Research Report

NOT ALL LAUGHS ARE ALIKE: Voiced but Not Unvoiced Laughter Readily Elicits Positive Affect

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Abstract—*We tested whether listeners are differentially responsive to the presence or absence of voicing, a salient, distinguishing acoustic feature, in laughter. Each of 128 participants rated 50 voiced and 20 unvoiced laughs twice according to one of five different rating strategies. Results were highly consistent regardless of whether participants rated their own emotional responses, likely responses of other people, or one of three perceived attributes concerning the laughers, thus indicating that participants were experiencing similarly differentiated affective responses in all these cases. Specifically, voiced, songlike laughs were significantly more likely to elicit positive responses than were variants such as unvoiced grunts, pants, and snortlike sounds. Participants were also highly consistent in their relative dislike of these other sounds, especially those produced by females. Based on these results, we argue that laughers use the acoustic features of their vocalizations to shape listener affect.*

Although most people agree that laughter plays an important role in human social interactions, surprisingly little empirical information about this species-typical, nonlinguistic signal is available. An array of hypotheses concerning the occurrence of laughter have nonetheless been offered, with some emphasizing presumed links between laugh production and various emotional states (e.g., Apte, 1985; Darwin, 1872/1998; Keltner & Bonanno, 1997; Ruch, 1993), and others speculating on the messages or meanings conveyed by the sounds (e.g., Deacon, 1997; Grammer, 1990). Another approach has been to draw on constructs from classical ethology, treating laughter much like a specialized fixed-action pattern (Grammer, 1990; Provine & Yong, 1991).

Although we agree with some sentiments expressed in such accounts, we also contend that they are problematic. In particular, any successful approach to laughter must explain its substantial acoustic variability. For example, we recorded laughs from a large number of individuals as they watched humorous film clips either alone or with a same- or other-sex friend or stranger (Bachorowski, Smoski, & Owren, 2001b). We then examined numerous acoustic measures, including laugh rate, duration, and fundamental frequency (F_0). The latter is the frequency of vocal-fold vibration, with voiced laughs showing quasi-periodic oscillation and unvoiced laughs being aperiodic and noisier. Significant variability was found on all measures, with the most striking outcome being that laugh rate and acoustics were differentially associated with both the sex and the familiarity of the testing partner. These results present a problem for meaning-based and classical-ethology approaches, which typically propose that specific messages are being conveyed in stereotyped signals.

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We suggest instead that these acoustic differences are functionally important, and that vocalizers can use different laugh variants in a nonconscious yet strategic fashion (see Bachorowski et al., 2001b; Owren & Bachorowski, 2001a, 2001b). The basic premise is that nonhuman and human vocalizers alike shape listeners' affect using both direct effects of signal acoustics and indirect effects mediated by previous interactions (Owren & Rendall, 1997, in press). In this article, we are primarily concerned with the former: the immediate auditory and affective impact associated with acoustic features like abrupt onsets, high amplitudes, high F_0s, and dramatic F_0 modulations. Because such features are much more prevalent in voiced than unvoiced laughter, we hypothesized that participants would not respond equivalently to these two variants. Rather, we expected voiced laughter would demonstrate significantly greater affect-induction impact than unvoiced laughter.

EXPERIMENT 1

Our first approach was based on Grammer and Eibl-Eibesfeldt's (1990; Grammer, 1990) procedure, in which laughs were recorded from mixed-sex dyads consisting of strangers waiting for an experimenter to return from a purported telephone call. Of particular interest was the finding that the number of voiced laughs produced by individual females predicted their male testing partners' subsequently reported interest in them. This outcome indicates that some laughs may sway a listener's affective stance more than others. We therefore tested whether listeners hearing laughter over headphones would report more interest in meeting laughers who produced voiced rather than unvoiced sounds.

Method

Participants

Listeners were 8 male and 8 female Cornell University undergraduates. Each provided informed consent and was paid $6. All listeners were native English speakers without speech or hearing impairments.

Materials

Testing occurred in a room with five booths equipped with Beyerdynamic DT109 headphones (Farmingdale, New York) and TDT response boxes (Gainesville, Florida). Booths were operated from an adjacent room using TDT modules, a computer, and custom-written software (B. Tice & T. Carrell, http://hush.unl.edu/LabResources.html). Stimuli were prepared with these programs and SpeechStationII (Sensimetrics, Cambridge, Massachusetts).

