Journal of Music Therapy Advance Access published May 8, 2015

Journal of Music Therapy, 00(00), 2015, 1–26
doi:10.1093/jmt/thv003

Self-Regulation and Infant-Directed Singing in Infants with Down Syndrome

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Background: *Infants learn how to regulate internal states and subsequent behavior through dyadic interactions with caregivers. During infant-directed (ID) singing, mothers help infants practice attentional control and arousal modulation, thus providing critical experience in self-regulation. Infants with Down syndrome are known to have attention deficits and delayed information processing as well as difficulty managing arousability, factors that may disrupt their efforts at self-regulation.*

Objective: *The researcher explored responses to ID singing in infants with Down syndrome (DS) and compared them with those of typically developing (TD) infants. Behaviors measured included infant gaze and affect as indicators of self-regulation.*

Methods: *Participants included 3- to 9-month-old infants with and without DS who were videotaped throughout a 2-minute face-to-face interaction during which their mothers sang to them any song(s) of their choosing. Infant behavior was then coded for percentage of time spent demonstrating a specific gaze or affect type.*

Results: *All infants displayed sustained gaze more than any other gaze type. TD infants demonstrated intermittent gaze significantly more often than infants with DS. Infant status had no effect on affect type, and all infants showed predominantly neutral affect.*

Conclusions: *Findings suggest that ID singing effectively maintains infant attention for both TD infants and infants with DS. However, infants with DS may have difficulty shifting attention during ID singing as needed to adjust arousal levels and self-regulate. High levels of neutral affect for*

Shannon de l'Etoile is Associate Dean of Graduate Studies and Professor of Music Therapy. The author wishes to acknowledge the mothers and infants who participated in the study as well as the many agencies and individuals who assisted with recruitment, especially the Children's Diagnostic & Treatment Center.

This research was supported by a Max Orovitz Award in the Arts and Humanities and a General Research Support Award. Both awards were granted by the Research Council of the University of Miami. There are no conflicts of interest in the authorship or publication of this manuscript.

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all infants imply that ID singing is likely to promote a calm, curious state, regardless of infant status.

Keywords: *infants; self-regulation; infant-directed singing; Down syndrome*

Self-regulation encompasses a wide range of capacities that allow a person to modify inner states and, subsequently, behavioral responses (McCabe, Cunnington, & Brooks-Gunn, 2004). An important component of self-regulation is the ability to diminish, heighten, or maintain a current level of emotional arousal (Thompson & Meyer, 2007). Known as emotion or affect regulation, this capacity allows a person to manage how long, how intensely, or how quickly a particular emotion is experienced. Consequently, self-regulation allows for effective functioning in a variety of emotionally charged situations (Spiker, 2006). The developmental ramifications of self-regulation are far reaching, as such skills have been linked to secure attachment and resilience, as well as emotional and social competence, during early to middle childhood (McCabe et al., 2004).

For infants, attention is fundamental to self-regulation, as selectively deploying and controlling attention enables arousal modulation (Berger, 2011a). One way infants can obtain experience in attentional control and arousal management is when their mothers sing to them as part of caregiving. Known as infant-directed (ID) singing, infants prefer this distinct musical form that has been observed in all human cultures and documented throughout history (Huron, 2003). Understanding the relationship between self-regulation and ID singing requires consideration of two factors common to both constructs, namely neuroanatomy and caregiver interactions.

Self-regulation is subserved by various interconnected brain structures, including the prefrontal cortex (PFC), orbitofrontal cortex (OFC), anterior cingulate cortex (ACC), and amygdala (AMYG) (Banfield, Wyland, Macrae, Münte, & Heatherton, 2004; Beer & Lomdardo, 2007; Payne & Bachevalier, 2009). The PFC contributes to self-regulation in numerous ways, including the control of selective and sustained attention, and facilitation of attentional switching. Meanwhile, strong connections with the limbic system enable the OFC to manage the emotional aspects of self-regulation, such as reading and responding to emotional cues and directing attention to emotionally significant events. The ACC regulates both cognitive and emotional processing via connections with the PFC and various limbic structures, including the AMYG. By receiving input from multimodal sensory areas, the AMYG helps interpret emotional and social cues, such as facial expressions and vocal sounds.

While data regarding infant brain activity during ID singing have yet to be published, healthy adults show reliable activation in the PFC, OFC, ACC, and AMYG when listening to music (Blood & Zatorre, 2001; Brown, Martinez, & Parsons, 2004; Menon and Levitin, 2005). Such activation is especially prominent when the listening task includes an affective component, such as making an emotional judgment or having an emotional response. Thus, both self-regulation and music listening utilize brain structures needed for critical attention skills and processing of emotional information. This neuroanatomical overlap explains how exposure to music can promote self-regulation, specifically emotion regulation.

Development of self-regulatory brain structures begins in infancy and is influenced by the quality of caregiving the infant receives (Payne & Bachevalier, 2009). Sensitive caregiving in particular, in which infant cues are consistently recognized and promptly addressed, contributes to self-regulation by helping infants to modulate arousal (Berger, 2011b; McCabe et al., 2004). Through responsive dyadic interaction with a caregiver, infants entrain with caregivers' patterns of modulated, flexible emotional responding, and thus experience episodes of emotionally charged yet organized behavior (Sroufe, 2000).

