HHS Public Access

Author manuscript

J Mood Anxiety Disord. Author manuscript; available in PMC 2025 January 10.

Published in final edited form as:

J Mood Anxiety Disord. 2024 December ; 8: . doi:10.1016/j.xjmad.2024.100090.

Depressive symptoms and suicidal ideation in sexual minority adolescents: An examination of social reward responsiveness and support as moderators

Yinru Long[a,*], **Samantha Pegg**[a], **Christian A.L. Bean**[a], **Andrew Kittleson**[b], **Kirsty Clark**[a,c], **Autumn Kujawa**[a]

[a]Department of Psychology and Human Development, Vanderbilt University, USA

[b]Department of Psychiatry and Behavioral Sciences, Vanderbilt University Medical Center, USA

[c]Department of Medicine, Health and Society, Vanderbilt University, USA

Abstract

Sexual minority (SM) youth are at increased risk of depression and suicidal ideation (SI), due in part to discrimination and other stressors. This raises questions about social factors that may increase risk or resilience to stressors commonly faced by SM youth. The goal of this multimethod study was to examine both neural processing of social feedback and perceived social support as potential moderators of the association between SM identity, depressive symptoms, and endorsement of SI in adolescents. For this study, 165 adolescents aged 14–17 (22.42 % identifying as SM) were oversampled for current depression. Participants self-reported social support, depressive symptoms, and SI. Electroencephalogram (EEG) was recorded while participants completed a computerized peer interaction task in which the reward positivity (RewP) component was measured in response to social acceptance vs. rejection feedback. We tested social RewP and social support as moderators of associations between SM identity, depressive symptoms, and whether SI was reported. SM youth reported lower social support and elevated depressive symptoms and were more likely to endorse SI compared to non-SM youth. Social RewP moderated the associations between SM identity, depressive symptoms, and SI such that SM youth with blunted neural responses to social acceptance had higher depression and were more likely to endorse SI. Lower social support was associated with greater depressive symptoms and SI, but social support was not a significant moderator of the association between SM identity and symptoms. This is among the first studies to use affective neuroscience methods to examine social processes in SGM youth and our findings underscore the role of social factors in SGM youth mental health.

[*]Correspondence to: Department of Psychology and Human Development, Peabody College, 230 Appleton Place, Nashville, TN 37203–5721, USA. yinru.long@vanderbilt.edu (Y. Long).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Keywords

Sexual minority; Adolescents; LGBTQ+; Reward responsiveness; Electroencephalogram; Social support; Depressive symptoms; Suicidal ideation

1. Introduction

Depressive symptoms and suicidal ideation (SI) are highly prevalent among U.S. adolescents, with a 25 % lifetime prevalence for significant depression [1] and a 12.1 % lifetime prevalence for SI [2]. Adolescents who identify as lesbian, gay, bisexual, transgender, queer/questioning, and other sexual identities (LGBTQ+) are at disproportionally higher risk for depression and both SI and attempts compared to their cisgender, heterosexual peers [3–6]. According to the Youth Risk Behavior Survey in 2023, sexual minority (SM) adolescents were more likely than their heterosexual peers to attempt suicide, and 41% of adolescents who seriously considered suicide attempts identified as SM [7]. SM adolescents are often exposed to greater minority stressors such as victimization, discrimination, and internalized stigmatization, which are thought to be key contributing factors to mental health disparities [3,8–11]. This raises questions about the neural processes and subjective perceptions of social experiences that could impact the mental health outcomes in SM youth.

Social relationships play a crucial role in the lives of adolescents, as seeking peer acceptance and group affiliation constitutes a critical psychosocial stage during adolescence [12]. Social feedback from peers is essential to adolescents' peer relations and their self-identity development [13]. Thus, interpersonal stressors such as peer discrimination that disproportionally affect SM youth [14] may have particularly strong impacts on SM adolescents' social development, emotional well-being, and identity formation [8]. Ample research shows that SM youth experience higher peer victimization, including harassment, verbal abuse, and bullying, compared to their heterosexual peers, and victimization is, in turn, associated with an increased risk of depressive symptoms, SI, and suicidal behaviors [15–18]. These findings are consistent with the minority stress model, such that SM individuals are more likely to experience a range of social stressors rooted in discrimination. Meyer [19] suggested a distal-proximal distinction in conceptualizing the stressors of SM people, encompassing distal or external stressors, such as discrimination against SM populations, to proximal stressors, like internalized negative self-perceptions. The model suggests that these minority stressors can lead to mental health disparities among SM individuals and that systemic change is needed to reduce stigmatization at a societal level [19]. At the same time, there is also a need to consider individual risk and resilience factors that could interact with minority stress to shape mental health [11,20].

Developmentally, adolescents experience changes in social relationships, identity and changes in emotion-related brain function, such as heightened neural sensitivity to rewards [21,22], which is thought to contribute to depression and SI risk. Yet, the role of these brain circuits in SM youth mental health hasn't been extensively examined. Forbes et al. [23] proposed a social-affective neuroscience model to analyze risk and resilience factors

among SM youth to address this. For example, SM youth with more robust responses to social rewards may be more resilient in overcoming identity-based stress and developing healthy pathways. This suggests applying affective neuroscience methods to examine social processes and mental health outcomes in SM youth.

Event-related potentials (ERPs) derived from the electroencephalogram (EEG), such as the reward positivity component (RewP), are well suited to offer unique insights into the role of neural processing of social and emotional information in SM youth mental health. RewP is a positive deflection of ERP that peaks about 300 ms after a reward stimulus' presentation and is thought to reflect reinforcement learning signals in the brain [24]. Reduced RewP has been associated with depressive symptoms cross-sectionally (e.g., [25–28]) and shown to prospectively predict the development of depressive symptoms in adolescents (e.g., [29–31]). Importantly, evidence suggests that RewP interacts with stressful life events [32,33] or interpersonal trauma [34] to exacerbate depressive symptoms in adolescents, suggesting that low reward responsiveness may be a vulnerability factor for depression that increases risk in combination with other factors. Although altered reward responsiveness is also thought to play a critical role in SI, results have been mixed (for a review, [35]). For example, one study found that heightened monetary RewP was associated with active suicidality in depressed adolescents [36], while other studies showed reduced RewP to monetary reward in adults and children with recent SI [37,38] and others found no difference in RewP between children with or without recent SI [39].

Neural reward responsiveness is typically examined using monetary reward tasks. However, individual differences in responsiveness to social reinforcers may better capture risk processes in interpersonal stress, as inconsistent social cues might alter adolescents' expectations of social feedback [40]. In addition, prior work suggests that RewP can be reliably elicited in social feedback tasks, with some distinct neurophysiological properties compared to those observed in more traditional monetary reward tasks, such as later appearance in the ERP wave (from 275 to 375 ms, [41]). There is also emerging evidence that social reward responsiveness may be a critical factor in linking social experiences to the emergence of psychopathology [40,42], with relevance for understanding mental health disparities in SM youth. For example, one study found that peer victimization was associated with blunted social reward responsiveness, with stronger associations to blunted neural responses to peer acceptance than monetary rewards [43]. In addition, a recent study indicated that SM youth who experienced low levels of family support exhibited a blunted RewP to peer acceptance feedback [44]. Taken together, evidence that neural response to reward is associated with depression and SI risk in general samples, moderates effects of interpersonal stress on depression, appears to be blunted in youth with negative peer experiences and points to the need to consider the role of social reward responsiveness in SM youths' mental health.

It is important to note that social reward responsiveness is only one potential risk or resilience factor. It is essential to also consider other contextual factors, such as social support, that shape risk and resilience in SM youth. For instance, perceived social support is a well-established factor that impacts depressive symptoms, SI, and suicidal behaviors among SM youth [45,46]. Support from the community, friends, peers, and families is

critical to protecting SM youth against depressive symptoms and SI [47]. Research informed by the National Institute of Mental Health's Research Domain Criteria (RDoC) initiative emphasizes the importance of multiple methods to examine dimensions of emotions, cognitions, and social functions in psychopathology research [48]. As such, there is a need to consider multiple aspects of social functioning, including both neural measures of social reward responsiveness and self-report measures of perceptions of social support, that impact SM youths' mental health.

