MIND, BRAIN, AND EDUCATION

Lessons Learned from a Predominantly Latinx Autistic Population: Preliminary Effects of the PEERS Intervention on Neural and Perceived Educational Performance

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ABSTRACT— Thirteen autistic teens, who were predominantly Latinx, completed the Program for the Education and Enrichment of Relational Skills (PEERS), a 16-week social skills intervention. Time-frequency decomposition was calculated using advanced electroencephalographic techniques to measure oscillatory brain activity during reward anticipation and processing before and after PEERS. Fourteen neurotypical teens participated but did not receive intervention. The perception of educational performance was also measured. The perception of educational performance did not differ between groups and did not change after participation in PEERS. Approach motivation increased after intervention in the autistic group. This suggests an enhancement of social motivation after learning social skills in a group composed of a majority of Latinx autistic teens.

Identity-first language will be used throughout the text to reflect the preferred terminology of autistic self-advocates for whom autism is integral to their personal identities and lived experiences –(Botha, Hanlon, & Williams, 2021).

Health disparities are more pronounced in Latinx communities in the US, and Latinx individuals often experience poor health outcomes regardless of socioeconomic status (Doshi et al., 2020; Institute of Medicine, 2003). Latinx autistic youth are less likely to receive services than their White counterparts and often have less access to specialty clinics for treatment and intervention (Broder-Fingert, Shui, Pulcini, Kurowski, & Perrin, 2013; Magaña, Lopez, Aguinaga, & Morton, 2013). Moreover, autistic Latinx children receive fewer social skills services in school and are less likely to have an individualized education plan (IEP) compared to White students (for review, see Angell, Empey, & Zuckerman, 2018).

The intersection of race and diagnostic status may impact the cultural validity and effectiveness of evidence-based interventions (EBIs) for autism spectrum disorder (ASD). EBIs are considered effective based on the outcomes of rigorous experimental research studies. Hispanic autistic children with milder symptoms are less likely to receive EBIs compared to their White counterparts (Sridhar et al., 2022). Thus, Latinx and Hispanic autistic children may not be accessing empirically-supported interventions. Consequently, less is known about EBI effectiveness in racially

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diverse minoritized populations (Steinbrenner et al., 2022), where cultural heterogeneity and distinctive presentations of ASD are present.

Academic self-concept is a multi-dimensional set of attributes that individuals apply to themselves regarding their educational capabilities (Marsh & Martin, 2011). A stronger self-concept relates to perceived strengths in educational settings, which in turn, facilitates academic achievement (Valentine, DuBois, & Cooper, 2004). A relation between math performance and self-concept has been observed in autistic youth (McCauley et al., 2018); however, the broader domain of academic self-concept has not been widely examined in autistic adolescents. Furthermore, the perspectives of neurodivergent participants should be obtained in addition to parent perspectives of their youth's abilities to fully capture the rich and varied experiences of autistic individuals in research.

In addition to incorporating autistic perceptions of intervention, the use of neuroscientific techniques may enable researchers to better appreciate and understand Latinx autistic populations (Rule, Freeman, & Ambady, 2013). Studies have shown distinct neural patterns in response to social scenarios in individuals based on cultural differences. For example, non-autistic Latinx teens display increased neural reward activity when contributing money to their families compared to White teens, for whom reward activity increases when keeping the money for themselves (Telzer, Masten, Berkman, Lieberman, & Fuligni, 2010). This suggests a potential role for culture in reward-related brain activity, underscoring the importance of including historically minoritized populations in neuroscientific research, as findings from largely White samples may not generalize to other populations.

The current study is a preliminary investigation into measuring neural oscillations of anticipation of and response to social and nonsocial rewards in a majority Latinx autistic sample before and after completing the Program for the Education and Enrichment of Relational Skills (PEERS) program, an EBI focused on developing and maintaining friendships. In addition, we sought to understand the perspectives of autistic teens beyond changes in social behaviors by measuring their self-concept in relation to school/educational performance. Prior research has shown that through peer social support, social skills positively affect the academic self-concept of students with special needs (Pratiwi & Mangunsong, 2020). This may suggest that as autistic teens improve their social skills within the educational environment and build a network of supportive peers, their academic self-concept may also increase.

