ANTHROZOÖS
2024, VOL. 37, NO. 4, 791–810
https://doi.org/10.1080/08927936.2024.2320997

Routledge
Taylor & Francis Group

OPEN ACCESS

Check for updates

Vocal Emotion in Pet-Directed and Infant-Directed Speech: Similar Sounds and Functions, but Different Determinants

Denis Burnham[a], Michelle Opacic[a], and Ute Vollmer-Conna[b]

[a]MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Penrith, Australia; [b]School of Psychiatry, University of New South Wales, Australia

ABSTRACT

Pet-directed speech and infant-directed speech sound similar. This study concerned this similarity, specifically with respect to (a) the relative degree of emotion in speech to pets and infants, (b) if the degree of emotion is affected by whether the speaker has only a pet, only an infant, or both a pet and an infant, and (c) any differences in the social or psychological determinants of emotion in speech to pets versus infants. Emotion in speech is conveyed by various factors, most notably via the semantics and prosody of the speech. Here we compared the prosody of pet-owners' and parents' speech; that is, their "vocal emotion" in three groups of women: those only with a pet ($n = 10$, only pet-directed speech recorded), only an infant ($n = 10$, only infant-directed speech recorded), or both a pet and infant ($n = 10$, both pet- and infant-directed speech recorded). The degree of vocal emotion, derived from naïve listeners' ratings on a well-established set of communicative intent scales, was found to be similar in the pet-directed speech of women who had only a dog and the infant-directed speech of those who had only an infant. However, for women with both a pet and an infant, vocal emotion was significantly lower in their pet- than their infant-directed speech. Regression analyses showed no social/psychological predictors of vocal emotion in infant-directed speech, but there were both positive and negative predictors of pet-directed speech. The better the pet owner's social support, the greater vocal emotion in their pet-directed speech, and if the pet owner also had an infant, then there was less vocal emotion. Results are discussed in terms of the similarities and differences between vocal emotion in pet- and infant-directed speech and the possible determinants of the differences.

KEYWORDS
Dogs; human–animal interaction; mothers; social support; speech registers; vocal emotion

In casual conversation, especially involving pet owners and parents, it is oft-times remarked that the sound of a human speaking to a pet and an infant is surprisingly

CONTACT Denis Burnham Denis.Burnham@westernsydney.edu.au MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia

Supplemental data for this article can be accessed online at https://doi.org/10.1080/08927936.2024.2320997.

similar. In turn, this observation is often followed by questions about the origins and determinants of the two speech registers. About 50 years ago, psycholinguists began to ask similar questions – Is speech to pets derived from speech to infants (or vice versa), or are they both derived from a third factor (Berko-Gleason & Weintraub, 1978; Brown, 1977; Ferguson, 1977)? Soon after, the first scientific study was conducted.

Pet-Directed Speech and Adult-Directed Speech

Hirsh-Pasek and Treiman (1982) employed an experimental manipulation in which four female participants aged between 25 and 32 years spoke to their dogs ("doggerel," as it was then called, now pet-directed speech [PDS]) and the experimenter (adult-directed speech [ADS]). Although two of the women had young children and two did not, the two parents' speech to their children was not studied, and there was no formal investigation of the effect of parenthood on speech to pets. Rather, the analysis involved comparison of the four females' PDS to their dogs and their ADS to the experimenter. The relationship between these two registers was then compared with the relationship between that which was already known from previous studies between "motherese" (as it was then called, now infant-directed speech [IDS]) and ADS. There were some differences; notably, while there are more deictic utterances ("that is a ball") in IDS than ADS, there were no more deictic utterances in PDS than in ADS. However, most other variables showed similarities: compared with ADS, shorter utterances in both IDS and PDS, more repetitions in both IDS and PDS, more questions in both IDS and PDS, and more use of present tense in both IDS and PDS. This evidence for the similarity of PDS and IDS led the authors to conclude, albeit speculatively, that IDS does not arise as a response to the intellectual/cognitive level in the child; that is, IDS might serve a broader role than teaching the child about the structure of language.

Pet-Directed Speech and Infant-Directed Speech – Functions

Possibly due to their psycholinguistic background, Hirsh-Pasek and Treiman (1982) compared PDS and IDS on specifically linguistic dependent variables, and their conclusions were couched in terms of PDS being similar to, or a subset of, IDS. In a more recent study, Mitchell (2001) constructed a comprehensive set of 41 behaviors on which to compare PDS and IDS that extended beyond a linguistic/psycholinguistic focus. Mitchell collected PDS data from 23 dog owners' speech to their own dog and an unfamiliar dog, coded that speech on the 41 behaviors, and compared it with IDS data on the same 41 behaviors gleaned from a number of previous studies of IDS. Mitchell (2001) makes the point that the correspondence between a behavior label and the actual behavior may differ between pets and infants. For example, most repetitions to dogs are of a few standard phrases that are not modified over repeats, whereas repetitions to infants are more varied and often involve expansions (Mitchell & Edmonson, 1999). However, these limitations are tempered by the fact that Mitchell (2001) used a comprehensive range of behaviors on which PDS and IDS could be compared, and that he further classified and combined these 41 behaviors to provide conclusions on five functions: (1) controlling addressee by having a persistent focus on object or activity; (2) communicating with an inattentive addressee with limited understanding; (3) indicating friendliness and affection; (4) pretending that the other is conversant; (5) tutoring. The prevalence of behaviors in the first three functions was found to be "frequent" in both PDS and IDS, whereas the last two were "mostly frequent" in IDS but "infrequent," "rare," or "extremely rare" in PDS.

Mitchell's (2001) five functions that encompass both PDS and IDS map quite well onto the three IDS functions that Fernald (1992b) proposed: attentional (see 1 and 2 above), didactic (5 above), and affective (3 above).[1] Acoustic and phonetic underpinnings that are linked to, and are indices of, the first two functions – attentional and didactic – have now been identified. First, the attention-getting function is indexed by the acoustic pitch of the voice, quantified by the overall height and the variability of fundamental frequency (F0; Fernald & Simon, 1984; Fernald et al., 1989); and second, the tutoring or didactic function of speech is indexed by the phonetic measure of vowel hyperarticulation – greater separation of vowels in formant space in IDS than in ADS (Burnham et al., 2002; Kuhl et al., 1997). Both of these (pitch and vowel hyperarticulation) have now been used to investigate PDS.

With respect to pitch, Ringrose (2015) recorded a dog owner's PDS to her dog and her ADS to the experimenter in a single interactive session. Analysis of F0 showed that whenever the dog owner switched attention from the experimenter to her dog (ADS to PDS), F0 increased. Further studies have verified that there is higher pitch in PDS than in ADS, and also that, based on behavioral responses (Ben-Aderet et al., 2017) and on an adaptation of gaze duration used to investigate infants' auditory preferences (Jeannin et al., 2017), dogs actually prefer to listen to PDS than to ADS. Moreover, in both these studies, canine attention was positively related to the pitch height of the incoming PDS.[2] Interestingly, in addition to PDS and ADS, Jeannin et al. (2017) also presented the dogs with IDS and showed that dogs preferred both IDS *and* PDS to ADS, although there was some indication that puppies did not differentiate IDS and PDS as well as older dogs.

