

Infants Attend Longer to Controlling versus Supportive Directive Speech

Sarah Gerson and Netta Weinstein*

Cardiff University

Merideth Gattis

Cardiff University

Silke Paulmann

University of Essex

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***Co-first authors**

Corresponding Address:

School of Psychology

Cardiff University

70 Park Place

Cardiff

CF10 3AT

Tel: +44 (0)29 2087 0480

Email: WeinsteinN@cardiff.ac.uk

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Abstract

Directive communications play a critical role in infants' and young children's daily routines as they are regularly guided by close others. An extensive literature describes two ways of directing action, autonomy support and control. These motivational qualities are thought to be especially important to development since they shape well-being, learning, and exploration. The way in which such motivations are communicated through tone of voice may be especially important for preverbal infants, who respond to tone more than words. At present, there is little understanding of what role these motivational qualities expressed through tone of voice play in directive speech. To fill this gap in our understanding, we conducted an experiment with 39 infants ranging in age from 9-12 months. Infants were presented with validated directive phrases previously recorded by current day-care staff members in autonomy-supportive and controlling tones. Results showed infants attended longer to controlling tones than to autonomy-supportive ones, evidencing their ability to discriminate between motivational qualities at this early age. Implications for early learning and well-being are discussed.

Keywords: infants; prosody; motivation; early development; attention; self-determination theory

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An extensive literature has shown that infants prefer communication directed at them, called infant directed speech (IDS), to speech spoken toward adults (adult directed speech, ADS), even when both types of communications involve similar words or *semantics* (Papousek, Papousek, & Bornstein, 1985). IDS is characterized by a distinctive tone of voice – or *prosody* – including greater modulation of pitch, slower tempo, and more emphasis placed on certain words within a phrase (Burnham, Kitamura, & Vollmer-Conna, 2002; Fernald & Mazzie, 1991). These characteristics are beneficial not only in that they create melodic tones that are pleasant to the infant but also because they have a functional significance: they bolster language acquisition through facilitating word segmentation, phonetic distinction, and communicative intent (see Cristia, 2013, for a review). Beyond a preference for IDS, seminal work has shown that infants around 5 months of age already respond with more positive and less negative affect to approvals (*you're so good!*) as compared to disapprovals (*you're so naughty!*) in IDS (Fernald, 1993; p. 660). These series of experiments, however, failed to find consistent effects on infants' attention to these messages as measured by gaze (as has been found with IDS relative to ADS).

Speaker intent expressed through tone of voice is thus important to infants, and has the potential to influence parent-child interactions. Indeed, parents of 3-6 month-olds are likely to use affection and approval in their speech (Kitamura & Burnham, 2003), and infants show clear preference to it relative to other forms of IDS (Kitamura & Lam, 2009). Yet, throughout the first year this preference shifts, and both research on parent speech and on the way that it is perceived by infants (Kitamura & Burnham, 2003; Kitamura & Lam, 2009) shows that by 9 months of age, there is a move toward emphasizing *directive* speech, which guides infants to action. Thus, by the final months of the first year, parents and other caregivers instruct infants to “look at this”, or “go to sleep”, and infants begin to attend to this

motivating form of speech in line with the emphasis these phrases place on approving (rewarding the baby) and comforting (calming the baby). This shift in infant preference is sensible, given that as infants develop the ability to manipulate their world, they naturally seek to adapt to and ultimately master it (White, 1959). In this paper, we argue that such directive speech, which is a key aspect of early learning (Deci & Ryan, 2008), can be differentiated by whether it uses tones that convey support for infants' autonomy – that infants have a *choice* to act – or alternatively uses tones that convey control – that infants *must* behave in line with speaker expectations.