The social-affective neuroscience model of adolescent depression and resilience suggests the examination of the interaction between stressors and neural systems that characterize depression, such as reward system dysfunctions [23]. Our study directly addresses this need by examining both neural and contextual factors that interact with pathways to clinical symptoms or resilience in SM adolescents. Specifically, we examined the roles of neurophysiological reactivity to social reward feedback and self-reported perceived social support in the association between SM identity and depressive symptoms and the endorsement of SI in adolescents (age 14–17 years). We used a computerized peer interaction task previously validated in adolescents [49] to measure ERP responses to peer acceptance and rejection feedback. We first examined associations between SM identity, social reward responsiveness (i.e., RewP to social acceptance feedback), social support satisfaction, depressive symptoms, and the endorsement of SI. We hypothesized that SM identity would be associated with lower social reward responsiveness, social support satisfaction, greater depressive symptoms and a higher likelihood of endorsing SI. Then, we examined the interaction effects of SM identity and social reward responsiveness, measured by RewP, on depressive symptoms and SI. We hypothesized that blunted RewP to peer acceptance feedback would potentiate the association between SM identity and depressive symptoms and the association with SI endorsement. Finally, we examined the perceived social support as a moderator. We hypothesized that higher perceived social support would attenuate the association between SM identity and depressive symptoms, as well as SI endorsement.

2. Methods and materials

2.1. Participants

We recruited participants through advertisements distributed throughout an academic medical center, pediatric and mental health clinics, and the broader community. Participants were adolescents ($N = 165$) aged 14–17 years ($M = 15.23$, $SD = 1.07$); 61.8% were assigned female sex at birth. In terms of sexual orientation, 76.4% of participants identified as straight. We categorized all participants who did not identify as heterosexual into the sexual minority (SM) group ($n = 37$). Among the SM group, 3 adolescents identified as gay, 15 as bisexual, 7 as not sure, 7 preferred to self-describe (6 identified as pansexual and 1 as lesbian), and 5 preferred not to say. Concerning gender diversity, 1 participant identified as transgender, and 2 participants self-described their gender identities as gender fluid or using they/them pronouns. All three participants also identified as SM. In terms of race and ethnicity, 1.2% of the sample identified as American Indian or Alaska Native, 6.1% Asian, 15.8% Black or African American, 69.7% White, 1.2% Native Hawaiian or Pacific

Islander and 6.1% Other; 6.7% also identified as Hispanic or Latinx. Adolescents were oversampled for current depression using the Kiddie Schedule for Affective Disorder (K-SADS) interview [50]. At the time of the assessment, 36.9% of participants met the criteria for a current depressive disorder, including major depressive disorder (MDD), persistent depressive disorder (PDD), or unspecified depression.

2.2. Procedure

The Institutional Review Board at Vanderbilt Univdrsity approved the study, and informed consent was obtained from all parents and informed assent from minor participants before study procedures began. Following informed consent and assent, adolescents were interviewed by trained graduate students using the K-SADS semi-structured interview [50] to obtain diagnoses. Next, participants completed a battery of self-report questionnaires, including demographics, depressive symptoms, social support, and SI, using the online survey platform REDCap [51]. Finally, participants came to the lab for an EEG assessment and completed the computerized peer interaction task.

2.3. Measures

2.3.1. Social Reward Responsiveness—We used the Island Getaway Task to elicit neural reactivity to social feedback in youth. This task has been previously validated among adolescents [49] and used in studies of SM youth [44]. Before the task began, participants selected and sent a photo of themselves to the research assistant to be used in their virtual profile. During the task, participants were led to believe that they were interacting with other peers online in real-time (when, in fact, all responses were computerized). Participants were instructed to vote to remove or retain other players from the game. After they placed their vote, they received acceptance feedback, indicated by a green thumbs-up, or rejection feedback, indicated by a red thumb-down, from the presumed peers in the game. Each trial began with the presentation of a co-player profile, including their photo and personal information, until the participant made a vote. A fixation "+ " is presented for 1000 ms, followed by a feedback display for 2000 ms, and then a blank screen for 1500 ms, followed by the next co-player profile. The first 50 feedback trials in the task were split evenly between acceptance and rejection feedback. The last feedback trial was determined randomly. The task included a total of 6 rounds; players responded to an additional poll question (e.g., "If you could have dinner with anyone in the world, dead or alive, who would the person be?") at the start of each round to gradually learn more details about other players. Participants were debriefed about deception after the task.

2.4. EEG data collection and processing

We used a 32-channel actiCHamp system from BrainProducts (Munich, Germany) to continuously record EEG data. A subset of 15.5% of participants completed their EEG assessments early in the COVID-19 pandemic, and we used 16 key electrodes to collect in a 32-channel system to minimize the time in participant contact as suggested by [52]. Among the 165 total participants, 142 had usable EEG data. We excluded 8 due to withdrawal, 3 that did not have data due to errors in data collection, 11 for noisy data, and 1 because the participant wanted us to remove their data after debriefing. Electrodes measuring electro-

oculogram (EOG) were positioned approximately 1 cm above and below the right eye (VEO) and 1 cm to the side of each eye (HEO). To ensure appropriate referencing for EOG channels, a reference electrode was placed on the back of the neck, following the BrainProducts bipolar-to-auxiliary adapter design. We relied on cap electrodes rather than facial electrodes for participants with the reduced electrode set early in the pandemic to measure EOG [53].

Offline, the EEG data were re-referenced to the mastoid recordings (TP9/TP10) and filtered using a bandpass filter of 0.1 to 30 Hz. Trials were segmented from −200 ms to 1000 ms relative to the stimulus onset. We implemented ocular correction using VEO and HEO whenever available. In cases where VEO was unavailable, we utilized cap electrode FP1 with a common reference to capture vertical eye movements [53]. Similarly, when HEO was not usable, we used cap electrodes FT9 with reference FT10 to record horizontal eye movements. Semiautomatic artifact rejection was conducted based on specific criteria: a maximal allowed voltage step of 50 μV/ms, a maximal allowed difference of values in intervals of 175 μV (interval length: 400 ms), minimal allowed amplitude of −200 μV and a maximal allowed amplitude of 200 μV, and lowest allowed activity in intervals of 0.5 μV (interval length: 100 ms). We then used visual inspection to remove any remaining artifacts.

Data were averaged across trials separately for acceptance and rejection feedback. Baseline correction was applied, aligning the activity to 200 ms before the feedback onset. RewP was calculated as the mean amplitude within the time window of 275 to 375 ms after feedback onset at electrode site Cz, consistent with where the component was maximal in the overall sample (Fig. 2). This scoring method aligns with previous research on this task [33,43,54,55] and is consistent with the identified timing and distribution of RewP peak using temporospatial principal component analysis [56]. The split-half reliability for RewP to peer acceptance feedback (Spearman-Brown) was .90, and for RewP to peer rejection feedback (Spearman-Brown) was .88. We calculated the residuals of social RewP by saving the unstandardized residuals of RewP to peer acceptance accounting for RewP to peer rejection feedback [57].

2.4.1. Social support—Participants completed the Social Support Questionnaire (SSQ-6), a brief self-report measure of the number of people identified as social support[7] and perceived social support satisfaction [58]. Given that perceived social support may be more reliably associated with mental well-being compared with the number of social support providers [59], we focused on the satisfaction subscale, in which each item is rated on a scale from 1 (very dissatisfied) to 6 (very satisfied). The internal consistency of perceived social support satisfaction was high (Cronbach's alpha =.92). The average rating for social support satisfaction was 5.20 (*SD* =.83, range = 2.6–6).

[7]The independent sample t-test revealed a non-significant difference ((*t* (155) = 1.20, Cohen's *d* = *.22, p* = .23) between the number of people identified as social supports in the non-SM group (*M* = 11.67, *SD* = 7.58) and the SM group (*M* = 9.97, *SD* = 7.19). Although not the primary focus of the paper, we also explored analyses with the number of social supports endorsed. Similarly, the number of social supports did not significantly moderate associations between SM identity and depressive symptoms with robust SEs (*β* = *−.08*, z = −1.05, *p* = .29) or with standard SEs (*β* = *−.08*, z = −1.18, *p* = .24). The number of social supports also did not significantly moderate association between SM identity and the endorsement of SI (*OR* =.96, *Wald* =.01, *p* = .91, *CI* = [−.74,.65]).

