

Integrated Parent-Child Music Classes for Preschoolers with and without ASD: Parent Expectations and Experiences

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Abstract

Integrated recreational programs designed to support neurodiverse children and their families are important vehicles for community participation. In this mixed-methods study, we investigated the mechanisms by which parent-child music classes for autistic and neurotypical children can support community participation. Parents of autistic ($n=33$) and typically developing (TD; $n=28$) preschoolers were interviewed about their expectations for and experiences of participating in a 12-week psychoeducational parent-child music program. Parents completed ratings of momentary affect and social connection and researchers coded children's behavioral engagement during classes at multiple time points throughout the program. Primary motivations for enrolling in an integrated music class included children's interest in music and opportunities for child socialization. Parent-focused reasons were less frequently endorsed as primary motivations for participation. Yet, momentary ratings indicated that music classes supported parents' affect regulation and social connection with other parents at the level of individual classes and across the program. These in-class experiences were echoed by interviews following program completion, which additionally highlighted use of new parenting strategies through the musical activities. As parental emotional experiences of activities, supportive community relationships, and parenting confidence are all linked with increased community participation, integrated music classes may support participation and satisfaction with community experiences.

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Introduction

Integrated recreational community programs, which are designed to support the social and physical engagement of children with diverse developmental needs and their parents, provide opportunities for community participation and support family well-being.¹⁻³ Reduced community participation is frequently observed among families of young children with autism spectrum disorder (ASD),^a a common neurodevelopmental disorder characterized by difficulties with social interaction and communication.⁴⁻⁶ Parents of autistic children express interest in increased child and family participation in activities, and positive involvement in community activities is increasingly being highlighted as a meaningful outcome of interventions for families of autistic children.⁷⁻¹⁰ Community activities can foster social support and relationships, important for increasing child and parent well-being and reducing parenting stress, which is often elevated in parents of autistic children.^{2,5,11,12} Community activities also provide opportunities for skill development and generalization for individuals with disabilities.^{2,5,13} Moreover, integrated community activities can shape attitudes of other community members and their understanding of disability.^{1,2}

Community participation is impacted by a variety of factors related to the child, parent, other community members, activity demands, accessibility, and the setting/environment.^{1,4,6,14-16} During the preschool period, community participation includes family involvement in recreational activities. Parents of autistic children are generally more involved in their child's community participation than parents of typically developing (TD) children.¹⁶ Parents of autistic preschoolers report that they are as willing to take their children to community activities as

^a We use both identify-first (i.e., "autistic children") and person-first (i.e., "children with ASD") language, in line with preferences expressed by self-advocates, caregivers, and professionals and APA guidelines for terminology around disability.^{54,55}

parents of TD children but less satisfied with their child's participation.^{4,10,16} Particularly for recreational activities, parents of young autistic children report fewer positive and more negative emotions, and that activity participation is more difficult, compared to parents of TD children.¹⁶ Parents' negative or positive emotional experiences of activities can lead to parents' reduced or increased willingness, respectively, to participate in future activities.¹⁶ Increased family participation and satisfaction with their child's participation is also observed when parents feel more competent in their parenting skills, when parents are more involved and satisfied with their own activity participation, and when families experience more positive attitudes and interactions from other community members.^{2,16-19} Thus, positive and supportive community experiences can impact families' current and future willingness to participate in community recreational activities.

Musical activities may provide a promising pathway for positive community participation experiences for families of young children with ASD due to their potential impacts on both child and parent behavior.²⁰ Musical activities such as parent-child music classes are common in early childhood, and many autistic children are interested in musical activities.²¹ The PRESS-Play Framework highlights how aspects of musical activities, including predictability, reinforcement, emotion regulation, shared attention, and social play, can scaffold participation of children with ASD and their parents or peers.²⁰ Indeed, beyond traditional parent-child recreational music classes, music therapy focuses on the use of music in the context of a therapeutic relationship to support non-musical goals.^{22,23} In autism, this has included using family-centered, parent coaching, and improvisational music therapy approaches to support children's social communication skills such as joint engagement and joint attention, as well as the parent-child relationship.²⁴⁻²⁸

Music can be a powerful tool for emotion regulation, eliciting emotional responses in part due to psychoacoustic properties like mode and tempo, as well as by fostering positive shared social experiences.^{29,30} Music engages the dopaminergic reward system and modulates autonomic nervous system and hypothalamic-pituitary-adrenal system activity,³⁰⁻³² including during parent-child musical experiences, suggesting that musical activities may be a platform for increasing positive emotions during a community activity.^{21,33-35} Joint music activities also support social connection and bonding,^{36,37} including between parents and children and between (unfamiliar) adults or children.^{21,33,38,39} While both group and individual singing are associated with decreases in the production of the stress hormone cortisol, only group singing is associated with increases in oxytocin, a neuropeptide associated with social bonding.³⁷ Joint music activities impact social connection in part due to increasing interpersonal synchrony, which occurs due to music's predictable melodic and rhythmic structure.³⁶ The predictability and repetition of musical activities can also serve as a support for child participation, especially for autistic children who benefit from predictable structures and routines.²⁰ Additionally, musical activities naturally support positive parenting practices such as nonverbal responsiveness and shared attention and can provide a platform for teaching parenting skills and increasing parent competence, which may in turn contribute to increased community participation.^{38,40-42}

