

THE DEVELOPMENT OF ANTIPHONAL LAUGHTER BETWEEN  
FRIENDS AND STRANGERS

By

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## CHAPTER I

### INTRODUCTION

Laughter is a highly common form of human vocal production that occurs in a wide variety of social circumstances. Given everyday experiences with laughter, it is not surprising to find that this signal is often theoretically linked to pleasurable states and circumstances. Specific hypotheses in this vein variously consider laughter to be an expression of positive internal emotional states (e.g., Darwin, 1872/1998; van Hooff, 1972), a signal of playful intent (e.g., Glenn, 1991/1992; Grammer & Eibl-Eibesfeldt, 1990), or a response to humor (e.g., Apte, 1985; Deacon, 1989; Weisfield, 1993). In addition to indicating internal state, laughter is also considered to induce arousal and affect in listeners (Bachorowski & Owren, 2001). The ensuing hedonic tone is thought to vary as a function of the listener's sex, current affective state, and relationship to the laugher (Owren & Bachorowski, 2003). In light of evidence that such induction effects do indeed occur (Bachorowski & Owren, 2001), I became interested in examining the temporal pattern of laughter between social partners. I more specifically wanted to determine whether the production of this affect-inducing signal is more closely time-locked between friends than between strangers.

#### *Social Functions of Laughter*

In thinking about laughter's functional significance, it is important to bear in mind that laughter is decidedly a social signal, as it is far more likely to be produced in the

presence of another individual than when alone. This basic effect has been observed in both naturalistic (Provine & Fischer, 1989) and laboratory settings (Bachorowski, Smoski, Tomarken, & Owren, 2004; Brown, Dixon, & Hudson, 1982; Devereux & Ginsburg, 2001; Young & Frye, 1966). The type of social partner also moderates both the rate of laugh production and the types of laughs produced. Males produce more laughs and more acoustically extreme laughs with their friends, especially their male friends. Females, on the other hand, produce more laughter with males than with other females, and more acoustically extreme laughs with stranger males (Bachorowski et al., 2004). One characteristic of laughter that has received little empirical attention is the *temporal* sequence of laugh production, or the degree to which social partners laugh together. Temporal association is an inherently social characteristic of laughter, as by definition it requires at least two laughers. Previous investigators have indicated that the laughs produced by two social partners can have differential temporal associations based on social partner characteristics. For example, mothers and toddlers show increasing temporal association of the laughter as the toddler enters the second year of life (Nwokah, Hsu, Dobrowolska, & Fogel, 1994). Additionally, temporal association in laughter correlates with the degree to which social partners endorse a desire to interact with one another (Grammer & Eibl-Eibesfeldt, 1990). However, there have been few attempts to rigorously quantify or understand such temporal associations.

One challenge in examining temporal associations in laughter is in defining and operationalizing the temporal relationship. Previous studies have likened the temporal relationship between social partners' laughs to a process of "contagion" (e.g., Provine, 1992, 2000). Rather than relying on either the term contagion, which suggests that

some behavior or agent has been unwittingly caught, or “reciprocal” (Nwokah et al., 1994), which can imply conscious intent, the term “antiphonal” laughter is used in this paper. Used in the animal literature to refer to co-occurring vocal signals (e.g., Biben, 1993; Snowdon & Cleveland, 1984), the application of the term to laughter refers to instances in which the laughter of one social partner co-occurs or is immediately followed by the laughter of another partner. I will use the term “antiphonal laughter” to refer to the full episode of dyadic laughter, including the initial laugh and the subsequent partner laugh. Within that two-laugh episode, I will refer to the first laugh as the “initial laugh” and the second laugh as the “subsequent laugh.”

#### *Affect Induction Model*

Antiphonal laughter is conceptualized as a form of affect induction that promotes affiliative, cooperative behavior between social partners (Owren & Bachorowski, 2003; Owren, Rendall & Bachorowski, 2003; see also Dimberg & Öhman, 1996; Keltner & Kring, 1998; Owren & Rendall, 1997; 2001). From this perspective, laughter has a two-pronged impact on listener affect. First, the acoustic properties of laughter themselves can have a direct impact on listener arousal and affect. In support of this direct-effect hypothesis, empirical evidence shows that particular kinds of laughs have acoustic properties that readily elicit positive affect in listeners (Bachorowski & Owren, 2001). Provine (1992, 2000) likened the impact of one laugh on another person’s behavior to a process of “contagion” and proposed that contagious laughter occurs due to the activation of a laugh-specific auditory feature detector and subsequent triggering of a “laugh-generator,” although the affective implications of this mechanism are unclear.

The direct effects of laughter may in some ways be comparable to the effects of facial expressions such as smiling and anger, which have been shown to elicit complementary responses in individuals viewing the expressions—even when perception is considered to be nonconscious (Dimberg, Thunberg, & Elmehed, 2000; see also Neumann & Strack, 2000).

Laughter is a highly variable acoustic signal that involves multiple vocal-production modes (Bachorowski, Smoski, & Owren, 2001). One of the most salient distinguishing features among production modes is the presence or absence of voicing. Voiced laughs are quasi-periodic and therefore have a fundamental frequency and a perceptible pitch. Unvoiced laughs are aperiodic and are perceived as sounding grunt-like or snort-like. The direct impact of a laugh on listener affect has been shown to be influenced by production mode. When listening to laugh sounds over headphones, listeners rated themselves as feeling significantly more positive in response to voiced versus unvoiced laughter. In comparison to laughers who produced unvoiced laughs, listeners also rated the producer of the laugh friendlier and sexier, and expressed more interest in meeting the producers of voiced laughs (Bachorowski & Owren, 2001; see also Bradley & Lang, 1999). Grammer & Eibl-Eibesfeldt (1990) found that individual male interest in further contact with his study partner was correlated with the amount of vocalized (but not unvocalized) laughter on the part of his female partner (here, vocalized laughter is presumed to be equivalent to voiced laughter). Thus, all laughs are not equal in their impact on listener response systems. In terms of laugh production, the ratio of voiced to unvoiced laughter is related to laugher sex, with females producing more voiced laughs than males (Bachorowski et al., 2001). The relative production of

voiced versus unvoiced laughs does not appear to be influenced by the affiliative status of laugh partners, with friends and strangers not found to differ in either the overall number of voiced or unvoiced laughs produced (Bachorowski et al., 2004). It is unknown, however, whether voiced or unvoiced laughter occurs more frequently in antiphonal laughter.

The second way that laughter is hypothesized to impact listener response systems is through comparatively indirect processes. In addition to the ability to directly impact listener affect, the acoustic properties of laughter contain perceptual cues to the individual identity of the laugher (Bachorowski et al., 2001). Given repeated pairings between individually distinctive acoustic properties and affect on the part of listeners, learned affect-related responses may occur in reaction to those individually distinctive acoustics. For example, a person may be repeatedly irritated in the presence of a boorish co-worker. Over time, simply hearing this co-worker's individually distinctive laugh may evoke annoyance. Likewise, repeatedly hearing a friend's laugh in the context of enjoyable social interactions may result in positive affect from simply hearing that friend laugh in the next room. The production of a subsequent laugh can be understood as a learned, positive affective response to the initiating laugh produced by an individual with whom one shares an ongoing positive relationship. Individuals who routinely laugh together in positive circumstances, such as friends, have the opportunity to associate the idiosyncratic acoustic features of a given friend's laugh with a positive emotional state.

### *Laughter and Affiliation*

Laughter, and especially antiphonal laughter, has been linked to greater satisfaction and desire for affiliation among social partners. In a “strangers meet” paradigm, Grammer & Eibl-Eibesfeldt (1990) recorded stranger dyads as they interacted with one another while ostensibly waiting for an experiment to begin. Participants then rated the degree to which they would like subsequent contact with their testing partner. The amount of laughter produced by a female partner, as well as the degree to which the dyad laughed together, predicted individual male interest in future contact with his partner. Individual female interest correlated with the degree to which she produced subsequent laughs following a laugh by her male partner. As only strangers were tested in this paradigm, it is unknown if antiphonal laughter also predicts interest in continued contact among friend or acquaintance dyads. Antiphonal laughter is also more frequent during pleasant and satisfying interactions. For example, antiphonal laughter occurred more frequently during doctor visits that were subsequently rated by patients as highly versus less satisfying (Sala, Krupat, & Roter, 2002). In addition, male business associates produced the highest ratio of subsequent laughs to single laughs when conversation members were discussing pleasant topics, such as what they did in their free time (Adelswärd & Öberg, 1998). In my previous work, friend and stranger dyads were audiorecorded while they played games together. Across both same- and mixed-sex dyads, friends produced significantly more antiphonal laughter than did strangers (Smoski & Bachorowski, 2003). Thus, affiliative status affects the degree to which social partners laugh together.