Mothers who demonstrate sensitive caregiving during ID singing make unique contributions to changes in infant attention and arousal. To explain, ID singing is known for having specific acoustic properties, such as high pitch level, gliding between pitch levels, slow tempo, and sustained vowels (Bergeson & Trehub, 1999, 2002; Trainor, Clark, Huntley, & Adams, 1997). When mothers instinctively manipulate these features to either reflect or modify infant state, they effectively capture infant attention and keep the infant engaged in the interaction (Delavenne, Gratier, & Devouche, 2013; de l'Etoile, 2006, 2012; de l'Etoile & Leider, 2011). For instance, a mother may sing more slowly or more softly to encourage a fussy infant to fall asleep. By contrast, if an infant is alert and in a playful mood, a mother may sing in a more rhythmic, clipped style with fluctuating dynamics. Thus, through ID singing, mothers can demonstrate awareness of infant state and react in a timely, appropriate manner. In response, infants may adjust attention by focusing more on themselves (i.e., body, clothing, chair) during lullabies, and directing attention outward to the caregiver (i.e., through mutual gaze) during rhythmic playsongs (Rock, Trainer, & Addison, 1999).

With attention focused, infants can then process the emotional content of their mothers' singing; an experience they find inherently rewarding and that produces desirable shifts in arousal (Bergeson & Trehub, 2002; Nakata & Trehub, 2004). By directing infant attention and eliciting optimal arousal, mothers provide two essential ingredients that infants need for affect regulation (Thompson, 1994). While attention and arousal responses to ID singing are well established for typically developing (TD) infants, they have not been extensively explored in infants who face self-regulatory challenges, such as infants with Down syndrome (DS).

Infants with Down syndrome (DS) tend to experience differences in both neuroanatomy and caregiver interactions that may jeopardize self-regulation. For example, they show reduced volume in the temporal limbic system, as well as the frontal cortex, superior temporal gyrus, brainstem, cerebellum, and hippocampus (Jernigan, Bellugi, Sowell, Doherty, & Hesselink, 1993; Nadel, 1999; Pinter et al., 2001). Consequently, infants with DS have deficits in attentional control and information processing that manifest as slowed responses to environmental stimuli and difficulty comprehending the emotional displays of others (Virji-Babul, Kerns, Zhou, Kapur, & Shiffrar, 2006; Wishart & Pitcairn, 2000). Differences in brain volume also contribute to low arousability in infants with DS who, once aroused, may have difficulty "shutting down" their responses to social interactions and environmental stimuli (Gartstein, Marmion, & Swanson, 2006).

Slow responses and low arousability may give the impression that infants with DS have "'muted"' or "'dampened"' affective expressions, and that they are passive or disengaged (Carvajal & Iglesias, 2006; Slonims & McConachie, 2006; Spiker, 2006). These expressions may be difficult or less rewarding for mothers to read (Spiker, 2006), thus mothers adjust their interaction style (Cebula, Moore, & Wishart, 2010). Compared with mothers of TD infants, mothers of infants with DS show significantly greater levels of "warmth" during interaction with their infants, indicating a greater effort to engage and higher levels of absorption in their infants (Moore, Oates, Goodwin, & Hobson, 2008; Moore, Oates, Hobson, & Goodwin, 2002).

This modified interaction style may result in positive or negative outcomes for the infant with DS. A mother's focus on warmth and engagement can provide much-needed scaffolding to optimize an infant's participation in a social interaction (Crawley & Spiker, 1983;

Tannock, 1988). In the short term, it may help young infants with DS establish emotional attachment with their mothers and reinforce their attention regulation as well as information processing abilities (Moore et al., 2002). By contrast, mothers can be so focused on giving warm and positive feedback that they miss important infant cues and become more forceful or directive (Spiker, 2006). This "forceful warmth" may result in infants becoming dependent on the mother for engaging and directing their attention and thus less likely to spontaneously explore objects or events outside the dyadic interaction. Over the long term, a warm yet directive interaction style could interfere with an infant's acquisition of triadic exchanges as needed for the development of joint attention, language, and flexible thinking (Moore et al., 2008).

For these reasons, infants with DS need interactions that promote attentional control and arousal modulation to support self-regulation. Early research showed that infants and young children with DS appear to be competent at effectively processing basic musical elements, although they may require additional time to complete the task (Glenn & Cunningham, 1982; Glenn, Cunningham, & Joyce, 1981). Furthermore, they demonstrate interest in music stimuli, especially when the human voice or some type of social interaction is involved (Ruskin, Kasari, Mundy, & Sigman, 1994). Thus, ID singing may be an appropriate interaction for infants with DS.

The purpose of this study was to observe self-regulatory responses to ID singing in infants with DS and compare them with those of TD infants. The behaviors selected for observation included gaze and affect as common indicators of attention and arousal, two primary components of self-regulation. Due to attention deficits and delayed information processing as well as difficulty managing arousability, infants with DS were expected to demonstrate sustained or uninterrupted gaze with their mothers more often than TD infants. Additionally, based on the slow social responses and low arousability previously observed in infants with DS, it was anticipated that DS infants in this study would display a more muted or less intense affect type in comparison with TD infants.

