompson & Holman, 2013; Olff et al., 2013), given its influence on social behaviors (Heinrichs et al., 2013) and responses to stressors (Kumsta & Heinrichs, 2013). In particular, oxytocin is believed to influence the perception of social cues (i.e., social salience; Bartz, Zaki, Bolger, & Ochsner, 2011) and attenuate subjective and

physiological reactivity to stressors (MacDonald & Feifel, 2013). A silent SNP, rs53576 (G/A), located in the third intron of the *OXTR* gene, on chromosome 3p25, has been linked to social behaviors that may enhance coping efforts (e.g., emotional support seeking; Kim et al., 2010) as well as biological responses to interpersonal stressors and social supports (e.g., cortisol reactivity; Chen et al., 2011), consistent with a role for oxytocin in social salience. Specifically, GG homozygotes show greater responsiveness to social cues and engage in more prosocial behaviors than AA and AG individuals (Kogan et al., 2011; Rodrigues, Saslow, Garcia, John, & Keltner, 2009; Tost et al., 2010). In contrast, a haplotype derived from the A allele (and another *OXTR* SNP) was over-represented in males with childhood-onset aggression compared to those without (Malik, Zai, Abu, Nowrouzi, & Beitchman, 2012). As such, GG homozygotes may be more sensitive to social cues, whereas A-allele carriers may be more prone to aggression; however, other studies have failed to replicate differences in youth aggression across oxytocinergic gene variants (Beitchman et al., 2012; Sakai et al., 2012). It is notable that these prior investigations have focused exclusively on physical aggression, to the exclusion of RA, which may be particularly relevant given its interpersonal nature.

Conceptualized as social salience, inter-individual differences in oxytocin functioning conferred by rs53576 may increase sensitivity to both positive and negative social cues, resulting in increased vulnerability to depression when exposed to interpersonal stressors (McQuaid, McInnis, Abizaid, & Anisman, 2014). For example, mothers with the GG genotype show more sensitive parenting than A-allele carriers (Bakermans-Kranenburg & van IJzendoorn, 2008); however, GG homozygotes who experience severe maltreatment in childhood also exhibit greater emotional dysregulation and disorganized attachment in adulthood than A-carriers

(Bradley et al., 2011). Moreover, depressive symptoms are more strongly associated with early-life maltreatment among G-carrier young adult than for AA homozygotes (McQuaid, McInnis, Stead, Matheson, & Hymie, 2013). Despite the balance of studies showing an association between the GG genotype and greater social salience, this pattern is not without exceptions, even in the opposite direction (e.g., Thompson, Hammen, Starr, & Najman, 2014). These mixed findings may be indicative of context-specific vulnerability conferred by different rs53576 variants, highlighting a need for research elucidating the inter-individual and antecedent factors that may influence the developmental pathways linking oxytocin function to social behaviors and adjustment (Bartz et al., 2011).

The Present Study

The current investigation constitutes the first research to examine the joint contributions from an *OXTR* SNP and RA to depression in a community sample of early adolescent youth. Based on prior research (Bradley et al., 2011; Kogan et al., 2011; McQuaid et al., 2013; Rodrigues et al., 2009; Sturge-Apple, Cicchetti, Davies, & Suor, 2012; Tost et al., 2010), we hypothesized that GG homozygotes would be more susceptible to depression in the context of social problems generated by their own relationally aggressive behavior. To this end, we tested whether (1) the association between RA and subsequent depressive symptoms one year later was mediated by social problems, and (2) risk for depressive symptoms conferred by RA-linked social problems was moderated by the rs53576 genotype.

Method

Participants

Participants were 307 youth (51.5% female; mean age = 11.63, $SD = 0.84$) from the Child Personality and Behavior Study (CPBS), a four-wave longitudinal investigation of personality development and behavioral outcomes. At the outset of the larger longitudinal investigation, 346 children aged 9-to-10 years ($M = 9.96$, $SD = 0.83$) and their parents were recruited using a community-based participant pool maintained by the Department of Psychology and flyers posted throughout the community. Additional participants were recruited at later waves to increase the overall sample size and to account for attrition, resulting in an overall sample of 446 youth. Parents reported the following ethnicity breakdown for their children: 65.7% Caucasian, 9.4% Asian-Canadian, 3.6% African-Canadian, 0.4% Hispanic, 0.2% Pacific Islander, 18.2% Other/Multiracial, and 2.5% not reporting ethnicity. Inclusion criteria were fluency in English for both the caregiver and child; exclusion criteria were the presence of neurodevelopmental disorders, psychotic disorders, or intellectual disability in the child. Informed consent was obtained from parents and assent was obtained from participating youth. Ethics approval was obtained from the Institutional Review Board. A detailed description of recruitment, informed consent procedures, and demographic information for the larger longitudinal sample can be found in Tackett, Kushner, Herzhoff, Smack, & Reardon (2014).