Although the association between laugh production and affiliative behavior has been shown in multiple contexts, the mechanism that links the two is in need of clarification. One possibility is that laughter is a by-product of a desire to affiliate. For example, interest in a partner could promote positive emotions or increased arousal, thus lowering the threshold at which laughter occurs. Empirical evidence to date does not, however, support this mechanism. If increased rates of laugh production were caused by a desire to affiliate, an individual's rate of laugh production should correlate with that individual's interest in his or her social partner. In the Grammer and Eibl-Eibesfeldt (1990) experiment, this was not the case: the amount of laughter produced did not correlate with the laugher's interest in his or her partner. This null effect was replicated in another experiment in which participants "interacted" with a videotaped opposite-sex confederate and rated their interest in future contact with the confederate (Simpson, Gangestad, & Biek, 1993). Participants who produced higher rates of laughter did not indicate greater interest in dating the confederate. Thus, it does not appear that social interest in a partner drives increased laugh production, at least among strangers.

Given that the overall rate of laugh production is not secondary to social interest, the possibility remains that laughter itself plays a causal role in relationship initiation and development. By promoting positive affect in listeners via direct and indirect induction effects, laughter may dispose a social partner to react positively. From a "broaden-and-build" perspective, this shared experience of positive affect builds and reinforces social relationships (Fredrickson, 1998, 2001). Likewise, an individual's laugh may indicate something about that person's attitudes or preferences. For example, if a person laughs

in response to something their partner also finds funny, laughter may serve to mark or tag a point of agreement between the partners. Empirical support for the notion of laughter as a marker of agreement is meager, but one study did attempt to test the relationship between cognitive similarity and laughter. Wolosin (1975) used a self-report measure to test participants for their cognitive similarities on a particular topic.

Participants were scheduled in same-sex groups of four individuals, and asked to tell each other jokes and funny stories for ten minutes. For males, the total amount of group laughter correlated with the cognitive similarity score for the group. For females, however, the correlation between group laughter and group cognitive similarity was non-significant. It is possible that individuals who hold similar attitudes are more likely to laugh at the same stimulus, thus reinforcing their cognitive similarities. This phenomenon could also be interpreted as another instance of indirect effects of laugh acoustics. If a person experiences repeated pairings of feeling pleasant (due to an external stimulus) and another person's laughter (due to the same external stimulus), this could promote a learned positive response to the laughter of their social partner. In summary, although laughing with a social partner is linked to liking and wanting to affiliate with that social partner, the mechanism explaining that link still requires examination. It does not appear that people laugh more simply because they like their partner more, but it is uncertain if partners laugh together because of acoustic properties of laughter, cognitive similarities, or a combination of factors.

## *Laughter and Personality*

A final factor that could influence laugh production is individual differences among laughers. Several personality characteristics have the potential to influence the rate and type of laugh production. Extraversion, a trait characterized by sociability, talkativeness, and cheerfulness, is a prime candidate for influencing laugh production. In fact, laughter is sometimes considered to be an indicator of extraversion: “I laugh easily” is an extraversion item on the NEO Personality Inventory (Costa & McRae, 1992), and Eysenck described extraverts as likely to “laugh and be merry” (Eysenck & Eysenck, 1975). Empirical support for a link between laughter and extraversion is equivocal, however. Across multiple studies, the correlation between laugh production and extraversion has been inconsistent (Ruch & Deckers, 1993). Ruch attributes the lack of consistent results to the measurement of laughter. He has found that when laughter is operationalized as involving symmetrical contraction of zygomatic major (associated with lip raising) and orbicularis oculi (associated with eye crinkling) muscles, laugh production does correlate strongly with self-report measures of extraversion (Ruch, 1994, 1997). This facial configuration has been dubbed a “genuine” or “Duchenne” smile, and is postulated by Ruch to be an indicator of intense enjoyment. This operationalization reflects only a small subset of everyday conversational laughter, however, and was specifically selected to disregard laughter used as “social signals” as opposed to “emotional displays” (Ruch, 1994).

Another individual characteristic that may relate to laugh production is emotional expressivity. Regardless of internal state, individuals may vary in the extent to which they display their emotions through facial, vocal, or gestural channels. People who are

high in emotional expressivity may have a lower threshold for laugh production, resulting in a higher rate of laugh production. The relationship between laugh production and emotional expressivity has not yet been tested empirically, although emotional expressivity has been shown to affect the production of positive facial expressions. For instance, self-reported emotional expressivity was found to correlate with the number, duration, and intensity of positive facial expressions when watching a happy film clip (Kring, Smith, & Neale, 1994). Emotional expressivity may correlate with increased laugh production across the board, or like extraversion, may be related solely to certain types of laughs.

### *The Present Study*

In the present study, stranger and acquaintance dyads were audiorecorded in three game-playing sessions over the course of their first semester of college. The study was designed to test several hypotheses concerning antiphonal laughter. It has been previously demonstrated that friends produce more antiphonal laughter than do strangers (Smoski & Bachorowski, 2003), but the strength and duration of the friendships in that study were not measured. The present study was designed to test the hypothesis that individuals produce increasing rates of antiphonal laughter during the development of new friendships. I predicted that the use of antiphonal laughter would increase over the three testing sessions, especially among dyads that were familiar with each other at the beginning of the study. Laughter sex is a second factor that might moderate the occurrence of antiphonal laughter. As measured by self report (Doherty, Orimoto, Singelis, Hatfield, & Hebb, 1995; Eisenberg & Lennon, 1983), behavioral

ratings (Doherty et al., 1995), and facial EMG (Dimberg & Lundquist, 1990), females have been shown to be more influenced than males by the emotional expressions of others. Females also produce more antiphonal laughter than males in mixed-sex dyads (Smoski & Bachorowski, 2003). Therefore, sex-based changes in antiphonal-laugh production over time was tested. Finally, the moderating effects of individual differences in key personality and affective characteristics on laugh production were examined.

## CHAPTER II

### METHODS

#### *Participants*

Data were collected in two consecutive waves, each beginning at the start of an academic year. A total of 108 Vanderbilt University undergraduates were recruited for participation, with 52 tested in Wave 1 and 56 in Wave 2. These individuals were tested as part of either a same- or mixed-sex acquaintance or stranger dyad. Participants primarily came from sections of General Psychology and received research credit towards that course. Those tested as part of a stranger pair were matched with an unfamiliar student by the experimenter, and verification that the two were indeed unfamiliar to each other occurred when they were introduced in the laboratory. Those tested as part of a same-sex acquaintance dyad were asked to bring a hallmate (not roommate) to the testing session. Hallmates were requested because they were thought to spend less overall time together than roommates, but would still have frequent exposure to one another as the semester progressed. Due to the single-sex structure of first-year housing at Vanderbilt, those tested as mixed-sex acquaintances could not be hallmates. Participants in that category were asked to bring a friend of the opposite sex, without housing restrictions. Acquaintances participating at the request of another participant received a total of \$20, but had the option of receiving General Psychology credit if they were enrolled in that course.

Participants were tested over three sessions, each one month apart. Complete three-session data is available for 45 of the 54 dyads tested. Each of the six dyadic contexts (e.g., male-male acquaintances) is represented by between 6 and 10 dyads with complete three-session data, and between 7 and 11 with at least two sessions of data. Session 1 data for 3 dyads were lost due to experimenter error. Session 2 data are missing for 3 dyads (due to experimenter error,  $n = 1$ ; and participant attrition,  $n = 2$ .) Session 3 data is missing for 5 dyads (due to equipment failure,  $n = 1$ ; and participant attrition,  $n = 4$ ).

Participants had a mean age of 18.04 years ( $SD = .40$ ) and primarily identified themselves as White ( $n = 87$ ). The remaining participants identified themselves as Black ( $n = 10$ ), Asian ( $n = 3$ ), Hispanic ( $n = 2$ ), subcontinent Indian ( $n = 1$ ), and of mixed decent ( $n = 3$ ). Two individuals declined to provide race information. Informed consent was obtained prior to testing, and participants were debriefed regarding the experimental focus on laughter after the third testing session. At that time, all participants gave written consent for the use of their laughter data.

### *Stimuli and Apparatus*

Twelve potential game items were tested in a pilot study, and the nine items that promoted the most laughter among pilot participants were used in the present study. A “warm-up” question (e.g., “If you could be romantic with any cartoon character, who would it be and why?”) was included before the game items to help accustom participants to the procedure. Laughs from the warm-up questions were not examined. Three game items were played in each session (see Appendix A). An example of a

game item is “Draw a picture of each other using the paper and crayons provided.” Instructions for the items were printed separately on index cards. Participants were instructed to work on each item for the full duration of a 3-min timer, although some dyads worked a bit longer than the designated interval.

Recordings were made using Audio-Technica Pro 8 headworn microphones (Stow, OH), which were connected through a wall conduit to separate inputs of an Applied Research Technology 254 preamplifier (Rochester, NY) located in a control room. Each signal was amplified by 20 dB and then recorded on separate channels of a Panasonic Professional SV-4100 digital audiotape (DAT) recorder (Los Angeles, CA).