With respect to vowel hyperarticulation, Burnham et al. (2002) recorded IDS from 12 mothers to their infant and PDS to their pet dog or cat. They found that mothers' corner vowels (i, u, a) were hyperarticulated (more peripheral and more separated) in IDS than in ADS, but there was no difference between the articulation of vowels in PDS and ADS.

Emotion in Pet-Directed Speech and Infant-Directed Speech

The focus of this study was emotion – identified by Fernald (1992b) as the "affective" function and by Mitchell (2001) as "indicating friendliness and affection." There are many aspects of, and cues for, affect in speech, including facial expressions and gestures, and, in the speech itself – both the semantics of *what* is being said and the prosodic characteristic of *how* it is being said. Here we focused only on the acoustic aspects of speech and more specifically on the sound, not the content, of the speech. We call this the "vocal emotion" of speech which can be isolated experimentally by low-pass filtering speech samples such that the prosody – rhythm, stress, intonation – can be perceived but the distinct phonemes (and thus the words and semantics) cannot. Thus, an operational definition of vocal emotion is: "the rated emotion present in the low frequency bands of speech; that is, the prosody of the speech – rhythm, stress, intonation – devoid of any semantic speech content." In our case, these ratings came from naïve listeners' ratings of low-pass filtered speech on the five components of the Communicative Intent Scale (see "Vocal Emotion" section below and stage 2 "Procedure" for further details).

Vocal Emotion

Vocal emotion is related to a number of acoustic variables (Katz et al., 1996; Kitamura & Burnham, 1998), most notably F0 (Fernald & Simon, 1984), or more correctly its perceptual correlate, pitch. Katz et al. (1996) showed that the dynamic aspects of F0 (contours such as falling, rising, bell-shaped) and the summary features of F0 (mean, standard deviation, duration) are both important determinants of vocal emotion in IDS. For example, when mothers were asked to speak to their infants in terms of certain emotions, "attention" and "comfort" speech contained more bell-shaped curves than "approval" speech, whereas approval speech had greater mean and standard deviation F0. However, the relationship between vocal emotion and pitch is not as clear-cut as it is in the attention-getting function of speech. Scherer (1986) maintains that vocal emotion is most strongly associated with voice quality, which is basically perceptual in nature and most often measured using rating scales (Krieman et al., 1993). In this study we used a set of communicative intent rating scales that have been developed and validated in a number of studies (Burnham et al., 2002; Kitamura & Burnham, 1998, 2003; Kondaurova et al., 2015; Panneton et al., 2006).

Determinants of Vocal Emotion in Pet-Directed Speech and Infant-Directed Speech

The primary concerns in this study were whether the degree of vocal emotion in PDS is affected by (diminished or even enhanced) by the pet owner also having a young infant (and vice versa); that is, whether owning a pet affects vocal affect in IDS; and whether the determinants of vocal emotion are the same or different in PDS and IDS.

First, with respect to the relative degree of vocal emotion, in our previous study (Burnham et al., 2002), we recorded speech of women who had both an infant and a pet and found that, while the degree of vocal emotion in both PDS and IDS was higher than in ADS, vocal emotion in IDS was yet higher than in PDS. This may have been due to finite emotional reserves. That is, because the mothers in the study had both an infant and a pet, their ability to provide an equivalent degree of vocal affect to each was constrained. If so, we would expect that in women who have either an infant or a pet, but not both, levels of vocal affect will be more comparable. To explore this issue, here we compared mothers with an infant but no pet (Infant Only [IO]), women with a pet dog but no children (Pet Only [PO]), and mothers with an infant and a pet dog (Both [P + I]).

Second, with respect to the determinants of vocal emotion, it may be that these differ in mothers' IDS and PDS. For example, vocal emotion may mediate early attachment in human infants, such that mothers instinctively use various features (pitch, stress, and rhythm) to attune to and regulate arousal and attention in their infants in a manner that is quite different from their interactions with pets (Field, 1985). Although we might have examined puppy-directed speech to make the comparison between pet- and infant-directed speech more directed toward early attachment for both species, most of the research on pet-directed speech concerns dogs older than puppies. In any case, the issue is whether PDS and IDS have common antecedents or whether they each spring from different sources. In this regard, clinical depression in mothers has been found to be associated with changes in IDS, especially reduced pitch variability (Kaplan et al., 2009). So, it is of interest to investigate any effect of people's physical and mental health (Castelli et al., 2001; Garrity et al., 1989; Raina et al., 1999; Virues-Ortega & Buela-Casal, 2006) on the degree of vocal affect in PDS and IDS. Accordingly, in this study we used two scales to measure physical and mental health of the pet owners and mothers.

In addition, some researchers hold that any positive effects of pet ownership might be explained by the level of social support that is associated with owning a pet rather than pet ownership per se (i.e., the owner's relationship with the pet) (Duvall Antonacopoulos & Pychyl, 2010; Winefield et al., 2008). In order to investigate this, on the one hand, we included a measure of social support for both the mothers and the dog owners, and on the other, we also employed a measure of pet–owner interaction on a pet relationship scale (for the dog owners only). By these means we aimed to determine whether there are common or distinct antecedents of PDS and IDS.

Objectives, Hypotheses, and Expectations

The objectives of this study were to investigate (a) relative degree of emotion in speech to dogs and infants, (b) if the degree of emotion is affected by whether the speaker has only a dog, only an infant, or both a dog and an infant, and (c) any differences in the social/psychological determinants of emotion in speech to pets versus infants.

Hypotheses and expectations were as follows:

(a) It was expected that the previously noted greater degree of vocal emotion in IDS than PDS (Burnham et al., 2002) would again be found here.

(b) It was unclear whether having two recipients (dog and pet) versus a single recipient (dog or pet) would affect vocal emotion, but the degree to which it did impact either register or both would reflect the interrelationship between emotion in speech and the nature of, or the number of, the recipients.

(c) It was unclear whether social/psychological determinants (mood, mental health, social support, and for pet owners, pet relationship) would affect vocal emotion, but the degree to which they did would reflect the interrelationship between emotion in speech (to pets, infants, or both) and be determined by factors extraneous to the actual here-and-now interaction.

Methods

The study was conducted in two stages: First, we collected primary data from 30 speakers in three groups ($n = 3 \times 10$) and second, a separate group of 10 participants gave blind ratings of the speech. Ethics approval for a project entitled, "Oochie Coochie Coo: Emotional benefits of talking lovingly to pets and infants" (Approval Number, H5134) was given by the Western Sydney University Human Research Ethics Committee which is an accredited Human Research Ethics Committee under the terms of the Australian National Health and Medical Research Council. Informed consent, in the form approved by the council, was obtained from all human adult participants.

Stage 1: Primary Data Collection

Participants (Speakers)

There were three groups of 10 participants. The IO group consisted of 10 mothers of infants aged 3–6 months who did not have a pet. The P + I group consisted of 10 mothers with an infant aged 3–6 months as well as a pet dog. These 20 mothers were recruited by telephone from the MARCS BabyLab infant register, a database of mothers who had volunteered for participation in infant-related research. Mothers' pets were restricted to dogs to control for extraneous factors possibly related to pet type. The PO group consisted of female dog owners with no children, recruited through fliers posted around Western Sydney University and at veterinary practices and hospitals, as well as via advertisements placed in local newspapers. The mean ages of the women in the PO, IO, and P + I groups were 33.80 ($SD = 7.73$), 31.50 ($SD = 5.79$), and 31.89 years ($SD = 3.41$), respectively, and there were no significant differences between ages ($F_{(2,\ 18)} = 0.017$, $p > 0.1$). All participants were born in Australia and spoke English as the primary language to their babies and dogs.