Initial studies of therapeutic music groups primarily focused on the effects on the child or the parent-child relationship. Understanding the expectations and experience of *parents* participating in integrated parent-child music programs, including how these may differ for families of autistic and TD children, may inform successful implementation of such music programs. In a small pilot study of an integrated psychoeducational parent-child music class program, qualitative coding of parent interviews about their program experience demonstrated

the feasibility of such a setting for promoting components known to be important for increasing community participation (e.g., enjoyable and meaningful activity, supportive community and environment, increased skills and competence in using musical activities).³⁸ In the current mixed-methods study of the same psychoeducational music program,^b we extend prior findings by directly assessing parents' perceptions during music classes in real time, combined with qualitative analyses of parent interviews both prior to and following their experience in the music class program, to advance understanding of mechanisms by which such a program may promote community participation.

Methods

Participants. Participants in the current study included preschool-aged children with ASD (n=33) or typical development (TD; n=28) and their parents/caregivers who attended at least six classes of the 12-week Serenade parent-child music class program offered as part of a research study (mean (SD): 9.8 (1.5) classes attended per family (range: 6-12)). There were two autistic sibling pairs, one TD sibling pair, and one sibling pair with one autistic and one TD child, resulting in a total of 57 unique families participating.^c For data analysis purposes, all child participants underwent assessments and behavior coding of class engagement (see below); however, parent questionnaires and interviews were only collected one time per family via the primary

^b The current study uses the same curriculum as the pilot study³⁸ but is an entirely separate cohort of participants. The pilot study used a 10-week version of the curriculum; the current study extended the curriculum to 12-weeks due to family feedback in the pilot study.

^c As part of the overall Serenade program and associated research, we aimed to enroll a *minimum* of 50 unique participants (n=25 ASD, n=25 TD). Enrollment goals were informed by sample size recommendations for the qualitative analysis approach, including when applied with families/participants with ASD given the heterogeneity in this population,⁵⁶⁻⁵⁸ as well as to be well-powered to detect medium effect sizes for quantitative analyses (group x time interactions). Due to family interest in the program and group session scheduling availability, we were able to meet and somewhat exceed this minimum sample size requirement during the time period the Serenade program was offered.

parent/caregiver. Demographic information for the primary parent/caregiver and child participants is presented in Tables 1-2. Children with ASD were somewhat older than children with TD but had lower non-verbal and language scores. Participating families were not involved in concurrent music therapy or other community parent-child music programs.

The study was approved by the university Institutional Review Board (IRB). Written, informed consent was obtained by a parent or guardian of the children. Children above the age of three years and with appropriate language level provided verbal assent.

Procedures

Families participated in the 12-week Serenade parent-child music class program (families attended the same session weekly so the class makeup was consistent across weeks). Parents completed interviews before and after the music class program with an unfamiliar study team member. Parents completed study surveys (see below) at the start and end of an early, middle, and late class week. Children's engagement during music class was coded during the early and late class week. Early, middle, and late typically corresponded to the first, sixth, and twelfth class week; however, if a family was not present at class during these weeks, surveys/behavior were collected at an adjacent week as possible.

Serenade Parent-Child Music Class

Serenade is a 12-week parent-child music class program, led by a board-certified music therapist, that provides music-based parent training and peer interaction in a musical play context following a manualized curriculum. During Serenade's weekly class sessions, groups of 4–6 families (~half with child with ASD) participate in joint music making activities that are

designed to facilitate children's engagement while also teaching parents behavioral strategies to promote children's social engagement and positive behavior. Each week of the program is focused on a different theme targeting use of specific musical strategies, with families receiving weekly handouts on the topic and related supports (e.g., visual schedules, audio recordings) (see Supplementary Table 1).

The Serenade music class format and sample session activities have been described previously³⁸ (see Supplementary Table 2). In brief, each class involves a warm-up period during which children engage in free play while the music therapist leads parents in a discussion of their home practice goals and introduces the theme for the week. The music therapist then leads families in ~30-40 minutes of eight structured group music activities, throughout which the therapist demonstrates ways in which the music activities connect with the session theme. At the end of each class, the therapist reviews the theme, and families set individual goals for at-home practice. All families participate in all class aspects such that the program incorporates aspects of community music classes, parent training/psychoeducation, and parent support groups. The music therapist is supported by ~2 research assistants who provide behavioral or technical support (e.g., video cameras) as needed. The music therapist and a research assistant completed fidelity checklists after each session to ensure high fidelity to program curriculum (>97% by each rater).