### *Self-Report Measures*

Participants completed a background-information form and two personality measures at the beginning of Session 1. The background-information form requested information about factors that could affect acoustic features of the participant’s speech, such as smoking habits, history of speech or hearing disorders, and native language. The NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992), a 60-item self-report measure, was used to assess the personality domains of Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. Internal consistency coefficients for the domain scales range from .68 to .86, and normed means for college-age samples are available. The Emotional Expressivity Scale (Kring et al., 1994) is a 17-item scale that measures the extent to which individuals outwardly express their positive and negative emotions. It has been shown to have high internal consistency

(Cronbach's alpha = .91) and to correlate with the duration, frequency, and intensity of facial expressions.

At the end of each session, participants completed the McGill Friendship Questionnaire-Respondent's Affection (MFQ-RA; Mendelson & Aboud, 1999). This 16-item questionnaire has two subscales. One subscale measures positive feelings for a friend, and the other provides an index of friendship satisfaction. The factor structure of the MFQ-RA has been validated on two separate samples of undergraduates, and the measure has been found to correlate with friendship duration. In addition to the MFQ-RA, participants were asked if they were currently or had ever been in a romantic relationship with their partner, and were asked to rate their emotional state and perception of relative social dominance during the game session.

### *Design and Procedure*

Testing occurred in a comfortably furnished laboratory room. Participants were told that the study concerned social communication. Participants were seated in futon chairs positioned 0.9 m apart and separated by a low footstool. Game materials were located in a cart positioned next to the footstool. Participants were instructed to "Take turns reading the card instructions out loud to your partner, and follow the cards' instructions." The experimenter then left the room and monitored participants through the headphone output of the digital audiotape recorder. The experimenter did not communicate with participants during the games, and did not re-enter the testing room until the games had ended.

### *Laugh Selection and Behavioral Coding*

Laughter is broadly defined as being any sound that would be considered a laugh if heard under everyday circumstances (Bachorowski et al., 2001; Bachorowski et al., 2004). Laugh sounds thus include comparatively stereotypical, song-like laughs, as well as noisier grunt- and snort-like laughs. Laughs are further coded as being voiced or unvoiced. Voiced laughs are identifiable by a quasi-periodic waveform structure and an identifiable harmonic structure on a narrowband spectrogram. Unvoiced laughter is identifiable by a noisier waveform structure and the absence of harmonic structure in a spectrographic representation.

An instance of antiphonal laughter is defined as the production of a laugh by one member of a dyad that begins within a specified period following the onset of laugh production by the other member of the dyad. The antiphonal window of between 300 ms and 2800 ms was determined by examining the distribution of laugh latencies in the present study (see Results). Laugh-free periods are coded as “No Laughter.” Five behavioral codes were thus used: Participant 1 Voiced Laugh (V1), Participant 2 Voiced Laugh (V2), Participant 1 Unvoiced Laugh (U1), Participant 2 Unvoiced Laugh (U2), and No Laughter (N). These five categories comprise a mutually exclusive and exhaustive set in which codes cannot repeat. Codes were then concatenated into a behavioral sequence for each dyad. For example, a “V2-U1-U2-N-V1” sequence could mean that Participant 2 first produced a voiced laugh, Participant 1 began an unvoiced laugh 500 ms following Participant 2’s laugh, Participant 2 began an unvoiced laugh 2000 ms following Participant 1’s laugh, neither person laughed for more than 2800 ms, and the sequence concluded with a voiced laugh produced by Participant 1. Both the “V2-U1”

sequence and the “U1-U2” sequence in this example are instances of antiphonal laughter, with the first reflecting antiphonal laughter on the part of Participant 1, and the second reflecting antiphonal laughter on the part of Participant 2.

Coding was performed using ESPS/waves+ 5.3.1 digital signal processing software (Entropics, Washington, DC). Audio waveforms for both participants in a given dyad were viewed time-locked both to each other and to a labeling window. This procedure permits visual representation of the time-locked vocal utterances to within  $10^{-5}$ -s accuracy.

An index of antiphonal laughter was determined for each dyad using sequential analysis techniques implemented in the General Sequencer (GSEQ) for Windows version 4.1 (Bakeman & Quera, 2002). Yule’s Q was used as an index statistic to quantify the sequential association (Bakeman & Gottman, 1997; Bakeman, McArthur, & Quera, 1996; Yoder & Feurer, 2000). Unlike transitional probabilities (i.e., the probability of one partner laughing given the occurrence of the other partner’s laugh), Yule’s Q is not confounded with base rates of behavior. Yule’s Q meets the assumptions underlying the general linear model, including an approximately normal distribution with a mean of zero (Bakeman et al., 1996). As such, it is appropriate for use in parametric inferential statistics. Possible values of Yule’s Q range from -1.0 to +1.0, with a value of 0.0 reflecting no sequential association. In the present application, significant positive Yule’s Q values indicate more antiphonal laughter than expected by chance, whereas significant negative values indicate less antiphonal laughter than expected by chance.

## CHAPTER III

### RESULTS

#### *Antiphonal Laughter Timing Baseline*

The operational definition of antiphonal laughter requires a specified latency window in which a subsequent laugh must fall in order to be considered antiphonal. In previous studies, this window has ranged from 1 to 4 s (Provine, 1993; Nwokah et al., 1994; Smoski & Bachorowski, 2003; Wolosin, 1975), while others do not specify a window (e.g., Grammer & Eibl-Eibesfeldt, 1990; Sala et al., 2002). In order to best characterize the temporal range in which a following laugh occurs, I examined the distribution of laugh onset latencies from 300 ms to 4300 ms following the onset of a partner laugh. In order to reduce the possibility that a subsequent laugh was prompted by factors other than the partner's laugh (e.g., both laughing at the same external stimulus), subsequent laughs were excluded if they occurred too soon following an initial laugh to have been in response to that laugh's acoustic properties. A cut-off value of 300 ms was selected, as reaction times to produce non-word syllables following a stimulus average around 300 ms (e.g., Klapp, 2003). The 4300 ms limit was used because no previous study had examined an onset latency longer than 4 s, and delays longer than 4 s were deemed unlikely to be connected to the previous laugh. The limit was extended from 4 s to 4300 ms in order to allow for equal division into 500 ms groups.

The onset latency for each laugh was calculated for all participants. In other words, for each laugh, I first determined if there was an initial partner laugh, and then calculated the duration between the onset of the initial laugh and the onset of the target subsequent laugh. This was accomplished via custom-written computer scripts. Laughs were excluded from analysis if there was no initial partner laugh, or if the initial laugh occurred less than 300 ms or more than 4300 ms before the target laugh. A total of 631

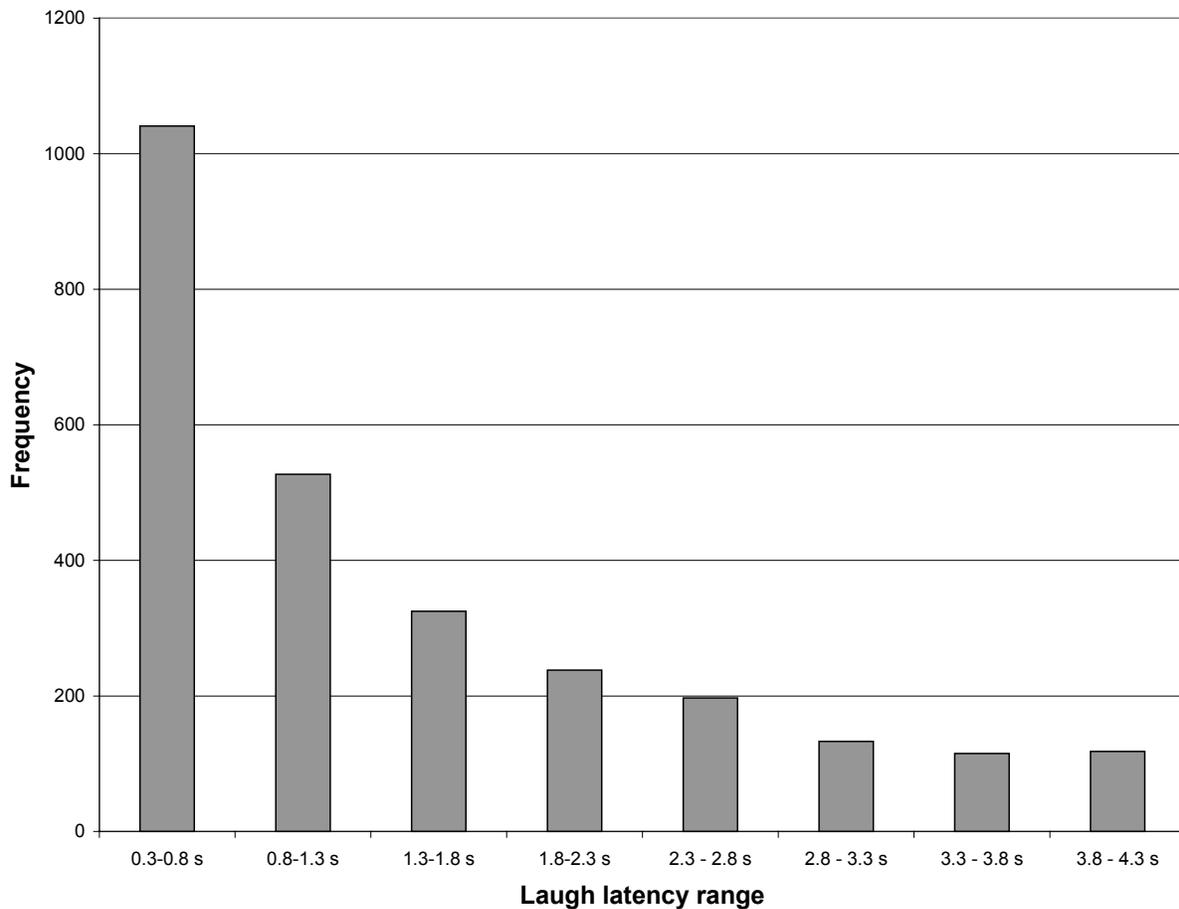


Figure 1. *Frequency Distribution of Latencies between Initial Laughs and Subsequent Laughs.*