Procedure

In a visit to their home, all participants received an instruction sheet, a study information sheet, a consent form, a Walkman recorder, and questionnaires to complete. As set out below, all were (1) involved in an interactive session in which they were recorded speaking to their dog and/or infant, depending on the group, and (2) asked to complete the same three health-related self-report questionnaires in all three (IO, PO, P + I) groups, plus one extra questionnaire for the dog owners (in the PO and P + I groups). The consent form was filled in and collected on the first visit. Once participants had completed their recording and the questionnaires, they contacted the experimenters to arrange for the materials to be picked up in a second home visit. If participants had not called back within one week, we contacted them and reminded them to complete the recordings and questionnaires.

Speech Register Data

PDS and IDS speech data were collected via Sony Professional Walkman machines with an attached lapel microphone and a TDK audio cassette. Participants were given a Walkman and shown how to record and attach the lapel microphone on their clothes close to their mouths. They were asked to record 10–15 min of speech with their pet and/or infant at times when they would typically engage with them, such as playing or walking or schmoozing on the sofa (for dogs) or changing or feeding (for infants). They were asked to ensure that, as far as possible, there was minimal other background noise; for example, another dog or dogs present or another human adult or child present.

Self-Report Questionnaires

All participants in the PO, IO, and P + I groups completed the Profile of Mood States (POMS), the Short Form-12 Health Survey (SF-12), and the Medical Outcome Study Social Support Survey (MOS), and dog-owners (in the PO and P + I groups) also completed the Pet Relationship Scale (PRS).

Profile of Mood States (POMS). The 65-item POMS (McNair et al., 1971) measures six mood states: tension, depression, anger, fatigue, confusion, and vigor. The Total Mood Disturbance (TMD) score is calculated by adding together the scores on the first five scales and subtracting the vigor score. In a bibliography of its use, McNair et al. (2003) reported internal consistency between 0.63 and 0.96, a correlation between the subscales and the TMD of 0.84, and good external validity with measures such as the Functional Assessment of Cancer Therapy scale and the Psychological Well-Being scale (see also Wyrwich & Yu, 2011). Here, only the depression scores were used, and questions related to the participants' past week. Higher scores indicate higher levels of depression.

Short Form-12 Health Survey (SF-12). This 12-item scale provides a physical and a mental health measure. Only mental component summary scale (MCS) scores were used here. This survey measures functional and role limitations related to mental health, in addition to mood state, with questions relating to the previous four weeks. Scoring is norm-based – scores above and below 50 ($SD = 10$) are above and below the US population average, respectively. Higher scores indicate better functioning. MCS test-retest reliability has been reported as 0.76 (Ware et al., 1998).

Medical Outcome Study Social Support Survey (MOS). This 20-item scale measures aspects of functional support, including emotional/informational, tangible, affectionate, and positive social interaction, as well as structural support. An overall score was used here, with higher scores indicating greater social support. The MOS is distinct from measures of mental health, and support is distinct from concepts like loneliness and family functioning (Sherbourne & Stewart, 1991).

Pet Relationship Scale (PRS). This 22-item scale has three subscales: affectionate companionship, equal family member status, and mutual physical activity. A lower overall score indicates a better relationship with the pet. Internal consistency has been reported at 0.9, and alpha estimates of 0.81–0.85 confirm that the overall PRS scale is unidimensional (Lago et al., 1988).

Stage 2: Rating of Speech Samples Obtained in Stage 1

Participants

Ten women (mean age = 31.4 years, $SD = 2.63$) who did not participate in stage 1 were recruited through fliers placed around the university.

Procedure

These participants were asked to rate the speech recordings from stage 1 on the Communicative Intent Scale (CIS). Following the procedure in our earlier studies (Burnham et al., 2002; Kitamura & Burnham, 1998, 2003; Kondaurova et al., 2015; Panneton et al., 2006) two 15-second speech samples were extracted from each recording (one approximately two minutes into the recording; another approximately halfway through), with the proviso that there were no background noises such as dog or infant vocalizations (e.g., audible footsteps or knocking of furniture by dogs or banging of rattles or toys by infants).

Within CoolEdit 2000, speech samples were low-pass filtered at 400 Hz such that speech prosody was maintained but no individual words were identifiable. Given there were (1) 10 speakers in each of the three groups and (2) four different speech conditions (IDS in the IO group, PDS in the PO group, and both IDS and PDS in the P + I group – resulting in 20 PDS samples and 20 IDS samples), and (3) two samples from each recording, there was a total of 80 filtered speech samples. These were split into five separate files with 16 samples in each file. In each file, the 16 speech samples were presented in pseudo-randomized order such that the same participant's samples never occurred consecutively.

The CIS (Burnham et al., 2002; Kitamura & Burnham, 2003) was used to measure perceived vocal emotion. It involves raters evaluating speech samples on five scales: (1) the degree of perceived positive or negative affect (scale from −4 [negative] to +4 [positive]), and the intention of the speaker to (2) express affection (1–5, low to high), (3) encourage attention (1–5, low to high), (4) comfort or soothe (1–5, low to high) and (5) direct behavior (1–5, low to high). All 80 speech samples were rated by all 10 participants. Following four practice trials, the five 16-sample files were presented in counterbalanced order between subjects using a Sony CD player with headphones.

A factor analysis was conducted on ratings from the 10 raters using the five rating scales for all 80 samples. As in factor analyses conducted in our previous studies (Burnham et al., 2002; Kitamura & Burnham, 1998), two factors resulted: Affect and Attention (see Table 1).

As can be seen, the *Affect* factor weighted highly positive on (1) the positive/negative affect scale (all ratings were on the positive side of the −4 to +4 scale); (2) the express affection scale; and (3) the soothe or comfort scale. On the other hand, the *Attention* factor weighted *negatively* on the positive/negative affect scale, but highly positive on (2) encourage attention, and (3) direct behavior. As affect was of interest here, only the *Affect* coefficients for the five scales were used to derive *Affect* factor scores, the measure of *Vocal Emotion* in this study. In this way, the *Vocal Emotion* scores reflect emotion without any "contamination" due to attentional aspects of speech. In this regard, it is interesting to note (especially as the pets here were dogs), that the *Affect* factor contained very little of encouraging attention (e.g., "C'mon, girl, let's go!" (when starting to run)), or of directing behavior (e.g., "Go fetch, boy" (throwing a stick) or "No, don't dig there!" (pointing to garden bed)). Thus, the *Affect* factor does not include any of these more active behaviors more commonly associated with dogs than, say, cats. So, while not definitive, this partitioning of the CIS suggests that while this study employs dogs, the results could be more widely applicable to other pets.

Table 1. Factor loadings for the five scales.

	Scale				
Factor	Positive/negative affect	Express affection	Encourage attention	Soothe or comfort	Direct behavior
Affect	0.875	0.912	0.364	0.784	−0.145
Attention	−0.691	0.588	0.806	0.238	0.913

As there were two factor scores per speech recording (one for each sample), these were averaged for later statistical analyses. Thus, there were 20 *Vocal Emotion Affect* factor scores of mothers speaking to their infant (10 from the IO group, 10 from the P + I group), and 20 *Vocal Emotion Affect* factor scores of participants speaking to their pet (10 from the PO group, 10 from the P + I group).