2.4.2. Depressive symptoms—Participants completed the 33-item Mood and Feelings Questionnaire (MFQ), a self-report measure of depressive symptoms widely used among children and adolescents [60]. Items include "I felt miserable or unhappy" and "I felt I was no good anymore." Each item was rated on a scale from 0 (*not true*), 1 (*sometimes true*), to 2 (*true*). A mean score was computed by averaging all 33 items (M = 15.96, SD = 14.29, range = 0–62). The internal consistency in the current sample was Cronbach's alpha = .96, indicating high reliability. The Shapiro-Wilk test revealed that the assumption of normality in the residuals was violated (W =.94, p = <.001). Thus, we also used the maximum likelihood with robust standard errors (MLR) to address the non-normality [61].

2.4.3. Suicidal ideation—Participants completed the Beck Scale for Suicidal Ideation (SSI), a 19-item self-report measure of SI that has shown high reliability and concurrent validity with clinician ratings [62]. The SSI has also shown good reliability and validity in adolescent samples [63,64]. Each item includes three choices, such as "I have a moderate to strong wish to live," "I have a weak wish to live," or "I have no wish to live," which were rated from 0–2. Each participant first answered five screening questions, and if the answer to the fourth or fifth question was above 0 (indicating active and passive SI), they would answer the rest of the items. The internal consistency in the current sample was Cronbach's alpha = .89, supporting the measure's reliability [65]. Among 149 participants who completed the SI measure, 69% of participants (n = 106) did not endorse any SI, and 31 participants had scores greater than 1. Given that SI was relatively infrequently endorsed and violated assumptions of normality of residuals, we dichotomized the variable into any vs. no endorsement of SI and conducted logistic regression analysis [66].

2.5. Data analysis

SPSS software (Version 26; SPSS Inc., Chicago, IL) and R studio[67, 68] were used to analyze data. To isolate the variance in RewP associated with responses to acceptance while controlling for responses to rejection, we computed unstandardized residual scores [57]. Then, we examined bivariate associations between all study variables (Pearson's r for continuous variables and Phi coefficient for associations between binary variables). We also generated interaction terms by multiplying mean-centered social RewP and social support satisfaction with SM identity. We conducted multiple linear regression analyses to test the association of SM identity, social variables (RewP, social support), and their interactions with depressive symptoms. We tested two models with standard or robust standard errors (SE) to account for mild skewness in the distribution of residuals [61]. Due to the low endorsement or SI, we analyzed SI as a dichotomous outcome variable in logistic regression with the same predictors. We used full information maximum likelihood (FIML) in bivariate correlation, multiple regression, and logistic regression analyses to account for the missing data [69] with the *lavaan* package [68] and *mdmb* package [70] in R, allowing us to use all 165 participants in the multiple regression analyses[69]. An online computational tool developed for conducting multiple linear regression 2-way interactions [71] was used to generate plots for interaction and simple slopes. A table showing the odds ratio of the SM group and non-SM group endorsing SI at low, mean, and high levels of social RewP was included to illustrate interactions in the logistic regression analyses(see Table 4).

In terms of missing data, 8 participants were missing sexual orientation data and were not categorized into SM/non-SM group, 6 were missing self-report data on social support, 6 were missing data on depressive symptoms, and 14 were missing data on SI (these missing data were due to incomplete self-report questionnaires). As for social RewP, 23 participants were missing EEG data for the IG task (see Section 2.4 above for the reason of exclusion and/or missingness). Among those missing EEG data, 8 were in the SM group, 2 did not report sexual orientation, and 13 were in the non-SM group. To assess the pattern of missing data and identify predictors of missingness, we created a variable to indicate missingness in each variable of interest (missing = 1, not missing = 0) and conducted correlation analyses with all variables of interest. No significant predictors of missingness were observed (all *r*s < =.13, *p*s >=.17). The strongest correlation was between SM identity and missingness in social RewP ($\varphi = .15$, $p = .17$),

3. Results

3.1. Descriptive analyses

Bivariate correlation analyses were conducted to explore the relations between all variables of interest (see Table 1). Depressive symptoms and SI were positively correlated with SM identity and negatively correlated with social support satisfaction. SM identity was also correlated with lower social support satisfaction. Social reward responsiveness was not significantly correlated with any variables of interest. We found a trending yet non-significant association such that most of the SM youth identified as female as their sex assigned at birth ($\varphi = .15$, $p = .06$).

3.2. Moderating effects of RewP to peer acceptance feedback on the associations of SM identity with depressive symptoms and SI endorsement

We tested social reward responsiveness as a moderator of the association between SM identity and depressive symptoms (Table 2). Social RewP significantly moderated the association between SM identity and depressive symptoms using standard SEs ($\beta = -.21$, $z = -2.30$, $p = .02$, $CI = [-.16, -1.07]$, $R^2 = .28$). With robust SEs, the interaction between SM identity and social RewP on depressive symptoms trended towards but did not reach significance ($\beta = -.21$, $z = -1.90$, CI = [−2.18,.03], $p = .057$, $R^2 = .28$).

To interpret the interaction effect on depression in line with the proposed conceptual model, we examined the association between SM identity and depressive symptoms at mean, high (+1 *SD*), and low (−1 *SD*) levels of social RewP. Results of the Johnson-Neyman regions of significance test indicated that the association between SM identity and depressive symptoms was significant when social RewP is below 6.62 (see Fig. 2). Thus, the association between SM identity and depressive symptoms was significant for adolescents at all levels of RewP (*p*s < .01), but the association was the strongest among adolescents with social RewP scores at one standard deviation below the mean (i.e., a blunted RewP; $\beta = 1.70$, $t = 6.77$, $p < .001$). This association between SM identify and depressive symptoms was weaker among adolescents with mean levels of RewP ($\beta = 1.25$, $t = 6.54$, $p < .001$) and adolescents with social RewP scores at one standard deviation above the mean (i.e., an enhanced RewP; $\beta = .79$, $t = 2.66$, $p = .01$).

Similarly, the logistic regression analyses revealed a significant interaction effect of SM identity and social RewP on the endorsement of SI (*OR* =.80, *Wald* = 5.02, $p = .03$, *CI* = [−.43, −.03]; see Table 3). This suggested that the SM group's odds of endorsing SI would decrease as the social RewP increases. To further illustrate the interaction, we reported the log odds of endorsing SI in the SM and non-SM groups at low, mean, and high levels of social RewP and the odds ratio at each level (Table 4). At a low level of social RewP (1 SD below the mean), the odds of endorsing SI were 11.36 times higher in the SM group than in the non-SM group ($p < .001$); at the mean level of social RewP, the odds of endorsing SI were 1.72 times higher in the SM group than in the non-SM group ($p < .001$); and at the high level of social RewP (1 SD above the mean), the odds of endorsing SI were 1.12 times higher in the SM group than in the non-SM group ($p = .89$; See Table 4).

3.3. Moderating effects of social support satisfaction

We then tested social support satisfaction as a moderator of the association between SM identity and depressive symptoms and endorsement of SI. We found significant main effects of both SM identity ($\beta = .41$, $z = 6.36$, $p < .001$) and social support satisfaction ($\beta = -.38$, $z = -6.00$, $p < .001$) on depressive symptoms, but social support satisfaction did not significantly moderate the association between the SM identity and depressive symptoms ($\beta = .002$, $p = .99$, $R^2 = .38$).

The logistic regression analysis results similarly revealed a significant main effect of both the SM identity (*OR* = 3.21, *Wald* = 7.32, $p = .01$, *CI* = [.32, 2.01]) and social support satisfaction (*OR* =.49, *Wald* = 8.79, $p = .003$, *CI* = [−1.20, −.24]) on endorsement of SI. However, social support satisfaction did not significantly moderate the association between SM identity and SI (*OR* =.88, *Wald* =.05, $p = .82$, *CI* = [−1.17,.92]; see Table 6).

3.4. Sensitivity analyses

Given that 46.7% of participants' EEG data had to be processed using the alternative method of ocular correction, we examined whether RewP magnitude differed as a function of ocular correction electrodes. We did not find any significant main effect of electrode selection on the social RewP magnitude ($\beta = .08$, $p = .34$). Results from a mixed-design ANOVA with the valence of feedback (accept vs. rejection) as the within-subjects factor and ocular correction electrodes (VEO/HEO or alternative electrodes) as the between subjects. The results revealed that the electrode selection × valence interaction was non-significant ($F(1140) = .83$, $p = .36$, $\eta_p^2 = .01$), suggesting that the effect of feedback valence is consistent with or without the EOG replacement. Furthermore, we covaried the binary variable to determine whether an alternative method for ocular correction other than EOG was used in all primary models. The SM identity × RewP interaction effects on depressive symptoms (with standard SEs) and SI remained significant (ps < .05), and this interaction effect on depressive symptoms remained non-significant in the regression model with robust SEs ($p = .51$). The interaction between SM identity and social support satisfaction on depressive symptoms or SI remained non-significant (ps > .90).