laughs were excluded for occurring less than 300 ms before the target laugh. The 2694 remaining eligible laughs were then sorted into eight 500 ms bins, resulting in a frequency count of the number of laughs occurring between 300 - 799 ms, 800 - 1299 ms, 1300 - 1799 ms, etc., following a partner laugh. The frequency distribution is shown in Figure 1. A Kolmogorov-Smirnov test confirmed that the frequency distribution is not normal ( $z_{KS} = 7.37, p < .001$ ). Visual examination of the distribution suggested that laugh latencies were concentrated close to the initial laugh, with an eventual tapering of frequency in the right tail of the distribution. The criterion for antiphonal laughter was established as subsequent laugh onset between 300 ms and 2800 ms following the onset of an initial laugh. This criterion represents 86.4% of potential antiphonal laughs within the preliminary window of 4.3 seconds following onset of a partner laugh. The 500 ms bins beyond the 2800 ms bin each contain less than 5% of the sample of potential antiphonal laughs.

### *Analytical Approach*

The effects of sex, experimental condition, participant characteristics, and change over time were analyzed with mixed-model analysis of variance implemented via SAS PROC MIXED (Singer, 1998). Linear mixed-model techniques were used in order to provide greater flexibility in accounting for the potential covariance of laugh behavior between dyad members. Sex, condition (same- or mixed-sex friend or stranger), and the interaction between sex and condition were modeled as fixed effects. Dyad membership was modeled as a repeated factor, with error terms modeled with a compound symmetrical structure to allow for correlation between dyad members.

Restricted maximum likelihood was used to estimate all parameters. All fixed effects were tested using the Satterthwaite degrees of freedom, which provides a more accurate approximation of the correct degrees of freedom than residual or between- and within-subject degrees of freedom. (Please note that the Satterthwaite degrees of freedom are not necessarily whole numbers.) In modeling change over time, experimental session was modeled as a repeated factor. One benefit of a mixed-model approach in analyzing longitudinal data is that mixed models are more robust with regard to missing data than traditional repeated-measures ANOVA. Observations at each time point influence the estimates at every other time point, meaning that even incomplete data from a subject is used in creating models.

### *Sex and Familiarity Differences*

The antiphonal index for all participants was calculated, collapsing across “voiced” and “unvoiced” categories. Yule’s Q values were then averaged across sessions. A linear model testing the fixed effects of sex (male or female), condition (same-sex stranger, same-sex friend, mixed-sex stranger, or mixed-sex friend) and the Sex x Condition interaction on the production of antiphonal laughter was tested. A planned acquaintance versus stranger contrast was tested as well. No significant effects were found for sex, condition, the Sex x Condition interaction,  $F(1,100) = 1.26, p = .26$ ;  $F(3,100) = 1.66, p = .18$ ; and  $F(3,100) = .28, p = .84$ , respectively), or the acquaintance versus stranger contrast,  $F(1,100) = 2.15, p = .15$ .

### *Antiphonal Laughter and Voicing*

The influence of laugh type on antiphonal laugh production was tested. Separate Yule's Q values were calculated for voiced and unvoiced initiating laughs (e.g., V1 → [V2 or U2] for preceding voiced laughs). Likewise, Q values were calculated for subsequent laugh type (e.g., [V1 or U1] → V2 for voiced antiphonal laughs). Separate models were tested for each of the four conditions (voiced initial, unvoiced initial, voiced subsequent, and unvoiced subsequent laughs.) As in the previous analysis, fixed effects included sex, condition, and the interaction between sex and condition. Planned contrasts between acquaintances and strangers were also tested. Two additional models were tested to determine if voiced or unvoiced laughter is used more frequently as either an initial laugh or a subsequent laugh.

Different results were found for voiced versus unvoiced initial laughs. For voiced initial laughs, there was a trend for a main effect of sex,  $F(1,100) = 3.02, p = .085$ . Fixed effects of condition and the Sex x Condition interaction were nonsignificant,  $F(3,100) = 2.06, p = .11$  and  $F(3,100) = .34, p = .79$ , respectively. The acquaintance versus stranger contrast was nonsignificant,  $F(1,100) = .54, p = .46$ . Examination of the trend suggests that voiced female laughs are more likely to initiate antiphonal laughter than voiced male laughs, regardless of testing condition or acquaintanceship status. For unvoiced initial laughs, the fixed effects of sex, condition, and the Sex x Condition interaction were all nonsignificant,  $F(1,100) = .92, p = .34$ ;  $F(3,100) = 1.96, p = .13$ ; and  $F(3,100) = .09, p = .96$ , respectively). However, the acquaintance versus stranger contrast was significant,  $F(1,100) = 5.47, p = .02$ . Acquaintances were more likely to laugh following an unvoiced laugh than strangers were.

Likewise, different results were found for voiced versus unvoiced subsequent laughs. For voiced subsequent laughs, no significant effects were found for sex, condition, Sex x Condition, or the acquaintance versus stranger contrast. For unvoiced subsequent laughs, there was a main effect of condition,  $F(3,100) = 2.74, p = .05$ , and a significant acquaintance versus stranger contrast,  $F(1,100) = 4.89, p = .03$ . Acquaintances are more likely to use an unvoiced laugh following an initial partner laugh than strangers are.

Finally, models were fit to test if voiced or unvoiced laughter is more common as either an initial laugh or as a subsequent laugh. In the first model, voicing (voiced versus unvoiced laughter) was used as both a fixed effect and as a repeated effect in predicting antiphonal laugh index values. The antiphonal values were calculated based on the voicing qualities of the initial laugh. Covariance terms were blocked by dyad. The fixed effect of voicing was significant,  $F(1,161) = 29.11, p < .0001$ , indicating that voiced laughs were more effective in prompting a subsequent laugh than unvoiced laughs were. The second model again used voicing as both a fixed and a repeated effect, this time predicting antiphonal-index values based on the voicing quality of the subsequent laugh. Again, there was a significant effect of voicing,  $F(1,161) = 40.38, p < .0001$ , with voiced laughs used more commonly as subsequent laughs than unvoiced laughs.

### *Antiphonal Laughter over Time*

Linear growth models were used to test changes in antiphonal laughter use across the three sessions. sex, condition, and the interaction between sex and condition were specified as fixed effects, with session as a repeated effect. The covariance

pattern for the residual matrix was blocked by dyad, meaning that a common covariance value was estimated for all observations within a dyad. There was a significant interaction between sex and session,  $F(2, 236) = 3.61, p = .03$ . Males appeared to increase their use of antiphonal laughter over time, while females reduced their antiphonal laugh production over time. No other main effect or interaction was significant.