Previous publications reporting data from this sample have reported perceived and observed improvements in social behaviors in autistic teens after the completion of PEERS (Laugeson, 2013) (Baker, Veytsman, Choy, Blacher, & Stavropoulos, 2021; Veytsman et al., 2022). Specifically, teens displayed improved social responsiveness and social skills, which was corroborated by observed improvements in their conversational skills. This study is one of the first of its kind to measure the effects of an intervention on educational constructs and neural correlates of social behavior in a group of predominantly Latinx autistic teens. It is important to note that a version of PEERS designed for and with Latinx youth and their families has *not* been developed for use in the present study; however, this investigation measures effects of the standardized PEERS program in Latinx youth. We asked the following research questions:

1. Does perception of educational performance change after completion of the PEERS intervention in a diverse group of autistic teens?
2. Do event-related spectral perturbations (ERSPs) of reward anticipation (e.g., alpha-band) and reward response (e.g., theta-band) of social and nonsocial stimuli change after PEERS intervention in the autistic group? How do ERSPs of reward processing compare between typically developing (TD) and autistic teens?
3. Do social and nonsocial ERSPs of reward anticipation and reward response correlate with perceptions of educational performance in the autistic group?

METHODS

Participants

Participants included 13 autistic adolescents (M (SD) = 14.17 (2.09) years, 10 male), and 14 sex-, age-, IQ-, and race-matched TD adolescents (M (SD) = 13.22 (1.63) years, 12 male). Most participants in both groups were Latinx (autistic group: 9 Latinx, 3 White, 1 mixed race; TD group: 8 Latinx, 4 White, 1 Asian, 1 mixed race). For detailed participant demographic information, refer to Table 1. Exclusionary criteria for the autistic and TD groups included: an IQ below 70, a history of seizures/epilepsy, a history of brain injury/disease, and a diagnosis of intellectual disability. Additional exclusionary criteria for the TD group included a psychiatric diagnosis of any kind and an immediate family history of ASD. Autistic participants had their diagnoses confirmed with the Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2) (Lord et al., 2012).

A total of 17 autistic participants were initially enrolled in the study. Four autistic adolescents and their parents dropped out of the study for reasons including difficulty with transportation, psychiatric hospitalization, and no longer wanting to attend sessions. Thus, 13 autistic participants

Table 1
Descriptive Characteristics of the Autistic (ASD) and Neurotypical (TD) Groups, as Reported in Baker et al., 2021

Characteristics	*ASD,* n = *13*	*TD,* n = *14*
Sex	10 male	12 male
Age (*M* (*SD*), range)	14.17 (2.09)	13.22 (1.63)
IQ, *M* (*SD*), range	99.54 (15.62)	106.14 (15.49)
Race (*n*)		
White	3	4
Latinx	9	8
Mixed race/other	1	2
Maternal education level (*n*)		
Less than college	10	5
College and above	3	9
Household income (*n*)		
Up to $50,000	4	4
$50,001–$100,000	5	4
Over $100,001	4	5
Missing data	--	1

were included in the final sample. The 14 TD participants were not enrolled in the PEERS intervention and instead were seen at two timepoints 16 weeks apart. This study was approved by the Institutional Review Board at the University of California, Riverside. Caregivers provided informed consent, and adolescents provided assent.

Intervention

PEERS is a 16-week manualized friendship skills intervention consisting of weekly 90 min concurrent but separate sessions for adolescents and parents (Laugeson, 2013). Adolescent group sessions focused on teaching social skills specific to making and keeping friends and handling peer conflict and rejection. Skills were taught using didactic instruction, role-play demonstrations, behavioral rehearsal activities with reinforcement and corrective feedback, and weekly homework assignments. Weekly individual check-outs were provided for each family to individualize treatment and troubleshoot issues related to teen progress and other program components. Parent group sessions were provided in a bilingual format to accommodate Spanish-speaking families. All written parent materials were provided in Spanish and English.

Prior to study recruitment and implementation, focus groups were conducted to gain information about families' attitudes regarding the feasibility of the planned methods for this intervention study. We gained valuable information about transportation, session length, program duration, scheduling, and childcare concerns. As a result of the focus groups, the study team provided parking passes to encourage attendance and scheduled intervention sessions later in the day to accommodate school and work schedules.

Piers-Harris Self-Concept Scale, Second Edition (Piers, Harris, & Herzberg, 2002)

The Piers-Harris Self-Concept Scale, 2nd edition, is a 60-item self-report measure for children ages 7 to 18 that assesses self-esteem and self-concept. Autistic and TD teens completed the measure at Time 1 (pre-intervention for the autistic group) and Time 2 (post-intervention for the autistic group). Subscale scores are calculated as t-scores to measure unique dimensions. In this study, we examined the Intellectual and School Status subscale, consisting of 11 items, that examines an individual's self-perception of educational success. Higher scores indicate a more positive self-concept.