Method

Participants

Participants included 16 mothers and their infants with Down syndrome, as well as 15 mothers and their TD infants. Following approval from a university human subject committee, recruitment took place in a culturally diverse, major metropolitan area within the southeastern United States. Study materials were circulated to various community organizations that serve mothers and infants, and to clinical settings that provide services for infants with special needs.

On average, the sample size exceeded figures reported in previous studies that explored interaction between mothers and their infants with DS (Baird, Ingram, & Peterson, 1998; Berger & Cunningham, 1981, 1983, 1986; Carvajal & Iglesias, 2000; Crown, Feldstein, Jasnow, Beebe, & Jaffe, 1992; Gartstein et al., 2006; Gunn, Berry, & Andrews, 1982; Mahoney & Robenalt, 1986; Maurer & Sherrod, 1987; Moore et al., 2008; Slonims & McConachie, 2006; Tannock,1988). Additionally, the sample size was comparable to figures reported in prior research that examined infants and/or children with DS and their responses to music (Glenn & Cunningham, 1982, 1983; Glenn et al., 1981; Ruskin et al., 1994).

Data were discarded for one mother of an infant with DS because the mother did not follow the protocol (e.g., she did not sing). Data analyses, therefore, pertain to the remaining 30 infants, who ranged in age from 3 to 9 months. The researcher used individual matching to ensure that infants in the two groups were matched by chronological age. DS infants had a mean age of 5 months 28 days, while TD infants averaged 5 months 27 days. The DS infant group included 8 males and 7 females, as did the TD infant group. Infants who were born prematurely were age matched according to their adjusted age. To be included in the study, infants were either born full-term or after the 32nd week of gestation. This criterion was deemed appropriate, as the human auditory system is typically functional by this time (Graven, 2000). Thus, infants meeting this standard should have had intact sensory and perceptual systems during postnatal exposure to the mother's voice. Although infants were not screened for sensory impairment, all mothers reported typical hearing and vision for their infants.

Cross-tabulations indicated no significant differences between infant groups with regard to infant age, time of gestation, or birth order. Additionally, no significant differences existed between infant groups for the demographic variables of mother's educational or ethnic background. See Table 1 for demographic information on mothers.

TABLE 1
Demographic Information on Mothers According to Infant Status

	Mothers of Infants with DS	Mothers of TD Infants	Total Mothers
	$N = 15$	$N = 15$	$N = 30$
Age range, in years	20–42	29–39	20–42
Average age	33.9	33.27	33.60
Educational background			
Did not complete high school	2 (13.3%)	0	2 (6.7%)
High school	1 (6.7%)	0	1 (3.3%)
Some college coursework	2 (13.3%)	0	2 (6.7%)
Associate's degree	2 (13.3%)	0	2 (6.7%)
Bachelor's degree	3 (20%)	5 (33%)	8 (26.7%)
Graduate degree	5 (33.3%)	10 (66.7%)	15 (50%)
Ethnicity			
African American	2 (13.3%)	0	2 (6.7%)
Hispanic	9 (60%)	12 (80%)	21 (70%)
Caucasian	2 (13.3%)	1(6.7%)	3 (10%)
Other	2 (13.3%)	2 (13.3%)	4 (13.3%)

The 3- to 9-month age range for this study was selected for a number of reasons. First, this age range is comparable to that utilized in previous studies that also explored mother-infant interaction in infants with DS (Berger & Cunningham, 1981; Gartstein et al., 2006; Moore et al., 2008) or that examined responses to ID singing in both typical and clinical populations (de l'Etoile, 2006, 2012; Nakata & Trehub, 2004). In addition, this age range corresponds with the developmental trajectories for the behaviors of interest, gaze and affect. For example, by 3 months of age, the visual system for infants with and without DS allows for prolonged face-to-face eye contact as well as reliable discrimination between faces and toys (Berger & Cunningham, 1981).

Infant affect, or facial expression of emotion, also undergoes significant development from 3 to 9 months (Bennett, Bendersky, & Lewis, 2005). Admittedly, infants' emotional expressions can be difficult to interpret, as they may have different meanings than in children and adults, and in some cases, may be more indicative of general arousal level than differentiated emotion (Bennett et al., 2005; Camras & Shutter, 2010). For the purposes of this study, infant affect was considered a measure of general arousal having varying degrees of positive, negative, or neutral valence. In conclusion, the 3- to 9-month age range in the current study seemed to be an appropriate window of time for observing self-regulatory behaviors, such as gaze and affect, in response to ID singing.

The decision to match infants by chronological age was based on knowledge of developmental differences between the two infant groups, as well as the challenges of testing young infants' cognitive capacities. Carvajal and Iglesias (2002) report that in studies exploring infant behavior in the first post-natal year, infants with DS tended to be matched with TD infants according to chronological age. Conversely, research conducted on DS infant behavior in the second year typically matched infant groups by mental or verbal age. The authors explain this demarcation through the understanding that developmental differences between infants with DS and TD infants become more pronounced in the second year. Additionally, common measures of mental or verbal age in infancy and early childhood often involve the use of non-cognitive skills, such as social interaction, motor manipulation, and language, any of which may obscure infant performance (Moore et al., 2002). Since all infants in the current study were observed in the first post-natal year, matching by chronological age was the logical choice.