Next, we conducted analyses covarying for sex and age to determine whether the same results persist. This is important given an established sex difference in depression risk, with

female adolescents reporting higher incidence and levels of depressive symptoms than male adolescents [72,73]. Furthermore, as adolescents' identity exploration grows with age, there are also trends for associations between age and clinical symptoms in adolescents [74]. In combination with a higher percentage of SM adolescents in our sample identifying as female as the sex assigned at birth, we conducted sensitivity analyses with covariates of age and sex. The analyses revealed that the interaction effect between SM identity and social RewP on depressive symptoms remained significant with standard SEs ($\beta = -.20$, $z = -2.19$, $p = .03$, $CI = [-1.94, -.11]$) and was trending significance with the robust SEs ($\beta = -20$, $z = -1.81$, $p = .07$, $CI = [-2.14,.09]$). The interaction between SM identity and social RewP on the endorsement of SI also remained significant after covarying age and sex ($OR = .78$, $Wald = 5.63$, $p = .02$, $CI = [-.46, -.04]$). The interaction between SM identity and social support satisfaction on either depressive symptoms or SI remained non-significant ($ps > .80$).

Finally, 5 participants reported "prefer not to say" when reporting sexual orientation. Since we did not know their actual sexual identity, we then ran our models excluding these participants. We found that the interaction between SM identity and social RewP remained significant in depressive symptoms ($\beta = -.21$, $z = -2.16$, $p = .03$, $CI = [-2.08, -.10]$) and the endorsement of SI ($OR = .80$, $Wald = 4.60$, $p = .03$, $CI = [-.43, -.02]$). The interaction between SM identity and social support satisfaction remained non-significant in depressive symptoms ($\beta = -.01$, $z = -.08$, $p = .94$, $CI = [-4.91, 4.53]$) and the endorsement of SI ($OR = .92$, $Wald = .02$, $p = .88$, $CI = [-1.15,.98]$).

4. Discussion

Informed by the social-affective neuroscience model of depression [23], we explored the role of social reward processing and perceived social support in moderating the increased risk of depression and SI in SM youth, which is likely driven by part by identity-based minority stress [19]. Consistent with prior literature on mental health disparities, we found that the SM identity was associated with greater depressive symptoms and higher odds of endorsing SI [3–6]. As we hypothesized, neural responsiveness to social rewards moderated the associations of SM identity with depressive symptoms and SI endorsement. Specifically, the association between SM identity and depressive symptoms or SI endorsement was the strongest among adolescents who also exhibited a blunted RewP to social acceptance feedback and relatively weaker among adolescents who exhibited an enhanced RewP to social acceptance feedback. Contrary to our hypotheses, although social support satisfaction was related to SM identity, depression, and endorsement of SI, it did not significantly moderate the associations between SM identity and symptoms. Our findings on the main effects were generally consistent with prior literature showing that social support satisfaction is an essential protective factor for adolescents' mental health outcomes[75] but is lower in SM adolescents [44].

Emerging evidence suggests that social processes may be key to understanding the risk of psychopathology among SM youth, who often encounter heightened interpersonal stress. Our study expands upon existing literature, revealing that, in addition to the overall increased risk of psychopathology among SM adolescents, those with blunted social reward responsiveness face an elevated risk of depression and SI. This suggests that a low level of

neural responsiveness to social reward could reflect a vulnerability that increases the risk for depression and SI in combination with interpersonal stressors. On the other hand, a more robust neural response to social reward may reflect a protective factor that buffers against mental health disparities in SM youth. The findings could facilitate the adoption of more personalized approaches, such as neurophysiological markers, to differentiate depression and suicide risk among SM adolescents, providing valuable insights into neurophysiological social factors that can influence individual variations in psychopathology risk. Furthermore, the findings shed light on more targeted intervention development for SM youth, as researchers have begun to explore ways to enhance social RewP as a preventive target and protect against stress effects on depression [42,76].

Despite prior studies underscoring the importance of social support for adolescent mental health [45,47], we did not find significant differential associations between SM identity and mental health depending on level of social support satisfaction. This suggests that although social support is clearly important to mental health for youth in general, it did not appear to impact the strength of association between SM identity, depressive symptoms, and SI in this sample. The absence of association might stem from the study's limited sample size, reliance on self-report measures at single time points, and a generally low incidence of SI within the non-clinical adolescent sample. Future research should investigate the varying sources of social support in a larger sample, including clinical populations, to deepen understanding of these dynamics.

The study's strengths include integrating multiple methods to characterize social processes that could promote risk and resilience for SM youth. At the same time, it is important to acknowledge several study limitations. First, our sample of SM adolescents is relatively small ($N = 37$), and most SM adolescents reported their sex assigned at birth as female ($N = 28$). Given female adolescents are identified as an at-risk group, we included sex as a covariate in our sensitivity analyses to account for the association between sex and depressive symptoms and the odds ratio of endorsing SI. Second, our study was cross-sectional, thus limiting our capacity to examine the extent to which blunted level of social reward responsiveness would interact with SM identity to influence the development of depressive symptoms or SI over time. Future studies could integrate a longitudinal design with ambulatory assessments such as daily surveys to examine associations between real-world social interactions and laboratory-measured neurophysiological or behavioral responses to social feedback.

Furthermore, given our focus on depression and SI, as well as the robust prior literature on reward responsiveness as a marker of depression vulnerability [30,31,42], we did not examine individual differences in response to social rejection, which could also be relevant to SM adolescents' daily experience. Future research could explore social rejection and acceptance's role in SM adolescents' social processes and mental health outcomes. In addition, data on perceived acceptance from SM adolescents' social support networks after coming out would also provide valuable information on the impacts of major stressors.

Lastly, it is essential to note that we did not test the moderation of minority stress directly due to a lack of a dimensional measure of minority stress. Sexual minorities are

often exposed to interpersonal stress originating from stigma, which could serve as a key mechanism linking SM identity and adverse mental health outcomes [11,19]. Prior findings of minority stress serving as a mediator between minoritized sexual identities and mental health outcomes provided support for this direction as well [11,77]. Further research is needed to more directly examine how distal or proximal stressors or protective factors might interact with SM adolescents' social, reward, or threat-processing systems at the neural level to better understand minority stress effects. This exploration could also be critical to understanding resilience to minority stress and psychopathology risk, given the heightened malleability of brain development during adolescence.

Our findings advance the understanding of neurophysiological and contextual factors that potentiate and attenuate the association between SM identity and clinical symptoms. We examined the neural responses to social acceptance feedback from peers and self-reported social support satisfaction as moderators of associations between SM identity, depression, and SI in adolescents. These findings provide preliminary insights into novel intervention targets, such as positive valence systems for this marginalized community of adolescents. Previous studies have found effects of positive emotion-focused interventions on mitigating clinical symptoms [76] and motivation manipulation on increasing reward positivity [78]. Thus, the results indicate that targeted interventions tailored to SM youth to enhance social reward responsiveness could be effective in reducing risk for depression and SI. Finally, individual differences in contextual factors such as social support and neurophysiological factors like neural responses to social feedback are potentially downstream effects of structural stigma, encompassing homonegative social norms, attitudes, laws, and policies [79]. Thus, we call for systems-level efforts to decrease structural stigma against SM adolescents, such as enacting protective laws and policies [80], to ultimately reduce the risk for psychopathologies disproportionately affecting SM youth.

Funding

This work was supported by a Klingenstein Third Generation Foundation Fellowship and Brain and Behavior Research Foundation Katherine Deschner Family Young Investigator Grant awarded to A.K. It was also supported in part by UL1 TR000445 from the National Institute of Health (NIH). S.P. was supported by the National Institute of Mental Health (NIMH) grant F31-MH127817 and T32-MH18921 during the completion of this work. CALB was supported by the NIMH grant T32MH-18921. KAC was supported by the NIMH grant K01MH125073.