Results

Results for *Vocal Emotion* in PDS in the PO group, IDS in the IO group, and PDS and IDS in the P + I group (see objectives (a) and (b)) are presented below followed by results for speaker characteristics and the relationship between these two (objective (c)). For further details, see the online supplemental file.

Vocal Emotion in Pet-Directed Speech and Infant-Directed Speech

Figure 1 shows the mean *Vocal Emotion* scores for PDS in the PO and the P + I groups (two left-hand bars) and for IDS in the IO and P + I groups (two righthand bars). We wished to know (1) whether there was a significant PDS versus IDS difference in vocal emotion between the 10 dog owners in the PO group and 10 mothers in the IO group, (2) whether there was a significant PDS versus IDS difference in vocal emotion within the speech of the 10 women in the P + I group who were both dog owners and mothers, and (3) whether the size of any PDS–IDS difference in vocal emotion between dog owners (PO group) versus mothers (IO group) differed from any PDS–IDS difference in vocal emotion within the women in the P + I group.

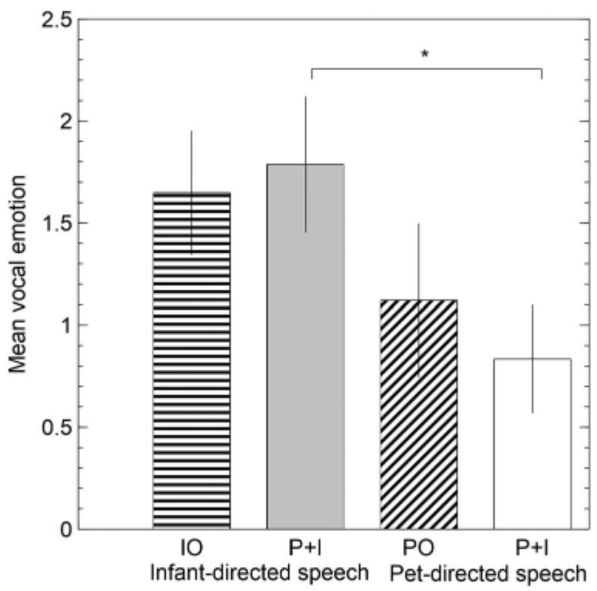

Figure 1. Mean vocal emotion scores of infant- and pet-directed speech (IDS, PDS). Asterisk = significant difference; vertical lines = standard deviation; IO = infant-only group; P + I = pet + infant group; PO = pet-only group.

PDS Versus IDS: PO Versus IO Groups

The PDS and IDS collected here was between groups and so a one-way between-subjects analysis of variance (ANOVA) was conducted. While there appears to be greater *Vocal Emotion* in IDS than in PDS (see first and third bars from left in Figure 1), there was no significant difference in the degree of *Vocal Emotion* between IDS ($M = 1.65$, $SD = 0.61$) in the IO group and PDS ($M = 1.12$, $SD = 0.65$) in the PO group ($F_{(1,\ 18)} = 3.63$, $p = 0.09$, $\eta_p^2 = 0.163$).

PDS Versus IDS: Within the P + I Group

The PDS and IDS samples analyzed here were spoken by the same participants – that is, a repeated measure – and so a one-way within-subjects ANOVA was conducted. This revealed significantly greater *Vocal Emotion* in IDS ($M = 1.79$, $SD = 0.67$) than in PDS ($M = 0.83$, $SD = 0.52$, $F_{(1,\ 8)} = 12.02$, $p < 0.01$, $\eta_p^2 = 0.409$) (see second and fourth bars from left in Figure 1).

PDS/IDS × Women with One (Pet or Infant) × Women with Both (Pet and Infant)

The interaction between vocal emotion in PDS versus IDS and whether these speech registers were spoken by different women (PO v IO) or the same women (PDS in P + I v IDS in P + I) involved comparing a between-subjects effect and a within-subjects effect, which is not possible in the usual ANOVA. However, ANOVA is quite robust to violations of assumptions (Caldwell et al., 2022) and their results can be useful even when some assumptions are violated. Accordingly, we conducted a 2 (PDS/IDS) × 2 (pet or infant/pet and infant) ANOVA treating both factors as independent between-subjects. As this involved re-using the data in the first two analyses, a Bonferroni correction was applied. (α was changed to $0.05/2 = 0.025$.)

Regardless of whether data came from different or the same participants, there was a significant main effect of speech register. That is, *Vocal Emotion* was higher overall in IDS ($M = 1.72$, $SD = 0.63$) than in PDS ($M = 0.98$, $SD = 0.60$, $F_{(1,\ 36)} = 14.43$, $p < 0.001$, $\eta_p^2 = 0.279$) (see two lefthand versus two righthand bars, Figure 1). Thus, we obtained the expected result as set out in objective (a). In relation to objective (b), there was no significant effect for whether the participant spoke to one recipient (dog or infant; $M = 1.38$, $SD = 0.67$) or two recipients (dog and infant; $M = 1.31$, $SD = 0.76$, $F_{(1,\ 36)} = 0.14$, $p = 0.71$, $\eta_p^2 = 0.003$) (see the difference between the two striped bars and that between the two solid bars, Figure 1). Nor was there an effect for any speech register × one versus two recipients ($F_{(1,\ 36)} = 1.20$, $p = 0.28$, $\eta_p^2 = 0.023$).

So, while there was greater vocal emotion in IDS than PDS overall, the size of the IDS > PDS difference was not significantly greater in the dog-owner mothers in the P + I group ($1.79 - 0.83 = 0.96$) than in the dog owners (PO group) and the mothers (IO group) ($1.65 - 1.12 = 0.53$). However, it must be noted that this ANOVA is indicative only as the within-subject factor was, for purposes of direct comparison, treated as a between-subject factor, thus violating ANOVA assumptions and not taking advantage of the greater power of repeated-measures analyses.

In the spirit of avoiding Type II errors, and indeed considering effect sizes in addition to significance levels, the IDS > PDS effect in the first analysis (IO v PO) approached, but failed to reach, significance ($p = 0.09$). However, the effect size ($\eta_p^2 = 0.163$) was "large."[3] In comparison, the IDS > PDS effect in the second analysis (PDS and IDS in the P + I group) was significant ($p < 0.001$) and also had a large effect size ($\eta_p^2 = 0.279$); in fact, somewhat higher than in the IDS > PDS effect in IO versus PO.

Speaker Characteristics

Three one-way ANOVAs confirmed that there were no significant differences between the three groups (PO, IO, P + I) in depressed mood, mental health functioning, or social support, or between the PO and P + I groups on pet relationship (see Table 2). Between these measures there was a significant correlation between depressed mood and mental health functioning ($r = -0.56$, $p < 0.01$), but no other correlations were significant (all rs < 0.33).