Measures

The Infant Behavior Rating Scales (IBRS) were originally designed to assess responses of TD infants during ID singing across four behavioral domains: cognitive, physical, vocal, and facial/affect (de l'Etoile, 2006). The cognitive component was later revised to explore infant responses to ID singing in mothers with post-partum depression (de l'Etoile, 2012). Additionally, the affect component was revised specifically for the current study. In both domains, revisions pertained to clarifying operational definitions of the target behavior and reducing the measurement scale from 7 to 5 points in order to improve reliability. The revised versions of the cognitive and affect portions thus constitute the Infant Behavior Rating Scales-Revised (IBRS-R), which were used in this study. The physical and vocal portions of the original IBRS have not been revised and were not used.

The cognitive component of the IBRS-R assesses direction and duration of infant gaze toward a social partner during a face-to-face interaction. Infant gaze is a common behavioral index of self-regulation in both TD infants and infants with DS and can reflect the infant's attempts at modulating attention and arousal (Berger & Cunningham, 1981; Carvajal & Iglesias, 2002; Moore et al., 2002). Previously, the cognitive component of the original IBRS and the

IBRS-R demonstrated high inter-rater agreement between observers, ranging from $r = 0.85$ to $r = 0.93$ (de l'Etoile, 2006, 2012).

With the IBRS-R, infant gaze is coded using a 5-point scale ranging from "–2" to "+2" to indicate negative or positive type of gaze, as well as neutral gaze. Brief descriptions of the five gaze types are as follows:

–2 = roaming gaze: the infant is not engaged with social partner and is actively looking around the room.
–1 = averted gaze: the infant is attempting to avoid or terminate interaction with partner by head turning, or blocking vision with hands or arms.
0 = neutral gaze: the infant is not avoiding interaction with partner, but is distracted by some other object (i.e., shoelace, strap on infant seat, etc.).
+1 = intermittent gaze: the infant alternates gaze from partner's face to another object.
+2 = sustained gaze: the infant looks only at the partner's face (i.e., eyes or mouth) with level head orientation.

In the IBRS-R, infant affect is considered to reflect arousal level with varying degrees of positive, negative, or neutral valence. Affect is determined by a specific constellation of movements and postures involving the infant's forehead, eyes, cheeks, and mouth. In the original version of the IBRS, the affect component was used in research involving ID singing with TD infants; however, difficulties with data capture and lack of variability in the data precluded statistical analysis (de l'Etoile, 2006). Consequently, levels of inter-rater agreement are not available for the affect portion of the IBRS. The same 5-point scale ranging from "–2" to "+2" is used to indicate negative or positive affect, as well as neutral affect, as defined below:

–2 = large grimace: infant demonstrates some forehead wrinkling, eyebrows are drawn together, eyes can be squinting, mouth is open and squarish, infant may show pre-cry or cry face. Infant looks angry, upset, or worried.
–1 = frown: inner corners of infant's eyebrows are raised, eyes are open or squinting, mouth can be slightly ajar or "pout lip," mouth corners can be pulled down or lips squeezed tightly together in a line. Infant looks grouchy, irritable, or scared.

0 = neutral affect: infant has a smooth forehead; eyes are open, round, or relaxed; mouth is relaxed and open or closed or slightly pursed. Infant's forehead or eyebrows may wrinkle slightly but more out of interest than distress, and eyebrows may rise out of interest. Infant's mouth should stay relaxed and tongue may protrude. Infant looks relaxed, comfortable, or curious.

+1 = smile: infant has a smooth forehead, eyes are open, mouth corners are curved up, and mouth may be open or closed. Infant looks playful.

+2 = large, expansive smile: infant has a smooth forehead, cheeks are raised, mouth corners drawn back and curved up in full display, and mouth is fully open. Infant's eyes may "crinkle" around the edges and may be partially closed. Infant looks gleeful and may be laughing.

Using the IBRS-R, both gaze and affect are coded from video using a 5-second time sampling procedure during 90 seconds of data collection. Data coders have a 5-second window to "observe" infant behavior, followed by a 5-second window in which to "record" infant behavior. Thus, nine data points are coded per infant within 90 seconds. To determine dominant gaze or affect type in each 5-second observation interval, an audio cue indicates when to begin observing, and then provides metronome clicks to demarcate each second of the interval. An additional audio cue specifies when to record infant behavior. Data coders hear only these instructional audio cues when observing and recording infant behavior; they do not hear the mothers' singing. Please contact the author for complete details regarding the IBRS-R.

For this study, two research assistants received 10 hours of training in IBRS-R coding procedures, in which they reached 90% inter-rater agreement with the author. Both research assistants were blind to the purpose of the study and not informed of infant status, although the diagnosis of Down syndrome was detectable by video. Research assistants coded gaze and affect separately (e.g., only one behavior was coded at a time). Using Cohen's Kappa, inter-rater reliability for 20% of all observations reached .97 for gaze and .85 for affect.

Procedure

Each mother-infant pair was videotaped while the mother sang to her infant for two minutes. Mothers were instructed to sing any song(s) of their choosing, in any language they preferred, and to sing to their infants as they normally would at home. Previous research has indicated that infants are likely to show a more positive response when mothers are allowed to choose the song, most likely due to infant familiarity (de l'Etoile, 2006). Mothers could sing one song repeatedly or several different songs during the two-minute recording. Since the focus of the research was to determine infant response to the mother's voice and face, mothers were discouraged from making physical contact with infants or using hand gestures or movements while singing. To promote face-to-face interaction between mothers and infants, each infant was secured in an infant car seat placed on a table approximately two feet from the mother's face while she was seated at the table.