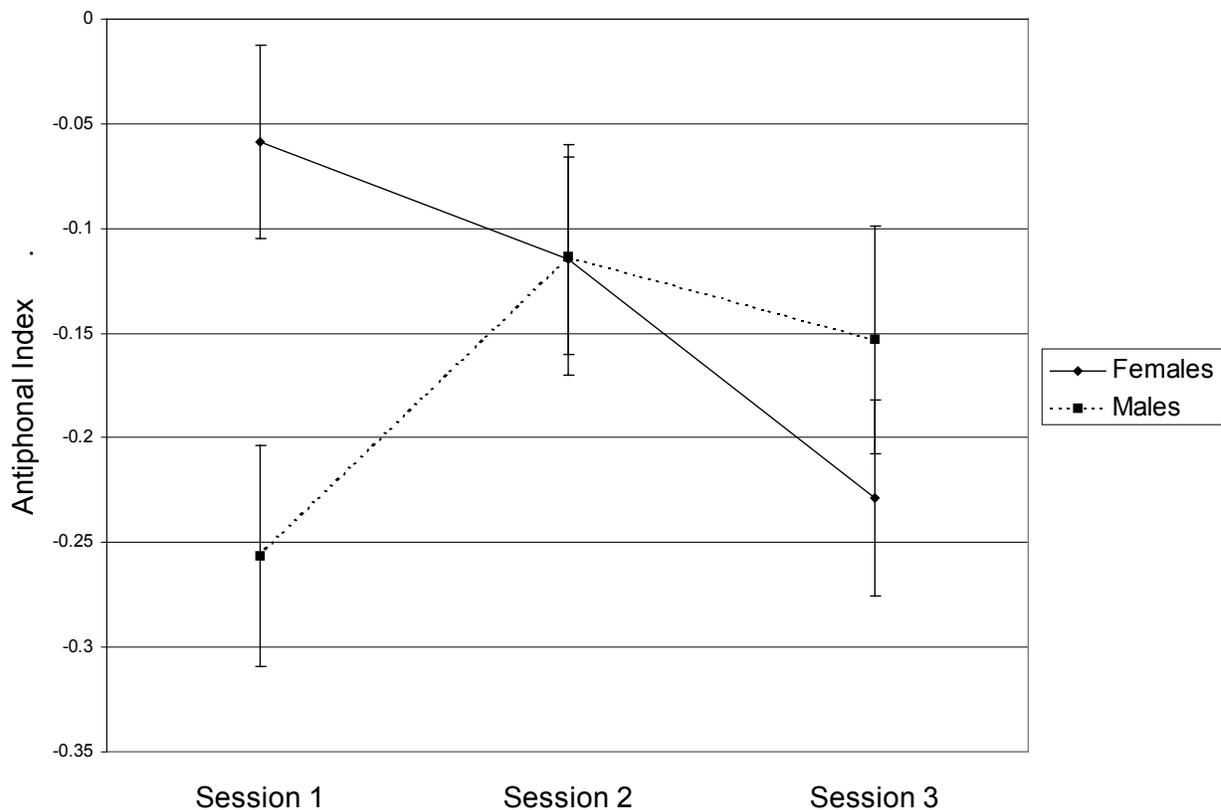


Figure 2. *Antiphonal Laugh Use Across Sessions by Sex*. Error bars represent standard error of the mean.

### Total Laugh Production

In addition to the study's primary focus on antiphonal laughter, it is of interest to examine the total amount of laughter produced by participants. The average number of laughs per session was tabulated for each participant, and is represented in Figure 3. Kolmogorov-Smirnov tests indicated that the count of laughs per session fit a normal distribution, and were thus appropriate for parametric tests. Separate mixed models were fit predicting voiced laughs per session, unvoiced laughs per session, and total laughs per session. Sex, condition, and the interaction of sex and condition were fitted

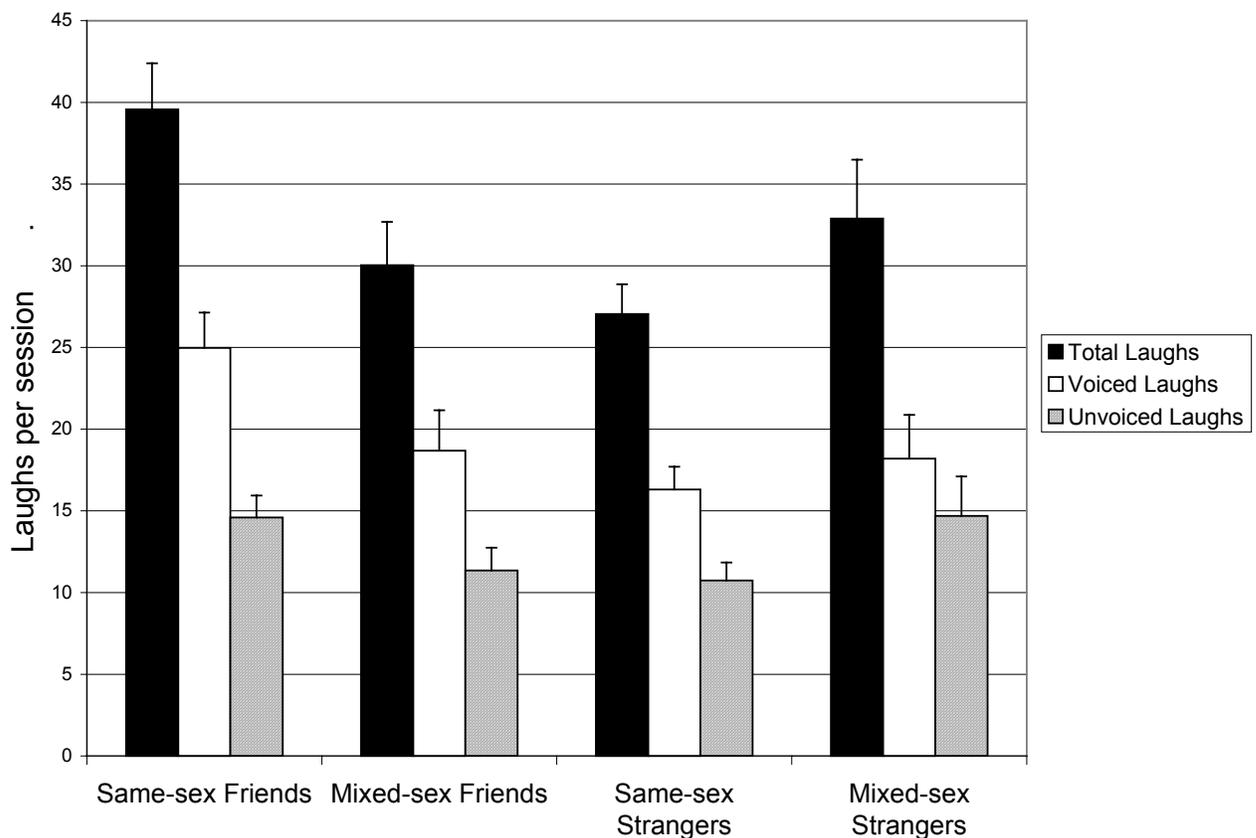


Figure 3. *The Average Number of Voiced, Unvoiced and Total Laughs per Session, Clustered by Dyad Condition.* Error bars represent standard error of the mean.

as fixed effects, with a common covariance term between dyad members. For total laughter, there was a significant effect of condition,  $F(3,100) = 4.91, p = .003$ . A planned contrast between acquaintances and strangers revealed a trend for acquaintances to produce more laughter than strangers,  $F(1,100) = 2.80, p = .098$ . Females and males appeared to produce equivalent amounts of laughter, as indicated by a non-significant main effect of sex, and the interaction of sex and condition was not significant. For voiced laughter, the main effects of both sex and condition were significant,  $F(1,100) = 10.78, p = .001$  and  $F(3,100) = 3.69, p = .01$ , respectively. Their interaction was not significant. Again, there was a trend for acquaintances to produce more laughter than strangers,  $F(1,100) = 3.79, p = .054$ . For unvoiced laughs, sex and condition were again significant,  $F(1,100) = 10.90, p = .001$  and  $F(3,100) = 2.88, p = .04$ , respectively. The directions of the main effects of sex differed between voiced and unvoiced laughter, with females producing more voiced laughter than males, and with males producing more unvoiced laughter than females.

### *Measurement of Friendship Strength*

Changes in friendship strength over time were assessed using growth curve models in which sex, condition, and session were fit as fixed effects and session as a repeated factor in predicting MFQ scores. Dyad members shared a common covariance value across sessions. Mean MFQ scores are presented in Table 1. There was a significant effect of condition,  $F(3,46.2) = 30.35, p < .0001$ , as well as a significant effect of session,  $F(2,231) = 5.64, p = .004$ . No other main effects or interactions were significant. Planned contrasts indicated that acquaintances rated each other more highly

than strangers did when averaged across all time points,  $F(1,46.1) = 63.83, p < .0001$ , and that all ratings increased linearly over time,  $F(1,231) = 11.24, p = .0009$ . There was a trend for same-sex dyad members to rate each other more highly than members of mixed-sex dyads.

Table 1. *Means and Standard deviations of McGill Friendship Questionnaire Scores Across Testing Sessions*

	Session 1	Session 2	Session 3
<b>Acquaintances</b>			
Mean	34.11	37.87	40.75
Standard Deviation	18.74	17.67	16.70
Sample Size	52	48	48
<b>Strangers</b>			
Mean	8.82	9.96	13.58
Standard Deviation	17.03	16.69	18.69
Sample Size	56	55	52

#### *Antiphonal Laughter and Friendship Strength*

It was of interest to test if the increased use of antiphonal laughter precedes, corresponds with, or follows friendship development. Two cross-lagged panel models (Finkel, 1995) were tested using AMOS structural equation modeling software. The general structure of the models is shown in Figures 4 and 5. Antiphonal laughter index scores and MFQ scores were specified as lagged endogenous variables at each of the three time points. Variables were standardized to check for outliers, and the MFQ score

for one participant at Session 2 was found to lie more than three standard deviations below the sample mean. This score was removed from the dataset for subsequent analyses. Mean centered scores were used in the model specification. Four measures were used to assess the overall fit of the models. The generalized likelihood ratio tests whether an over-identified model (i.e., a model with specified paths) is a worse representation of the data than a just-identified version of the model (i.e., a model in which all variables are allowed to covary). A significant chi-square value indicates that the over-identified model is a worse model than the just-identified model. The Comparative Fit Index (CFI) indicates the proportion of improvement of the specified model over an independence model, in which all observed variables are assumed to be uncorrelated. The Tucker-Lewis Index (TLI) also indicates a proportion of improvement, but includes a correction to minimize the bias towards more complex models having a better fit. CFI and TLI values closest to 1 are an indication of good fit (Kline, 1998). Finally, the root mean square error of approximation (RMSEA) was estimated, which measures differences between the model estimate and the data per model degree of freedom. Values of .05 or less are considered a good fit, and values of .1 or above are considered an unacceptable fit (Browne & Cudeck, 1993).