Measures

Parent Interviews. Before and after their participation in the music class program, parents completed an individual semi-structured interview about their expectations for (pre-interview) and experiences with (post-interview) the program. In the pre-interview, parents were asked about prior experience with children with autism or other developmental disabilities, how they

envisioned their family (including child and parents) potentially benefitting from the program, and any concerns they had about participating. In the post-interview, parents were asked about their general impressions of the class including positive and negative aspects, perceived impact of the program on their family (including child and parents), and if the program impacted their thoughts about parenting, autism, and their own child. Interviews were recorded and transcribed off-line.^d

Parent Momentary Affect. Parents completed the Positive and Negative Affect Schedule (PANAS)⁴³ at the start and end of the first, middle, and last weeks' sessions. The PANAS consists of ten positive and ten negative affect items that are rated on a 5-point scale from "not at all" to "very much". Parents were asked to rate the extent to which they felt each emotion "right now, that is, at the present moment." A total score is generated for each scale (PANAS Positive; PANAS Negative) with possible score ranges from 10 to 50.

Parent Momentary Sense of Connection. After completing the PANAS, parents completed two Inclusion of the Other in the Self (IOS) scales to measure parents' perceived social connection to their child and to other members of the class⁴⁴. Parents selected one of seven Venn diagrams with circles labeled as "self" or "other" that ranged from not overlapping at all to nearly entirely overlapping to represent how "connected or close" they felt to their child or other members of the class, respectively, at that moment (i.e., at start and end of class). Possible scores for each IOS scale (their child; other class members) range from 1 to 7.

Children's Class Engagement. Children's engagement during class music activities was manually coded using a 15-second momentary coding scheme from videos of the music classes. Engagement was determined based on children's song-related movements/singing and gaze

^d Due to audio device malfunction, interviews were not available for one family at pre (ASD) and one family at post (TD).

direction. For every 15-second interval, each child's behavior was scored hierarchically as active engagement (child overtly participating in class through movement and/or singing while attending to class activities), facilitated engagement (parent or staff physically prompting child while child attended to class activities), passive engagement (child attending to class activities but no overt movement/singing), unengaged (child not attending to class including off-task behavior), or disruptive (e.g., child screaming). Due to the low number of unengaged and disruptive intervals, unengaged/disruptive were combined. If the child was not visible on the video, the interval was marked as uncodable. Engagement was coded throughout each active music activity except for the lullaby (because children were not expected to actively move/sing during the lullaby) and book activities (because different books provided different opportunities for movement/singing) (see Supplementary Table 2). Proportions for each engagement state were calculated by dividing the number of intervals in each engagement state by the total number of codable intervals across all activities. Videos were coded using ProCoderDV™⁴⁵ by two trained coders masked to video week. The two coders double coded 12% of the videos (randomly selected) for reliability (ICC's: active = 0.973; facilitated = 0.980, passive = 0.897; disruptive/unengaged = 0.623).

Data Analysis

Parent Interview Coding and Analysis. A thematic analysis approach was used to illuminate parent expectations for and experiences of participation.⁴⁶ All interview transcripts were first reviewed by two coders for familiarity with their contents and to determine and discuss emerging themes. The coders then re-reviewed all transcripts to assess for any additional themes so that saturation was achieved (i.e., the data set was fully represented by the themes). One coder

(different coders for pre- and post-interviews) then re-reviewed all transcripts line-by-line and labeled all relevant lines with codes; a second coder co-coded 28% of transcripts. In places of disagreement (5.7% of codes), the reviewers discussed and came to consensus. Sub-themes were clustered together, and names of overarching and sub-themes were refined to best reflect participant responses.

Parent Momentary Ratings and Child Engagement. Parent class experience focused on four dependent variables: parent positive affect (PANAS Positive), negative affect (PANAS Negative), connection to child (IOS-child), and connect to other class members (IOS-others). For each dependent variable, we conducted separate linear mixed models with within-subjects fixed factors of class timepoint (2: start, end) and week (3: early, middle, late) nested with the random factor of parent, and between-subjects factor of child diagnosis (2: ASD, TD). Both timepoint and week were included in analyses because we hypothesized changes could occur within and across class sessions. Linear mixed models were conducted using the *lmerTest* package in jamovi (v. 1.6.23.0).^{47,48} Factors were contrast coded centered on 0 so model estimates reflect main effects across entire sample/time points. Child engagement analyses focused on children's active engagement during the music program. We conducted a repeated measures ANOVA to examine change in children's active engagement over weeks (2: early, late) by diagnostic group (2: ASD, TD).