Infant behaviors were captured using a Sony DCR-SR68 Handycam Camcorder mounted on a standard tripod. All video-recording equipment was hidden behind a screen so as not to influence infant behavior. Mothers' singing voices were also recorded as part of a different study designed to explore the acoustic parameters of ID singing in mothers of infants with DS (de l'Etoile & Leider, 2012).

Following data collection, each mother received a $25.00 gift card. The researcher also allowed each mother to watch the video recording of her infant and offered each mother feedback regarding her infant's behavior. The intent of the feedback was to help mothers recognize the importance of infant responses and to promote the use of ID singing in future situations to prompt these same behaviors. The researcher offered these comments based on her professional background as a music therapist working with at-risk mother-infant dyads.

Statistical Analyses

Version 19 of the Statistical Package for the Social Sciences (SPSS) was used to analyze data. The percentage of time that each infant spent displaying a particular gaze type or affect type during ID singing was first calculated. Mean percent of each gaze and affect type as well as standard deviations were then examined as a function of infant status. Separate one-way analyses of variance (ANOVA) were conducted for each gaze and affect type to determine the main effect of infant status on response to ID singing. Additionally, two-way analyses of variance were performed to identify interaction effects between infant status and gender, as well as between infant status and age, as previous research regarding behavioral responses to ID singing revealed both gender and age effects (de l'Etoile, 2006). To clarify, age was treated categorically by considering 3- to 6-month-old infants as "younger" and 6- to 9-month-old infants as "older."

As needed, further one-way ANOVAs were conducted to explore main effects of age and gender. For all inferential analyses, a p-value < .05 was used to determine significance, and a p-value < .10 defined results that were trending or approaching significance. Finally, to determine practical significance, partial eta squared values were calculated and interpreted as follows: 0.01 represented a small effect, 0.09 indicated a medium effect, and 0.25 designated a large effect (Cohen, 1988).

Results

This study assessed and compared self-regulatory behaviors in infants with DS with those of TD infants during ID singing. The two behaviors measured included gaze and affect, as these behaviors may indicate attempts at self-regulation during face-to-face interaction.

Infant Gaze Type

Ranging from most negative to most positive, types of infant gaze included roaming, averted, neutral, intermittent, and sustained. Descriptive statistics revealed that on average, both infant groups showed roaming and averted gaze at low percentages (i.e., less than 7% and less than 3% of the time, respectively), and displayed neutral and intermittent gaze at moderate levels (close to 25% for all infants). Both TD infants and DS infants demonstrated sustained gaze the largest percentage of time (i.e., more than 40% of the time in both groups). See Table 2 and Figure 1 for descriptive statistics regarding percentage of time infants spent in each gaze type.

No significant differences emerged between infant groups for the two negative gaze types: roaming gaze $F(1, 28) = 1.42$, $p = .243$, or averted gaze $F(1, 28) = .59$, $p = .449$. Additionally, the two infant groups did not differ significantly for percentage of time spent in neutral gaze $F(1, 28) = .21$, $p = .650$ or sustained gaze $F(1, 28) = .02$, $p = .884$. However, infant status had a significant main effect on intermittent gaze $F(1, 28) = 6.58$, $p = .016$, $\eta_p^2 = .190$, with TD

TABLE 2

Descriptive Statistics for Percentage of Time Infants Spent in Each Gaze Type During ID Singing

	Infants with DS ($n = 15$)		TD Infants ($n = 15$)		Total Infants ($n = 30$)	
	M	SD	M	SD	M	SD
Roaming Gaze	9.72	20.53	3.17	5.50	6.45	15.14
Averted Gaze	4.44	17.21	.95	3.69	2.70	12.36
Neutral Gaze	26.94	30.72	22.52	21.17	24.73	26.02
Intermittent Gaze	15.09	15.04	31.37	19.45	23.23	18.98
Sustained Gaze	43.80	36.88	41.97	31.01	42.88	33.49

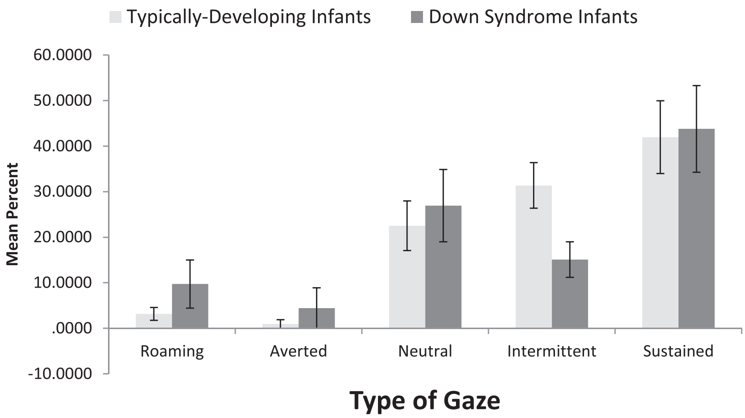

FIGURE 1.
Average percentage of time infants spent in each gaze type during ID singing, according to infant status.

infants displaying intermittent gaze a larger percentage of time than infants with DS. No main effects were noted for infant gender or age, and no interaction effects were observed between infant status and gender, or between infant status and age for any gaze type.