Table 1. *Descriptive statistics associated with the stimulus set*

	Male laughs		Female laughs	
Statistic	Voiced	Unvoiced	Voiced	Unvoiced
Bout[a] duration (s)	0.93 (0.61)	1.28 (1.06)	0.76 (0.57)	0.57 (0.27)
Number of calls[b] per bout	4.08 (2.27)	5.11 (4.34)	4.12 (2.69)	2.30 (1.57)
Mean F_0[c] (Hz)	299 (159)		408 (157)	
Mean standard deviation of F_0[c](Hz)	22 (18)		33 (22)	
Mean minimum F_0[c](Hz)	266 (144)		352 (143)	
Mean maximum F_0[c](Hz)	330 (171)		448 (167)	
Mean range of F_0[c](Hz)	64 (52)		96 (70)	

Note. Standard deviations are in parentheses.
[a]A bout is an entire laugh episode.
[b]Calls are the discrete acoustic units that make up a laugh bout; each call corresponds to a laugh note or syllable.
[c]Statistics for F_0 were originally derived from F_0 measurements for each call within a bout (see Bachorowski, Smoski, & Owren, 2001a, 2001b). The statistics provided here were calculated for all calls within each sex.

Twenty-five voiced and 10 unvoiced sounds from each sex[1,2] were selected from the corpus recorded earlier (Bachorowski et al., 2001b). Voiced laughs varied in duration and mean F_0, but were largely harmonically rich, vowellike sounds. Unvoiced laughs also varied, for instance, including grunt-, cackle-, and snortlike sounds (see Table 1 for descriptive statistics and Fig. 1 for representative spectrograms).[3]

Procedure

Participants were told that the stimuli consisted of male and female laughter, and that they should rate each according to their interest in meeting the person who produced it. Response buttons were labeled "definitely interested," "interested," "not interested," and "definitely not interested."[4] Participants became accustomed to the procedure by rating 12 laughs not included in testing. The 70 test stimuli were presented in random order, and then repeated in a new random order. Maximum-amplitude-adjusted stimuli were heard at a comfortable level against low-amplitude background noise.

Analyses

The two dependent measures were mean interest-in-meeting ratings and associated standard deviations. Statistical tests relied on repeated measures analyses of variance, and post hoc contrasts used Tukey's honestly significant difference and Fisher's least significant difference methods.

Results and Discussion

Both male and female listeners gave significantly higher interest-in-meeting ratings to voiced than unvoiced laughs, $F(1, 14) = 14.10$, $p < .01$. Sex of the laugher and voicing interacted, $F(1, 14) = 28.31$, $p < .0001$, with post hoc comparisons showing that all means differed from one another. As illustrated in Figure 2a, participants were especially interested in meeting females who produced voiced laughs. Ratings were also high for voiced laughs from males, but slightly lower than for female versions. Listeners were less interested in meeting laughers after hearing unvoiced grunt- and snortlike sounds—particularly for female vocalizers. Sex of the listener did not interact with either voicing, sex of the laugher, or the two together.

Variability of interest-in-meeting ratings was also influenced by voicing, with main effects found for both voicing and sex of the laugher, $F(1, 14) = 6.30$, $p = .025$, and $F(1, 14) = 8.14$, $p = .01$ (Fig. 2f). In general, listeners were more consistent when evaluating unvoiced laughs than when evaluating voiced laughs. A concomitant interaction effect, $F(1, 14) = 7.29$, $p < .025$, was attributable to low variability in rating female unvoiced laughs. Thus, both male and fe-

1. We tested more voiced than unvoiced laughs so that associations between detailed aspects of voiced-laugh acoustics and listeners' responses could be examined. These outcomes are not reported here.

2. Ten listeners rated each stimulus according to both the perceived sex of the laugher and whether or not the sound was, in fact, a laugh. Listeners correctly identified the laugher's sex for 94% of voiced sounds, but were biased to perceive unvoiced sounds as being produced by males (92% correct for male and 54% correct for female versions; see Bachorowski, Smoski, & Owren, 2001a, for details concerning sex differences in laugh acoustics). Nearly all voiced (96%) and male unvoiced (96%) sounds were deemed to be laughs, whereas fewer female unvoiced sounds were (78%). One female unvoiced and one female voiced sound were not considered laughs by six and eight listeners, respectively. Both were one-syllable sounds, suggesting that expectancies concerning temporal characteristics influenced the listeners' evaluations.