Measures

Social Relations Questionnaire (SRQ; Lahey et al., 2004). RA was measured using the youth-report version of the SRQ, a structured interview adapted from the Child and Adolescent Psychopathology Scale (Lahey et al., 2004). The SRQ consists of seven items that assess the frequency of relationally aggressive behaviors (e.g., excluded others; teased others; spread rumors about others) within the past 12-months. Interviewers rated items on a 4-point

scale (1 = *not at all*, 4 = *very much*). The SRQ generates a sum score for total RA. Internal consistency (Coefficient α) was .67 in the current sample.

Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993). Social problems were measured using an abbreviated version of the FQQ, a self-report questionnaire intended to assess friendship quality among middle childhood-aged youth. The abbreviated FQQ was developed for use in the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development, and consists of 21 items that assess the target child's relationship with his or her best friend. The FQQ includes five subscales measuring positive friendship quality (Companionship and Recreation, Conflict Resolution, Help and Guidance, Intimate Exchange, and Validation and Caring), and one subscale measuring negative friendship quality (Conflict and Betrayal). Items were rated on a 5-point scale (1 = *not at all true*, 5 = *really true*). The present investigation used the Conflict and Betrayal scale as one contributor to a composite measure of Social Problems (e.g., get mad at each other a lot, argue a lot; fight); the remaining FQQ scales were not included because they do not measure interpersonal difficulties. Coefficient α was .75 in the current sample.

Youth Self-Report (YSR; Achenbach, 1991). Social problems and depressive symptoms were measured using the Youth Self-Report (YSR; Achenbach, 1991), a self-report questionnaire intended to assess psychopathology among 11-to-18 year-old youth. Items were rated on a 3-point scale (0 = *not true*, 2 = *very true or often true*). The YSR consists of 112-items that assess the frequency of emotional and behavioral problems within the past six months. The YSR generates broadband dimensional scores for Internalizing Problems, Externalizing Problems, and Total Problems, as well as syndrome and DSM-oriented scale scores. The present

investigation used the Social Problems scale (e.g., feels lonely, gets teased, not liked by others; *T*-score $M = 54.49$, $SD = 6.11$) as a contributor to the composite measure of Social Problems (described below) and the DSM-oriented Affective Problems scale (e.g., enjoys very little, cries a lot, feels worthless or inferior; *T*-score $M = 53.25$, $SD = 4.93$). The Affective Problems scale shows high diagnostic accuracy for predicting depressive episodes in adolescents (Aebi, Metzke, & Steinhausen, 2009). Due to ethical constraints (some waves of data were collected by mail barring rapid follow-up), participating youth were not asked to respond to two items that assess for self-harm behaviors and suicidal ideation. Coefficient α was .72 for Social Problems and .71 for Affective Problems in the current sample.

Genotyping

DNA was extracted from saliva collected using Oragene DNA collection kits (OG-500; DNAGenotek Inc., Ontario, Canada). *OXTR* SNP rs53576 was genotyped using Sequenom iPLEX technology (MassARRAY system, Sequenom Inc., San Diego, CA) by the Mount Sinai Hospital Clinical Genomics Centre (<http://clinicalgenomics.ca/>). The genotype distribution for *OXTR* rs53576 ($n_{AA} = 37$, $n_{AG} = 141$, $n_{GG} = 129$) was in Hardy-Weinberg equilibrium ($\chi^2(1) = 0.03$, $p = .862$) and allele frequency was similar to previous reports (e.g., Chen et al., 2011; McQuaid et al., 2013; Thompson et al., 2014). Consistent with most prior investigations (e.g., Bakermans-Kranenburg & van IJzendoorn, 2008; Bradley et al., 2011; Sturge-Apple et al., 2012), rs53576 was coded as a dichotomous variable (AA/AG and GG) for the current analyses.