Results

Parent Interviews

Pre-Interviews. During the pre-interviews, parents' responses addressed the topics of (1) child-related reasons for participating; (2) parent-related reasons for participating; and (3)

participation concerns; within these overarching themes, specific subthemes emerged (Supplementary Figure 1a).

Nearly all families (90% ASD; 100% TD) reported on child-related reasons for participating. The majority of ASD (83.3%) and TD (61.5%) families specifically commented on the musical experience as motivating their participation because of their child's love of music. Parents wanted their children to enjoy a fun musical experience and also wanted to expand their child's musical knowledge (e.g., by broadening child's musical repertoire). A second sub-theme that emerged was child socialization (63.3% ASD, 88.5% TD). Parents of autistic children expressed interest in opportunities for their children to interact with others (including children with and without autism) while parents of TD children often commented on their child engaging with neurodiverse populations. The third sub-theme to emerge reflected other non-musical skill development; this theme was expressed less often and primarily by ASD families (40.0% ASD; 7.7% TD). Some parents hoped that the music classes might help the child with, for example, their speech and communication skills.

Parent-related themes were less frequently discussed by parents. Approximately a third of parents (46.7% ASD; 23.1% TD) expressed interested in having a shared experience/activity with their child. A similar percentage (36.7% ASD; 34.6% TD) expressed interest in learning new activities or strategies through the program, with parents primarily focused on opportunities to broaden their own knowledge of musical activities. The third subtheme to emerge related to parent-to-parent connections (20.0% ASD; 19.2% TD).

Participation concerns primarily focused around child behavior (60.0% ASD; 19.2% TD). Some parents expressed concerns about their child having behavior difficulties, being overwhelmed, or not participating in class activities. Approximately one-third of parents

expressed other eclectic concerns such as potential scheduling issues, parents' own (self-perceived) lack of musical skills, and if the music would be interesting for their child.

Post-Interviews. Five main themes emerged from the post-interview regarding experience in the program. These themes were generally consistent with themes previously identified in a smaller pilot study of the music program:³⁸ (1) importance of a positive and supportive activity (100% of parents); (2) community connections and autism awareness (71.0% ASD; 84.0% TD); (3) within family connections (54.8% ASD; 84.0% TD); (4) parenting strategies (100% ASD; 92.0% TD); and (5) perceived child behavior changes (87.1% ASD; 68.0% TD) (Supplementary Figure 1b).

Within these themes, parents frequently reflected upon the importance of having a “fun” activity for both their child and themselves, incorporation of structure and clear expectations (including predictable routines and visual supports), and adequate staffing to support participation. Some parents, particularly those of autistic children, commented on the importance of knowing that other families would be understanding of differences in their child's engagement and behavior during classes, though they noted feeling concerned at times about children's behavior (e.g., when child not engaged in class activities). At the same time, many parents expressed pride in seeing their own child and other children in the class increase their engagement in activities over the program. Parents also appreciated the opportunity to learn from and connect with other parents and the opportunity for their children to interact with other children. Consistent with the psychoeducational components of the curriculum, parents reported on increased musical parenting skills that supported both parent-child connections (e.g., shared musical games during class and at home) and specific child behavioral needs (e.g., ways to use music in daily living routines).

Parent Momentary Ratings and Child Engagement

Parent positive affect significantly increased from the start to end of music classes ($B=1.28, t=2.90, p=0.004$; Figure 1a). Though effect of child diagnosis on parent positive affect was not significant ($B=-3.70, t=-1.86, p=0.07$), there was a significant interaction between week and diagnosis ($B=-2.64, t=-2.37, p=0.02$; Figure 2a). Follow-up simple effects testing suggested increased positive affect in parents of autistic children at the late versus early week ($B=1.45, t=1.93, p=0.05$) but no change in parents of TD children. For parent negative affect, the only significant factor was class, with negative affect decreasing from start to end of classes ($B=-1.54, t=-5.83, p<0.001$; Figure 1b).

At the start of the first class, before parents had the opportunity to engage with others, sense of connection to others was low (ASD: 2.1 (1.4); TD: 2.0 (1.4)). Parents' connection to others increased significantly from start to end of individual classes ($B=0.58, t=5.37, p<0.001$; Figure 1c) and across the weeks of the program (middle vs. early week: $B=1.17, t=9.03, p<0.001$; late vs. early week: $B=1.26, t=9.17, p<0.001$; middle and late weeks do not differ; Figure 2c). There were no effects related to child diagnosis.

Parents' sense of connection to their own child was already high at the start of the first class (ASD: 5.4 (1.5); TD: 5.7 (1.0)). While there were no main effects for class, week, or diagnosis, there was a significant interaction between child diagnosis and program week for the late versus early week ($B=-0.94, t=-4.09, p<0.001$; Figure 2d). Parents of autistic children reported greater sense of connection to their child at the late versus early week ($B=0.36, t=2.36, p=0.02$) while parents of TD children reported reduced sense of connection to their child ($B=-0.57, t=-3.37, p<0.001$), though overall connection remained high.