The Relationship Between Vocal Emotion and Speaker Characteristics

In relation to objective (c), the relationship between vocal emotion and speaker characteristics in PDS and in IDS, two standard multiple regression analyses were used to examine and compare relationships between speaker characteristics and vocal emotion to (1) pets (Table 3) and (2) infants (Table 4). In the PDS regression ($n = 20$), *Vocal Emotion to Pet* was the dependent variable and the predictors were *Infant or No Infant* (a dummy variable to differentiate P + I and the PO groups), *Depressed Mood*, *Mental Health Functioning,* and *Social Support*. The IDS regression ($n = 20$) had exactly the same structure: *Vocal Emotion to Infant* was the dependent variable and the predictors were *Pet or no Pet* (to differentiate P + I and the IO groups), *Depressed Mood*, *Mental Health Functioning,* and *Social Support*. Note that in order to be able to compare the results of the two regressions, the *Pet Relationship* scores for the 20 (PO & P + I) participants with pets were not included in the PDS regression, so follow-up regressions were conducted in which *Pet Relationship* scores were included for the 20 (PO & P + I) participants.

The overall model for IDS was not significant; none of the variables were significant predictors of vocal emotion in IDS, and speaker characteristics accounted for only 4% of the variance. In contrast, the overall model for PDS was significant ($F_{(4,\ 15)} = 6.8$, $p < 0.01$), with speaker characteristics accounting for 60% of the total variance (see Table 4). Vocal emotion in PDS was significantly predicted by both social support ($\beta = 0.74$, $p < 0.001$) and whether the speaker also had an infant ($\beta = -0.52$, $p < 0.05$). That is, both the pet-owners' perception of stronger social support and their absence of an infant were associated with greater vocal emotion in PDS. A follow-up regression that included *Pet Relationship* scores as a predictor, but excluded *Infant or No Infant*, was also significant,

Table 2. Means (*M*) and standard deviations (*SD*) for speaker characteristics.

	Mood (depression) *M (SD)*	Mental health functioning *M (SD)*	Social support *M (SD)*	Pet relationship *M (SD)*
Pet only	5.5 (5.8)	44.5 (10.4)	82.2 (12.6)	52.6 (10.7)
Infant only	5.3 (7.4)	52.3 (6.2)	87.3 (7.6)	N/A
Infant & pet	5.8 (4.8)	51.4 (6.2)	86.9 (9.4)	56.6 (14.0)

Table 3. Regression model for infant-directed speech.

Variable	*B*	*β*	*p* (*β*)
Pet or no pet	0.13	0.10	0.64
Social support	0.02	0.25	0.30
Mental health	−0.05	−0.44	0.16
Mood	−0.06	−0.54	0.08
(Constant)	2.67		0.20

Notes: $R^2 = 0.24$, Adj $R^2 = 0.04$.

Table 4. Regression model for pet-directed speech.

Variable	*B*	*β*	*p* (*β*)
Infant or no infant	−0.60	−0.52	0.01
Social support	0.04	0.74	< 0.001
Mental health	0.02	0.28	0.19
Mood	0.00	0.00	0.99
(Constant)	−2.96		0.02

Notes: $R^2 = 0.64$, Adj $R^2 = 0.60$.

with speaker characteristics accounting for 50.5% of the total variance and the social support variable ($\beta = 0.66$) remaining significant ($p < 0.05$). However, *Pet Relationship* ($\beta = 0.156$) was not a significant predictor; and a further regression with just the three sub-scales of *Pet Relationship* – affectionate companionship, equal family member status, and mutual physical activity – revealed no significant effects.

Discussion

The results of this study highlight differences between PDS and IDS – the effect of having a young infant on a speaker's degree of vocal emotion in their PDS and vice versa – and the influence of speaker variables on vocal emotion in PDS and IDS. The following results were found with respect to the three hypotheses set out in the introduction.

Objective (a) – Relative Degree of Vocal Emotion in PDS and IDS

The previously found greater degree of vocal emotion in IDS than in PDS (Burnham et al., 2002) was supported: there was more vocal emotion overall in IDS than in PDS. This is supported by the significantly greater vocal emotion in IDS than PDS in the P + I group, the large effect size for the greater vocal emotion in IDS in the IO group versus PDS in the PO group, and the significant overall greater vocal emotion in IDS than PDS in the 2 × 2 ANOVA (PDS/IDS x one/two recipients). However, the presence of an IDS > PDS difference in the degree of vocal emotion in the two registers by no means implies there was low vocal emotion or even negative vocal emotion to pets. In Burnham et al. (2002), in which vocal emotion was measured in IDS, PDS, and ADS, it was found that vocal emotion was greater in IDS than in PDS. But in both PDS and IDS, the levels of vocal emotion (PDS, 1.18; IDS, 1.67) were much higher than in ADS (0.14), and so well above the amount of vocal emotion in normal everyday speech to another adult. While there were no measures of vocal affect in ADS in this study, these values are comparable with those for vocal emotion in PDS and IDS in the P + I group in Figure 1 (0.83, 1.79), and there is no reason to expect any difference here.

Objective (b) – One Addressee or Two?

There is an effect of having both a pet and an infant on the degree of vocal emotion. As in the P + I group here, and as in all the human participants in Burnham et al. (2002), having both a pet and an infant, compared with only a pet, actually reduces the degree of vocal emotion in PDS. This is shown by the fact that there was significantly greater vocal emotion in IDS than PDS in the P + I group but not between IDS and PDS in the IO and PO groups, respectively. However, this evidence is not unequivocal. As we pointed out earlier, the IDS versus PDS in the IO and PO groups effect approached significance and had a large effect size. However, there are two additional pieces of evidence to suggest that having an infant as well as a pet may in fact reduce vocal affect to the pet. First, inspection of Figure 1 shows *higher* vocal emotion in IDS in the P + I group than in the IO group, but *lower* vocal emotion in PDS in the P + I group compared with the PO group. While these differences are not significant, it would be of interest to repeat this study with greater power (i.e., a larger sample size). Second, the regression analyses show that when entered as a predictor, having an infant (as well as a pet) negatively affects vocal emotion in PDS.

Objective (c) – Speaker Characteristics and Vocal Emotion

Speaker characteristics can affect vocal emotion, but only when the speaker is speaking to a pet. The IDS regression analysis showed that none of the speaker characteristics predicted vocal emotion in IDS irrespective of whether the speaker also had a pet. The PDS regression analysis showed that social support had a significant positive effect on vocal emotion and that having an infant (as well as a pet) had a negative effect on vocal emotion. Now, as mentioned earlier, this does not imply that there was low vocal emotion or even negative vocal emotion to pets when the owner also had an infant. It is simply that vocal emotion was lower when the owner also had an infant. The aspect that is both curious and interesting is that PDS vocal emotion was affected by two speaker variables whereas IDS vocal emotion was unaffected by speaker variables.

The Effect of Motherhood on Vocal Emotion in PDS

With respect first to the effect that having an infant has on PDS vocal emotion, a simple divided-attention explanation is not viable because there is no evidence here for the opposite, an effect of having a pet on IDS vocal emotion. So, what to make of these differences? One possibility is that emotion in mothers' IDS appears to take precedence over that in their PDS. This is consistent with, but by no means necessarily supported by, the notion that IDS is related to early infant attachment (Burnham et al., 2002; Kitamura & Burnham, 2003) and that IDS facilitates emotional attunement between infants and mothers (Field, 1985). In this regard, results from two recent studies are of note.

First, there is now evidence that infants themselves play an important role in eliciting IDS from their parents and other interlocutors through subtle cues of which the interlocutor (and presumably the infant) are unaware (Kalashnikova et al., 2020; Lam & Kitamura, 2012). That this is the case in human parent–infant dyads might assist in explaining the higher emotion in mothers' IDS than in their PDS. However, the evidence so far is one-sided – we require similarly detailed investigations of nonhuman parent–infant dyads before any conclusions can be drawn.