Self-Determination Theory

To define these two qualities of directive communication and understand their implications, we apply the theoretical framework provided by self-determination theory - a widely applied metatheory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017) that has argued these two qualities of motivation can be meaningfully differentiated in characterizing parent-child interactions (Deci & Ryan, 1975; Ryan, Deci, Grolnick, & La Guardia, 2006; Stern, 2009; Stipek, Feiler, Daniels, & Milburn, 1995). Empirical work informed by this theoretical approach has suggested that autonomy-supportive parental communications can enrich learning, exploration, and well-being of children, whereas controlling speech can undermine these beneficial outcomes for children (Grolnick, Gurland, DeCoursey, & Jacob, 2002; Grolnick & Ryan, 1987; 1989; Joussemet, Koestner, Lekes, & Landry, 2005). Though most research has focused on older children and largely ignored infants, two studies have suggested that these motivational qualities, operationalized in terms of mothers' relational actions in a joint lab activity, similarly influence infants' exploration (Whipple, Bernier, & Mageau, 2011) and mastery orientation (Grolnick, Frodi, & Bridges, 1984). These studies based their operationalization of motivational qualities on a range of observed activities exhibited by mothers, including words, gestures, and tones. They did not, however, isolate

prosody as a conveyor of motivational quality or systematically manipulate motivational qualities to rule out the influence of other qualities of the mother-infant relationship, more broadly. Thus, while the findings of these two studies suggested infants may flourish when mothers use autonomy-supportive versus controlling motivational qualities in their words and behaviour, they left us with little understanding of whether infants differentiate between these motivational qualities when expressed by tone of voice.

The two literatures described above offer reason to believe that infants attend to directive verbal communications (regardless of their motivational qualities) and to autonomy-supportive or controlling motivational qualities exhibited through a coalesced set of activities. Integrating these two literatures is crucial to understanding how motivation in directive speech influences infants. The current project sought to explore whether infants discriminate between these two forms of motivation by examining infant attention in response to autonomy-supportive and controlling *motivational prosody* or tone of voice. No studies of which we are aware have investigated whether infants recognize and respond to motivating communications that are autonomy supportive or controlling.

Uncovering whether infants can discriminate between autonomy supporting and controlling tones is of particular interest for two reasons. First, it has been especially difficult to study how parents motivate their infants because infants under one year are preverbal. Although motivational psychology has a long tradition of exploring how individuals respond to motivational ideas expressed through words (e.g., Barber, 1996; Ryan & Deci, 2000; Soenens & Vansteenkiste, 2010), the motivational communications beyond words has received little attention with individuals of any age until recently, when it was found that *adults* show earlier and enhanced early electro-physiological responses to controlling tones of voice than they do to autonomy-supportive tones (Paulmann, Weinstein, & Zougkou, in press; Zougkou, Paulmann, & Weinstein, 2017).

Second, understanding tone of voice is especially important given that parents may use motivationally neutral directive phrases “stop that”, or “come back to me” in a range of expressive tones rather than directly using controlling language such as “you *must* come back to me”. Parents of infants, in particular, rely on expressive tones rather than specific words to convey attitudes and attempt to influence behavior (Trainor, Austin, & Desjardins, 2000). Importantly, infants can process intent (Fernald, 1993; Sakkalou & Gattis, 2012) and emotions (Moses et al., 2001; Trainor, Austin & Desjardins, 2000; Walker-Andrews, 1997) in tone of voice, but this research does not take place in the context of directive communications and testing motivational qualities, leaving a gap in our understanding of whether different motivational qualities are meaningful to infants.

Present Study

The current study sought to explore whether infants aged 9-12 months of age can discriminate between two motivational qualities in directive speech, autonomy-support and control, when they are solely communicated through speakers’ tone of voice. To this end, infants listened to pseudo-randomly presented, validated phrases spoken in two tones (controlling motivating, autonomy-supportive motivating), and we measured attention by the length of time infants looked at the sound source. We predicted that infants would attend longer to controlling versus autonomy-supportive speech because adults process controlling tones more immediately and intensely than they do autonomy-supportive tones (Zougkou et al., 2017; Paulmann et al., in press), and because theorists posit that controlling motivational communications demand more immediate response (Deci & Ryan, 2012).