Infant Affect Type

Infant affect types, from most negative to most positive, consisted of large grimace, frown, neutral, smile, and large, expansive smile. The descriptive analysis showed that no infants displayed a large grimace in response to ID singing. Only infants with DS demonstrated a frown, and for a very small percentage of time (i.e., on average, less than 4% of the data-collection period). Both infant groups exhibited high levels of neutral affect (i.e., more than 80% of the time), and infants with DS showed slightly more neutral affect than their TD peers. Smile and large, expansive smile occurred slightly more often in the TD infant group, but overall were seen at a low percentage of time in both infant groups (smile ~12% of the time; large, expansive smile = 4.5% of the data-collection period). More details on the descriptive analysis for affect type are presented in Table 3 and Figure 2.

Infant status did not have a statistically significant main effect on any of the five types of affect. However, results for neutral affect approached significance, $F(1, 28) = 3.71$, $p = .064$ with a medium

TABLE 3

Descriptive Statistics for Percentage of Time Infants Spent in Each Affect Type During ID Singing

	Infants with DS ($n = 15$)		TD Infants ($n = 15$)		Total Infants ($n = 30$)	
	M	SD	M	SD	M	SD
Large Grimace	00.00	00.00	00.00	00.00	00.00	00.00
Frown	3.71	11.63	00.00	00.00	1.85	8.3
Neutral	89.63	16.52	73.55	27.78	81.59	23.90
Smile	5.93	11.00	18.19	20.74	12.06	17.46
Large, Expansive Smile	.74	2.87	8.26	15.62	4.5	11.68

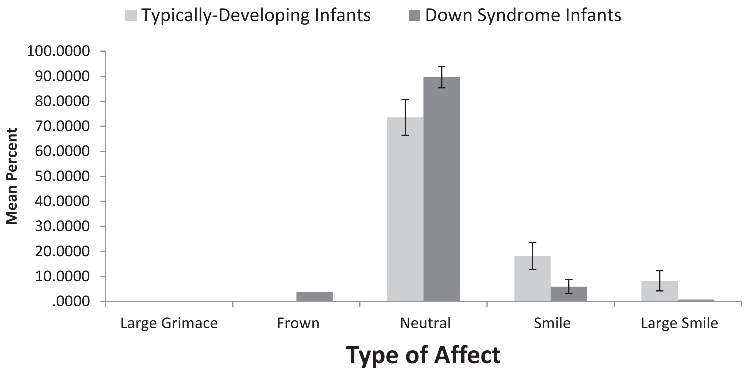

FIGURE 2.
Average percentage of time infants spent in each affect type during ID singing, according to infant status.

effect size of .12, demonstrating that infants with DS tended to display neutral affect more than TD infants. Additionally, infant status showed a trending effect for smile, $F(1, 28) = 4.09$, $p = .053$, ηp2 = .127, and for large, expansive smile $F(1, 28) = 3.36$, $p = .077$, ηp2 = .107, with TD infants displaying these affect types more often than infants with DS. No main effects emerged regarding the effect of infant gender or age on affect type. Moreover, no interaction effects were detected between infant status and gender, or between infant status and age for any affect type.

Discussion

The purpose of this study was to observe gaze and affect in infants with DS during ID singing, and to compare their responses with those of TD infants. The intent was to determine whether infants with DS utilize these self-regulatory behaviors during ID singing, despite their having reduced volume in related brain structures and potentially experiencing altered caregiver interactions. These findings may further the understanding of self-regulation in infants with DS, specifically in response to a caregiver interaction that involves singing.

Gaze Responses to Infant-Directed Singing

With regard to gaze behavior, the most noteworthy infant responses pertained to sustained gaze and intermittent gaze. Both infant groups showed sustained gaze at similar levels and more than any other gaze type. Distinct group differences emerged, however, with regard to percentage of time spent in intermittent gaze. To clarify, sustained gaze is coded when the infant looks only at the mother's face (e.g., eyes or mouth) with level head orientation for the duration of the 5-second observation period. This behavior typically indicates that the infant is attending to the interaction, finds the interaction interesting and/or appealing, and wants the interaction to continue. In the current study, both infants with DS and TD infants showed high levels of sustained gaze (i.e., more than 40% of the time in both groups), and in fact, displayed sustained gaze a larger percentage of time than any other gaze type.

These findings agree with previous research in which sustained gaze emerged as the predominant gaze type for TD infants during ID singing (de l'Etoile, 2006). Additionally, these results align with prior research involving infants and toddlers with DS who demonstrated sustained and frequent interest in adult singing over instrumental versions of nursery rhymes (Glenn & Cunningham, 1983; Glenn et al., 1981), and who preferred a live singing interaction over toy play (Ruskin et al., 1994). Considering that most mothers in the current study sang nursery rhymes or other simple songs, the findings also confirm earlier claims that the repetitive and rhythmic nature of nursery rhymes effectively maintains infant attention (Glenn & Cunningham, 1982, 1983).