Second, in a three-dimensional electromagnetic articulography study, Kalashnikova et al. (2017) found that IDS does not differ from ADS in terms of specific differences in articulation. Rather, when adults talk to infants the only articulatory difference is that there is an overall raising of the larynx compared with when they talk with other adults. The higher the larynx, the shorter the vocal tract, and the shorter the vocal tract, the higher the pitch of vocalizations. While this may suggest that (1) there is a phylogenetic basis for this specific difference (i.e., heightened pitch) between IDS and ADS in humans (Falk, 2004; Ohala, 1984) or (2) heightened pitch is used by human parents to express vocal emotion and emotionally regulate their infants (Fernald, 1992a; Fernald et al., 1989), such arguments are undermined by the fact that other nonhuman species use pitch variations to signal size and degree of threat, with high pitch signifying smallness and non-threat, and low pitch signifying largeness and threat (Fitch, 1997, 1999; Morton, 1977; Ohala, 1984).

Moreover, functional use of high versus low pitch vocalizations is not unique to humans, and further, the functional use of high versus low pitch vocalizations in humans is *not only* and *not always* evident in speech to infants. In studies of Quiché Mayan parents' speech to their children, Pye (1986; Ratner & Pye, 1984) found that Quiché Mayan IDS (1) does not entail heightened pitch, (2) contains only a few of the 17 features that Ferguson (1978) lists in speech to children, and (3) contains eight additional features (e.g., whispering) not listed by Ferguson (1978), the latter showing that IDS can occur without heightened pitch. Additionally, Ratner and Pye (1984) state that in Quiché Mayan adult-to-adult speech, there is a heightened pitch speech register used as a form of deference to show respect for higher status addressees.

So, while there appears to be an articulatory antecedent of higher pitch to infants (larynx raising; Kalashnikova et al., 2017) in English language IDS, such functional use of heightened pitch in speech is not unique to humans (Fitch, 1997; 1999; Morton, 1977; Ohala, 1984) and is not always manifested in speech to infants in other languages (Pye, 1986; Ratner & Pye, 1984). Therefore, explanations of differences in vocal affect in IDS and PDS based on "special" antecedents for pitch variation in IDS are not valid as pitch is neither a necessary nor sufficient condition for the IDS register. Clearly, further research is required before definitive answers to the IDS/PDS issue can be resolved.

Another, simpler, explanation of why there is more vocal emotion in IDS than in PDS could be that mothers of young infants may well have less time to interact with their dog than do non-mothers. The measure of vocal emotion here is a composite of elements of positive affect, expressed affection, and soothing/comforting evident in the voice. As the factor analysis effectively removed any attentional or directive elements of speech, it is a valid measure of emotion. However, there are still aspects that must be sacrificed to obtain this measure: it is a composite of different types of emotional interaction taken at certain limited points in time, and it does not consider when and under what conditions emotional interactions occur. Thus, there remain many nuances yet to be investigated in the comparison of vocal emotion and more broadly regarding how emotion in different speech registers (PDS and IDS), might bear on the other.

The Effect of Social Support on Vocal Emotion in PDS

A most intriguing finding here is the predictive link between perceived social support and vocal emotion, a link that is only evident in PDS. A possible reason for this is that a higher level of social support leads to happier speakers, in turn leading to more affection in the voice. However, to check this we found that the correlations between social support and mood/mental health were very weak (0.0 and 0.07, respectively), so, while not definitive, this explanation is unlikely. Although no causal conclusions can be drawn, it is possible that the relationship between social support and vocal emotion in PDS reflects a third unmeasured personality factor such as, for example, "agreeableness," which has been linked with positive social relations (Schmutte & Ryff, 1997). A more interesting speculation is that if people have the opportunity to interact with a pet, and if they use that opportunity to its full benefit, then they may be more inclined to be nice/agreeable to other humans, with better social support ensuing. In this context, pet ownership has been found to be associated with some forms of social interaction (e.g., chatting while walking the dog) and with perceived neighborhood friendliness (Wood et al., 2005). Further research is required to examine whether the present results extend to speech directed to pet cats, which are not usually associated with this type of social interaction. In general, these results support previous assertions that human social support (and other non-pet factors) critically contribute to the complex links between pet ownership and health (Duvall Antonacopoulos & Pychyl, 2010; Winefield et al., 2008).

Other Speaker Variables

With regard to the effect of speaker variables on vocal emotion, neither depressed mood nor mental health functioning significantly predicted vocal emotion in either IDS or PDS. However, as there was no evidence of post-natal depression in the mothers here and all the participants had normal mental health functioning (within one standard deviation of the US SF-12 scale average), it is possible that the variance in these mood and mental health data was too restricted to predict differences in vocal emotion in either IDS or PDS.

Surprisingly, there was no relationship between scores on the Pet Relationship Scale and *Vocal Emotion* in PDS. This might suggest a difference between reporting of an affectionate attachment to a pet and the expression of that affection in PDS in real-life face-to-face interactions. That is, the source of this apparent discrepancy may be the nature of the Pet Relationship Scale that we used; it is possible that other pet relationship scales may better incorporate traditional components of Bowlby's (1969) attachment theory while placing less emphasis on routine daily care of the animal (Crawford et al., 2006; Winefield et al., 2008). However, attachment and emotion are quite separate constructs; we feel that a more likely source of this apparent discrepancy between the questionnaire and vocal emotion is the nature of the vocal emotion measure itself. Our measure of emotion is vocal emotion in which naïve raters rate the degree of emotion in low-pass filtered speech, speech that includes the prosody of the speech but excludes the semantic aspect of speech. In future research, it would be interesting to have separate measures of (1) prosodic emotion (the vocal emotion here), (2) semantic emotion, in which rather than removing word identity by low-pass filtering, speech with clearly audible words is presented in a monotone by removing all intonation from the speech (using, e.g., STRAIGHT; Kawahara & Morise, 2011), and (3) prosodic + semantic emotion (i.e., normal, unaltered speech). Then more extensive analyses of the differences between emotion in PDS and IDS could be undertaken, as well as between the components of emotion in PDS and IDS and perhaps an extended range of social, health, and psychological questionnaires.

Limitations

One limitation of this study is that the age of the pet dogs varied but was not systematically controlled. In this regard, it would be of interest to expand the preliminary findings of Kim et al. (2006) on the effect of the age of the pet on emotion in the voice of the speaker. If "maternal instinct" in part determines the level of emotion, one would predict more vocal emotion in speech to puppies than to grown dogs, and vocal emotion in PDS to puppies may be more similar to that in IDS. Further research could also measure vocal emotion in PDS before and after the birth of a baby. Finally, pet owners and parents were given instructions and the tools for their interactions, but we left the participants to choose time and place. So, we did not systematically investigate the conditions under which the PDS and IDS were collected. Obviously, feeding an infant is generally more interactive than putting food in a bowl, while playing fetch with a dog may be more interactive than changing an infant. Future studies should examine contexts more finely.