The first model examined the relationship between friendship strength and initial laugh production. In other words, does the degree to which a person initiates antiphonal laughter predict the degree to which that person considers their friendship to be strong (and vice-versa)? Path regression weights and fit index values are shown in Table 1. The overall fit of the model was acceptable, with all fit index values falling in the good to acceptable range. As indicated by significant path regression weights, the degree to

which a participant rated the friendship as strong was predictive of friendship strength at the next time point. Likewise, the degree to which a person initiated antiphonal laughter in the first session predicted initial laugh production in the second session. However, initial laugh production in Session 2 did not predict initial laugh production in Session 3. Friendship strength did not predict antiphonal laugh initiation at any time point, but initial laugh production in Session 2 did negatively predict ratings of friendship strength in Session 3.

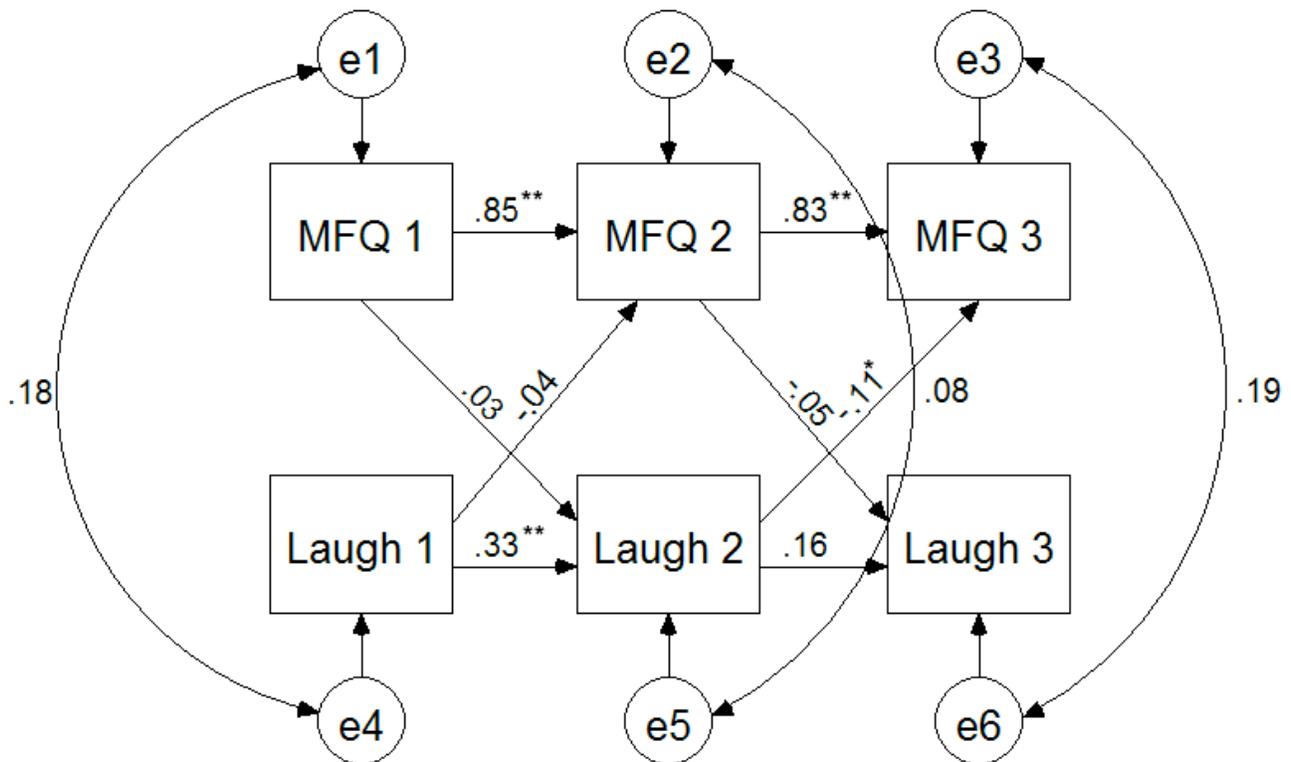


Figure 4. *Cross-Lagged Panel Model of Initiated Antiphonal Laughter and Friendship Strength*. Values are standardized regression weights and correlations. MFQ = McGill Friendship Questionnaire scores at Sessions 1, 2, and 3, respectively. Laugh = Antiphonal laughter index values. e1, etc. = error terms.

\*Significant at  $p < .05$ . \*\*Significant at  $p < .001$ .

Table 2. Analysis of a Cross-Lagged Panel Model of Initiated Laugh Production and Friendship Strength

Correlations						
Variable	1	2	3	4	5	6
1. MFQ 1	1					
2. MFQ 2	.84	1				
3. MFQ 3	.76	.82	1			
4. Laugh 1	.18	.14	.08	1		
5. Laugh 2	.10	.12	-.02	.33	1	
6. Laugh 3	.00	-.01	.06	.14	.15	1
<i>M</i>	21.93	24.48	27.71	-.15	-.11	-.19
<i>SD</i>	21.91	21.89	22.26	.37	.37	.35
Goodness of Fit Summary						
	$\chi^2$	<i>df</i>	<i>p</i>	TLI	CFI	RMSEA
	5.8	4	.23	.961	.993	.065

Note: MFQ values represent McGill Friendship Questionnaire scores at each session. Laugh values represent antiphonal laugh indices to each individual's initial laugh production.

The second model examined the relationship between friendship strength and subsequent laugh production. In other words, does the degree to which a person laughs following a partner laugh predict the degree to which that person considers their friendship to be strong (and vice-versa)? Path regression weights and fit index values are shown in Table 2. The overall fit of this model was less strong, but generally fell

within the acceptable range. As in the initial laugh model, the degree to which a participant rated the friendship as strong was predictive of friendship strength at the next time point. Likewise, the degree to which a person produced subsequent laughter in the first session predicted subsequent laugh production in the second session, but Session 2 laugh production did not predict Session 3 laugh production. Subsequent laugh production in Session 2 predicted higher ratings of friendship strength in Session 3.

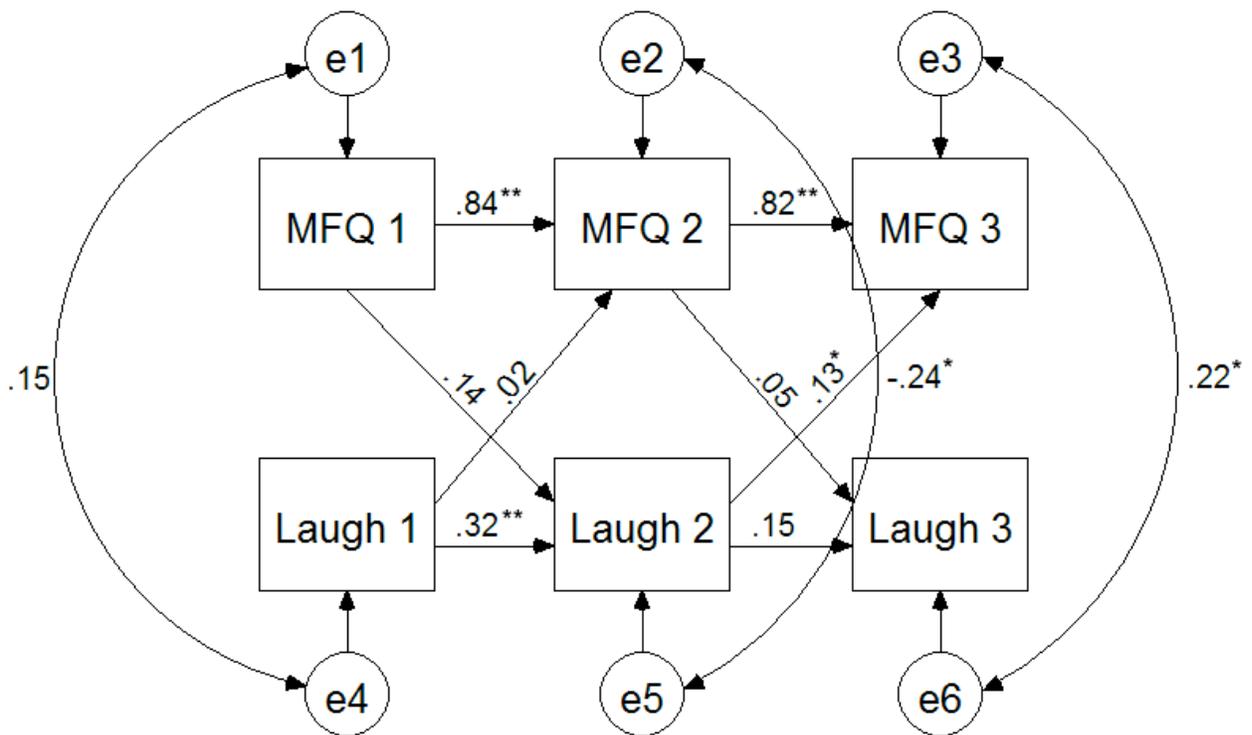


Figure 5. *Cross-Lagged Panel Model of Subsequent Antiphonal Laughter and Friendship Strength*. Values are standardized regression weights and correlations. MFQ = McGill Friendship Questionnaire scores at Sessions 1, 2, and 3, respectively. Laugh = Antiphonal laughter index values. e1, etc. = error terms.