3. Examples can be heard on the World Wide Web at http://www.psy.vanderbilt.edu/faculty/bachorowski/.

4. Position of the labels did not affect any outcomes.

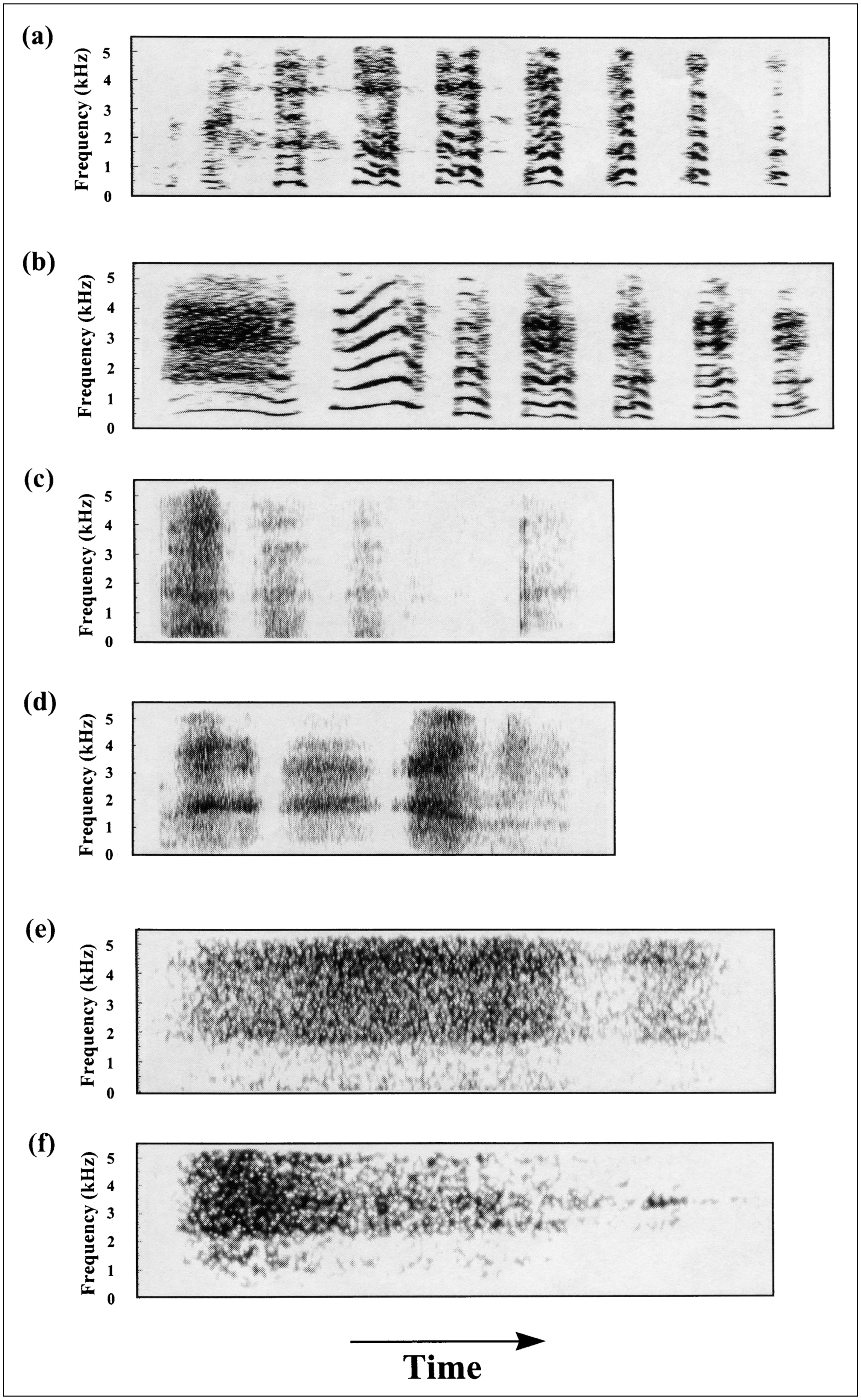

Fig. 1. Narrowband spectrograms of (a) male and (b) female voiced laughs, wideband spectrograms of (c) male and (d) female unvoiced gruntlike laughs, and wideband spectrograms of (e) male and (f) female unvoiced snortlike laughs.