Method

Participants

Forty-seven infants aged 9-12 months¹ were tested using materials developed and validated for this study (see below). Five participants were excluded from analyses because they did not provide data for at least half of the trials ($n = 4$), or were distracted by a toy the mother produced ($n = 1$). Three additional infants were excluded because a majority ($> 50\%$) of their gazes lasted less than one second. These exclusion criteria are similar to criteria used in previous experimental research with infants in this age range (ManyBabies Collaborative, 2017).

The final sample comprised of 39 infants ranging in ages from 9 to 12 months. Of these, 19 were boys and 20 girls with an average age of 10.92 months of age ($SD = 0.65$). All infants were recruited from a database of interested families in the local [deleted for blind review] area. Demographic information was not collected. Our aim was to achieve power $1-\beta = .80 - .90$ to detect an effect at 95% confidence. Our sample was just sufficiently powered to detect a moderate effective size of cohen's $d = .60$ based on a within-subjects test with two conditions.

Materials

To increase external validity of the materials used in the present study, three current female staff members working with infants at a day-care recorded motivational phrases using either controlling or autonomy-supportive tones. Specifically, they recorded fifty phrases developed by the research team based on earlier work by Zougkou et al. (2017), which had tested motivational prosody effects on adults. In this earlier work, the researchers identified phrases that were directive (that is, they requested the listener do something), but that did not include words indicative of either autonomy support or control, so that phrases could be intoned in either of the two qualities of motivation. For the purposes of the present study,

¹ We advertised for babies ages 10-12 months but accepted 9-month old infants whose parents volunteered. An additional infant who was 13 months old was tested as a pilot for the study but was not included in analyses.

stimuli were modified so that the content was applicable to statements that might be made to infants. As was the case in earlier research, these phrases were designed to provide the type of directive instructions that motivate listeners (in this case, infants) to action. They were also designed so that they could be expressed in either an autonomy supportive or controlling tone of voice. Example phrases are “put this toy away”, “pay attention”, and “look over there”. This approach produced materials that were semantically identical across conditions (that is, both conditions presented exactly the same words), but distinct in terms of prosodic realization, thus isolating the potential effect of tone from that of words.

To prepare speakers for intoning motivational phrases, they were first given a definition of each of the two qualities of motivation in line with our working definition in this paper. As was done when training speakers in Weinstein et al. (2018), they were then provided with scenarios in motivational approaches, given that autonomy and control are reflected by the same dynamics across the lifespan (Ryan & Deci, 2017). Specifically, two sets of scenarios adapting vignettes used in the General Causality Orientations Scale (Deci & Ryan, 1985) – one depicting controlling motivational climates and the second depicting autonomy-supportive ones – were taken from Weinstein et al. (2018). The scale described interpersonal contexts imbued with these motivational qualities, including at education, work, and close relationship contexts.

Phrases were then recorded in a soundproof booth. Each speaker intoned 50 phrases in a block design – first interpreting the phrases in an autonomy-supportive tone of voice, followed by a break and further reflection on the nature of controlling motivation, and then intoning the same phrases using a controlling tone of voice. Each sentence was repeated three times or until the speaker was happy that the sentence was intoned properly to get the best possible exemplars expressing both types of motivational prosody. Importantly, although the aim was to give speakers a good sense of what autonomy support and control meant in

interpersonal contexts, we intentionally avoided biasing speakers' decisions on how specifically to intone motivations in the context of interacting with infants. Thus, the experimenter did not give speakers instructions on how to alter their voices in order to express motivational qualities.

The resulting stimuli were acoustically analyzed using Praat (Boersma & Weenink, 2016). Descriptive analyses can be found in Table 1. Results showed, for example, that mean pitch was higher and speech rate was faster for stimuli expressing autonomy-support as opposed to control. Average intensity was normalized across stimuli (i.e. root-mean square amplitude was set to 70dB), but maximum loudness was reached more quickly for sentences intoned in controlling voices as opposed to autonomy-supportive qualities. Thus, while semantic content was held constant across conditions, stimuli from each condition were expressed with different acoustic profiles.