\*Significant at  $p < .05$ . \*\*Significant at  $p < .001$ .

Table 3. *Analysis of a Cross-Lagged Panel Model of Subsequent Laugh Production and Friendship Strength*

Correlations						
Variable	1	2	3	4	5	6
1. MFQ 1	1					
2. MFQ 2	.84	1				
3. MFQ 3	.76	.82	1			
4. Laugh 1	.15	.15	.08	1		
5. Laugh 2	.15	.05	.17	.33	1	
6. Laugh 3	.00	.09	.19	.14	.15	1
Goodness of Fit Summary						
	$\chi^2$	<i>df</i>	<i>p</i>	TLI	CFI	RMSEA
	7.7	4	.11	.925	.983	.092

Note: MFQ values represent McGill Friendship Questionnaire scores at each session. Laugh values represent antiphonal laugh indices to each individual's initial laugh production. Means and standard deviations are identical to Table 2.

### *Antiphonal Laughter and Personality*

The effect of extraversion (as measured by the NEO-FFI) and emotional expressivity (as measured by the EES) on both overall and antiphonal laugh production was tested via a series of linear mixed models. Likewise, the effect of extraversion on friendship strength was examined.

Self-reported extraversion did not predict total laugh production,  $F(1,106) = 1.21$ ,  $p = .27$ , nor did it predict voiced or unvoiced laugh production,  $F(1,106) = 2.02$ ,  $p = .16$ ,

and  $F(1,106) = 0.00, p = .99$  respectively. It was originally hypothesized that extraversion might mediate a link between voiced laugh production and the rate of antiphonal laughter. Voiced laugh production does, in fact, predict antiphonal laughter,  $F(1,106) = 17.40, p < .0001$ . However, the addition of extraversion to the model did not reduce the significant relationship between voiced laughter and antiphonal responding,  $F(1,105) = 16.50, p < .0001$ , nor was the fixed effect of extraversion significant,  $F(1,105) = 0.15, p = .70$ .

Extraversion was more strongly related to friendship strength. Voiced laugh production and self-reported extraversion were used as fixed effects in a model predicting the partner's rating of friendship strength. Both effects were significant,  $F(1,105) = 6.97, p = .01$  for voiced laugh production and  $F(1,105) = 5.02, p = .03$  for extraversion. Thus both extraversion and voiced laugh production provide independent contributions to the prediction of friendship strength.

Self-reported emotional expressivity was tested as a fixed effect in predicting total laugh production. The effect was not significant,  $F(1,106) = 0.02, p = .89$ . Likewise, emotional expressivity did not predict antiphonal laugh production,  $F(1,106) = 0.05, p = .82$ . Separate analyses were performed for acquaintance pairs and stranger pairs, but no significant effects of emotional expressivity emerged. Moreover, emotional expressivity did not predict partners' perception of friendship strength,  $F(1,106) = 0.11, p = .75$ .

## CHAPTER IV

### DISCUSSION

Antiphonal laughter is thought to be one of the affect-related tools available to humans to help us negotiate the complex task of forming and maintaining cooperative relationships. Laughter itself is posited to promote positive affect in a social partner through direct and indirect effects on listener affect response systems. Laughing together with a partner may be mutually reinforcing, providing both members of a dyad with the opportunity to induce positive affect in a partner and to elicit a positive response to their own individually distinctive laugh acoustics. The present study demonstrates that an increased use of antiphonal laughter is present early in developing friendships, but only for unvoiced laughter. New acquaintances are more likely to produce a subsequent laugh following an unvoiced initial laugh than strangers are, and are also more likely to use unvoiced laughter as a subsequent laugh than strangers are. These results stand in contrast to previous work with presumably more established friendships, in which antiphonal laughter in general was more common in friends than in strangers (Smoski & Bachorowski, 2003).

The use of unvoiced laughs in antiphonal laughter by acquaintances may be related to indirect learning effects. Voiced laughs have been shown to have more direct effects on listener response systems than unvoiced laughs, promoting more positive affect and more positive ratings of the laugher (Bachorowski & Owren, 2001). This general effect is also apparent in the current study, as voiced laughs initiated antiphonal

laughter to a greater extent than did unvoiced laughs. Without a learning history in which the individual acoustic properties of an unvoiced laugh are associated with positive affect, unvoiced laughter may represent a weak affective stimulus. But with even a relatively brief learning history, unvoiced laughter may have increased value as an affect-related stimulus. It is unclear, however, why voiced laughs did not also show a benefit of indirect effects.

The timing of antiphonal laugh use in developing friendships remains somewhat of a mystery. Unlike a previous study (Smoski & Bachorowski, 2003), acquaintances in the present study did not produce more antiphonal laughter than strangers did at any of the three time points, implying that consistent use of antiphonal laughter may not develop until friendships are older or more established. In fact, the average antiphonal index in the study did not rise above 0, indicating that the use of antiphonal laughter was close to or below what one would expect given the base rate of laugh production from each partner. Statistically this would indicate that participants may have inhibited production of antiphonal laughter, with greater antiphonal laugh use indicating the lack of inhibition. Negative Yule's Q values are consistent with the behavior of strangers in a previous study (Smoski & Bachorowski, 2003). Changes in the use of antiphonal laughter initiated by either voiced or unvoiced laughs over the course of the study could not be determined because of sample restrictions: Not enough voiced or unvoiced laughter was produced in each session to derive a stable Yule's Q value. Given that acquaintances did produce more antiphonal laughter initiated by unvoiced laughs, increases in antiphonal laughter initiated by unvoiced laughter may occur earlier in

friendship development, with antiphonal laughter initiated by voiced laughter occurring later in development.

Tangential support for the hypothesis that antiphonal laughter promotes affiliation by inducing positive affect was demonstrated by comparing the interrelationship between antiphonal laugh production and friendship strength ratings. As predicted, the perceived degree of friendship strength in either the first or second session did not predict antiphonal laugh use in later sessions. Thus, it is not the case that perceived affiliation drives subsequent antiphonal laugh use, at least within the time frame studied. The finding that initial laugh production in Session 2 predicts lowered friendship strength in Session 3 was unexpected. Previous research found no effect of initiating “synchronized laughter” on subsequent interest in spending time with a stranger (Grammer & Eibl-Eibesfeldt, 1990), although the time to rating interest was immediate, as opposed to one month after laughing together. It is possible that production of subsequent laughs can have an aversive effect in early relationships or perhaps can cause negative interpretations on the part of the initial laugher, especially if he or she was not intending to initiate antiphonal laughter. On the other hand, the finding that subsequent laugh production in Session 2 predicts stronger friendship ratings in Session 3 is consistent with learning-based hypotheses. Producing a laugh following an initial laugh may indicate successful positive mood induction by the initial laugh, and as positive mood is conditioned to the individually distinctive acoustic signature of the initial laugher, perception of friendship strength may increase.

Personality characteristics had remarkably little effect on antiphonal laugh production. Laugh rates were not related to extraversion in the present study. The lack

of a relationship is not necessarily surprising, given the inconsistency of previous studies in demonstrating a laughter-extraversion link (see Ruch & Deckers, 1993, for a review). Likewise, extraversion did not predict antiphonal laugh production. As predicted, extraverts were rated more highly by their partners on the measure of friendship strength. However, the higher ratings for more extraverted participants was unrelated to laughter production on the part of extraverts, with extraversion and voiced laugh production both making independent contributions to greater friendship strength. Thus, it does not appear that extraverts are more likely than introverts to influence affiliation via laugh production. These findings are not necessarily in conflict with Ruch and colleagues (Ruch, 1994; Ruch & Deckers, 1993), who distinguished between laugh production that reflects a “social signal” versus an “emotional display.” Ruch has found that extraversion is linked to the production of laughter accompanied by a Duchenne smile, which he believes indicates a genuine positive state on the part of the laugher. It may be that displays of trait positivity (as indexed by extraversion, and perhaps, by laughter-Duchenne-smile production) and the induction of positive affect (as indexed by voiced laugh production) are both important yet relatively unrelated means of promoting affiliative relationships. Following much the same pattern as extraversion, participants who rated themselves as more emotionally expressive did not laugh more, nor did they produce more antiphonal laughter. Although emotional expressivity has been found to predict increased rates of facial expressions (Kring et al., 1994), it was not related to laugh production in our sample, nor was it related to friendship strength.