Fig. 2. Mean listener ratings in Experiments 1 through 5 (a–e), and variability associated with those ratings (f–j). Error bars show standard errors. For each rating strategy, responses were coded using a scale from 1 (*most negative*) to 4 (*most positive*).

male listeners were comparatively uninterested in meeting females who produced unvoiced laughs, and were consistent about this.

Grammer and Eibl-Eibesfeldt (1990) found that male interest was partly predicted by the number of voiced laughs produced by female partners, but not the converse. Relying on a meaning and fixed-action-pattern perspective, Grammer and Eibl-Eibesfeldt argued that these and other outcomes indicate that laughter is a ritualized vocalization whose signal function is context-dependent and includes indicating that "this is play" in socially risky situations. However, that interpretation did not readily explain the sex difference observed or the different outcomes found for voiced and unvoiced laughs. Our results showed an analogous, albeit small sex difference in ratings of voiced laughter, but also that the voicing distinction had considerable impact on the interest reported by both male and female listeners. Our outcomes might thus actually be more consistent with the meaning-based perspective than those reported by Grammer and Eibl-Eibesfeldt, and do not clearly distinguish this interpretation from an affect-induction account. However, it is not evident why the "meaning" of male voiced laughter would have different effects in the two studies, if indeed a stereotyped signal is involved. We therefore conducted additional experiments in order to better distinguish meaning and affect-induction accounts.

EXPERIMENTS 2–5

To test whether the presence or absence of voicing was affecting listeners through differences in meaning versus affective responses, we presented the same set of laugh sounds in four additional experiments, but varied the particular judgment participants were requested to make. We reasoned that if the laughs were conveying specific meanings in each case, then participants in the different experiments would be evaluating and making sense of those messages in different contexts. Ratings would thus be variable across experiments, depending on the kind of evaluation involved. In contrast, if participants were basing their evaluations on the affect they themselves experienced as a result of hearing laughter with particular acoustic properties, the response induced would be similar irrespective of the evaluation context.

Method

Participants

Fourteen male and 14 female Cornell University undergraduates participated in each study and received $6 each.

Materials

The apparatus and stimuli were the same as in Experiment 1.

Procedure

The general procedures were the same as in Experiment 1, but the rating scales differed. In Experiment 2, listeners rated their own affective responses to the laughs, with choices ranging from "definitely positive" to "definitely not positive." In Experiment 3, listeners rated laughs for inclusion in a hypothetical laugh-track to accompany a humorous video, with choices ranging from "definitely include" to "definitely exclude." Listeners in Experiment 4 were told that some laughs are suspected to be warmer- or friendlier-sounding than others, and to rate the laughs as ranging from "definitely friendly" to "definitely not friendly." For Experiment 5, laughs were rated for sexual appeal using options that ranged from "definitely sexy" to "definitely not sexy."

Results and Discussion

Results of these studies were consistent with one another and with those of Experiment 1. Mean ratings of the listeners showed strong main effects of voicing, with voiced laughs always eliciting more positive responses than unvoiced laughs (all ps $< .0001$).[5] As shown in Figures 2b through 2e, interactions between voicing and sex of the laugher were significant irrespective of the evaluation involved ($p <$ .01 in Experiment 5 and ps $< .0001$ for the other experiments), although details varied slightly. Female voiced laughs were rated as being friendlier and sexier than their male counterparts, and male voiced laughs were not rated higher than female ones in any of these experiments. In contrast, female unvoiced laughs were never rated more positively than male unvoiced laughs, and received significantly lower scores for positive emotion and laugh-track use. Interactions between sex of the laugher and sex of the listener were significant for both laugh-track and sexiness evaluations (ps $< .01$). Female listeners were less likely than male listeners to endorse female laughs for a laugh track, and higher sexiness ratings were given to female laughs by male listeners than by female listeners.