Procedure

Data were drawn from the final two yearly assessment waves of the CPBS, at which time self-reported data were collected on the YSR. The current investigation included 309 youth who

provided saliva samples for DNA extraction and analysis during the final CPBS assessment wave (T2), when youth were primarily 12-to-13 years old ($M_{\text{age}} = 12.65$ years, $SD = 0.86$). Two saliva samples failed to produce sufficient quality DNA and therefore were omitted from the current investigation, resulting in viable data for 307 youth. RA and social problems were assessed approximately one year earlier (T1), when youth were primarily 11-to-12 years old ($M_{\text{age}} = 11.63$ years, $SD = 0.84$). During both waves, participating families were mailed informed consent and questionnaire packages containing the YSR to be completed at the participant's home. At T1, the YSR was returned either returned by mail ($n = 14$) or during a laboratory visit ($n = 276$), at which time the SRQ and FQQ were administered as part of a larger assessment battery. At T2, youth were also mailed Oragene DNA collection kits and instructions for their use; saliva samples and completed YSRs were returned to the lab by mail. Families received various combinations of monetary compensation and gifts for youth at different waves, depending on the extent of participation, with increasing compensation at each subsequent wave.

Statistical analysis

Missing data for all continuous variables (6.5-11.1%) were imputed using an expectation-maximization (EM) algorithm. We created a composite measure of Social Problems by subjecting items from the FFQ Conflict and Betrayal scale and YSR Social Problems scale to a principal component analysis and saving the regression-based factor score (item loadings ranged from .23 to .62). We first estimated a mediation model to test the assumption that the prospective effects of baseline RA on depressive symptoms at follow-up were mediated through social problems. We next tested for second stage moderation following the procedure outlined by Hayes (2015). This allowed us to examine whether *OXTR* rs53576 genotype moderated the

path between social problems and depressive symptoms (i.e., path *b*; see Figure 1), thus testing for a potential gene-environment interaction. The mediation and moderated mediation models were estimated using Hayes' (2013) PROCESS modeling approach. Indirect effects were estimated using 5000 bootstrap resamples (Preacher et al., 2007). Confidence intervals (95%) were bound using the bias-corrected method. Confidence intervals that did not include "0" were considered to reflect effects that are significantly different from "0." Independent and moderator variables were mean-centered for products. Statistical power was adequate (0.80) to detect moderately small effects ($d = .26$; Fritz & MacKinnon, 2007). All analyses were conducted using SPSS 22.

Results

Descriptive statistics

Table 1 displays Pearson correlation coefficients and descriptive statistics among RA, social problems, and depressive symptoms. Consistent with prior research and theory, all variables were positively correlated (all $ps < .001$). Independent-samples *t*-tests were computed to compare all variables across gender and the *OXTR* rs53576 genotype (AA/AG vs. GG). No mean differences emerged across gender (all $ps > .05$). Furthermore, none varied as a function of *OXTR* rs53576 genotype (all $ps > .05$); thus, on average, there was no evidence for a gene-environment correlation between rs53576 and social problems.

Mediation and second stage moderation analyses

We hypothesized that the prospective effects of RA on depressive symptoms would be mediated through social problems. Unstandardized path coefficients of the direct and indirect effects tested at 95% bias corrected confidence intervals are displayed in Table 2 based on

PROCESS model 4. Youth with higher levels of RA reported higher concurrent social problems, and more depressive symptoms at the one year follow-up. In addition, social problems positively predicted depressive symptoms at the one year follow-up. The indirect path from RA to depression via social problems was also significant, indicating that the direct effect of RA on affective problems was attenuated when the indirect path through social problems was taken into account.¹

We hypothesized that *OXTR* rs53576 would moderate the impact of RA-linked social problems on depressive symptoms (i.e., path *b*). Unstandardized path coefficients of the second stage moderation model are displayed in Table 3 based on PROCESS model 14. These analyses revealed that the association between social problems and affective problems was indeed significantly moderated by the *OXTR* rs53576 genotype. Moreover, the indirect effects from RA to affective problems via social problems were significant for youth with the GG rs53576 variant, but not among youth who carried the A-allele.

Discussion

The present investigation is the first to examine whether the *OXTR* rs53576 genotype interacts with RA-linked interpersonal problems in predicting depressive symptoms among early adolescent youth. Two main findings emerged. First, the prospective association between RA and depressive symptoms one year later was mediated by social problems. Second, depressive

¹ Results for the mediation model and second stage moderation were replicated using residualized difference scores derived from the T1 vs. T2 Affective Problems scores. The results of these analyses are available upon request.

vulnerability to social problems was unique to GG homozygotes. The current results thus provide a novel examination of genetic marker of interpersonal sensitivity in the context of externalizing behavior.