In this regard, it should be noted that the index of vocal emotion extracted from the CIS in this study was the *Affect* factor which loaded highly on positive affect, expressed emotion, and soothe or comfort, which are all the sorts of vocal productions that would occur both if the recipient was reasonably passive (infants) or more active (dogs). More boisterous behaviors (mostly by dogs) and thus corresponding vocal productions would be leached from the *Affect* factor by the independent *Attention* factor, which loaded highly on encourage attention and direct behavior (see Table 1). However, there are no data in this study to support such musings. So, future studies should examine more finely the contexts in which certain behaviors by dogs or infants occur and the corresponding vocal productions by carers or parents.

Conclusions

There is high vocal emotion in pet owners' and parents' speech to their dogs and infants, yet vocal emotion in speech to infants is higher than that in speech to their dogs. This difference in the degree of vocal emotion to pets and infants is more pronounced when comparing speech within the same individuals (those with a dog and an infant) than when comparing speech between individuals who have only a dog or only an infant. The strength of social support has a positive effect on vocal emotion in PDS but not on vocal emotion in IDS. Having an infant has a negative impact on vocal emotion in an owner-parent's PDS, but having a pet has no impact on vocal emotion in an owner-parent's IDS. While it is tempting to conclude that IDS is more intransigent and less affected by external factors, whereas PDS is more tractable and more affected by external factors, there are several issues yet to be addressed in relation to emotion in speech to infants and pet dogs. The results of this study draw attention to these IDS-versus-PDS issues and, more broadly, to fruitful avenues for further research regarding the nature, expression, and function of emotion in specific speech registers.

Notes

1. Fernald (1992b) did not propose a function like "4. pretending that the other is a conversant," but it should be noted that as IDS research has now progressed, there are indications that interlocutors are actually responding (not pretending) to conversant-like behaviors by infants (see Kalashnikova et al., 2018, 2020).
2. Similar results regarding attention and pitch have been found with infants listening to IDS (Fernald, 1985; Fernald & Kuhl, 1987).
3. Where η_p^2 around 0.01 is considered "small," around 0.06 "medium," and 0.14 and higher "large."

Acknowledgements

The data and initial analyses for this project were collected/conducted as part of a Master of Psychology thesis by the second author. We thank Dr Elizabeth Beach for copy-editing and other assistance with the manuscript.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Funding

This research was funded by Institute Australian Research Council Discovery Grants (A79917254; DP00025567) and a MARCS Institute WSU Research Support grant to the first author.

References

Ben-Aderet, T., Gallego-Abenza, M., Reby, D., & Mathevon, N. (2017). Dog-directed speech: Why do we use it and do dogs pay attention to it? *Proceedings of the Royal Society B: Biological Sciences*, *284*(1846), 20162429. https://doi.org/10.1098/rspb.2016.2429

Berko-Gleason, J., & Weintraub, S. (1978). Input language and the acquisition of communicative competence. In K. E. Nelson (Ed.), *Children's language* (Vol. 1, pp. 171–222). Gardner.

Bowlby, J. (1969). *Attachment and loss vol. I. Attachment*. Hogarth Press.

Brown, R. (1977). Introduction. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 1–27). Cambridge University Press.

Burnham, D., Kitamura, C., & Vollmer-Conna, U. (2002). What's new pussycat? On talking to babies and animals. *Science*, *296*(5572), 1435–1435. https://doi.org/10.1126/science.1069587

Caldwell, A. R., Lakens, D., Parlett-Pelleriti, C. M., Prochilo, G., & Aust, F. (2022). *Power analysis with Superpower* [Book under development]. https://aaroncaldwell.us/SuperpowerBook/violations-of-assumptions.html

Castelli, P., Hart, L. A., & Zasloff, R. L. (2001). Companion cats and the social support systems of men with AIDS. *Psychological Reports*, *89*(1), 177–187. https://doi.org/10.2466/pr0.2001.89.1.177

Crawford, E. K., Worsham, N. L., & Swinehart, E. R. (2006). Benefits derived from companion animals and the use of the term "attachment". *Anthrozoös*, *19*(2), 98–112. https://doi.org/10.2752/089279306785593757

Duvall Antonacopoulos, N. M., & Pychyl, T. A. (2010). An examination of the potential role of pet ownership, human social support and pet attachment in the psychological health of individuals living alone. *Anthrozoös*, *23*(1), 37–54. https://doi.org/10.2752/175303710X12627079939143

Falk, D. (2004). Prelinguistic evolution in early hominins: Whence motherese? *Behavioral and Brain Sciences*, *27*(4), 491–503. https://doi.org/10.1017/S0140525X04000111

Ferguson, C. A. (1977). Baby talk as a simplified register. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 219–232). Cambridge University Press.

Ferguson, C. A. (1978). Talking to children: A search for universals. In J. H. Greenberg (Ed.), *Universals of human language: Vol. 1. Method and theory*. 203–224. Stanford University Press.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development*, *8*(2), 181–195. https://doi.org/10.1016/S0163-6383(85)80005-9

Fernald, A. (1992a). Human maternal vocalizations to infants as biologically relevant signals: An evolutionary perspective. In J. H. Barkow, L. Cosmides, & T. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 391–428). Oxford University Press.

Fernald, A. (1992b). Meaningful melodies in mothers' speech to infants. In H. Papousek, U. Jurgens, & M. Papousek (Eds.), *Nonverbal vocal behaviour* (pp. 262–282). Cambridge University Press.

Fernald, A., & Kuhl, P. (1987). Acoustic determinants of infant preference for motherese speech. *Infant Behavior and Development*, *10*(3), 279–293. https://doi.org/10.1016/0163-6383(87)90017-8

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mother's speech to newborns. *Developmental Psychology*, *20*(1), 104–113. https://doi.org/10.1037/0012-1649.20.1.104

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language*, *16*(3), 477–501. https://doi.org/10.1017/S0305000900010679

Field, T. (1985). Attachment as psychobiological attunement: Being on the same wavelength. In M. Reite & T. Field (Eds.), *The psychobiology of attachment and separation* (pp. 415–454). Academic Press.

Fitch, W. T. (1997). Vocal tract length and formant frequency dispersion correlate with body size in rhesus macaques. *The Journal of the Acoustical Society of America*, *102*(2), 1213–1222. https://doi.org/10.1121/1.421048

Fitch, W. T. (1999). Acoustic exaggeration of size in birds via tracheal elongation: Comparative and theoretical analyses. *Journal of Zoology*, *248*(1), 31–48. https://doi.org/10.1111/j.1469-7998.1999.tb01020.x

Garrity, T. F., Stallones, L., Marx, M. B., & Johnson, T. P. (1989). Pet ownership and attachment as supportive factors in the health of the elderly. *Anthrozoös*, *3*(1), 35–44. https://doi.org/10.2752/089279390787057829

Hirsh-Pasek, K., & Treiman, R. (1982). Doggerel: Motherese in a new context. *Journal of Child Language*, *9*(1), 229–237. https://doi.org/10.1017/S0305000900003731

Jeannin, S., Gilbert, C., Amy, M., & Leboucher, G. (2017). Pet-directed speech draws adult dogs' attention more efficiently than adult-directed speech. *Scientific Reports*, *7*(1), 4980. https://doi.org/10.1038/s41598-017-04671-z

Kalashnikova, M., Carignan, C., & Burnham, D. (2017). The origins of babytalk: Smiling, teaching or social convergence? *Royal Society Open Science*, *4*(8), 170306. https://doi.org/10.1098/rsos.170306

Kalashnikova, M., Goswami, U., & Burnham, D. (2018). Mothers speak differently to infants at-risk for dyslexia. *Developmental Science*, *21*(1), e12487. https://doi.org/10.1111/desc.12487