Variability of the listeners' ratings was also consistent across studies. A main effect of voicing occurred in every experiment (ps $< .05$, .01, .025, and .0001 for Experiments 2–5, respectively), with listeners always being more consistent in evaluating unvoiced laughs than in evaluating voiced laughs (Figs. 2g–2j). The interaction between voicing and sex of the laugher was significant for laugh-track ($p < .0001$) and sexiness ($p < .025$) ratings, and approached significance for friendliness ratings ($p = .06$). As in Experiment 1, listeners more consistently disliked female unvoiced laughs than all other laughs.

5. Tables summarizing the results can be obtained from the first author.

GENERAL DISCUSSION

In these experiments, voiced laughter always elicited more positive evaluations than unvoiced laughter. This outcome occurred regardless of whether listeners rated their own responses (i.e., positive-emotion ratings), likely responses of other people (i.e., laugh-track inclusion), or perceived attributes of the laughers (i.e., interest in meeting, friendliness, and sexiness). Variability associated with the evaluations was also remarkably consistent across experiments, with significantly greater agreement regarding unvoiced than voiced versions.

Taken together, these results contradict the view that laughter is a uniform, stereotyped signal, and pose crucial problems for meaning- or message-based accounts. The results instead confirm that the acoustic variability readily documented in laughter (Bachorowski et al., 2001b; Bachorowski, Smoski, & Owren, 2001a) is in fact functionally significant to listeners. Furthermore, the remarkable consistency of laugh ratings in these five experiments strongly suggests that listeners were referencing their own affect in response to the sounds rather than some encoded message contained in each type of laugh. Although unvoiced laughs have received little attention, we (Bachorowski et al., 2001b) found them to account for more than half the total number of laughs recorded. Such a common type of laugh is unlikely to actually be aversive, but listeners in the present experiments were quite consistent in rating these sounds lower than voiced laughs, and liked them the least when the laugher was female. It is thus worth noting that female vocalizers in our earlier study produced disproportionately fewer unvoiced laughs than did males, in accordance with several other aspects of female vocal behavior in that study that were sensitive to likely listener responsiveness.

This affect-based perspective may also explain why Grammer and Eibl-Eibesfeldt (1990) found that listener's sex mediated reported interest in partners producing voiced laughs, whereas we did not (Experiment 1). If laughter functions primarily through its influence on the listener's affect, then acoustic properties associated with induction of arousal must also be important in these sounds (see Owren & Rendall, 1997, in press). For example, we (Bachorowski et al., 2001a, 2001b) have shown that voiced laughter can be endowed with exaggerated acoustic features, such as very high F_0s and strongly modulated frequency contours, that have in other contexts been associated with inducing and maintaining arousal in listeners (e.g., Fernald, 1992; Kaplan & Owren, 1994). Finding analogous features so prominently displayed in laughter produced in some social conditions but not others, we (Bachorowski et al., 2001b; Owren & Bachorowski, 2001b) have argued that females paired with male strangers should in particular make use of such sounds, whereas males paired with strangers of either sex should especially avoid them. It is therefore important that in Grammer and Eibl-Eibesfeldt's study, the unfamiliar person was actually present, whereas our participants heard disembodied laughs over headphones. Because being alone with a male stranger likely induces some wariness in females, the arousal-inducing properties of laughter may actually exacerbate that negatively tinged state, thereby offsetting any positive affect experienced. With no male present, however, our results should more clearly reflect only the affectively evocative properties of the laughs themselves. This interpretation can thus explain Grammer and Eibl-Eibesfeldt's failure to find a relationship between male voiced laughter and subsequent female interest, an outcome that is not well explained from a meaning-based perspective.

Clearly, major questions about laughter remain, particularly questions concerning the functional significance of unvoiced laughs. However, we believe that, taken together, the results of Grammer and Eibl-Eibesfeldt's (1990) study, our previous work on acoustic variation (Bachorowski et al., 2001a, 2001b; Owren & Bachorowski, 2001b), and the current experiments begin to form a pattern. The emerging picture is one of strategic laughing, with vocalizers tending to produce or not produce sounds in accordance with their own best interests in a given circumstance. We therefore suggest that rather than searching for encoded messages, researchers should investigate these vocalizations as an acoustic tool that humans use to sway listeners by inducing arousal and positive affect.

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