We conducted a perceptual rating study to validate the newly intoned phrases. To do this, a sample of 30 mothers of young children listened to phrases and rated them on three characteristics similar to previous procedures (Weinstein et al., 2018). According to theorizing in SDT, controlling motivational communications elicit behaviour through pressure and coercion, while autonomy supportive communications elicit behaviour through supporting choice and self-expression (Ryan & Deci, 2017). As such, participants of this validation study were asked to listen to each phrase and rate each on the extent to which it was pressuring (1 *not at all pressuring* to 5 *very pressuring*) and the extent to which it was autonomy supportive (1 *does not support choice* to 5 *very supportive of choice*). Participants also reported the extent they felt phrases were natural, on a scale from 1 (*not at all natural*) to 5 (*very natural*). Results of the validation study were then analyzed in two ways to select the final study materials. First, we examined discrepancies between how each sentence was intoned in the two conditions. In order to meet criteria, phrases had to be more than one unit

(equivalent to approximately two standard deviations) in difference for both perceived pressure (an indicator of control) and perceived choice (an indicator of autonomy support); that is, a controlling tone sentence had to be rated as 1 point or more higher in pressure, and 1 point or less lower in choice. In addition, phrases were required to be *less* discrepant than 1 on the absolute value of naturalness (that is, they had to be similarly natural and could vary in either direction). Further, both conditions were required to be rated as above 2.5 – the mid-point – in their respective characteristics; that is, controlling phrases had to be above 2.5 in being seen to be pressuring, and autonomy-supportive phrases had to be above 2.5 in being seen to be supportive of choice. These conservative tests yielded several different phrases for each speaker. To keep experimental run time within acceptable limits, we selected between two and four sentences per speaker resulting in a total of 20 phrases (the same 10 for each condition) played to infants. The phrases were consistent across conditions, so that infants heard identical phrases in each tone.

Procedure

Upon arrival, caregivers were told about the study while the infant was given the time to acclimate to the environment. After caregivers completed written informed consent, they were brought into a laboratory where the infants sat on caregivers' laps in front of a 60cm monitor. The monitor was mounted on a moveable arm that could be adjusted for optimal height and distance from infants (approximately 60cm). A camera attached to the top of the monitor recorded a live view of the infant so that an experimenter in an adjacent room could code the infants' gaze.

Infants' attention to the different phrases was measured using infant-controlled audio presentation. The infant sat in front of a screen that showed a multi-colored checkerboard (as used in previous research, Johnson, Westrek, Nazzi, & Cutler, 2011) and audio files were presented centrally. A trained coder sat in an adjacent room using jhab (Casstevens, 2007) to

code infants' looking duration. The coder could not hear the sentences and was thus blind to condition on each trial. If the infant looked away for two consecutive seconds (as indicated by jhab), an experimenter would manually progress to the next trial. There was no minimum looking time required. If the infant did not look away for two consecutive seconds, each trial would last a maximum of 25 seconds. The purpose of these trials was to teach the infants that looking away from the screen would end a trial, and so infants just heard classical music during these training trials (see ManyBabies Collaborative [2017] for similar methodology). Following these two trials, infants listened to up to 20 trials in which one of the validated phrases was repeated on loop for up to 25 seconds. The trials were presented in one of six pseudo-randomised orders. The orders were designed so that infants would never hear a sentence in one tone (controlling or supporting) on more than three consecutive trials. A second coder recoded 60% of trials to ensure looking times were reliable. Coders agreed on the look away that ended a trial for an average of 90% of trials (ranging from 75-100% of trials for each infant).

Results

Preliminary Analyses

Analyses across infants showed a marginal relation for male infants to pay more attention across trials, $t(38) = 1.98$, $p = .06$, but no relation with age, $r(38) = -.11$, $p = .53$; the absence of an effect of age may be due to a fairly small age range in the present set of participants (two months), but age may also play a more nuanced role, that is, as a moderator of condition (such that older infants show enhanced condition effects). As might be anticipated when assessing infant attention, a repeated measures ANOVA across conditions

showed a linear effect of time on attention, such that infant attention linearly dropped across trials, $F(1, 37^2) = 37.32, p < .001$.