The prevalence of sustained gaze observed here further confirms that ID singing effectively elicits and maintains infant attention and keeps the infant focused on the mother during face-to-face interaction. As mentioned earlier, sustained attention during interaction with a caregiver represents a fundamental component of self-regulation in infancy. Thus, by eliciting sustained attention, ID singing likely supports infant acquisition of self-regulation. These effects have been previously documented for TD infants, and now also appear evident for infants with DS.

Conclusions regarding sustained gaze, however, must be considered in light of results noted for intermittent gaze. By definition, intermittent gaze occurs when the infant alternates gaze between the mother's face and another object during the 5-second observation period. The "other object" is typically neutral in nature, such as the infant's shoe, the mother's hand, and so forth. During intermittent gaze, infants demonstrate an ongoing interest in the interaction, punctuated by brief considerations of neutral objects. Thus, intermittent gaze reflects a flexible form of attentional control, as the infant alternates from visually engaging with the mother and exploring the environment. Through this flexible shifting of attention, infants regulate the amount of stimulation they experience so as to achieve or maintain an optimal level of arousal. By shifting attention and optimizing arousal, infants use intermittent gaze to self-regulate.

In the current study, infants with DS spent significantly less time in intermittent gaze than their TD peers, regardless of age or gender. Infants with DS also displayed intermittent gaze far less often than they demonstrated neutral or sustained gaze. These findings concur with previous research regarding information processing and arousal in infants with DS.

As initially noted, infants with DS have attention and information processing deficits resulting in slowed responses to environmental stimuli and difficulty comprehending emotional displays of others (Virji-Babul et al., 2006; Wishart & Pitcairn, 2000). In response to music in particular, infants with DS show longer response durations than TD infants when recognizing familiar words in nursery rhymes, possibly reflecting deficits or delays in processing complex auditory stimuli (Glenn & Cunningham, 1982). Thus, during ID singing, infants with DS may require more time than TD infants to process information coming from the mother and to comprehend the emotional intent of her singing. This extended processing time may result in a longer duration of continuous attention toward the mother during ID singing (e.g., more sustained gaze), and fewer attempts at exploring the environment (e.g., less intermittent gaze).

Throughout this expanded window of processing, infants with DS may experience arousal to varying degrees. When aroused, infants with DS sometimes have difficulty "shutting down" their responses and become locked or stuck in the interaction (Gartstein et al., 2006). Infants may then struggle to shift attention as needed in order to adjust their arousal response. During ID singing, poorly managed arousal responses may further contribute to longer bouts of sustained gaze toward the mother and less frequent use of intermittent gaze. Challenges to information processing and arousal modulation may also help explain why infants with DS in this study used more neutral gaze than intermittent gaze. For example, if infants with DS became focused on a neutral object (e.g., their shoe, a strap on the infant seat, etc.), they may have found it difficult to shift attention away from that neutral object and back to the mother.

The data reported here provide partial support for one of the original predictions of this study, namely that infants with DS would show more sustained or uninterrupted gaze during ID singing than TD infants as a result of deficits in attention and information processing, as well as problems with arousal modulation. All infants used sustained gaze more than all other gaze types, and infants with DS displayed sustained gaze slightly more often than did TD infants, although not to a significant degree. The important difference that emerged between the two infant groups was the significantly lower level of intermittent gaze observed in infants with DS. Thus, while infants with DS displayed sustained gaze at levels comparable to their TD peers, they did not demonstrate as many occasional disruptions in gaze as TD infants are likely to do during ID singing.

Overall, low levels of intermittent gaze during ID singing, both in comparison with TD infants and with other gaze types, may reflect some of the innate characteristics of DS that put these infants at risk for problems with self-regulation. The unique nature of their responses in the current study suggests that infants with DS may be lacking or are slower to develop the internal mechanism that allows them to regulate incoming stimulation so as to achieve or maintain an optimal level of arousal. Ultimately, difficulties with attention, information processing, and arousal management are likely to interfere with acquisition of self-regulation in infants with DS.

Clinical Implications of Infant Gaze Results. Clinicians who work with mothers and their infants who have DS should first educate mothers as to the unique needs of their infants, so they can establish realistic expectations and learn how to best support their infants' attempts at self-regulation. For instance, therapists should explain to mothers that infants with DS may require extra processing time during a face-to-face interaction. With ID singing in particular, infants need time to process the acoustic features of the mother's voice and to interpret the emotional content of her singing. Infants must also decipher their mothers' facial expression, and integrate this visual information with the acoustic input of her singing. Based on the findings reported here in combination with previous research, an infant with DS may require more time than a TD infant to accomplish these tasks.

Affect Responses to Infant-Directed Singing

Although the two infant groups did not differ significantly with regard to affect type, certain trends emerged in the data that provide further insight into responses to ID singing. Affect types were somewhat similar in both groups, in that the most negative and most positive responses were observed in negligible amounts. For instance, no infants demonstrated large grimace, and only infants with DS displayed frown and for a very small percentage of time. For positive affect types, smile and large, expansive smile were seen at low levels and primarily in TD infants. Most notably, both infant groups spent the largest percentage of time displaying neutral affect, with mean levels exceeding 70% for TD infants and 80% for infants with DS.