EEG Recording

Electroencephalogram (EEG) was completed at Time 1 and Time 2. Details of the EEG task and recording procedures can be found in previous publications (Baker et al., 2021). Briefly, participants played a guessing game via button press to indicate whether the left or right stimulus was "correct." There were two feedback conditions: social versus nonsocial. In the social condition, faces were smiling for "correct" answers and frowning for "incorrect" answers. The nonsocial condition was composed of arrows that pointed upward for "correct" answers and downward for "incorrect" answers.

Time-frequency decomposition was performed to compute ERSPs. In order to measure reward anticipation, alpha band activity was examined between 8 and 12 hz with a baseline of −3,200 to −3,000 ms, and the data were epoched from −3,200 to 100 ms. To measure reward response, theta band activity was examined between 4 and 6 hz with a baseline of −100 to 0 ms, and the data were epoched from −100 to 800 ms.

Statistical Analyses

A 2 (group; ASD/TD) × 2 (time; 1/2) repeated-measures ANOVA was conducted to measure differences on the Piers-Harris Intellectual and School Status subscale. To test the effects of anticipatory alpha asymmetry, a 2 (group; ASD/TD) × 2 (time; 1/2) × 2 (condition; social/nonsocial) × 3 (electrode region; central/temporal/parietal) repeated-measures ANOVA was conducted. To test the effects of post-feedback theta, a 2 (group; ASD/TD) × 2 (time; 1/2) × 2 (condition; social/nonsocial) × 2 (feedback; correct/incorrect) repeated-measures ANOVA was conducted. Pearson correlations were conducted to examine the relation between Piers-Harris scores and the change in neural oscillations from Time 1 to Time 2 (i.e., the difference in mean alpha asymmetry and theta across time).

RESULTS

Behavior

Piers-Harris Intellectual and School Status subscale scores were stable across time in both groups, $F(1,22) = 1.00$, $p = .33$. In addition, TD and autistic teens did not differ in Intellectual and School Status scores, $F(1,22) = 1.84$, $p = .19$.

ERSP

Pre-Stimulus Alpha Asymmetry

A four-way interaction approached significance between time, condition, region, and group, $F(2,21) = 4.46$, $p = .054$. Post-hoc tests revealed an effect of time in the social condition for the autistic group within the parietal region, such that there was more left hemisphere alpha suppression at Time 2 compared to Time 1, $F(1,22) = 6.80$, $p = .02$. This suggests an increase in approach motivation for autistic teens when viewing faces after versus before intervention (Figure 1).

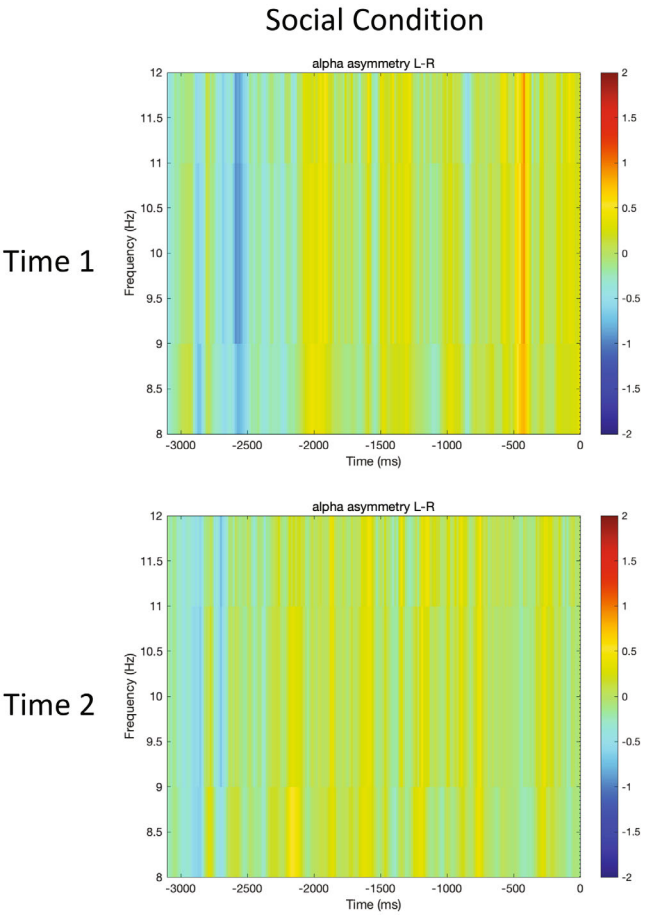

Fig. 1. Anticipatory alpha asymmetry (left minus right) in parietal electrode locations during the social condition in the autistic group at Time 1 and Time 2. Findings suggest an increase in approach motivation for autistic teens when viewing faces after versus before intervention, as evidenced by more left hemisphere alpha suppression at Time 2 compared to Time 1. This is depicted by predominantly cool colors (e.g., green and blue) versus warmer colors (e.g., yellow and red), such that cooler colors represent increased left-hemisphere alpha suppression and thus increased social approach motivation after intervention.