With few exceptions (e.g., Gibb & Hanley, 2010; Kawabata et al., 2012), the potential impact of RA on subsequent depressive symptoms have seldom been incorporated in studies of stress-generation. The current results implicate RA as a behavioral catalyst for youth depression, at least partly via associated social problems. Specifically, youth may experience interpersonal stress (i.e., conflict) as a result of their relationally aggressive behavior, contributing to social conditions that increase risk for depression (Hammen, 2005; Vrshek-Schallhorn et al., 2015). These findings represent the first to directly test the hypothesis that interpersonal stress generation may account for the prospective association between RA and depression (Kawabata et al., 2012).

Based on substantial heterogeneity in trajectories and psychosocial consequences of childhood RA (e.g., Côté et al., 2007; Vaillancourt et al., 2007), we hypothesized that the prospective association between RA and depressive symptoms might be moderated by individual differences such as underlying biological vulnerabilities. To this end, we examined the *OXTR* rs53576 genotype, which has previously been implicated in both the perception of social cues (i.e., social salience; Bartz et al., 2011) and reactivity to stressors (MacDonald & Feifel, 2013). The current results implicate the *OXTR* rs53576 genotype as a biological marker of interpersonal stress sensitivity, and suggest that GG homozygotes may be more susceptible to depression as a result of social problems generated by their own relationally aggressive behavior. Accordingly,

the current results may indicate that the rs53576 GG variant confers vulnerability to depression in the context of self-generated interpersonal stress.

By enhancing the perception of social salience (Bartz et al., 2011), the rs53576 GG variant may represent a genetic marker of vulnerability to depression in the context of interpersonal stressors. These findings corroborate prior findings showing that the rs53576 GG variant confers vulnerability for negative outcomes (e.g., emotional dysregulation, disorganized attachment, and depression) in the context of negative social cues (e.g., maltreatment; Bradley et al., 2011; McQuaid et al., 2013). Nevertheless, the rs53576 GG variant may also increase sensitivity to positive social cues (i.e., social salience), and has been associated with more positive outcomes (e.g., sensitive parenting) than A-allele carriers (Bakermans-Kranenburg & van IJzendoorn, 2008). Consistent with the differential susceptibility hypothesis (Belsky & Pluess, 2009), the rs53576 GG genotype may better represent a plasticity factor rather than a strict vulnerability factor for depression. That is, GG homozygotes may be particularly susceptible to social influences, whether they are negative (e.g., interpersonal conflict) or positive (e.g., interpersonal support). Although differential susceptibility may represent a plausible explanation for the current results, tests of differential susceptibility require both the concurrent assessment of adversity and environmental support, as well as a range of outcomes, spanning from maladjustment to competence (Belsky & Pluess, 2009).

Limitations and Future Directions

The current investigation is subject to several limitations. Notably, our mediation model examined the prospective association between RA-linked social problems and depression; however, there are important limitations to our measurement of social problems. In particular,

our measures of RA and social problems were completed concurrently. Accordingly, we did not assess whether social problems were the direct result of youth's RA, or if youth exposed to more social problems were more likely to respond with RA. There may also be important bidirectional associations between RA, social problems, and depression. Consistent with the stress-generation theory of depression (Hammen, 1991, 2006), individuals with a history of depression generate stressful life events (i.e., interpersonal stressors, like conflict arising from RA), which may serve to aggravate or maintain their depressive symptoms. Future longitudinal studies may aim to directly assess the social and contextual antecedents and consequences of RA to disentangle these effects. It is also unclear whether sensitivity conferred by the GG variant may be equally triggered by self-generated and independent (i.e., occurring outside of one's control) stressors. Elucidating specific contexts in which the rs53576 genotype confers vulnerability for depression represents an exciting direction for future research. The rs53576 genotype may represent a distal vulnerability factor for depression via its influence on more proximal vulnerabilities (e.g., personality traits; Kushner, 2014). For example, low agreeableness—a trait describing tendencies toward compliance and empathy versus antagonism—may contribute to interpersonal conflict via its association with RA (Tackett et al., 2014). Despite observed associations between *OXTR* rs53576 and characteristics of agreeableness (Kogan et al., 2011), no prior research has jointly examined their contributions to depression vulnerability. Future studies would also do well to investigate the functional biological mechanisms underlying associations between *OXTR* rs53576, social behavior, stress reactivity, and adjustment, given that this SNP is a putatively silent marker.

Another limitation of the current study is that that we did not evaluate the impact of positive social cues and their impact on positive emotional functioning. Future studies may include the concurrent assessment of adversity and environmental support, as well as a range of positive and negative outcomes in order to fully test the differential susceptibility hypothesis (Belsky & Pluess, 2009). Exploring these effects represents an exciting direction for future research.