Kalashnikova, M., Goswami, U., & Burnham, D. (2020). Infant-directed speech to infants at risk for dyslexia: A novel cross-dyad design. *Infancy, 25*(3), 286–303. https://doi.org/10.1111/infa.12329

Kaplan, P. S., Burgess, A. P., Sliter, J. K., & Moreno, A. J. (2009). Maternal sensitivity and the learning-promoting effects of depressed and nondepressed mothers' infant-directed speech. *Infancy, 14*(2), 143–161. https://doi.org/10.1080/15250000802706924

Katz, G. S., Cohn, J. F., & Moore, C. A. (1996). A combination of vocal F_0 dynamic and summary features discriminates between three pragmatic categories of infant-directed speech. *Child Development, 67*(1), 205–217. https://doi.org/10.1111/j.1467-8624.1996.tb01729.x

Kawahara, H., & Morise, M. (2011). Technical foundations of TANDEM-STRAIGHT, a speech analysis, modification and synthesis framework. *Sadhana*, *36*(5), 713–727. https://doi.org/10.1007/s12046-011-0043-3

Kim, H., Dieehl, N., Panneton, R., & Moon, C. (2006, June 19). *Hyperarticulation in mothers' speech to babies and puppies* [Paper presentation]. XVth Biennial International Conference on Infant Studies, Kyoto, Japan.

Kitamura, C., & Burnham, D. (1998). The infant's response to maternal vocal affect. *Advances in Infancy Research*, *12*, 221–236.

Kitamura, C., & Burnham, D. (2003). Pitch and communicative intent in mother's speech: Adjustments for age and sex in the first year. *Infancy*, *4*(1), 85–110. https://doi.org/10.1207/S15327078IN0401_5

Kondaurova, M. V., Bergeson, T. R., Xu, H., & Kitamura, C. (2015). Affective properties of mothers' speech to infants with hearing impairment and cochlear implants. *Journal of Speech, Language, and Hearing Research*, *58*(3), 590–600. https://doi.org/10.1044/2015_JSLHR-S-14-0095

Krieman, J., Gerratt, B. R., Kempster, G. B, Erman, A., & Berke, G. S. (1993). Perceptual evaluation of voice quality: Review, tutorial, and a framework for future research. *Journal of Speech, Language, and Hearing Research*, *36*(1), 21–40. https://doi.org/10.1044/jshr.3601.21

Kuhl, P. K., Andruski, J. E., Chistovich, I. A., Chistovich, L. A., Kozhevnikova, E. V., Ryskina, V. L., Stolyarova, E. I., Sundberg, U., & Lacerda, F. (1997). Cross-language analysis of phonetic units in language addressed to infants. *Science*, *277*(5326), 684–686. https://doi.org/10.1126/science.277.5326.684

Lago, D., Kafer, R., Delaney, M., & Connell, C. (1988). Assessment of favorable attitudes toward pets: Development and preliminary validation of self-report pet relationship scales. *Anthrozoös*, *1*(4), 240–254. https://doi.org/10.2752/089279388787058308

Lam, C., & Kitamura, C. (2012). Mommy, speak clearly: Induced hearing loss shapes vowel hyperarticulation. *Developmental Science*, *15*(2), 212–221. https://doi.org/10.1111/j.1467-7687.2011.01118.x

McNair, D. M., Heuchert, J. W. P., & Shilony, E. (2003). *Profile of mood states manual: Bibliography 1964–2002*. Multi- Health Systems Inc.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). *Edits manual for the Profile of Mood States*. Educational and Industrial Testing Service.

Mitchell, R. W. (2001). Americans' talk to dogs: Similarities and differences with talk to infants. *Research on Language & Social Interaction, 34*(2), 183–210. https://doi.org/10.1207/S15327973RLSI34-2_2

Mitchell, R. W., & Edmonson, E. (1999). Functions of repetitive talk to dogs during play: Control, conversation, or planning? *Society & Animals*, *7*(1), 55–81. https://doi.org/10.1163/156853099X00167

Morton, E. W. (1977). On the occurrence and significance of motivation-structural rules in some bird and mammal sounds. *The American Naturalist*, *111*(981), 855–869. https://doi.org/10.1086/283219

Ohala, J. J. (1984). An ethological perspective on common cross-language utilization of F_0 of voice. *Phonetica*, *41*(1), 1–16. https://doi.org/10.1159/000261706

Panneton, R., Kitamura, C., Mattock, K., & Burnham, D. (2006). Slow speech enhances younger but not older infants' perception of vocal emotion, *Research in Human Development*, *3*(1), 7–19. https://doi.org/10.1207/s15427617rhd0301_2

Pye, C. (1986). Quiché Mayan speech to children. *Journal of Child Language*, *13*(1), 85–100. https://doi.org/10.1017/S0305000900000313

Raina, P., Waltner-Toews, D., Bonnett, B., Woodward, C., & Abernathy, T. (1999). Influence of companion animals on the physical and psychological health of older people: An analysis of a one-year longitudinal study. *Journal of the American Geriatrics Society*, *47*(3), 323–329. https://doi.org/10.1111/j.1532-5415.1999.tb02996.x

Ratner, N. B., & Pye, C. (1984). Higher pitch in BT is not universal: Acoustic evidence from Quiche Mayan. *Journal of Child Language*, *11*(3), 515–522. https://doi.org/10.1017/s0305000900005924

Ringrose, C. (2015). Pitch change in dog-directed speech. *Lifespans and Styles*, *1*(4), https://doi.org/10.2218/ls.v1i0.2015.1181

Scherer, K. R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin*, *99*(2), 143–165. https://doi.org/10.1037/0033-2909.99.2.143

Schmutte, P. S., & Ryff, C. D. (1997). Personality and well-being: Reexamining methods and meanings. *Journal of Personality and Social Psychology*, *73*(3), 549–559. https://doi.org/10.1037/0022-3514.73.3.549

Sherbourne, C. D., & Stewart, A. L. (1991). The MOS social support survey. *Social Science & Medicine*, *32*(6), 705–714. https://doi.org/10.1016/0277-9536(91)90150-B

Virues-Ortega, J., & Buela-Casal, G. (2006). Psychophysiological effects of human–animal interaction. Theoretical issues and long-term interaction effects. *Journal of Nervous & Mental Disease*, *194*(1), 52–57. https://doi.org/10.1097/01.nmd.0000195354.03653.63

Ware, J. E. Jr, Kosinski, M., & Keller, S. D. (1998). *How to score the SF-12 physical and mental health summary scales* (3rd ed.). The Health Institute, New England Medical Center.

Winefield, H. R., Black, A., & Chur-Hansen, A. (2008). Health effects of ownership of and attachment to companion animals in an older population. *International Journal of Behavioral Medicine*, *15*(4), 303–310. https://doi.org/10.1080/10705500802365532

Wood, L., Giles-Corti, B., & Bulsara, M. (2005). The pet connection: Pets as a conduit for social capital? *Social Science & Medicine*, *61*(6), 1159–1173. https://doi.org/10.1016/j.socscimed.2005.01.017

Wyrwich, K. W., & Yu, H. (2011). Validation of POMS questionnaire in postmenopausal women. *Quality of Life Research*, *20*(7), 1111–1121. https://doi.org/10.1007/s11136-011-9846-2