Post-Stimulus Theta

An interaction between group and feedback approached significance, $F(1,25) = 4.08$, $p = .054$, such that in the autistic group, larger theta-band activity was observed in the incorrect condition compared to the correct condition, $F(1,25) = 4.70$, $p = .04$. This suggests increased evaluation of negative feedback regardless of intervention (i.e., time) or condition (i.e., social versus nonsocial) in the autistic group.

ERSP and Behavior

After correcting for multiple comparisons, no significant correlations between neural metrics and behavior were observed.

DISCUSSION

We investigated ERSPs of reward anticipation and reward response in autistic and non-autistic adolescents and examined the relation between ERSPs and self-concept of educational performance and success after completing a social skills intervention. The purpose of this preliminary study was to illustrate the importance of capturing unique neural correlates and self-perceptions in Latinx autistic adolescents. Please be aware that the sample size is small and some findings approached significance; as such, we encourage discussion points to be interpreted as precursory.

We found that self-concept of educational performance did not change as a result of the PEERS intervention in autistic teens. This lack of significant change may be explained by the short 16-week timeframe in which our study was conducted. It is possible that it was not feasible for autistic teens to build a network of supportive peers (as was suggested by Pratiwi & Mangunsong, 2020), which may have led to a significant change in academic self-concept. Stable academic self-concept reported by autistic teens may also suggest positive influences on achievement (Valentine et al., 2004), such that autistic teens who perceive themselves to be competent in a particular subject may be more likely to succeed academically. In addition, autistic teens had similar rates of self-concept of educational performance as TD teens. This finding aligns with previous studies that have shown similar rates of self-concept of educational performance in math and reading in autistic and TD youth (McCauley et al., 2018; Wei & Marder, 2012).

Social approach motivation increased after intervention in autistic teens, as evidenced by greater left-hemisphere alpha suppression after intervention in the parietal region. Thus, for autistic teens, increased approach motivation was observed in the social condition after intervention, suggesting an enhancement of social motivation after learning social skills in PEERS. In addition, incorrect feedback elicited larger theta activity versus correct feedback in the autistic group, indicating an increased evaluation of negative feedback. As such, the predominantly Latinx autistic adolescents in this sample appeared to find incorrect feedback more salient than correct feedback. In sum, these objective and brain-based findings demonstrate that social motivation was strengthened in autistic teens after PEERS. This is particularly relevant when situated in the cultural importance of family and friends during the adolescent period for Latinx adolescents (Way et al., 2005) and underscores the importance of strengthening social skills in this population.

This is one of the first investigations to examine the effects of intervention, educational self-concept, and neural correlates of reward in a historically marginalized population of Latinx autistic teens and a neurotypical comparison group. Findings support previous work showing social improvements after completion of the PEERS program (e.g., Laugeson, Gantman, Kapp, Orenski, & Ellingsen, 2015; Veytsman et al., 2022) and showcase the need for the inclusion of diverse samples in future intervention research studies.

Limitations

Although there were not enough White participants to make comparisons between racial and ethnic groups, this study demonstrated the importance of examining majority non-White populations in ASD intervention research. Despite attempts to implement feedback from focus groups to retain families, a portion ($n = 4$) of our autistic sample dropped out of the study. This may have implications for the acceptability of the program or may underscore the lofty participation requirements of intervention studies, particularly for culturally and linguistically diverse populations. Finally, this preliminary study contained a small sample size, and findings should be carefully interpreted as some analyses did not reach statistical significance.

CONCLUSION

Prioritizing the needs of Latinx populations through research contributes to what is known about diverse brain functioning in autism. Through the use of self-report data and advanced ERSP techniques, we found that teen perceptions of educational performance did not change after participation in the PEERS program. Approach motivation increased after intervention in autistic teens, as evidenced by greater left-hemisphere alpha suppression in the parietal region. Findings have implications for advanced techniques to measure changes in reward-related brain activity before and after intervention with diverse samples.

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ETHICS STATEMENT

The study was reviewed and approved by the Institutional Review Board at the University of California, Riverside. Written informed consent to participate in this study was provided by the participant's legal guardian/next of kin.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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