The current results are subject to the composition of the current sample and may therefore not generalize to other populations (e.g., clinical samples) or developmental periods (e.g., later adolescence, adulthood). Replication is therefore needed. Although the current sample size is small relative to some genetic studies, it is similar to the median sample size for published genetic research on candidate gene-by-environment interactions ($N = 345$; Duncan & Keller, 2011). Nevertheless, future research may require larger samples to elucidate the impact of the rs53576 genotype on associations among RA, social problems, and depressive symptoms. In particular, no existing research has tested gender specificity in the moderating effects of the rs53576 genotype (although see Thompson et al., 2014). This is particularly relevant, as adolescent females typically show higher sensitivity to interpersonal stressors and vulnerability for depression than males do (Rudolph et al., 2000).

Conclusion

Results from the present investigation support evidence that perpetrators of RA are at greater risk for subsequent depressive symptoms in an early adolescent community sample. Consistent with the stress-generation hypothesis for depression, this association was mediated through associated social problems. Moreover, the current results demonstrated support for a

significant gene-by-environment interaction, wherein the rs53576 genotype moderated the association between RA-linked social problems and subsequent depressive symptoms. In particular, the GG genotype was uniquely associated with depressive symptoms within the context of RA-linked social problems.

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Table 1

Correlation Coefficients

	1	2	3
1. Relational Aggression	1.00		
2. Social Problems	0.60***	1.00	
3. Depressive Symptoms	0.44***	0.40***	1.00

Note. Depressive symptoms were assessed approximately one year after Relational Aggression and Social Problems. Social Problems reflect the principal component score derived from the Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993) Conflict and Betrayal scale and the Youth Self-Report Questionnaire (YSQ; Achenbach, 1991) Social Problems Scale.

$N = 307$.

*** $p < .001$.

Table 2

Unstandardized Path Coefficients for Direct and Indirect Effects in the Mediation Model of the Associations Among Relational Aggression (RA), Social Problems, and Depressive Symptoms

	<i>B</i>	<i>SE_B</i>	95% CI
Direct Effects			
RA → Depression (<i>c</i>)	0.63***	0.07	[0.49, 0.78]
RA → Social Problems (<i>a</i>)	0.28***	0.02	[0.24, 0.32]
Social Problems → Depression (<i>b</i>)	0.65**	0.19	[0.26, 1.03]
RA → Depression (<i>c'</i>)	0.45***	0.09	[0.27, 0.63]
Indirect Effects (Mediation Test)			
RA → Depression via Social Problems (<i>ab</i>)	0.18	0.06	[0.08, 0.31]

Note. Values for *a* represents the relation of the independent variable to the mediator; values for *b* represent the relation from the mediator to the dependent variable; *c* represents the total effect of the independent variable on the dependent variable; *c'* represents the direct effect of the independent variable on the dependent variable after adjusting for the mediator, and; *ab* represents the indirect effect of the independent variable on the dependent variable through the proposed mediator. 95% CIs are based on bootstrapping.

** $p < .01$. *** $p < .001$.

Table 3

*Unstandardized Path Coefficients for Second Stage Moderation Effects of OXTR rs53576**Genotype*

	<i>B</i>	<i>SE_B</i>	95% CI
Direct Effects			
RA → Depression (<i>c</i>)	0.63***	0.07	[0.49, 0.78]
RA → Social Problems (<i>a</i>)	0.28***	0.02	[0.24, 0.32]
Social Problems → Depression (<i>b</i>)	0.71***	0.19	[0.33, 1.09]
OXTR → Depression	0.33	0.29	[-0.24, 0.91]
Social Problems × OXTR → Depression	0.82*	0.32	[0.19, 1.45]
RA → Depression (<i>c'</i>)	0.44***	0.09	[0.26, 0.62]
Indirect Effects (Mediation Tests)			
RA → Depression via Social Problems			
A-carriers	0.10	0.07	[-0.02, 0.24]
GG genotype	0.33	0.08	[0.18, 0.51]

Note. Second stage moderation of the associations among relational aggression, social problems, *OXTR* rs53576 genotype, and depressive symptoms. 95% CIs are based on bootstrapping.

*** $p < .001$. * $p < .05$.

Figure 1. Mediation model displaying the impact of relational aggression on depressive symptoms at one-year follow-up via associated social problems and second-stage moderation via the OXTR rs53576 genotype. Path a represents the relation of the independent variable to the mediator; path b represents the relation from the mediator to the dependent variable; path c' represents the direct effect of the independent variable on the dependent variable after adjusting for the mediator; path c represents the total effect of the independent variable on the dependent variable.