References

[1]. Kessler RC, Avenevoli S, Ries Merikangas K. Mood disorders in children and adolescents: An epidemiologic perspective. Biol Psychiatry 2001;49(12):1002–14. 10.1016/s0006-3223(01)01129-5. [PubMed: 11430842]

[2]. Nock MK, Green JG, Hwang I, McLaughlin KA, Sampson NA, Zaslavsky AM, Kessler RC. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: Results from the national comorbidity survey replication adolescent supplement. JAMA Psychiatry 2013;70(3):300–10. 10.1001/2013.jamapsychiatry.55. [PubMed: 23303463]

[3]. Battalen AW, Mereish E, Putney J, Sellers CM, Gushwa M, O'Brien KHM. Associations of discrimination, suicide ideation severity and attempts, and depressive symptoms among sexual and gender minority youth. Crisis 2020. 〈https://econtent.hogrefe.com/doi/10.1027/0227-5910/a000718〉 .

[4]. Guz S, Kattari SK, Atteberry-Ash B, Klemmer CL, Call J, Kattari L. Depression and suicide risk at the cross-section of sexual orientation and gender identity for youth. J Adolesc Health 2021;68(2):317–23. 10.1016/j.jadohealth.2020.06.008. [PubMed: 32680801]

[5]. Haas AP, Eliason M, Mays VM, Mathy RM, Cochran SD, D'Augelli AR, Silverman MM, Fisher PW, Hughes T, Rosario M, Russell ST, Malley E, Reed J, Litts DA, Haller E, Sell RL, Remafedi G, Bradford J, Beautrais AL, Clayton PJ. Suicide and suicide risk in lesbian, gay, bisexual, and transgender populations: review and recommendations. J Homosex 2011;58(1):10–51. 10.1080/00918369.2011.534038. [PubMed: 21213174]

[6]. Rivas-Koehl M, Valido A, Espelage DL, Robinson LE, Hong JS, Kuehl T, Mintz S, Wyman PA. Understanding protective factors for suicidality and depression among u.s. sexual and gender minority adolescents: Implications for school psychologists. Sch Psychol Rev 2022;51(3):290–303. 10.1080/2372966X.2021.1881411.

[7]. Centers for Disease Control and Prevention. Youth Risk Behavior Survey Data Summary & Trends Report: 2013–2023. U.S. Department of Health and Human Services; 2024. 〈www.cdc.gov/yrbs〉 .

[8]. Dürrbaum T, Sattler FA. Minority stress and mental health in lesbian, gay male, and bisexual youths: A meta-analysis. J LGBT Youth 2020;17(3):298–314. 10.1080/19361653.2019.1586615.

[9]. Lucassen MF, Stasiak K, Samra R, Frampton CM, Merry SN. Sexual minority youth and depressive symptoms or depressive disorder: A systematic review and meta-analysis of population-based studies. Aust NZ J Psychiatry 2017;51(8):774–87. 10.1177/0004867417713664.

[10]. Miranda-Mendizábal A, Castellví P, Paŕes-Badell O, Almenara J, Alonso I, Blasco M, Alonso J. Sexual orientation and suicidal behavior in adolescents and young adults: systematic review and meta-analysis. Br J Psychiatry 2017;211(2):77–87. 10.1192/bjp.bp.116.196345. [PubMed: 28254960]

[11]. Hatzenbuehler ML. How does sexual minority stigma "get under the skin"? A psychological mediation framework. Psychol Bull 2009;135(5):707–30. 10.1037/a0016441. [PubMed: 19702379]

[12]. Tanti C, Stukas AA, Halloran MJ, Foddy M. Social identity change: Shifts in social identity during adolescence. J Adolesc 2011;34(3):555–67. 10.1016/j.adolescence.2010.05.012. [PubMed: 20547418]

[13]. Brown BB, & Larson J (2009). Peer relationships in adolescence. In Handbook of Adolescent Psychology. American Cancer Society. 10.1002/9780470479193.adlpsy002004.

[14]. Scheer JR, Edwards KM, Sheinfil AZ, Dalton MR, Firkey MK, Watson RJ. interpersonal victimization, substance use, and mental health among sexual and gender minority youth: The role of self-concept factors. NP18104–NP18129 J Interpers Violence 2022;37(19–20). 10.1177/08862605211035868.

[15]. McKay T, Lindquist CH, Misra S. Understanding (and acting on) 20 years of research on violence and LGBTQ+ communities. Trauma, Violence, Abus 2019;20 (5):665–78. 10.1177/1524838017728708.

[16]. Goodenow C, Watson RJ, Adjei J, Homma Y, Saewyc E. Sexual orientation trends and disparities in school bullying and violence-related experiences, 1999–2013. Psychol Sex Orientat Gend Divers 2016;3:386–96. 10.1037/sgd0000188. [PubMed: 29322064]

[17]. Johns MM, Lowry R, Rasberry CN, Dunville R, Robin L, Pampati S, Stone DM, Mercer Kollar LM. Violence victimization, substance use, and suicide risk among sexual minority high school students—United States, 2015–2017. Morb Mortal Wkly Rep 2018;67(43):1211–5. 10.15585/mmwr.mm6743a4.

[18]. Norris AL, Orchowski LM. Peer victimization of sexual minority and transgender youth: A cross-sectional study of high school students. Psychol Violence 2020;10: 201–11. 10.1037/vio0000260. [PubMed: 35979532]

[19]. Meyer IH. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: Conceptual issues and research evidence. Psychol Bull 2003;129(5): 674–97. 10.1037/0033-2909.129.5.674. [PubMed: 12956539]

[20]. Baams L, Grossman AH, Russell ST. Minority stress and mechanisms of risk for depression and suicidal ideation among lesbian, gay, and bisexual youth. Dev Psychol 2015;51(5):688–96. 10.1037/a0038994. [PubMed: 25751098]

[21]. Braams BR, van Duijvenvoorde ACK, Peper JS, Crone EA. Longitudinal changes in adolescent risk-taking: A comprehensive study of neural responses to rewards, pubertal development, and risk-taking behavior. J Neurosci: J Soc Neurosci 2015; 35(18):7226–38. 10.1523/JNEUROSCI.4764-14.2015.

[22]. Galván A The teenage brain: Sensitivity to rewards. Curr Dir Psychol Sci 2013;22 (2):88–93. 10.1177/0963721413480859.

[23]. Forbes EE, Eckstrand KL, Rofey DL, Silk JS. A social affective neuroscience model of risk and resilience in adolescent depression: preliminary evidence and application to sexual and gender minority adolescents. Biol Psychiatry: Cogn Neurosci Neuroimaging 2021;6(2):188–99. 10.1016/j.bpsc.2020.07.020. [PubMed: 33097468]

[24]. Proudfit GH. The reward positivity: From basic research on reward to a biomarker for depression. Psychophysiology 2015;52(4):449–59. 10.1111/psyp.12370. [PubMed: 25327938]

[25]. Foti D, Hajcak G. Depression and reduced sensitivity to non-rewards versus rewards: Evidence from event-related potentials. Biol Psychol 2009;81(1):1–8. 10.1016/j.biopsycho.2008.12.004. [PubMed: 19162124]

[26]. Wen-hua Liu, Ling-zhi Wang, He-rui Shang, Yue Shen, Zhi Li, Cheung Eric FC, Chan Raymond CK. The influence of anhedonia on feedback negativity in major depressive disorder. Neuropsychologia 2014;53(2014)):213–20. 10.1016/j.neuropsychologia.2013.11.023. [PubMed: 24316199]

[27]. Mulligan EM, Flynn H, Hajcak G. Neural response to reward and psychosocial risk factors independently predict antenatal depressive symptoms. Biol Psychol 2019; 147:107622. 10.1016/j.biopsycho.2018.11.008. [PubMed: 30468896]

[28]. Nelson BD, Jarcho JM. Neural response to monetary and social feedback demonstrates differential associations with depression and social anxiety. Soc Cogn Affect Neurosci 2021;16(10):1048–56. 10.1093/scan/nsab055. [PubMed: 33942882]

[29]. Bress JN, Foti D, Kotov R, Klein DN, Hajcak G. Blunted neural response to rewards prospectively predicts depression in adolescent girls. Psychophysiology 2013;50 (1):74–81. 10.1111/j.1469-8986.2012.01485.x. [PubMed: 23252717]