The different patterns for parents' sense of connection to their child between the ASD and TD groups over the repeated weeks in the program may in part relate to how children participate in the music classes. There were substantial individual differences in children's active engagement in the classes (Table 3). TD children were more actively engaged than autistic children (repeated measures ANOVA: $F(1,49)=4.33$, $p=0.04$, $\eta^2_c=0.07$) but both groups increased their active engagement from the early to late week ($F(1,49)=49.16$, $p<0.001$, $\eta^2_c=0.16$). We conducted a linear mixed model to examine the possibility that active engagement differentially impacted parents' social connection to their child depending on diagnostic group. There was a significant interaction between child diagnosis and child active engagement ($B=-3.27$, $t=-3.45$, $p<0.001$). As children's active engagement increased, parents of autistic children reported increased connection to their child ($B=1.79$, $t=2.77$, $p=0.006$) while parents of TD children reported decreased connection to their child ($B=-1.49$, $t=-2.09$, $p=0.038$).

Discussion

Integrated community experiences may benefit both typical and neurodiverse populations by fostering opportunities for skill development, increasing parent and child emotional well-being and social relationships, and impacting perceptions of and understanding of disability.^{1,2,13} The current study focuses on parent expectations for and experiences with an integrated parent-child music class program. By combining real time ratings of parent affect and social connections during music classes with parent interviews, the current study sheds light on the mechanisms by which music programs may impact community participation of families of autistic children.

The primary motivations of parents of autistic and TD children for participating in the music program were their child's interest in musical activities and opportunities for peer

socialization. Parents also expressed interest in shared parent-child activities. As musical activities are a common form of positive social interaction between parents and children and children and their peers,^{21,49} integrated music classes provide a context aligned with parents' goals for community participation. Parents typically seek out recreational community activities that are enjoyable, aligned with children's interests, and meaningful for families.⁵⁰ Interests in child social experiences were not limited to parents of autistic children; indeed, the majority of families of TD children wanted their child to have experiences with children of diverse developmental profiles, perhaps reflecting growing interest and awareness of neurodiversity. While some families, particularly of autistic children, commented about the potential for their child to develop additional non-musical skills (e.g., communication skills), this was expressed by less than half of participants. At post-interviews, some parents of autistic children noted the tension they sometimes felt between treating all activities as interventions versus the music class as an opportunity to "be in something he could just enjoy and have fun."

Though specific parent-driven motivations for participation were less frequently endorsed at pre-interview, parents' real time ratings during music classes and post-interviews indicate specific impacts on parent emotions, social connections, and parenting skills. Parent affect was modulated within single classes and to some degree – for parents of autistic children – across program duration. For parents of autistic and TD children, social connection to others increased within single classes and across the program. These findings expand upon prior surveys, interviews, and physiological measurements conducted in other populations and settings such as parent-infant music classes and adult singing activities.^{33,37,39,51,52} Changes in affect and social connection across single classes is consistent with joint music making as a 'fast-acting' conduit for social bonding and emotion regulation.^{33,37,51} These effects at the timescale of single classes

may be important in providing immediate reinforcement to families to support their continued participation in the program. Increased social connection across the program may relate to continual impact of the shared music making activities as well as reflect an additional source of social support (e.g., from parent discussion components) for parents of TD and autistic children. For parents of autistic children in particular, social support contributes to increased parent well-being.¹²

Parent's connection to their own children was high throughout the program and may reflect characteristics of families interested in enrolling in parent-child music classes. On their momentary class ratings, parents of TD and autistic children reported different patterns of social connection to their child across the program, with modest decreases in TD and increases in autistic groups. Though speculative, perhaps as children became increasingly actively engaged in class music activities, parents of TD children perceived their child as more independent while parents of autistic children perceived their child as more participating in a shared experience. In the post-interview, parents of both autistic and TD children reported increased connections within their family in response to the music program.

Parenting competence is another attribute associated with increased community participation.¹⁶ Though sense of competence was not measured in real time, parent post-interviews revealed perceived gains in parenting skills and perceived changes in child behavior. As their children increased their active engagement during classes and parents learned specific parenting skills through the psychoeducational curriculum embedded in the music program, this may have helped parents feel more confident in the music class setting and could potentially extend to new circumstances. For example, many parents spoke of applying musical strategies to

assist in non-musical activities (e.g., using a song to help with transitions), as well as incorporating non-musical supports (e.g., visual schedules) in their home environment.

Limitations of the current study include the sample demographics as participants were primarily well-educated, white, and had relatively high earnings. Future studies need to include more diverse families to study the generalizability of findings. At the same time, there was substantial variability in the developmental level and autism symptom severity among child participants. The data is limited to self-report and behavioral observation given the importance of parents' own perceptions of their experiences in shaping their participation.⁴ Future studies could elect to include physiological measurements (e.g., cortisol, oxytocin) from parents and/or children to examine biological correlates of these behavioral measures. The current study focused on real-time ratings, which captured parents' class experiences in the moment. Additional studies will be needed to examine if there are any long-term effects of integrated music programming on frequency, experience of, and satisfaction with future community participation activities.