Neutral affect is coded when the infant appears interested in or curious about the interaction but with a low level of intensity. An infant displaying neutral affect will have a smooth forehead; eyes that are open, round, or relaxed; as well as a relaxed mouth or a mouth that is slightly pursed. The infant's forehead or eyebrows may wrinkle or rise slightly during the interaction, but more out of interest than distress. Through this constellation of behaviors, the infant projects a sense of being at ease, comfortable, or curious.

The high levels of neutral affect observed in the current study agree with other research findings on mother-infant interaction. In a laboratory setting, Van Puyvelde et al. (2013) observed mothers and their 3-month-old TD infants for percentage of time spent in a joint negative, neutral, or positive engagement state during a face-to-face, 5-minute free-play session. Results indicated that even while mothers demonstrated positive engagement with their infants for more than 80% of the observation, infants showed neutral engagement (e.g., having a neutral or interested facial expression) more than 50% of the time.

Consequently, neutral affect appears to be a typical response of young infants during face-to-face interactions with their mothers. Neutral affect may indicate a particular infant arousal state, one that is not overly negative or overly positive. Rather, neutral affect seems to reflect a state of being relaxed or interested. For some infants, demonstration of neutral affect may represent having achieved a desired arousal level. Results of the current study suggest that neutral affect is the most common response to ID singing in both TD infants and infants with DS. These findings contradict an initial expectation of this study, namely that infants with DS would exhibit a muted or less intense type of affect than their TD peers, due to responding more slowly and having low arousability. Both groups, however, showed predominantly neutral affect in response to ID singing, indicating that most infants appeared calm yet interested in the interaction. Consequently, infants with DS in the current study did not appear to display a muted or dampened affect, at least not in comparison with the TD infants who participated.

Clinical Implications of Infant Affect Results. The importance of these findings lies in the mothers' interpretations of the infant's' affective display. If a mother understands that neutral affect reflects a calm, curious state that can be expected a majority of the time, she may feel confident that she is interacting in an appropriate and meaningful manner when her infant displays neutral affect.

Consequently, therapists should clearly inform mothers of infants with DS that neutral affect is a common response during face-to-face interaction, and that it possibly reflects a desired arousal state. In fact, during data collection for the present study, several mothers in both infant groups expressed concern over the fact that their infants did not show a more energetic or positive affective response during ID singing. Regardless of infant status, some mothers seemed dismayed by their infant's neutral engagement. Thus, all mothers would most likely benefit from knowing that neutral affect is a typical and, in some cases, desired response to ID singing and other forms of face-to-face interaction.

Future Directions and Limitations

This study represents an initial attempt to examine self-regulatory responses to ID singing in infants with DS, yet the constructs discussed here require further exploration. Specifically, researchers should strive to determine the precise level of arousal that infants with DS experience during ID singing. For example, the results obtained here regarding sustained and intermittent gaze may reflect problems with attentional control, information processing, and arousal management, issues that put these infants at risk for over-arousal. At the same time, findings for affect type suggest that infants with DS tend to experience a comfortable arousal level during ID singing.

This discrepancy could be resolved by incorporating different and varied methods of data collection. For instance, behavioral observation is subject to observer error and would best be used in conjunction with more objective indicators of attention and arousal, such as measurement of infant cortisol levels or brain activity, that could verify activation of self-regulatory systems. Any behavioral data-collection method used could also be improved to capture infant behavior more accurately and thoroughly over time. For instance, the time sampling protocol could be modified to include a shorter "observe" interval (i.e., 3 seconds instead of 5 seconds). Researchers could also opt to remove the "observe" interval and instead conduct a microanalysis of infant behavior for every second of the entire interaction. Further, future researchers could assess behavioral indicators of infant over-arousal, such as back-arching or blinking, to further confirm arousal level in response to ID singing.

Sample size and makeup may also have impacted the findings reported here. For instance, the small infant sample may have lacked sufficient power to detect significant effects of infant status on affect during ID singing. To explain further, differences between infant groups approached significance for three affect types, including neutral, smile, and large, expansive smile. Future analyses involving a larger sample size may reveal significant differences between infant groups that did not emerge here and that could alter the understanding of how infants with DS uniquely respond to ID singing.

Moreover, while cross-tabulations indicated no significant demographic differences between groups, a substantial discrepancy emerged with regard to mothers' educational background. Specifically, all mothers of TD infants reported that they had achieved a college education at the baccalaureate level or higher, compared with only half of the mothers of infants with DS. Mothers with a college education may have access to more resources that support effective parenting and infant development, such as health insurance or quality childcare. As a result, such mothers may be more aware of their infants' needs and may interact differently with their infants, in comparison with mothers who do not have a college education. Consequently, infants may respond with different types of gaze or affect. In the current study, this disparity could have contributed to the significant group differences noted for intermittent gaze. For future studies, researchers should seek to either minimize such discrepancies or explore educational background as a variable.

Conclusion

In summary, infants with and without DS showed high levels of sustained gaze with their mothers during ID singing, suggesting a positive attentional response to this interaction and confirming previous research findings. Infants with DS, however, also demonstrated significantly lower levels of intermittent gaze in comparison with their TD peers. This finding may reflect a delay or deficit in the ability to flexibly shift attention as needed to modify arousal level, thus limiting development of self-regulation. At the same time, both infant groups displayed predominantly neutral affect, a common response among young infants that most likely reflects a calm, relaxed state of arousal.

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