The lack of relationship between personality characteristics and laugh production highlights the potential error in conventional thinking that laughter reflects an internal

positive state or some other veridical attribute of the laugher. As highlighted by Ruch (1994), laughs that are accompanied by other indicators of positive emotional state (i.e., Duchenne smile) make up only a small proportion of laughter. Likewise, Provine (1993) found that the vast majority of laughter was not related to humorous statements by conversational partners, but rather appeared to serve a social function. When individuals rate their trait positivity or trait levels of emotional expression, they may be essentially only rating themselves for the small percentage of laughs that are direct reflections of internal positive states. This may not reflect their overall tendency to produce laughter regardless of emotional state; in fact, a person might consider himself emotionally unexpressive and low in extraversion if he tends to laugh in all situations regardless of emotional state (e.g., “nervous” laughter).

The present study represents an advance in the measurement and analysis of temporal patterns of laughter among social partners. Unlike previous studies, the laughs of each participant were labeled on audio tracks independent of the other dyad member. Thus, there was less potential for the laughter of one dyad member to influence raters' identification of laughter by the other dyad member. In addition, this study reflects the first time an antiphonal laugh latency was empirically determined. The examination of the distribution of potential antiphonal laughs revealed the largest density of subsequent laughs occurring within 2.8 s of initial laugh onset. It is notable that this time range is similar to the time course of psychophysiological reactions to affective auditory stimuli, including peak heart rate deceleration (Bradley and Lang, 2000) and peak pupil size enlargement (Partala & Surakka, 2003). If future studies duplicate this distribution range, the 2.8 s criterion provides an empirical standard for the definition of antiphonal

laughter. Finally, the use of sequential analysis techniques to index antiphonal laughter independent of total laugh production removes one of the greatest confounds in distinguishing the specific effects of the temporal patterning of laugh production from the total amount of laugh production.

In addition to its methodological strengths, there were several limitations to the current study. It would have been ideal to test acquaintances even earlier in the course of their relationships to capture their earliest use of laughter together. For example, future studies might test participants at Freshman Orientation and track dyads who do or do not go on to develop strong friendships. In addition, more time recorded in each session (with additional game items) might permit estimation of voiced-initiated versus unvoiced-initiated antiphonal laughter in each session, as opposed to concatenating the values across sessions. Another potential limitation is the nature of the game stimuli. The stimuli were specifically designed to promote a high rate of laugh production. Although a large number of laughs was ideal for the calculation of Yule's  $Q$ , the higher laugh frequency may have overshadowed more subtle yet measurable effects. Finally, additional information about the nature of the relationships would be useful. Although the present study did query about current or past romantic relationships, it did not ask participants about romantic attraction or desire to form a relationship, which might have differential effects on the use of antiphonal laughter.

Analysis of dyad-based data presented unique statistical challenges. In general, dyad-based studies in psychology have focused on within-dyad differences, such as differences between husbands and wives or parents and children, which can be analyzed using traditional paired t-tests or repeated measures ANOVA. In the present

study, however, the primary focus was on between-dyad differences. It is nonetheless reasonable to assume that members of a dyad share a certain degree of variance in their behavior, given the common testing conditions and the influence of one dyad member on the other. I accounted for this shared variance by allowing for covariance between dyad members in mixed models. However, this technique did not allow for separate specifications of within-subject and within-dyad variances for cross-session analyses, which might have improved the accuracy of cross-session results. The models of friendship strength and antiphonal laugh production also presented statistical challenges. No accommodation for shared within-dyad variance could be made, so these results should be interpreted with caution. Moreover, the sample size was lower than is recommended for path modeling. Kline (1998) recommends a participant-to-parameter ratio of 10:1, with a minimum of 5:1; the present study had a ratio of approximately 5:1. The finding that antiphonal laugh production influences later ratings of friendship strength should be therefore interpreted with particular caution.

Laughter continues to be a complex and intriguing aspect of human interactions. The current study provided more evidence for the link between laughter and affiliation, although the picture is not clear-cut. Further research will be necessary to determine the factors affecting laugh use in new friendships, as well as the broader questions of direct and indirect effects of laugh production on listener response systems. The current study does demonstrate that antiphonal laugh production is present early in friendship development, at least for certain kinds of initial laughs, and that the induction of laughter by an initial laugh influences a person's evaluation of a potential friend.

## Appendix A

Below are the instructions for each game played by participants:

### Session 1

*Warm-up item:* If you could be romantic with any cartoon character, who would it be and why?

*Game 1:* You are giving a poetry recital at a local coffeehouse. Practice by reading each other the poems on the cards marked “Haiku.” Alternate reading them until the timer runs out.

*Game 2:* Together, generate as many names for the inflated doll as you can. Use the timer for this item.

*Game 3:* Alternate drawing Pictionary cards. Read your card, but do not show it to your partner. Try to get your partner to guess what word or phrase is on the card by drawing it using the paper and crayons provided. See how many cards you can complete before the timer runs out.

### Session 2

*Warm-up item:* If you were having dinner at a professor’s house and found a cockroach in your salad, what would you do?

*Game 1:* Alternate drawing Pictionary cards. Read your card, but do not show it to your partner. Try to get your partner to guess what word or phrase is on the card by sculpting it using the Play-Doh provided. See how many cards you can complete before the timer runs out.

*Game 2:* You've been nominated as the casting directors of the next Star Wars movie.

Generate the worst possible cast you can. Decide who would do the worst job playing the following characters: Anakin Skywalker, Queen Amidala, C-3PO, Yoda, Obi-Wan Kenobi, Jar Jar Binks, and any other character you would like to cast. Use the timer for this item.

*Game 3:* Generate a list of the worst pick-up lines you can imagine. Use the timer for this item.

### Session 3

*Warm-up item:* If you had to eat the same Rand meal for the rest of your life, what would it be and why?

*Game 1:* Draw a picture of each other using the paper and crayons provided. Use the timer for this item.

*Game 2:* Working together, come up with an Ode to Burping. Use the timer for this item.

*Game 3:* You are each going home to meet your dates' parents. Show your study partner what you think he/she should wear, using the paper dolls provided. Use the timer for this item.

## APPENDIX B

### McGill Friendship Questionnaire–RA

# \_\_\_\_\_

The items on this form concern your feelings for your study partner. Imagine that the blank space in each item contains your study partner's name. With him or her in mind, decide how much you agree or disagree with the item. On the scale directly to the right of each item **circle the number** that indicates how much you agree that the statement describes your feelings. There are no right or wrong answers, because adults' feelings for friends differ from person to person. Just honestly describe your feelings for your study partner.

	Very Much Disagree	Some- what Disagree	0	Some- what Agree	Very Much Agree				
	-4	-3	-2	-1	0	1	2	3	4
1. I am happy with my friendship with ____.	-4	-3	-2	-1	0	1	2	3	4
2. I care about ____.	-4	-3	-2	-1	0	1	2	3	4
3. I like ____ a lot.	-4	-3	-2	-1	0	1	2	3	4
4. I feel my friendship with ____ is a great one.	-4	-3	-2	-1	0	1	2	3	4
5. I am satisfied with my friendship with ____.	-4	-3	-2	-1	0	1	2	3	4
6. I feel my friendship with ____ is good.	-4	-3	-2	-1	0	1	2	3	4
7. I want to stay friends with ____ for a long time.	-4	-3	-2	-1	0	1	2	3	4
8. I prefer ____ over most people I know.	-4	-3	-2	-1	0	1	2	3	4
9. I feel close to ____.	-4	-3	-2	-1	0	1	2	3	4
10. I think my friendship with ____ is strong.	-4	-3	-2	-1	0	1	2	3	4
11. I am pleased with my friendship with ____.	-4	-3	-2	-1	0	1	2	3	4
12. I am glad that ____ is my friend.	-4	-3	-2	-1	0	1	2	3	4
13. I hope ____ and I will stay friends.	-4	-3	-2	-1	0	1	2	3	4
14. I would miss ____ if he/she left.	-4	-3	-2	-1	0	1	2	3	4
15. I am content with my friendship with ____.	-4	-3	-2	-1	0	1	2	3	4
16. I enjoy having ____ as a friend.	-4	-3	-2	-1	0	1	2	3	4

Have you ever been romantically involved with your study partner?      Yes    No

Are you currently romantically involved with your study partner?      Yes    No

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