Although parents' statements may explicitly focus on the interests and needs of their child, parent-related factors greatly determine the degree of a family's current and future community involvement.^{4,16} The parent-related effects of parent-child music class participation -- such as parent affect regulation, social connection between parents, and parenting skills -- all align with frameworks for supporting parents' well-being.^{38,53} These effects were apparent for parents of both autistic and TD children, suggesting that integrated music class activities may engage mechanisms important for supporting community participation across diverse families. Integrated music class programs may hold promise for increasing the frequency of and satisfaction with meaningful community participation during early childhood.

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Figure Captions

Figure 1. Model score plots showing change in momentary ratings by parents of autistic (ASD) and TD children from start to end of individual music class sessions, controlling for week of program. (a) PANAS positive affect, (b) PANAS negative affect, (c) social connection to other class members (IOS-others), (d) social connection to own child (IOS-child). Error bars portray 95% confidence intervals.

Figure 2. Model score plots showing change in momentary ratings by parents of autistic (ASD) and TD children across early, middle, and late weeks of music class program, controlling for class timepoint. (a) PANAS positive affect, (b) PANAS negative affect, (c) social connection to other class members (IOS-others), (d) social connection to own child (IOS-child). Error bars portray 95% confidence intervals.

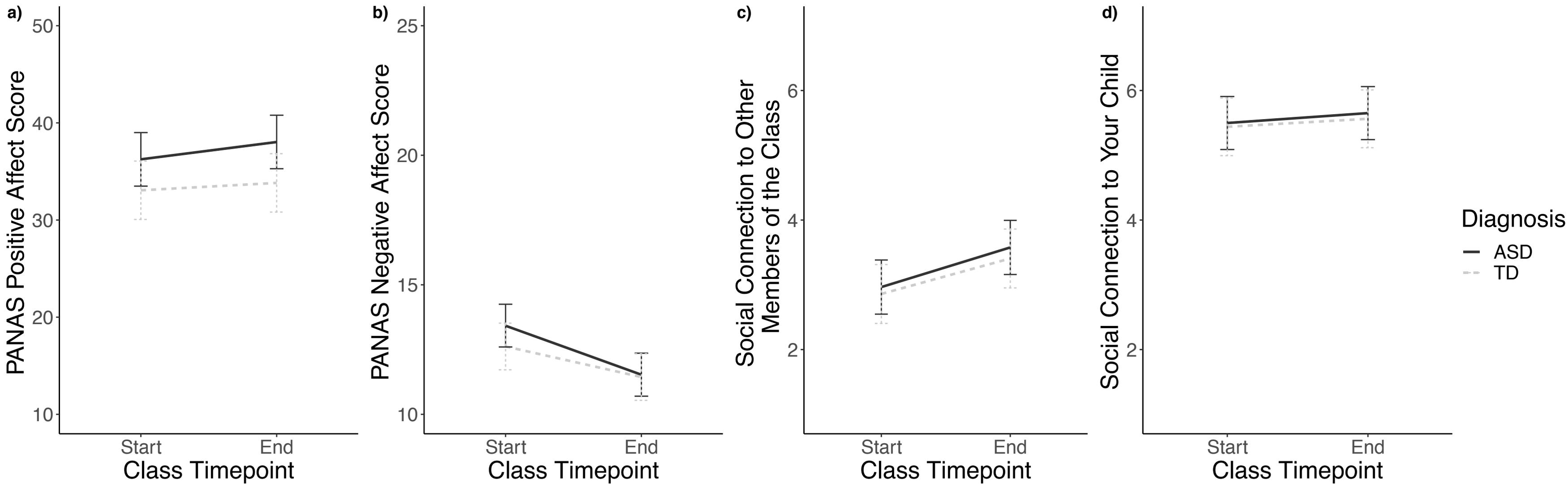


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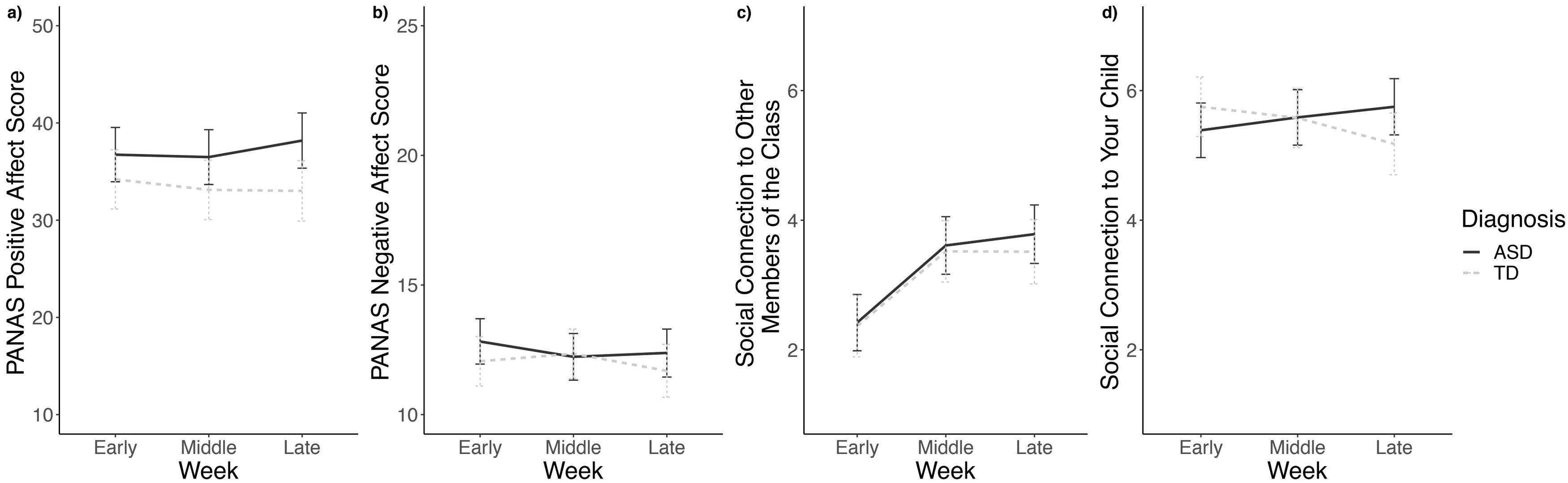


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Supplementary Materials

Serenade Parent-Child Music Class Program

Serenade is a 12-week parent-child music class program, led by a board-certified music therapist, that provides music-based parent training and peer interaction in a musical play context following a manualized curriculum.³⁸ During Serenade’s weekly class sessions, groups of 4–6 families (~half with child with ASD) participate in joint music making activities that are designed to facilitate children’s engagement while also teaching parents behavioral strategies to promote children’s social engagement and positive behavior. Each week of the program is focused on a different theme targeting the use of specific musical strategies, with families receiving weekly handouts on the topic (see Supplementary Table 1). Over the course of the program, families develop a “musical toolbox” of parenting strategies. At the start of the program, families receive audio recordings of the songs, access to video models of song activities used in class, a class social story, and a class visual schedule (also used during class). Throughout the class, visual supports, behavioral reinforcement, and prompting strategies are used to support all children’s participation, which also models the use of techniques for parents.