[30]. Kujawa A, Burkhouse KL, Karich SR, Fitzgerald KD, Monk CS, Phan KL. Reduced reward responsiveness predicts change in depressive symptoms in anxious children and adolescents following treatment. J Child Adolesc Psychopharmacol 2019;29 (5):378–85. 10.1089/cap.2018.0172. [PubMed: 31062997]

[31]. Nelson BD, Perlman G, Klein DN, Kotov R, Hajcak G. Blunted neural response to rewards as a prospective predictor of the development of depression in adolescent girls. Am J Psychiatry 2016;173(12):1223–30. 10.1176/appi.ajp.2016.15121524. [PubMed: 27363510]

[32]. Goldstein BL, Kessel EM, Kujawa A, Finsaas MC, Davila J, Hajcak G, Klein DN. Stressful life events moderate the effect of neural reward responsiveness in childhood on depressive symptoms in adolescence. Psychol Med 2020;50(9): 1548–55. 10.1017/S0033291719001557. [PubMed: 31274066]

[33]. Pegg S, Ethridge P, Shields GS, Slavich GM, Weinberg A, Kujawa A. Blunted social reward responsiveness moderates the effect of lifetime social stress exposure on depressive symptoms. Front Behav Neurosci 2019;13. 〈https://www.frontiersin.org/articles/10.3389/fnbeh.2019.00178〉 .

[34]. Long Y, Dickey L, Pegg S, Argiros A, Venanzi L, Dao A, Kujawa A. Interpersonal trauma effects on adolescent depression: the moderating role of neurophysiological responses to positive interpersonal images. Res Child Adolesc Psychopathol 2024; 52(2):195–206. 10.1007/s10802-023-01118-0. [PubMed: 37707698]

[35]. Bettis AH, Benningfield MM, Dao A, Dickey L, Pegg S, Venanzi L, Kujawa A. Self-injurious thoughts and behaviors and alterations in positive valence systems: A systematic review of the literature. J Psychiatr Res 2022;156:579–93. 10.1016/j.jpsychires.2022.10.033. [PubMed: 36370537]

[36]. Pegg S, Dickey L, Green H, Kujawa A. Differentiating clinically depressed adolescents with and without active suicidality: An examination of neurophysiological and self-report measures of reward responsiveness. Depress Anxiety 2020;37(9):876–84. 10.1002/da.23012. [PubMed: 32248653]

[37]. Klumpp H, Bauer BW, Glazer J, Macdonald-Gagnon G, Feurer C, Duffecy J, Medrano GR, Craske MG, Phan KL, Shankman SA. Neural responsiveness to reward and suicidal ideation in social anxiety and major depression before and after psychotherapy. Biol Psychol 2023;178:108520. 10.1016/j.biopsycho.2023.108520. [PubMed: 36801433]

[38]. Tsypes A, Owens M, Gibb BE. Blunted neural reward responsiveness in children with recent suicidal ideation. Clin Psychol Sci 2019;7(5):958–68. 10.1177/2167702619856341. [PubMed: 32042508]

[39]. Gallyer AJ, Burani K, Mulligan EM, Santopetro N, Dougherty SP, Jeon ME, Nelson BD, Joiner TE, Hajcak G. Examining blunted initial response to reward and recent suicidal ideation in children and adolescents using event-related potentials: failure to conceptually replicate across two independent samples. Clin Psychol Sci 2023. 10.1177/21677026221120426.

[40]. Palacios-Barrios EE, Patel K, Hanson JL. Early life interpersonal stress and depression: Social reward processing as a potential mediator. Prog Neuro-Psychopharmacol Biol Psychiatry 2024;129:110887. 10.1016/j.pnpbp.2023.11088.

[41]. Ethridge P, Kujawa A, Dirks MA, Arfer KB, Kessel EM, Klein DN, Weinberg A. Neural responses to social and monetary reward in early adolescence and emerging adulthood. Psychophysiology 2017;54(12):1786–99. 10.1111/psyp.12957. [PubMed: 28700084]

[42]. Kujawa A Reduced reward responsiveness and depression vulnerability: Consideration of social contexts and implications for intervention. e14528 Psychophysiology 2024;61(6). 10.1111/psyp.14528.

[43]. Rappaport BI, Hennefield L, Kujawa A, Arfer KB, Kelly D, Kappenman ES, Luby JL, Barch DM. Peer victimization and dysfunctional reward processing: ERP and behavioral responses to social and monetary rewards. Front Behav Neurosci 2019; 13. 10.3389/fnbeh.2019.00120.

[44]. Clark KA, Pachankis JE, Dougherty LR, Katz BA, Hill KE, Klein DN, Kujawa A. Adolescents' sexual orientation and behavioral and neural reactivity to peer acceptance and rejection: The moderating role of family support. Clin Psychol Sci 2023;216770262311585. 10.1177/21677026231158574.

[45]. Parra L, Bell T, Benibgui M, Helm J, Hastings P. The buffering effect of peer support on the links between family rejection and psychosocial adjustment in LGB emerging adults. Journal of Social and Personal Relationships. In press; 2017. 10.1177/0265407517699713.

[46]. Ryan C, Russell ST, Huebner D, Diaz R, Sanchez J. Family acceptance in adolescence and the health of LGBT young adults: Family acceptance in adolescence and the health of LGBT young adults. J Child Adolesc Psychiatr Nurs 2010;23(4):205–13. 10.1111/j.1744-6171.2010.00246.x. [PubMed: 21073595]

[47]. McDonald K Social support and mental health in LGBTQ adolescents: A review of the literature. Issues Ment Health Nurs 2018;39(1):16–29. 10.1080/01612840.2017.1398283. [PubMed: 29333899]

[48]. Insel T, Cuthbert B, Garvey M, Heinssen R, Pine DS, Quinn K, Sanislow C, Wang P. Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. Am J Psychiatry 2010;167(7):748–51. 10.1176/appi.ajp.2010.09091379. [PubMed: 20595427]

[49]. Kujawa A, Arfer KB, Klein DN, Proudfit GH. Electrocortical reactivity to social feedback in youth: A pilot study of the Island Getaway task. Dev Cogn Neurosci 2014;10:140–7. 10.1016/j.dcn.2014.08.008. [PubMed: 25212683]

[50]. Kaufman J, Schweder AE. The schedule for affective disorders and schizophrenia for school-age children: Present and lifetime version (K-SADS-PL). Comprehensive handbook of psychological assessment, Vol. 2: Personality assessment John Wiley & Sons, Inc; 2004. p. 247–55. 〈10.1016/j.comppsych.2019.152148〉 .

[51]. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, McLeod L, Delacqua G, Delacqua F, Kirby J, Duda SN. The REDCap consortium: Building an international community

of software platform partners. J Biomed Inform 2019;95: 103208. 10.1016/j.jbi.2019.103208. [PubMed: 31078660]

[52]. Simmons AM, Luck SJ. Protocol for reducing COVID-19 transmission risk in EEG research. Res Sq 2020:rs.3.pex-974 10.21203/rs.3.pex-974/v2.

[53]. Pegg S, Dao A, Venanzi L, Hill K, Kujawa A. The impact of electrode selection for ocular correction on the reward positivity and late positive potential components in adolescents. Psychophysiology 2023:e14497. 10.1111/psyp.14497. [PubMed: 38044748]

[54]. Babinski DE, Kujawa A, Kessel EM, Arfer KB, Klein DN. Sensitivity to peer feedback in young adolescents with symptoms of ADHD: examination of neurophysiological and self-report measures. J Abnorm Child Psychol 2019;47:605–17. 10.1007/s10802-018-0470-2. [PubMed: 30155685]

[55]. Hill KE, Pegg S, Dao A, Boldwyn E, Dickey L, Venanzi L, Argiros A, Kujawa A. Characterizing positive and negative valence systems function in adolescent depression: An RDoC-informed approach integrating multiple neural measures. J Mood Anxiety Disord 2023;3:100025. 10.1016/j.xjmad.2023.100025. [PubMed: 37982056]

[56]. Pegg S, Lytle MN, Arfer KB, Kujawa A. The time course of reactivity to social acceptance and rejection feedback: An examination of event-related potentials and behavioral measures in a peer interaction task. Psychophysiology 2022;59(7): e14007. 10.1111/psyp.14007. [PubMed: 35193158]

[57]. Meyer A, Lerner MD, De Los Reyes A, Laird RD, Hajcak G. Considering ERP difference scores as individual difference measures: Issues with subtraction and alternative approaches. Psychophysiology 2017;54(1):114–22. 10.1111/psyp.12664. [PubMed: 28000251]

[58]. Sarason IG, Sarason BR, Shearin EN, Pierce GR. A brief measure of social support: practical and theoretical implications. J Soc Pers Relatsh 1987;4(4):497–510. 10.1177/0265407587044007.