Analytic approach

Hierarchical linear modelling (HLM; Bryk & Raudenbush, 1992; Raudenbush & Bryk, 2002) was conducted to examine the effects of condition, which was further nested within infants. This method recognizes that trials collected from one infant are interdependent, while simultaneously recognizing that variation exists between infants. Thus, HLM was well-suited to isolate the variance between infants from the variance accounted for by condition within each infant.

As is typical for ensuring HLM is the appropriate statistical tool for such a dataset, we first conducted an unconditional model to compute the intraclass correlation (ICC). The ICC provided an estimate of the variability within infants (and between trials) and between-infants. Findings showed that our outcome of interest – infant attention to stimuli – had sufficient variability at both levels to justify conducting full models. Specifically, 68% of variance in attention was within, rather than between, infants. Yet in both cases, a significant amount of variability was in evidence $\chi^2 = 356.83, p < .001$.

A primary model accounted for the fact that individual trials (defined at Level 1) were nested within infants (defined at Level 2). Level 2 variables were centered on grand means as recommended by Bryk and Raudenbush (1992), and Level 1 variables were left uncentered. At Level 1 (the between-sentence, and within-persons, level), condition (coded 1 = *Autonomy Supporting*; 2 = *Controlling*) was entered as a predictor. In the equation presented below, the slope of condition is represented by the coefficient, β_{10} . Also at Level 1, we simultaneously accounted for the order of listening as a covariate – whether it was the first or second time

² One infant was excluded from preliminary analyses because of missing data in a small number of trials; such missing data at Level 1 do not pose a problem for HLM analyses utilized in the primary model below.

infants heard a particular phrase (coefficient β_{20} below), because preliminary analyses suggested that stimuli presented toward the end of the session (second presentation) were attended to less than those presented at the start of the session (first presentation).

At Level 2 (between-person variables), total infant attention, age, and sex were defined because these three variables showed effects on attention or could be expected to do so in the capacity of a moderating relationship. In this model, total infant attention, age, and sex were defined twice: once as a main effect to control for baseline differences across infants (β_{01-03} , where the 0 refers to the placement of the predictor as having a Level 2 main effect on the outcome, infant attention), and the second time as potential controls and moderators for the condition effect (β_{11-13} , where the 1 refers to the placement of the predictor as a potential moderator of condition effects)³. Finally, we allowed variability at both levels ($r_0 + e$ in the equation below). The resulting statistical model was:

$$Y_{ij} = \beta_{00} + \beta_{10}*(CONDITION) + \beta_{20}*(ORDER) + \beta_{01}*(TOTAL\ INFANT\ ATTENTION) + \beta_{02}*(AGE) + \beta_{03}*(SEX) + \beta_{11}*(TOTAL\ INFANT\ ATTENTION) + \beta_{12}*(AGE) + \beta_{13}*(SEX) + r_0 + e.$$

Model of Interest

As may be expected, at Level 2, infants who paid more attention to stimuli across the session also attended more in any particular trial, $b = .01$, $t(35) = 2.16$, $p = .04$. Consistent with preliminary analyses above, age did not relate to attention in our model, $b = .40$, $t(35) = 0.49$, $p = .63$. Further, there was no effect of gender at Level 2, $b = -1.81$, $t(35) = -1.15$, $p = .26$; that is, male and female infants attended to auditory stimuli similarly when controlling for variance accounted for by other predictors in the model.

³ Models not moderating by age and sex produced similar results, so we selected to include adjusted, conservative models; total infant attention was an important consideration as substantial variability in attention was evidenced at Level 2.

At Level 1, there was no direct relation between first or second stimulus presentation and attention, $b = -.37$, $t(598) = -1.25$, $p = .21$, though a small amount of variability was present such that infants paid less attention in the second round in which they listened to stimuli.

The hypothesized effect was present at Level 1, $b = .67$, $t(598) = 2.17$, $p = .03$. In general, infants attended more to controlling (*Adjusted Mean* = 6.52 seconds) versus autonomy-supportive (*Adjusted Mean* = 5.82 seconds) phrases.