The Serenade music class format and sample session activities have been described previously³⁸ (see Supplementary Table 2). Each class involves a warm-up period during which children engage in free play while the music therapist leads parents in a discussion of their home practice goals and introduces the theme for the week. The music therapist then leads families in ~30-40 minutes of ~eight structured group music activities, throughout which the therapist demonstrates and provides instruction on ways in which the music activities connect with the session theme. The song activities provide opportunities for practicing specific parenting strategies (e.g., following child’s lead, animacy, positive reinforcement) to support children’s

social interaction and behavior (e.g., attending to others, imitation, turn-taking). Variations in song activities are introduced over successive classes by modulating pacing, types of song movements and gestures, incorporation of props/instruments, and adding new verses and songs. At the end of each class, the therapist reviews the theme and families set individual goals for at-home practice. All families participate in all class aspects such that the program incorporates aspects of community music classes, parent training/psychoeducation, and parent support groups. The music therapist is supported by ~two research assistants who provide behavioral or technical support (e.g., video cameras) as needed.

The classes were videorecorded with four cameras, one in each corner of the room, which were combined into a single video for offline behavior coding of child engagement (see Main Text). Child behavior was coded for all song activities except for the book and lullaby activities (see Supplementary Table 2) because different books provided different opportunities for movement/singing and because children were not expected to actively move or sing during the lullaby.

Supplementary Table 1. Weekly Themes of Serenade Parent-Child Music Class Program

1. Using Music to Support Social Interaction	7. Modeling and Modulating Emotions with Music
2. Capturing your Child’s Attention with Music	8. Promoting Turn-Taking and Making Choices through Music
3. Music for Imitation and Communicative Gestures	9. Music for Pretend Play and Imagination
4. Promoting Speech and Language Skills with Music	10. Expanding to New Routines
5. Music as Behavioral Reinforcement	11. Exploring New Musical Contexts
6. Music for Redirection and Transitions	12. Music for Peer Interactions and Games