[59]. Wills TA, Shinar O. Measuring perceived and received social support. In Social support measurement and intervention: A guide for health and social scientists. Oxford University Press; 2000. p. 86–135. 〈10.1093/med:psych/9780195126709.003.0004〉.

[60]. Costello EJ, Angold A. Scales to assess child and adolescent depression: Checklists, screens, and nets. J Am Acad Child Adolesc Psychiatry 1988;27(6):726–37. 10.1097/00004583-198811000-00011. [PubMed: 3058677]

[61]. Savalei V, Rosseel Y. Computational options for standard errors and test statistics with incomplete normal and nonnormal data in SEM. Struct Equ Model: A Multidiscip J 2022;29(2):163–81. 10.1080/10705511.2021.1877548.

[62]. Beck AT, Steer RA, Ranieri WF. Scale for suicide ideation: Psychometric properties of a self-report version. J Clin Psychol 1988;44(4):499–505. 10.1002/1097-4679(198807)44:4. [PubMed: 3170753]

[63]. Holi MM, Pelkonen M, Karlsson L, et al. Psychometric properties and clinical utility of the Scale for Suicidal Ideation (SSI) in adolescents. BMC Psychiatry 2005;5:8. 10.1186/1471-244X-5-8. [PubMed: 15691388]

[64]. Steer RA, Rissmiller DJ, Ranieri WF, Beck AT. Dimensions of suicidal ideation in psychiatric inpatients. Behav Res Ther 1993;31(2):229–36. 10.1016/0005-7967(93)90090-H. [PubMed: 8442750]

[65]. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ 2011;2: 53. 10.5116/ijme.4dfb.8dfd. [PubMed: 28029643]

[66]. Harris JK. Primer on binary logistic regression. Fam Med Community Health 2021; 9(Suppl 1). 10.1136/fmch-2021-001290.

[67]. R Core Team. (2020). R: A language and environment for statistical computing. In R Foundation for Statistical Computing. 〈https://www.frontiersin.org/articles/10.3389/fnbeh.2019.00120〉.

[68]. Rosseel Y lavaan: An R package for structural equation modeling. J Stat Softw 2012;48(2):1–36. 〈10.1093/med:psych/9780195126709.003.0004〉.

[69]. Enders CK, Bandalos DL. The relative performance of full information maximum likelihood estimation for missing data in structural equation models. Struct Equ Model 2001;8:430–57. 10.1207/S15328007SEM0803_5.

[70]. Robitzsch A, Luedtke O (2024). mdmb: Model-Based Treatment of Missing Data. 10.32614/CRAN.package.mdmb, R package version 1.9–22.

[71]. Preacher KJ, Curran PJ, Bauer DJ. Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. J Educ Behav Stat 2006;31:437–48. 10.3102/10769986031004437.

[72]. Kessler RC, McGonagle KA, Swartz M, Blazer DG, Nelson CB. Sex and depression in the National Comorbidity Survey I: Lifetime prevalence, chronicity and recurrence. J Affect Disord 1993;29(2–3):85–96. 10.1016/0165-0327(93)90026-G. [PubMed: 8300981]

[73]. Conley CS, Rudolph KD. The emerging sex difference in adolescent depression: interacting contributions of puberty and peer stress. Dev Psychopathol Spring 2009;21(2):593–620. 10.1017/S0954579409000327.

[74]. Yorbik O, Birmaher B, Axelson D, Williamson DE, Ryan ND. Clinical characteristics of depressive symptoms in children and adolescents with major depressive disorder. J. Clin. Psychiatry 2004;65(12):1654–9. 10.4088/jcp.v65n1210. [PubMed: 15641870]

[75]. Standley CJ, Foster-Fishman P. Intersectionality, social support, and youth suicidality: A socioecological approach to prevention. Suicide Life Threat Behav Apr 2021;51(2):203–11. 10.1111/sltb.12695. [PubMed: 33876493]

[76]. Burkhouse KL, Dao A, Argiros A, Granros M, Cárdenas E, Dickey L, Feurer C, Hill K, Pegg S, Venanzi L, Kujawa A. Targeting positive valence systems function in children of mothers with depressive symptoms: A pilot randomized trial of an RDoC-Informed preventive intervention. Behav Res Ther 2023;168:104384. 10.1016/j.brat.2023.104384. [PubMed: 37591042]

[77]. Mongelli F, Perrone D, Balducci J, Sacchetti A, Ferrari S, Mattei G, Galeazzi GM. Minority stress and mental health among LGBT populations: An update on the evidence. Minerva Psichiatr 2019;60(1):27–50. 10.23736/S0391-1772.18.01995-7.

[78]. Pegg S, Kujawa A. The effects of a brief motivation manipulation on reward responsiveness: A multi-method study with implications for depression. Int. J. Psychophysiol 2020;150:100–7. 10.1016/j.ijpsycho.2020.02.004. [PubMed: 32044339]

[79]. Hatzenbuehler ML. Structural stigma: Research evidence and implications for psychological science (Nov) Am Psychol 2016;71(8):742–51. 10.1037/amp0000068. [PubMed: 27977256]

[80]. Hatzenbuehler ML. Advancing research on structural stigma and sexual orientation disparities in mental health among youth. J Clin Child Adolesc Psychol 2017;46(3): 463–75. 10.1080/15374416.2016.1247360. [PubMed: 27911583]

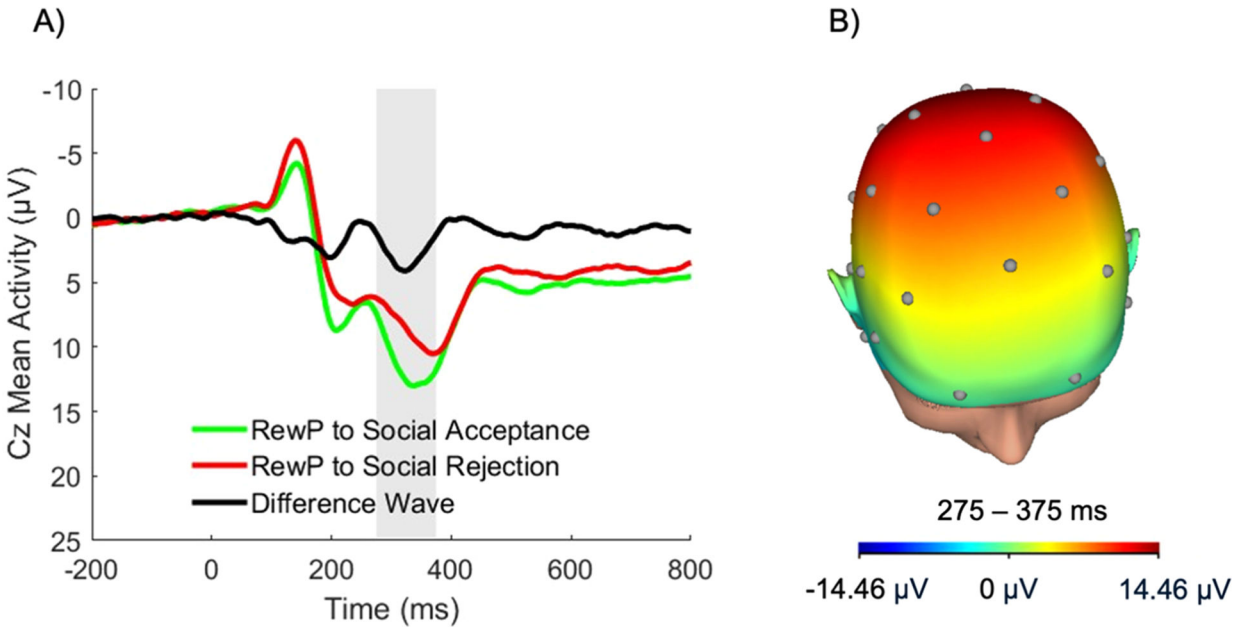

Fig. 1.