This effect did not differ as a function of infant total attention, $b = .01$, $t(598) = 0.86$, $p = .39$, suggesting whereas baseline individual differences may impact attention, more attentive infants were not more likely to respond to condition differently. Further, the main effect did not differ as a function of age, $b = .26$, $t(598) = 0.77$, $p = .44$, or gender, $b = .23$, $t(598) = 0.43$, $p = .75$. These lack of interaction effects suggested that older infants were not more likely to respond differentially to motivational tones, and female infants were similarly likely to respond to controlling tones over autonomy supportive tones as male infants.

Discussion

Parents motivate their infants to action daily, and while the words used are often directive but neutral with regard to motivational quality (*please go to sleep!*), the tone used may be controlling or, alternatively, supporting the child to choose her or his own path of action. The current study was aimed at understanding whether infants can discriminate between these two forms of motivation in directive speech as they are communicated through tone of voice (prosody). Our study is the first to evidence greater attention given to controlling tones of voice, in line with our predictions.

This finding provides a “far” conceptual replication (LeBel et al., in press) of adult ERP data showing enhanced P2 components in adults listening to controlling versus autonomy-supportive prosody (Zougkou et al., 2017), and is consistent with the motivation

literature suggesting that controlling motivational climates are used to elicit a stronger or more instant reaction from others (Bromberg-Martin, Matsumoto, & Hikosaka, 2010; Gagné & Deci, 2005), for example, because of parents' felt time pressures, or in its extreme, when an infant is about to touch a hot stove. However, in the current paper we extend earlier research to novel evidence about whether it is informative and worthwhile to study these forms of motivation in infants who are less sensitive to the *words* parents use to motivate them, which has been the focus of most research within this literature (Ryan & Deci, 2017).

This finding should be considered in light of past research (Mumme, Fernald, & Herrera, 1996) revealing that 12-month-old infants are more likely to adapt their behavior (e.g., show less interest in a novel toy; evidence more negative affect) when mothers produce fearful exclamations ("Oh! How frightful!") than happy exclamations ("Oh! How delightful!", p. 3224). In Mumme et al. (1996), the *words* used by mothers likely affected infants, since both words and tone concurrently varied across conditions. Still, the consistency of these and the current findings suggests that informative communications that directly call for listeners' immediate action (both fear and control are informative about direct responses to action) elicit a unique set of responses from infants as young as 9 months.

Importantly, though consistent with the Mumme et al. (1996) finding, the effect evidenced in this study seems, at first glance, in opposition to other identified effects of pitch on infant attention. For example, Fernald (1993) did not find consistent effects of disapproval and approval on duration of infant attention at 5 months of age (although they did identify effects on facial affective responses, but in the opposite direction as identified here in relation to directive sentences). Furthermore, Singh, Morgan, and Best (2002) found that infants attended more to happy than sad tones of voice. While the current effect does not align with this past research, it is also not incongruous, because while sadness may be amotivating

(Diamond & Aspinwall, 2003), controlling directives have the opposite effect – they explicitly call for immediate action, which therefore require immediate attention.

The varying effects of emotion (happy vs. sad/angry) and motivation (controlling vs. supportive) on infant attention in past research further implies that the current study is tapping something distinct from emotion in the prosody of the voice. That is, it suggests that infants in the current experiment were differentiating more than positive versus negative tones, and were instead attending to the *implications* of the tone. This raises the question, which acoustic cue, or cue combinations, do infants use to infer qualities of IDS? Our materials used in this study were characterized by a higher mean pitch for expressing autonomy support as opposed to control, similar to what has been found for happy versus sad expressions in adult-directed speech (e.g., Paulmann et al., 2008). This means that pitch direction might be shared across the domains of affect and motivation. However, past work (e.g., Weinstein et al., 2018) suggests that pitch is not a driving factor for *adult* listeners when inferring motivations from the voice. Rather, loudness and voice quality cues (e.g., distribution of energy in certain frequency regions) leading to the perception of harsh or soft voices seem to play a more prominent role when expressing motivations. In the current set IDS stimuli, voice quality was indeed expressed differently. Moreover, maximum phrase loudness was expressed more quickly for control than autonomy support stimuli, potentially contributing to signalling the need for immediate action to infants. It can be speculated that infants relied on voice quality indicators and intensity (loudness) location more so than they relied on pitch when identifying motivational quality within speech, but these aspects of tone should be more closely manipulated in future research, alongside testing how infants perceive motivations alongside emotions in tone of voice.