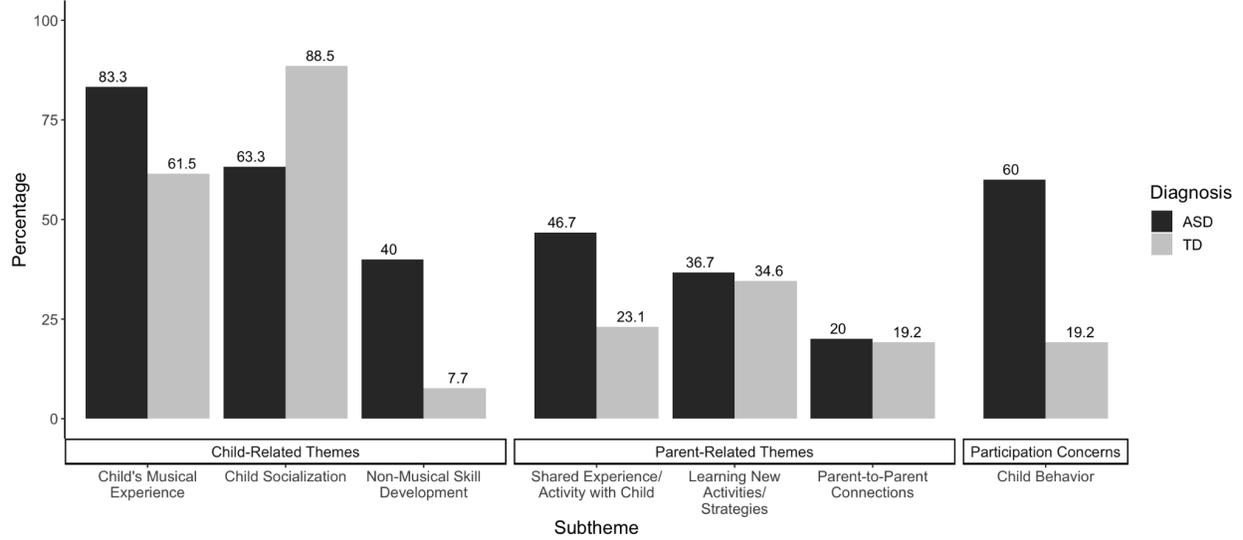
Supplementary Table 2. Serenade Class Activities and Examples of Variations on Song Activities for Session Themes

Session Activity and Songs	Session 3. Music for Imitation and Communicative Gestures	Session 7. Modeling and Modulating Emotions with Music
Check-in and discussion of at-home practice and goal from prior session. Introduce theme for the current session.		
Music-Making Activities:		
Greeting Routine: <i>Hello Song</i> (original)	Wave hello	Model smiling. As appropriate to child’s developmental level, label child’s emotion or ask child how they are feeling.
Small Body Movements: <i>Rum Sum Sum</i> (traditional)	Imitate hand gestures used in the song	Modulate the tempo, volume, and energy of the song and connect to emotional states.
Large Body Movements: <i>We are the Dinosaurs</i> (The Laurie Berkener Band); <i>Fire Truck</i> (Ivan Ulz)	Imitate large body movements and song-associated gestures	Contrast verses of song for energetic marching movements versus resting movements.
Turn-Taking/Choices: <i>Flower Shop Song</i> (traditional; the type of shop and associated props change throughout sessions); <i>In Our Band</i> (by Adam Summers)	Point to a choice board to choose a flower; imitate gestures with flower prop (e.g., smell flower)	Choose musical instruments during song; play musical instruments in different ways (loud/fast vs. quiet/slow)
Movement/Emotions: <i>Happy and You Know it</i> (traditional)	Imitate body movements (traditional song movements and new movements)	Practice emotions and coping strategies through song lyrics and movements (e.g., happy → clap hands; sad → get hug)
Book+Song (varied): Examples include <i>Brown Bear</i> by Bill Martin Jr; <i>Octopus (Slippery Fish)</i> by Charlotte Diamond	Point to pictures in book. Point to classmates to choose whose turn it is	Engage in movements and emotional facial expressions appropriate to song lyrics
Calming routine: <i>Lullaby</i> (varied). Examples include familiar nursery rhymes, original songs, and lullaby versions of popular songs	Incorporate gestures in song (e.g., hand movements to <i>Twinkle Little Star</i>)	Soothing lullaby routine (e.g., singing + rocking child) to a lullaby version of a popular song (demonstrating how can modulate any song to be a calming lullaby)
Goodbye Routine: <i>Goodbye Song</i> (original)	Wave goodbye	Model smiling. As appropriate to child’s developmental level, label child’s emotion or ask child how they are feeling.
Review session theme and provide handout to parents about theme. Parents set individual goal related to theme for at home practice.		

Table adapted from ³⁸.

Supplementary Figure 1. *Themes Endorsed by Families at Pre-Interview (1a) and Post-Interview (1b)*

1a) Pre-Interview Themes



1b) Post-Interview Themes