A) Grand average ERP waveforms (negative up) of responses to social acceptance and rejection feedback at Cz (mastoid reference). B) Scalp distribution of the difference between RewP to social acceptance and RewP to social rejection 275 – 375 ms after feedback onset.

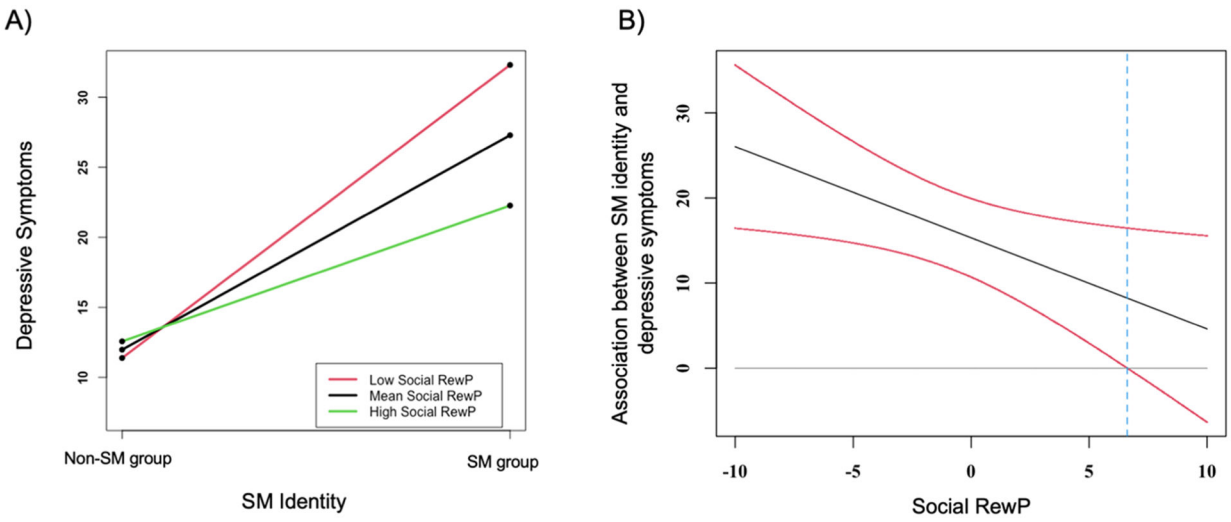

Fig. 2.

A) Simple slopes of the association between SM identity and depressive symptoms at low, mean, and high social RewP. B) Slope with (confidence bands and Johnson-Neyman region of significance) of the association between SM identity and depressive symptoms as a function of social RewP.

Table 1

Bivariate associations between variables of interest (*N*=165).

	Variable	Mean (SD) / Percentage%	1	2	3	4	5	6
1	SM identity	22% SM	—					
2	Age	15.23 (1.07)	.06	—				
3	Sex	62% female	.15	−.04	—			
4	Social RewP	.00 (5.24)	−.15	−.11	−.15	—		
5	Social support satisfaction	5.20 (.83)	−.23 **	−.09	.04	.11	—	
6	Depressive symptoms	15.96 (14.29)	.49 ***	.12	.10	−.15	−.48 ***	—
7	Endorsement of SI	29.4% endorsed SI	30 ***	−.04	.06	−.08	−.32 ***	.58 ***

** p < .01,

*** p < .001

Note. SM identity was coded as 1 = SM group, 0 = non-SM group; sex was coded as 0 = male, 1 = female, endorsement of SI was coded as 0 = no SI, 1 = SI above 0. SM identity= sexual minority identity Social RewP = reward positivity to peer acceptance feedback (residual adjusting for responses to social rejection, SI = suicidal ideation. Correlations between two binary variables are φ coefficients; correlations with continuous variables are Pearson's *r*. Full information maximum likelihood (FIML) was used to account for missing data in all analyses.

Table 2

Multiple regression analyses testing the main and interactive effects of SM identity and RewP to peer acceptance feedback on depressive symptoms (with standard SEs and robust SEs).

Depressive Symptoms							
Variable	***β***	***b* (standard SE)**	***CI* (standard SE)**	**z**	***b* (robust SE)**	***CI* (robust SE)**	**z**
SM identity	.46 ***	15.32 (2.34) ***	[10.73,19.91]	6.79	15.32(2.76) ***	[9.91, 20.73]	5.557
Social RewP (residuals)	.04	.11 (.25)	[−.38,.61]	.45	.11 (.22)	[−.33,.55]	.51
SM X Social RewP Res.	**−.21** *	**−1.07 (.47)** *	**[−.16, −1.07]**	**−2.27**	−1.07 (.56)	[−2.18,.03]	−1.89
Total Model R^2 = .28							

* p < .05,

*** p < .001

Note. SM = sexual minority, Social RewP = reward positivity to peer acceptance feedback, SM X Social RewP Res. = interaction between SGM identity and RewP residuals to peer acceptance feedback, CI = confidence interval. FIML was used to account for all missing data in the analyses.

Table 3

Logistic regression analyses testing the effects of interaction between SM identity and Social RewP to peer acceptance feedback on endorsement of SI.

Endorsement of SI				
Variable	**OR**	***b* (*SE*)**	**Wald**	***CI***
SM identity	3.73 ***	1.32 (.45)	8.62	[.44, 2.19]
Social RewP (residuals)	1.06	.05(.05)	1.21	[−.04,.15]
SM X Social RewP Res.	**.80** *	**−.23(.10)**	**5.02**	**[−.43, −.03]**
Pseudo R^2 = 0.41				

* p < .05,

*** p < .001

Note. SM = sexual minority, Social RewP = reward positivity to peer acceptance feedback, SM X Social RewP Res. = interaction between SGM identity and RewP residuals to peer acceptance feedback, OR = odds ratio, CI = confidence interval. FIML was used to account for all missing data in the analyses.

Table 4

The odds ratio of the SM group and non-SM group on the endorsement of SI at the low, mean, and high levels of social RewP.

Social RewP	Non-SM group (Log-Odds)	SM group (Log-Odds)	OR
Low (1 SD below the mean)	.21	2.55	12.36 ***
Mean Social RewP	.27	1.02	3.72 **
High (1 SD above the mean)	.36	.41	1.12

** p < .01,

*** p < .001

Note. Social RewP = reward positivity to peer acceptance feedback, SM = sexual minority, OR = odds ratio. FIML was used to account for all missing data in the analyses.

Table 5

Multiple regression analyses testing the main and interactive effects of SM identity and social support satisfaction to peer acceptance feedback on depressive symptoms (with standard SEs and robust SEs).

Depressive Symptoms							
Variable	***β***	***b* (standard SE)**	***CI* (standard SE)**	***z***	***b* (robust SE)**	***CI* (robust SE)**	***z***
SM identity	.41	13.71(2.21) ***	[9.38, 18.04]	6.21	13.71(2.48) ***	[8.85, 18.57]	5.53
Social support satisfaction	−.38	−6.62(1.35) ***	[−9.27, −3.97]	−4.90	−6.62(1.38) ***	[−9.32, −3.92]	−4.18
SM X Social support	.002	.04(2.36)	[−4.57, 4.66]	.019	.044(3.64)	[−7.10, 7.19]	.01
Pseudo R^2 = .41							

* p < .05,

** p < .01,

*** p < .001

Note. Social RewP = reward positivity to peer acceptance feedback, SM = sexual minority, SM X Social Support = interaction between SM identity and social support satisfaction. FIML was used to account for all missing data in the analyses.

Table 6

Logistic regression analyses testing the effects of interaction between SM identity and social support satisfaction on endorsement of SI.

Endorsement of SI				
Variable	**OR**	***b* (*SE*)**	**Wald**	***CI***
SM identity	5.92	1.78(2.68)	.44	[−3.48, 7.03].
Social support satisfaction	.51*	−.68(.30)	5.24	[−1.26, −.10]
SM X Social support	.88	−.12(.53)	.05	[−1.17,.92]
Pseudo R^2 = 0.44				

* p < .05,

** p < .01,

*** p < .001

Note. Social RewP = reward positivity to peer acceptance feedback, SM = sexual minority, SM X Social Support = interaction between SM identity and social support satisfaction. FIML was used to account for all missing data in the analyses.