Another fascinating avenue for future research is to examine whether more action-oriented forms of controlling infants are likely to be exhibited by mothers who also modulate

their tone of voice to emphasize control. Parents can direct infant attention in a way that is more forceful or even controlling, for example by introducing a new object, re-directing the infant's attention, or telling an infant to stop something (a prohibition; Bono & Stifter, 2003; Jennings, Harmon, Morgan, Gaiter, & Yarrow, 1979; Landry, Chapieski, & Schmidt, 1986). These behaviors may correspond with the use of more controlling tones as parents direct attention and action in ways that coerce and pressure infants. Further, these behaviors have been associated with less mature attention and language development in infants (Bono & Stifter, 2003; Landry, Smith, Miller-Loncar, & Swank, 1997; but see Landry, Smith, Swank, & Miller-Loncar, 2000 for evidence that directiveness has positive relations with development at younger ages). If verbal communications are an essential mode by which parents control infants' behaviors, acknowledging them alongside other behaviors would provide a more comprehensive profile of the way parenting infants looks. Finally, the extent to which verbal communications are an essential mode for shaping infant behaviour is still not well-understood, and future research could explore both the frequency and context for verbal motivational directives in parent-infant relationships. This might be done through careful corpus analysis of existing parent-infant interactions, and through observations of parents' behaviors in lab studies wherein infants and parents are encouraged to pursue expressed goals.

Our finding should be considered in light of several limitations of the study. First, the sample was relatively small with just under 40 infants providing usable data; this sample was sufficient for detecting our hypothesized effects, but just barely so. Second, the procedure and materials were adapted from adult studies for the purpose of testing this under-researched question. The paradigm used is methodologically sound and was largely based on a highly replicated design used to study infant versus adult directed speech (ManyBabies Collaborative, 2017), but the controls in place to minimize possible confounding factors

means that the laboratory setting was far removed from naturalistic environments of young infants. Findings should be replicated with more robust samples and future work should further develop the study methodology. Finally, we intentionally studied attention as a behavioral indicator of discrimination for this first study, but this research question should be further addressed using other behavioral measures, including observations of infant behavior (e.g., exploratory and interest behaviors) and ERP responding, particularly as these outcomes would converge more readily with the existing literature base in motivation in children using a self-determination theory approach.

The current study provided initial evidence that infants discriminate between autonomy supportive and controlling tones of voice in directive IDS. Together with previous research demonstrating that controlling versus autonomy-supportive motivational climates may harm infants' exploration (Whipple et al., 2011) and mastery orientation (Grolnick et al., 1984), these findings have implications for exploration, learning, and well-being in infancy and throughout childhood.

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Table 1

Key Prosody Indicators for Each of Two Conditions (Autonomy-Supportive and Controlling).

Condition	<i>M</i> Pitch (Hz)	<i>SD</i> Pitch (Hz)	Time Max Pitch (ms)	<i>M</i> Loud (dB)	<i>SD</i> Loud (dB)	Time Max Loud (ms)	Duration (sec)	High Energy Band (Hz)
Autonomy- Support	331.8	51.2	340.0	70.2	9.3	370.0	1.1	22.5
Controlling	261.3	56.6	350.0	70.2	8.4	190.0	1.2	26.8

Notes. Loud reflects voice amplitude. Time max pitch and loud reflects the time of the sentence (delay, in ms, from start of sentence) in which the speaker intoned with the highest pitch and volume. High energy band reflects the harsh quality of voice used to intone sentences.